Attachment 5.04

HV distribution capacity model

January 2015

Contents

1 Introduction

Ausgrid has revised the HV Distribution Capacity component of the capex proposal for the 2015 – 19 regulatory control period. The revision was primarily driven by changes to the handling of low and negative zone average growth rates and to how the flexibility from repeal of schedule 1 of the licence conditions was accounted for. The revised methodology and the impacts on the final capex requirement are outlined below.

2 Low and negative zone average growth adjustment

One of the key inputs into the HV Distribution Capacity model is the rate of growth of the individual HV feeders. The previous versions of the model assumed that all feeders in a zone grew at the same underlying rate as the overall zone. Feeders in zones that had negative demand growth were shown to require no capacity investments. This was identified as erroneous as there are commonly pockets of growth within a zone even when the aggregate zone growth rate is negative. To correct this error, particularly for low and negative growth scenarios, an extra step was introduced to modify the input demand growth rates for each zone prior to the Distribution Network Development (DND) modelling.

To determine the adjustment required for the input growth rate, the actual loads over the period from summer 2011/12 to summer 2013/14 were compiled for every HV distribution feeder. The annual feeder demand growth and the annual aggregate growth rate of each zone were calculated and compared to produce a differential growth rate (feeder rate minus zone average). With rates outside the range of ±20% removed (as abnormals), the load weighted distribution of the differential was found to approximate a normal distribution (Figure 1).

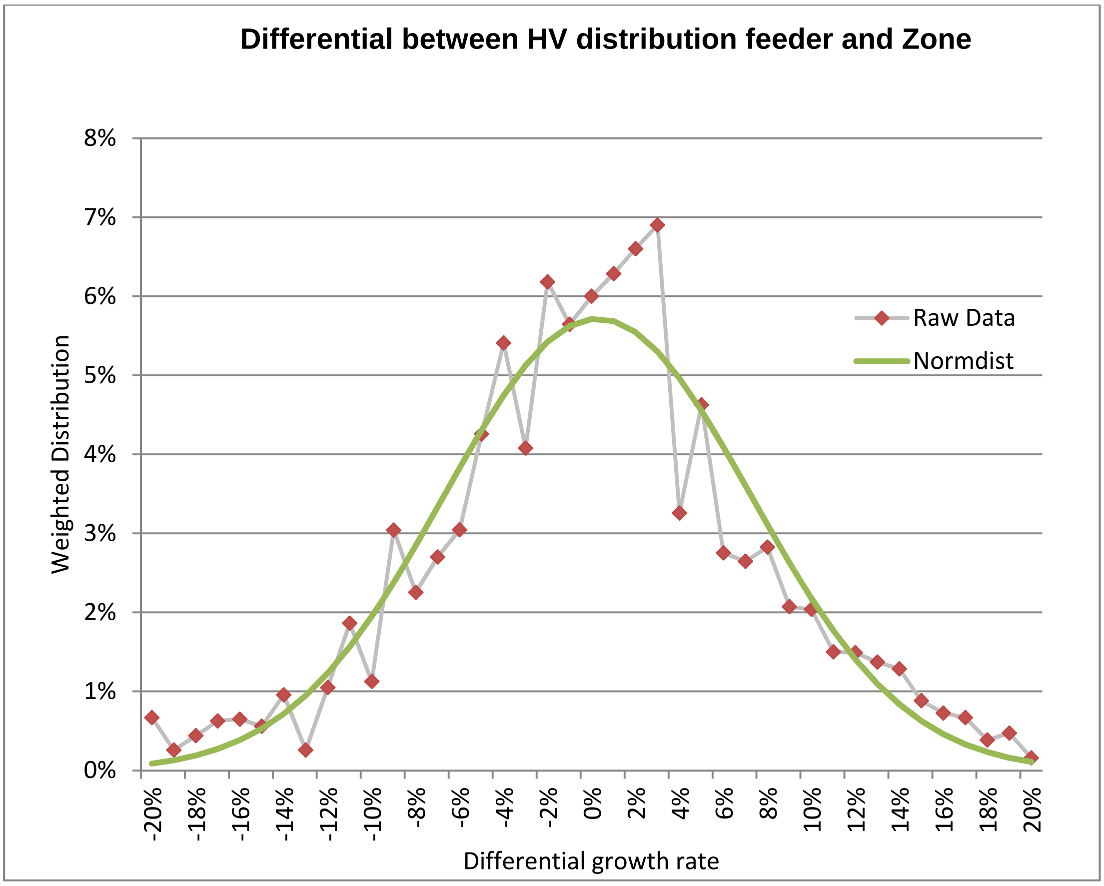

Figure 1 Differential between HV distribution feeder and Zone

Mapping the cumulative distribution of the differential growth rate against a cumulative normal distribution demonstrates an even better fit (r^2>0.99).

