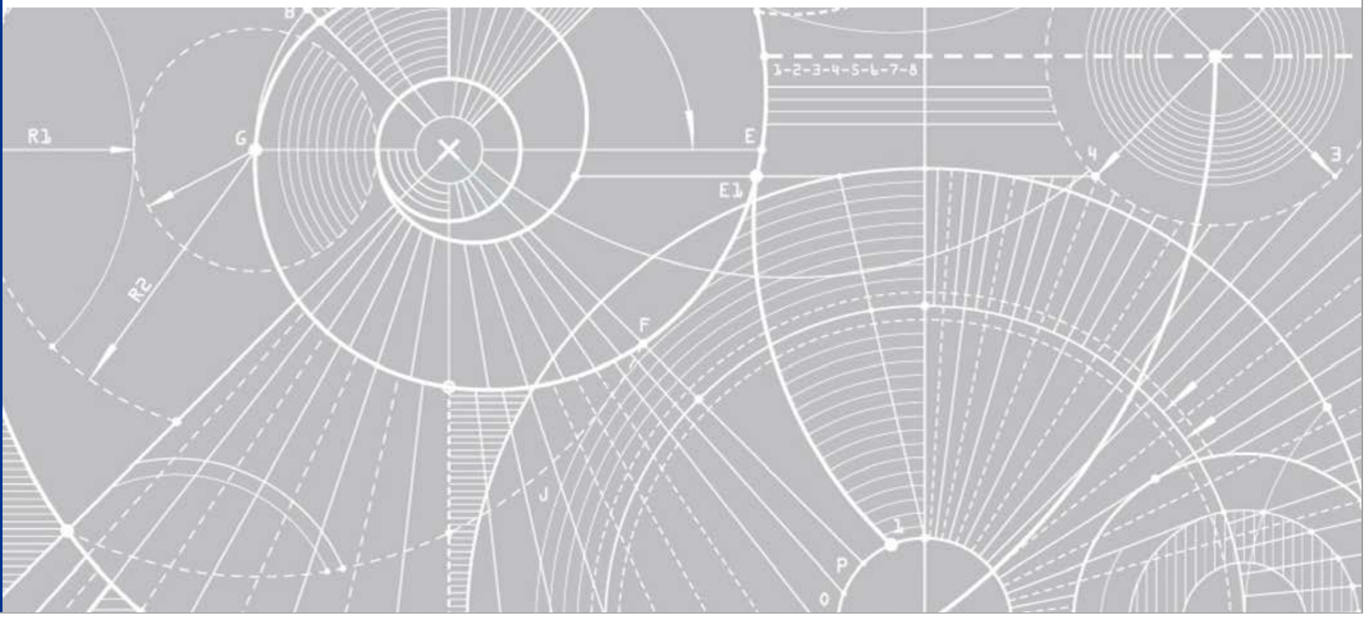
Asset Management Review - Phase 2

ACTEWAGL

Review of Demand Forecast Methodology

SH43539RP0001 | Final

06 May 2014



JACOBS SKM

Asset Management Review - Phase 2

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Document history and status

Revision	Date	Description	By	Review	Approved
Draft	10/02/2014	For client comment	C.Jones	J.Butler	18/02/2014
Final	06/05/2014	For client issue	C Jones	J Butler	06/05/2014

Contents

Executive summary

Jacobs® SKM has been engaged by ActewAGL to conduct a review of its demand forecasting methodology and results in order to support the demand forecast to be included in the Annual Planning Report (APR), due to be published in December 2013.

The outcome of the review will also be used to inform the preparation of ActewAGL's Transitional Regulatory Proposal (TRP) due in January 2014, and the full regulatory submission in May 2014.

This report summarises the results of Jacobs SKM's investigations, and proposes some steps to refine and enhance ActewAGL's demand forecasting techniques.

Jacobs SKM would make the following suggestions and recommendations to ActewAGL in regard to its load data collection, recording and forecasting techniques. We have confined these suggestions and recommendations to actions which we believe should be achievable within the timeframe available for the main 2015/2019 regulatory submission in May 2014, and some of them should be achievable for the TRP at the end of January 2014.

- Update the forecast model input data with the 2013 winter load data, ensuring that non-permanent load transfers are excluded
- Consider reviewing the 2013 summer load data to ensure that any non-permanent load transfers was excluded
- Change the selection of the three (3) peak demands in summer and winter from 1 per month, to the highest three demands, regardless of which month they occur
- Put in place a formal notification process from system control to asset management and planning detailing all permanent and temporary inter-zone load transfers (load transferred, date, time, expected duration, etc), commencing in December 2013
- Consider putting in place a similar notification process for intra-zone load transfers
- Cease the practice of collecting, and using in the forecast, peak 11 kV feeder loads outside of the specified three months for summer (December/January/February) and winter (June/July/August). The practice can be continued if all temporary intra-zone transfers are identified and eliminated, but currently tends to capture abnormal loads outside the normal peak load months, resulting in some of the 11 kV feeder forecasts being erratic
- Reduce 11 kV feeder forecasts from 10 years to three years, or at most five years
- Continue to update the PV (and DM) sections of the Zone Development Reports
- Continue to update demand forecasts with the latest information on planned block load increases from the Electrical Load Forecast database
- Reconcile ActewAGL zone substation historical and forecast maximum demands with BSP (ActewAGL component) actual and forecast maximum demands, including calculation of substation demand diversity factors and ActewAGL system maximum demand. Produce a consolidated table of historical and forecast information
- Consider producing a consolidated historical/forecast maximum demand table of zone and BSP's which has the impact of known and highly probable network augmentation projects included, ie, including future permanent load transfers as a result of new feeders, upgraded and new zone substations, etc.
- Ensure that the 2013 demand forecast is reconciled with the 2013 energy forecast (being prepared by Jacobs SKM), and ensure that there is a credible trend in the average annual system load factor
- In the longer term, and after review of the results obtained from any changes implemented, consider revisiting the "confidence interval approach" in the forecasting model

Subsequent to the load forecasting debriefing workshop held at ActewAGL's offices on 29 November 2013, ActewAGL have incorporated a number of the above recommendations into their 2013 Peak Demand Forecast document (version 1.1, dated 23 Dec. 2013).

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs SKM is to ActewAGL's demand forecasting methodology in accordance with the scope of services set out in the contract between Jacobs SKM and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs SKM has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs SKM has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs SKM derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs SKM has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs SKM for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs SKM's Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs SKM and the Client. Jacobs SKM accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party

1. Scope of assignment

The scope of Jacobs SKM's work under this assignment is contained in SKM's proposal (ref. SHP4286-2 dated 22 November 2013.

Jacobs SKM understands that the purpose of conducting the review of demand forecasts is to support the APR that is due to be published in December 2013, and also to inform the preparation of the regulatory submissions (interim submission due in January 2014, and the full submission in May 2014). The timing of these key documents, in particular the APR, necessitates the early completion of the review of ActewAGL's demand forecasting methodology.

Jacobs SKM proposed to review the demand forecasting methodology in overview, to provide a high level assessment of the methodology currently used by ActewAGL. Jacobs SKM proposed to conduct this high level overview by comparing ActewAGL's demand forecasting methodology with the conceptual load forecasting sub-process, and "best practice characteristics" shown in attached Appendix A.

Appendix A shows a process flow chart which was developed by SKM for the Australian Energy Market Commission (AEMC) during SKM's 2009 review of the planning and forecasting practices of all the Distribution Network Service Providers (DNSPs) in the NEM.

SKM also undertook to review the extent to which ActewAGL's demand forecasting processes align with the procedures outlined in the Acil Allen Consulting report to the Australian Energy Market Operator (AEMO), titled *"Connection Point Forecasting"*, dated 26 June, 2013.

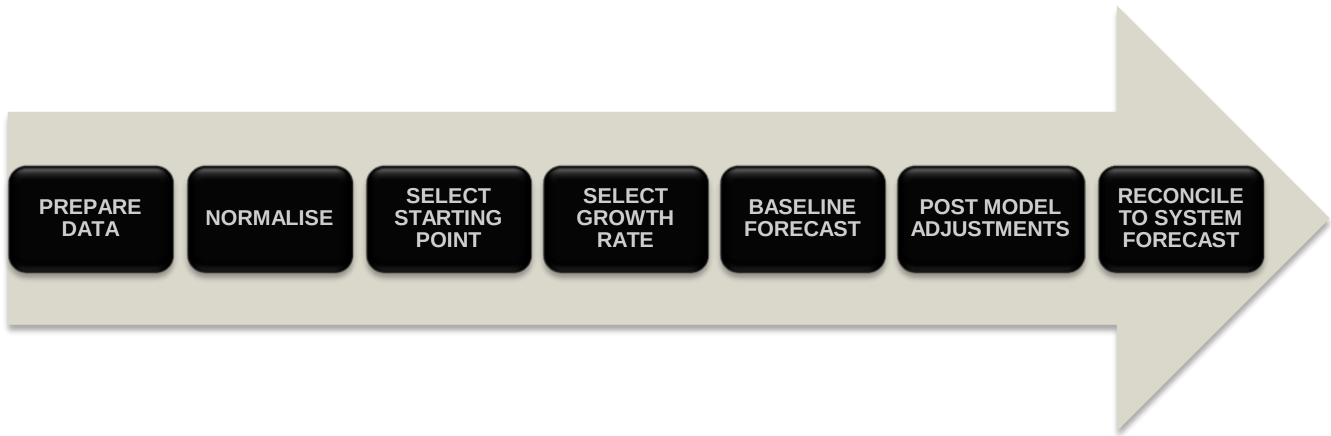
Based on this review, Jacobs SKM undertook to provide a report on the strengths and weaknesses of the ActewAGL forecasting methodology, and opportunities for improvement.

2. Other relevant documents reviewed

In June 2013, AEMO published the Acil Allen Consulting report titled *"Connection Point Forecasting – A national methodology for forecasting maximum electricity demand"*. The purpose of the report was to provide Network Service Providers with a framework methodology for producing forecasts of weather normalised maximum demand, typically at 10%, 50% or 90% probability of exceedence (PoE) levels.