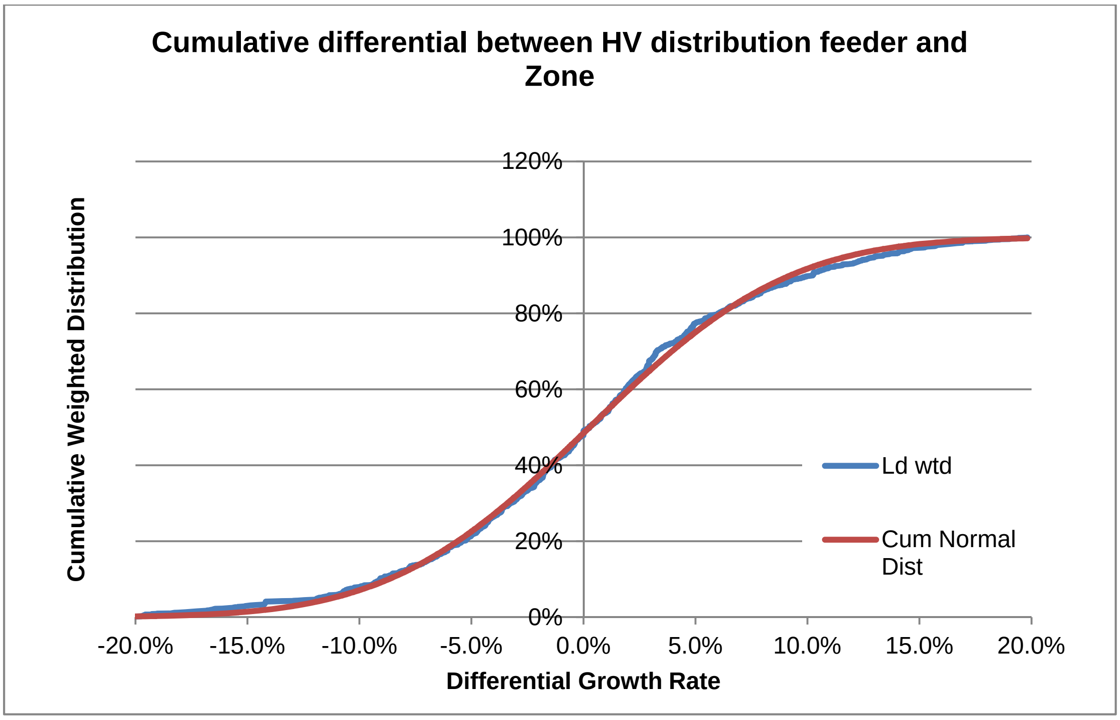

Figure 2 Graph of Cumulative differential between HV distribution feeder and Zone

The histogram curve fit is good (r^2>0.9) and the raw cumulative curve fit is very good (r^2>0.99) so the assumption of normal distribution is validated. Based on these r^2 values Ausgrid chose to use this model to determine a standard deviation of 7% based around a mean of zero to represent the probability distribution of the difference between individual feeder growth rates and zone average rates.

Once the distribution of the model was determined, it was applied to a range of zone average growth rates to determine the probability weighted distribution of growth rates for the feeders within the zone. We assumed that feeders with negative or zero growth rates would require no investment, and that investment at feeder level is on average linearly proportional to load weighted growth rate. We summed the effective investment requirement for the feeders in a zone with positive rates only and divided by the number of feeders to arrive at an effective average zone growth rate that would produce the corrected investment requirement in the DND model.

The output from this was mapped and an algorithm derived to describe the relationship between average zone growth rate and the effective growth rate that would deliver the corrected expenditure forecast from the DND model. The curve fitting exercise identified a fourth order polynomial with excellent fit to the data. This relationship is shown in the chart below (the red line).