An overview of the demand forecasting methodology recommended by Acil Allen Consulting is shown in the figure below.

Figure 1 : Overview of connection point maximum demand forecasting process



Source: Acil Allen Consulting, June 2013, *"Connection Point Forecasting: A Nationally Consistent Methodology for Forecasting Maximum Electricity Demand"*, Australian Energy Market Operator, p 2.

The AEMO report provides detailed discussions on the following aspects of the proposed forecasting methodology:

- The broad principles of best practice forecasting
- Data collection and management
- The recommended method of weather normalisation (alternative methods are also covered in an Appendix)
- Starting points and growth rates
- Post modelling adjustments
- The process for reconciling the baseline forecasts to an independently prepared system forecast.

The AEMO report is specifically about transmission connection point (CP) demand forecasting, and encompasses the principles of forecasting at the zone substation level, but it does not cover the data collection, analysis, and manipulation required at the distribution level (typically 11 kV and 22 kV) to produce credible and robust zone substation forecasts.

Jacobs SKM understands that ActewAGL management and staff are familiar with the AEMO report, and had the opportunity to review and comment on it at the time of publication.

2.1 SKM report to AEMC

In May 2009, the AEMC published the SKM report titled *"Advice on Development of a National Framework for Electricity Distribution Network Planning and Expansion"*. The purpose of this report was to provide background information on the various jurisdictional requirements, and planning processes undertaken by the thirteen (13) DNSPs operating in the NEM at the time.

One of the key subject matters covered in the report was “Maximum Demand (MD) Forecasting Methodologies”, and in the report SKM provided an analysis of the similarities and differences of the demand forecasting processes and techniques used by the DNSPs at that time.

As part of the review of DNSP demand forecasting processes SKM produced a flow chart of a “Conceptual Load Forecasting Sub-process”, being an element of the broader system planning, development, and augmentation process. This flow chart was intended to demonstrate the optimum design of process steps and activities that a DNSP would follow if it adopted “best practice characteristics” in demand forecasting.

Attached Appendix A demonstrates the conceptual load forecasting process, and Jacobs SKM has used this flowchart against which to test and compare ActewAGL’s current demand forecasting methodology.

2.2 ActewAGL load forecasting documents

During the course of this assignment, Jacobs SKM has reviewed a number of documents from ActewAGL on the subject of demand forecasting, and these are listed below:

- Historical and forecast demand data.xlsx – (December 2003 – February 2012 actuals)
- Belconnen zone development report.docx – v1.0, dated 12 December 2012
- Peak Demand Modelling Documentation – two pages, undated
- Demand forecast ActewAGL.docx – Updated forecast methodology, nine pages, undated
- Updated Latham zone forecast.xlsx – Summer, 2004-2013 actuals
- Electrical transmission system and zone substations map, A1 90-022
- ActewAGL Peak Demand Forecast 2013 – version 1.1, Effective date: 23 December 2013
- Acil Allen Consulting Report to AEMO – Connection Point Forecasting , Dated 26 June 2013

3. Jacobs SKM approach to the assignment

3.1 Review of existing ActewAGL forecasting methodology

Jacobs SKM reviewed the overall structure and methodology of the existing forecasting model in conjunction with the ActewAGL analyst who developed the model. This section presents a summary of the forecasting model, and the steps taken in producing a zone forecast. Note that this review was undertaken in November and early December 2013, prior to the development of the 2013 Peak Demand Forecast Report, and was based on the structure and methodology used at that time. ActewAGL has since adopted several of Jacobs SKM's initial recommendations, and incorporated these into the current forecasting methodology, which led to the demand forecast contained in the 2013 Peak Demand Forecast Report.

The nature of the review was to focus on the input data and assumptions, the nature of the correlation analysis, the temperature correction approach, and the resulting forecast for one sample zone substation (Belconnen).

We did not attempt to audit or validate the various formulae and algorithms internal to the model itself.

3.2 Description of ActewAGL forecasting model software

The software product that ActewAGL uses to generate its demand forecasting on is known as “R”, and is a free open-source software environment for statistical computing and graphics. R was developed at Bell Laboratories (formerly AT&T, now Lucent Technologies). More information on it can be found at http://www.r-project.org.

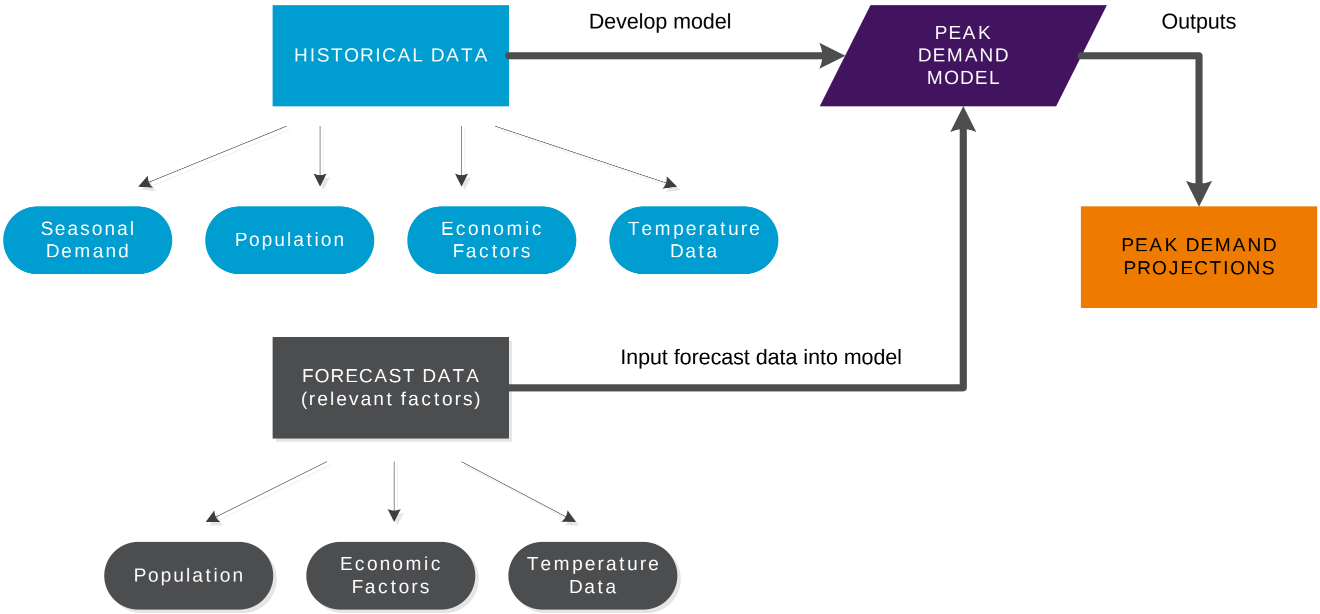
R provides a wide variety of statistical (linear and nonlinear modelling, classical statistical tests, time-series analysis, classification, clustering, etc) and graphical techniques. R is an integrated suite of software facilities for data manipulation, calculation and graphical display. It includes:

- An effective data handling and storage facility
- A suite of operators for calculations on arrays, in particular matrices
- A large, coherent, integrated collection of intermediate tools for data analysis
- Graphical facilities for data analysis and display either on-screen or on hardcopy
- A well-developed, simple and effective programming language which includes conditionals, loops, user-defined recursive functions and input and output facilities

The specific model chosen for the zone demand forecasts was one based on linear regression. Time series analysis modelling was also trialled, but was discarded because of its tendency to excessively weight the value of more recent data sets, compared to older data sets. The net result of this tendency was to exaggerate any short term upwards and downwards trends.

The following figure depicts the demand forecasting process using the model, and the following commentary outlines the step by step process followed in loading the input data, undertaking the regression analysis, identifying correlation of independent variables, and producing the 10% and 50% PoE demand forecasts.

Figure 2 : Overview of ActewAGL Demand Forecasting Model



3.2.1 Step 1: Collect historical data

This involves collecting historical data for the dependent variable (peak demand) and potential explanatory variables such as population, economic factors (eg, gross state product), and temperature factors (eg, maximum temperatures, minimum temperatures, cooling degree days etc).

3.2.2 Step 2: Develop model

For the dependent variable of demand, three peak points from each annual summer/winter was selected. Separate regression models were then fitted for each of the winter and summer seasons. These were then compared using various statistical criteria (eg, Adjusted R-squared, Pressp, Cp values). The best models – using the aforementioned criteria and stepwise regression were then selected as the final models.

3.2.3 Step 3: Input forecast data into the model

In order to forecast future peak demand, forecasts for the explanatory variables were required to be input into the model. This involved developing independent forecasts for population and temperature.

3.2.4 Step 4: Project future peak demand

After the forecast data has been input into the model, future peak demand can then be forecasted. 10% PoE and 50% PoE forecasts were developed by creating prediction intervals. Note that the way this is done currently is a little unorthodox, and requires some investigation. Basically, in the current method, the 50% PoE, is based on the upper bound of a 67% confidence interval. The intuition behind this is a 50% PoE, only has one point in two years higher than the regression line. In the Jacobs SKM model, we have three peak points a year. Hence, the upper bound of a 67% confidence interval (i.e. 83.3%) will mean that only one point out of 6 points will be higher than the regression, which is assumed to be quite similar to one point in two years. The 10% PoE forecast is derived similarly.

3.2.5 Step 5: Add effects of block loads

To generate the final forecast, the effects of block customer loads are added to the forecasts from Step 4. Note that because the effect of historical block customer loads has not been removed from the trend when developing the model, we only add the effect of block loads that are above the trend are added to the forecast. Consider the scenarios below:

Growth Rate: 5 MVA, Block Load of 3 MVA

In this scenario, the block load is considered to be within the trend, and is not added on top of the trend.

Growth Rate: 5 MVA, Block Load of 7 MVA

In this scenario, 2 MVA is added on top of the trend.