There is a range of reasons why this pure model may not represent correctly the expenditure requirements. These include the opportunity for feeders to support one another, where a feeder with negative growth might very inexpensively deal with growth on an adjacent feeder. In addition, the DND model itself has been previously calibrated against actual investment requirements where average zone growth rates were centred around 2%. This validation would have included a partial accounting for the effect of the distribution of feeder growth compared to zone average.

We assumed the calibration at average growth of 2% was accurate, and adjusted the coefficients of the polynomial to ensure the relationship that at 2% average growth, the effective growth was also 2%. The result is shown below as the green line.

By pre-processing the input growth rates for each zone using this relationship, we were able to use the DND model to forecast the required expenditure to meet the deterministic planning standards as per our previous planning standard.

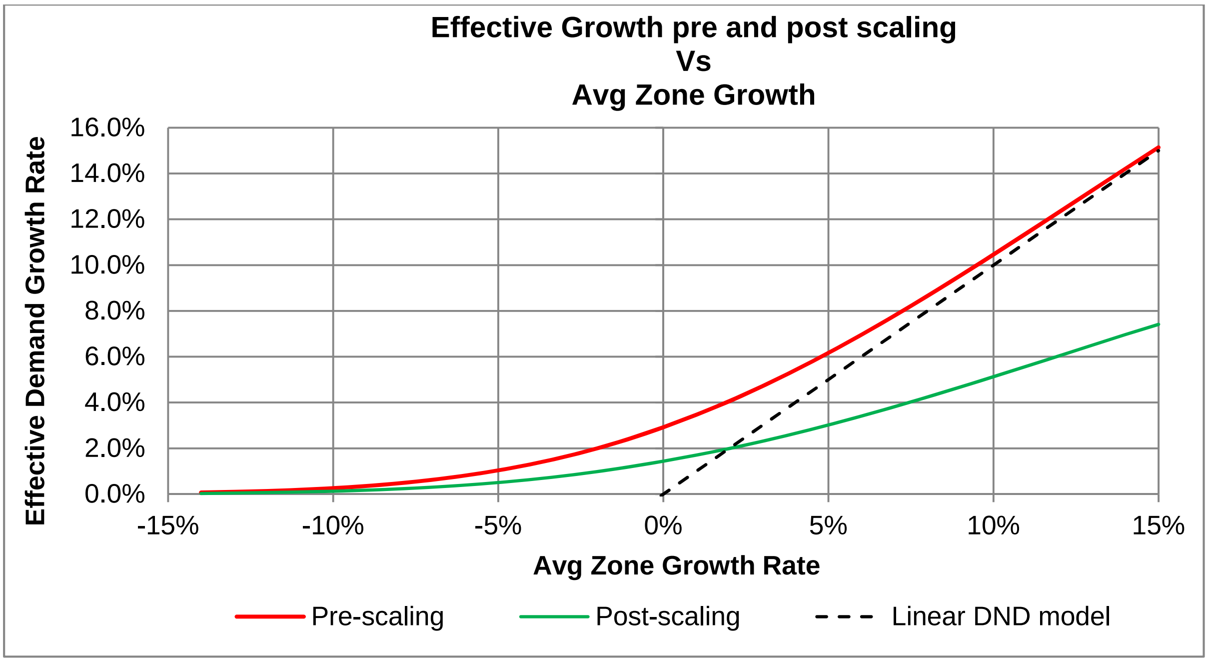

Figure 3 Effective growth pre and post scaling Vs Avg Zone Growth

3 Probabilistic planning adjustment

Since the removal of Schedule 1 of the Licence Conditions, Ausgrid has been developing new probabilistic methodologies for planning the network. While this methodology is being developed, a new interim planning standard has been implemented.

The interim planning standard requires that all distribution capacity investments have a $/kVA analysis performed to determine if the investment is likely to be cost beneficial. Higher cost per kVA of capacity shortfall would suggest those projects might not pass a cost benefit test and should be examined in more detail using more refined and detailed analysis. A sample of 27 recent HV distribution capacity projects from across Ausgrid's network was compiled to assess the distribution of the $/kVA index based on our historical investment program. Projects were specifically selected to only include those driven due to capacity constraints and not those from other programs. The analysis determined that an appropriate level for this review process was at $400 per kVA. This has been used as our interim planning approach for the very limited number of distribution capacity projects being considered.