3.3 Key features of the previous ActewAGL forecasting model

Some of the key features and characteristics of the ActewAGL model are:

- The model uses about nine years of historical demand data, and about 20-30 years of historical temperature data
- The input demand data used in the model has been the highest monthly demand reading in each of the three normal Summer months (November/December/Janunary), and each of the three normal winter months (June/July/August)
- ActewAGL were unable to extract past spot load increases from the historical demand trends. In adding future spot loads, ActewAGL only adds the increment that the spot load is above the forecast from the historical trend
- Initially, ActewAGL modelled a wide range of independent variables, including GDP growth, population, temperature variables, and others. Ultimately ActewAGL found that there were no strong correlations, except to one or more of the selected temperature variables
- The final suite of correlation variables may differ from zone substation to zone substation, depending on the strength of the correlation with each variable
- The ActewAGL modelling software internally correlates demand and temperature input variables, and produces a weather corrected demand forecast, but it does not explicitly weather correct the historical demand input data. This is somewhat different to other modelling techniques in which the historical demand data is weather corrected before input into the forecasting model
- In the existing load forecasting model, the 10% and 50% forecasts are developed by creating prediction intervals. This means that the 50% PoE (one data point in two years above/below the forecast) is derived from the upper bound of a 67% confidence interval. The upper bound of a 67% confidence interval will result in one data point out of six data points being above the forecast. It is unclear if the confidence interval approach gives the same result as the probability approach to a PoE forecast
- The model uses several different temperature variables as shown in the table below:

Variable	Definition
Year	Year
MaxTemp	The daily maximum temperature
CDD	The daily cooling degree days, defined as Max (0, Average daily temperature - CDD Threshold)
3DayCDD	The sum of the no. of cooling degree days in the previous three days
MinTemp	The daily minimum temperature
HDD	The daily heating degree days, defined as Max (0, HDD Threshold – Average daily temperature)
3DayHDD	The sum of the no. of heating degree days in the previous three days

- The internal software algorithms can identify certain demand data inputs that are classified as “outliers”, due to their variability from the general data set. This happened to some of the summer 2012 demand data, which was excluded from the forecast because it was deemed too low.

3.4 Jacobs SKM’s initial findings and observations

Jacobs SKM’s initial findings and observations were presented at a de-briefing workshop on 29 November 2013, and the notes from that workshop are attached at Appendix B. The key proposals made are summarised below:

- Update the forecast model input data with the 2013 winter load data, ensuring that non-permanent load transfers are excluded
- Consider reviewing the 2013 summer load data to ensure that any non-permanent load transfers was excluded
- Change the selection of the three (3) peak demands in summer and winter from one per month, to the highest three demands, regardless of which month they occur
- Put in place a formal notification process from system control to asset management and planning detailing all permanent and temporary inter-zone load transfers (load transferred, date, time, expected duration, etc), commencing in December 2013
- Consider putting in place a similar notification process for intra-zone load transfers
- Cease the practice of collecting, and using in the forecast, peak 11 kV feeder loads outside of the specified three months for summer (December/January/February) and winter (June/July/August). The practice can be continued if all temporary intra-zone transfers are identified and eliminated, but currently tends to capture abnormal loads outside the normal peak load months, resulting in some of the 11 kV feeder forecasts being erratic
- Reduce 11 kV feeder forecasts from 10 years to three years, or at most five years
- Continue to update the PV (and DM) sections of the Zone Development Reports
- Continue to update demand forecasts with the latest information on planned block load increases from the Electrical Load Forecast Database
- Reconcile ActewAGL zone substation historical and forecast maximum demands with BSP (ActewAGL component) actual and forecast maximum demands, including calculation of substation demand diversity factors and ActewAGL system maximum demand. Produce a consolidated table of historical and forecast information
- Consider producing a consolidated historical/forecast maximum demand table of zone and BSP’s which has the impact of known and highly probable network augmentation projects included, ie, including future permanent load transfers as a result of new feeders, upgraded and new zone substations, etc.
- Ensure that the 2013 demand forecast is reconciled with the 2013 energy forecast (being prepared by Jacobs SKM), and ensure that there is a credible trend in the average annual system load factor
- In the longer term, and after review of the results obtained from any changes implemented, consider revisiting the “confidence interval approach” in the forecasting model

4. Review of ActewAGL Peak Demand Forecast 2013

Jacobs SKM has received and reviewed the latest demand forecast, as contained in the report ActewAGL *"Peak Demand Forecast 2013 – version 1.1"*, with an effective date of 23 Dec 2013, and we would provide the following comments:

1) As an overall observation, Jacobs SKM find the report presents a credible set of zone substation forecasts, supported by an appropriate level of reconciliation with the overall system demand forecast, and the overall ActewAGL energy forecast.

2) Also, and again as an overall observation, the report has a strong analytical and statistical "flavour" to it, and there are several sections which would benefit by having additional explanation about the implications of past and future trends. (eg, declining average annual load factor implies declining revenue during a period of increased capex requirement). More general commentary about the growth of the supply area, characteristics of developments, control of urban growth, etc, would be useful.

3) Jacobs SKM has reviewed the year on year winter and summer forecasts contained in section 8 of the report, and consider the 10% PoE and 50%PoE shown graphically therein to be robust and credible.

4) Section 3.1 states that *"…known upcoming new customer block loads were also added into the zone forecasts."* This statement could mislead the casual reader. It is clarified later in the report, and other documentation that only that portion of block load increases in excess of normal annual trend increase, is "added into the zone forecasts". For future reference Jacobs SKM suggests that this clarification is always included.

5) The table and graph of system annual average load factor shown on page seven shows results in the range approximately 0.0004 and 0.0006. The more conventional way of showing this calculation (using Kwhr, instead of Mwhr) gives results in the range of 40% to 60%. Jacobs SKM understands that this has already been identified by ActewAGL.

6) The commentary in the report appears to suggest that the three highest days of maximum demand are used in the modelling, rather the highest maximum demand day in each of three months, as suggested by Jacobs SKM. Is this the case?

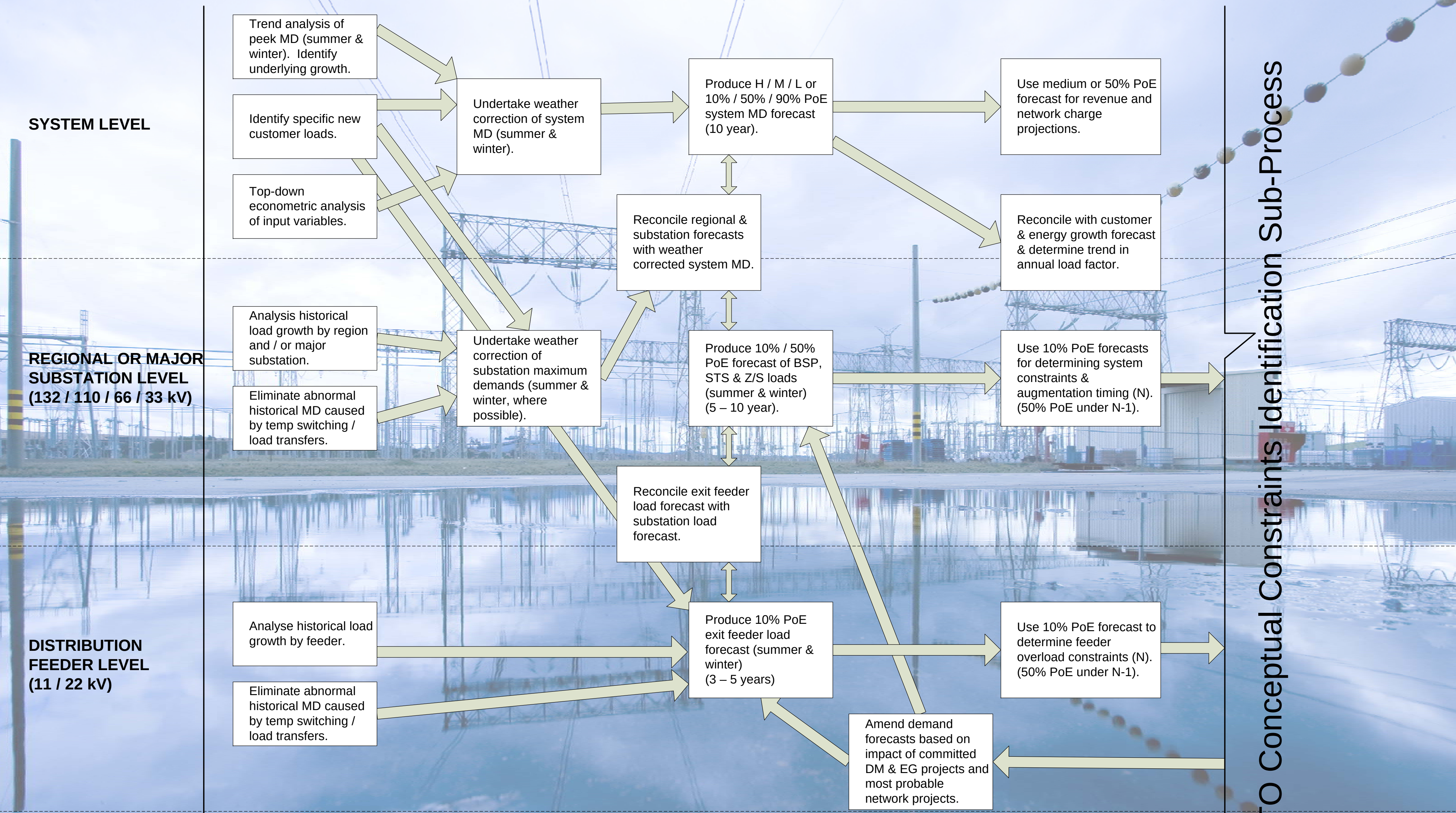
7) It is unusual to find a demand forecast in which so many cases of a flat growth profile occur. In the 2013 demand forecast report it occurs for System Winter, Belconnen (S&W), Civic (S&W), Latham (W), Theodore(W) and Woden(S). Is it a reasonable reflection of future reality for these cases, or is it a characteristic of the forecasting methodology?

8) The range of loss factors (7-10%) mentioned in section 9.3.1 appears to be on the high side, particularly if they represent only transmission and sub-transmission losses.