3.1 $/kVA assessment using AEMO VCR report

Following release of the recent AEMO Value of Customer Reliability report, we undertook a further analysis to an equivalent $/kVA threshold for investment by assessing the value of lost load incurred after a fault on the HV Distribution network. This analysis took into account fault rate, repair time, VCR and lifetime benefits of investments.

The HV Distribution network is constructed with both overhead and underground sections. Failure rates and repair times depend on construction type and on the nature of the failure.

The failure rates were determined on a zone by zone basis and then applied to several case studies. The repair time was assumed to be 48 hours as that is a balance between the faster repair time for overhead and the longer repair time for underground.

A load profile for the sample cases was derived from historical 15 minute interval data. For each 15 minute interval, the likelihood of an interruption, the load unable to be supplied and the Expected Unserved Energy was assessed.

A VCR was then selected (see Appendix 1) and applied to the Expected Unserved Energy. This value was assumed to be lost each year and from this figure de-annualised cost over 25 years was determined. This indicated the prudent value of investment to offset the Expected Unserved Energy. The $/kVA value was derived by dividing the de-annualised value of Expected Unserved Energy by the maximum value of load not supplied. As a result, we determined that an appropriate point for cost effectiveness testing was $450/kVA. This value was also similar to the previous analysis and provided added confidence to the analysis.

3.2 Application to the DND model

We identified a sample of historical projects and mapped the project cost and $/kVA index for each. The projects with $/kVA values in excess of the $450/kVA threshold were assumed to be replaced by lower cost projects which would have a $/kVA index at the threshold level. This resulted in a 20.4% reduction in the overall investment required for the sample projects. We have assumed that that impact can be replicated, on average, across the DND model expenditure forecast.

On that basis, we added a post-processing step to the modelling approach to reduce the raw output of the DND model (based on the pre-processed input data) by 20.4%.

4 Impact of these adjustments on the DND model results

The DND model has been run under a range of scenarios to provide both the expenditure forecast for the revised proposal and to demonstrate the effect of the adjustments. The results are in Table 1 ($2013/14, including overheads).

Table 1 2013 and 2014 Demand Forecasts

	2013 Demand Forecast	2014 Demand Forecast
Original DND Model (no corrections)	$130 million	$25 million
With input Corrections only	$136 million	$93 million
Final Model (input and output corrections)	$108 million	$73 million

The 2014 demand forecast results from the application of the final model, which includes both pre-processing of input growth rates, and post-processing to deal with efficiencies from application of cost benefit analysis were used as the basis for deriving the expenditure forecast for HV distribution capacity in the revised regulatory proposal.

Note that the expenditure forecast for HV distribution capacity also includes allowances for work in progress, voltage and fault level driven projects, CBD capacity, and offsets for demand management impacts and major project synergies.

Appendix 1

Selection of VCR for use in Probabilistic Planning adjustment

The VCR used in the $/kVA was calculated as follows:

1. Obtain the "Peak weekday summer" VCR for a 0-1 hour outage for the following customer groups:

   - New South Wales Residential
   - Small agricultural
   - Medium agricultural
   - Large agricultural
   - Small commercial
   - Medium commercial
   - Large commercial
   - Small industrial
   - Medium industrial
   - Large industrial

The VCRs are sourced from AEMO's "Value of Customer Reliability Review, Final Report, September 2014" (Appendix B)

2. Calculate the 2012/13 actual energy consumption for each of the following customer groups by tariff code allocation:

   - Residential
   - Small business (<40 MWh pa)
   - Medium business (40 - 160 MWh pa)
   - Large business (> 160MWh pa)

3. Assuming 10% agricultural, 80% commercial and 10% industrial energy consumption within the business groups, calculate a re-weighted "Peak weekday summer" VCR by taking the results of steps 1 and 2.

The final business VCR number is 65.36 $/kWh.

Peak weekday summer VCRs were used as HV distribution capacity projects are intended to reduce the impact of failures at times of peak load. For all cases examined, the highest load days occurred during the working week. Examination of selected load profiles has also confirmed that the load at risk is typically for durations of less than one hour.