The above comments are not intended to be a comprehensive review of the 2013 Peak Demand Forecast, as this was not included in the scope of the assignment. The comments are provided only to provide consideration and assistance for the future development of the report.

Appendix A. Conceptual load forecasting sub-process

APPENDIX A – Conceptual Load Forecasting Sub-Process



BEST PRACTICE CHARACTERISTICS

System Level
- Top down & bottom up forecasts
- Combine historical trend forecast with econometric modelling
- Eliminate spot loads from underlying trends
- Separate summer & winter forecasts
- External consultants to produce / review forecasts
- Produce 10% / 50% / 90% PoE system demand forecast
- Weather correct demand forecast
- Reconcile system MD forecast with BSP forecast
- Reconcile demand forecast with energy & customer forecast

Major Substation Level
- Trend analysis forecast
- Eliminate abnormal loads & load transfers
- Separate spot loads from underlying trends
- Weather correct substation loads
- Reconcile substation MD's with system MD
- Produce 10% & 50% PoE forecast

Distribution Feeder Level
- Trend Analysis Forecast, Eliminate abnormal loads and load transfers
- Separate spot loads from underlying trends, Reconcile feeder loads with substation MD
- Produce annual 3-5yr forecast
- Conduct annual assessment of load vs thermal rating and voltage drop.

Appendix B. Debriefing workshop notes – Friday 29 November 2013

ActewAGL - Demand Forecasting Review

Debriefing Session – Friday 29 November, 2013

1) **Key Points to Note: -** Key points are divided into two categories, "Things that ActewAGL do", and "Things that ActewAGL don't do, but should do".

2) **Refer first to Appendix C** – Conceptual Load Forecasting Sub-Process:

- Developed in 2009 from the analysis of all DNSPs load forecasting practices in the National Electricity Market (NEM).
- All DNSPs follow slightly different processes, and no DNSP follows all of the steps in the process – this represents an idealised process in a perfect world.
- The process steps have been colour coded to show where ActewAGL currently sits:
  - Green – ActewAGL does undertake this step in the process reasonably fully.
  - Yellow – ActewAGL either partially undertakes this step, or undertakes it in such a way as to deliver a sub-optimal result.
  - Red – ActewAGL does not undertake this step in the process

3) "Things that ActewAGL Do":

- Collect and analyse historical demand data – **yes**, back to 2004. Currently 9 full years of history.
- Eliminate abnormal demand points caused by temporary load transfers – **yes, but not done effectively**. Very important for inter-zone transfers, not so important for intra-zone.
- Weather correction of Summer and Winter zone MD's – **yes**, using several possible weather parameters. Good correlation analysis. Weather correction is merged with correlation of other independent variables (e.g. year of forecast, population, GSP growth)
- Produce 10% PoE exit feeder (11kV) forecast (Summer & Winter) with abnormal MD's caused by temporary switching/ load transfers removed – **yes**, **but most feeder forecasts are erratic, due probably to historical load transfers.**
- Amend demand forecasts based on impact of PV, DM, and most probable network projects **- yes for PV, unknown for DM, and unknown for network projects.**

4) "Things that ActewAGL don't do":

- Reconcile zone S/S MD's with BSP MD's and System MD (calculate Summer and Winter diversity factors) – **not done?**
- Produce H/M/L or 10%/50%/90% PoE System MD forecast – **not done?**
- Produce medium or 50% PoE forecast for revenue and network charge projections – **yes?** Someone must do it for MAR calculations? Likely to be "disconnected" from the MD forecast, unless the two are reconciled.
- Reconcile MD forecast with energy growth forecast, and determine trend in annual load factor **– not done?**
- Produce 10%/50% PoE forecasts of BSP and zone S/S loads (Summer and Winter, weather corrected, and reconciled to each other) **– not done?**
- Reconcile exit feeder (11kV) load forecast with zone substation forecast. Calculate diversity factors and apply to forecast – **not done?**

5) **Some initial findings / observations:**

The following list of initial findings and observations are based on the first few days of discussions, review of the “R” demand forecasting program, and review of the Belconnen Zone Development Report dated 11 December, 2012.

- A shortcoming of the existing zone substation demand forecast process is that historical loads are not reconciled against actual BSP loads to determine diversity factors, and these diversity factors used to reconcile the zone forecast against the BSP forecast going forward. Under such circumstances it is often found that the zone forecast may appear inflated when compared with the BSP and system forecast.
- While it is understood that there are very few inter-zone load transfers that could distort the normal historical loads on zone substations, such transfers have the potential to inflate future demand forecasts and should be pro-actively monitored on a monthly basis.
- It is Jacobs SKM’s experience that the normal margin between a 10% PoE forecast and a 50% PoE forecast is approximately 7% in summer (the 10% PoE forecast being higher). This is consistent with the outcome for Belconnen, where the margin is between 5.3% and 7.5% (subject to rounding) – refer P5.
- As would be expected, the margin between the two forecasts in Winter is lower, being between 2.7% and 3.3% (subject to rounding) – refer P6.
- The margin between the 10% PoE and 50% PoE forecast should be reasonably constant over time, which it is for the Belconnen zone forecasts, but not for the 11kV feeder forecasts
- Historical zone demand figures include both underlying generic growth and spot load demands. This tends to sustain a high forecast.
- Only known future block loads that are above the trend forecast annual growth rate are added on top of the trend, mainly in 2014/15. This tends to sustain a high forecast, but not excessively.
- For reasons unknown, the differential between the top 3 annual Summer MD’s are diverging as time goes on. This may be random, or it may reflect temperature differences between the 3 months in any one year. It is not evident in winter, and it’s implication for the accuracy of the forecast is tempered by other factors (e.g. application of the confidence interval approach discussed below).
- In the existing load forecasting model, the 10% and 50% forecasts are developed by creating prediction intervals. This means that the 50% PoE (1 data point in 2 years above/below the forecast) is derived from the upper bound of a 67% confidence interval. The upper bound of a 67% confidence interval will result in 1 data point out of 6 data points being above the forecast. It is unclear if the confidence interval approach gives the same result as the probability approach to a PoE forecast.
- The 15-16MVA demand reduction (approx. 22%) between the Summers of 2011 and 2012 are attributed to mild Summer conditions in 2012, however it is Jacobs SKM’s experience that even the most extreme variations in peak Summer conditions will not normally result in such material fluctuations in demand.
- The algorithms in the load forecasting programme identified the peak demand on Belconnen in 2012 as an outlier, and excluded it from the forecast. This is a problem, and will tend to sustain a high forecast until the results for 2013 are entered in which case the 2012 demand **may** come back to within acceptable limits.
- As an overall observation, Jacobs SKM is of the view that the combination of a number of the above factors is contributing to forecasts of future MD’s being overstated, and because there is no reconciliation with BSP and system maximum demands (both historical and forecast) the extent of overstatement cannot currently be estimated.
- Based on the non-coincident summer zone maximum demands shown in the load forecasting model, the total system load dropped by 17.8% from summer of 2011 (February peak) to summer of 2012, and recovered by 8.8% in summer of 2013 (January peak).

- Individual zone substations experienced demand reductions between 2011 and 2012 of between -8.9% (Woden), and -25.7% (Belconnen). It is unclear as to whether inter-zone load transfers have all been removed from the recorded loads in this period.
- Individual zone substations have shown recovery of demand growth between 2012 and 2013 of between +1.7% (Woden) and +33.4% (Gold Creek).
- The 2013 summer load on Civic zone substation is shown as 34.54 MVA, down from 52.52 MVA in 2012 and 65.33 MVA in 2011, indicating that there have been significant load transfers off the substation, due no doubt to the reconstruction works going on there.

6) Initial Jacobs SKM suggestions/recommendations

Based on our limited investigations and findings to date, Jacobs SKM would make the following suggestions and recommendations to ActewAGL in regard to its load data collection, recording and forecasting techniques. We have confined these suggestions and recommendations to actions which we believe should be achievable within the timeframe available for the main 2015/2019 regulatory submission in May, 2014, and some of them should be achievable for the Transitional Regulatory Proposal (TRP) at the end of January.

- Update the forecast model input data with the 2013 winter load data, ensuring that non-permanent load transfers are excluded.
- Consider reviewing the 2013 summer load data to ensure that any non-permanent load transfers was excluded.
- Change the selection of the three (3) peak demands in summer and winter from 1 per month, to the highest 3 demands, regardless of which month they occur in.
- Put in place a formal notification process from System Control to Asset Management and Planning detailing all permanent and temporary inter-zone load transfers (load transferred, date, time, expected duration, etc,) commencing in December 2013.
- Consider putting in place a similar notification process for intra-zone load transfers.
- Cease the practice of collecting, and using in the forecast, peak 11kV feeder loads outside of the specified 3 months for summer (Dec/Jan/Feb) and winter (June/July/Aug.). The practice can be continued if all temporary intra-zone transfers are identified and eliminated, but currently tends to capture abnormal loads outside the normal peak load months, resulting in some of the 11kV feeder forecasts being erratic.
- Reduce 11kV feeder forecasts from 10 years to 3 years, or at most 5 years.
- Continue to update the PV (and DM) sections of the Zone Development Reports
- Continue to update demand forecasts with the latest information on planned block load increases from the Electrical Load Forecast Database.
- Reconcile ActewAGL zone substation historical and forecast maximum demands with BSP (ActewAGL component) actual and forecast maximum demands, including calculation of substation demand diversity factors and ActewAGL system maximum demand. Produce a consolidated table of historical and forecast information.
- Consider producing a consolidated historical / forecast maximum demand table of zone and BSP's which has the impact of known and highly probable network augmentation projects included. i.e. including future permanent load transfers as a result of new feeders, upgraded and new zone substations, etc.
- Ensure that the 2013 demand forecast is reconciled with the 2013 energy forecast (being prepared by Jacobs SKM), and ensure that there is a credible trend in the average annual system load factor.
- In the longer term, and after review of the results obtained from any changes implemented, consider revisiting the "confidence interval approach" in the forecasting model.