2018-22
POWERLINK QUEENSLAND REVENUE PROPOSAL

APPENDIX 5.06

Powerlink Queensland
Transmission Annual Planning Report 2015
Appendix B

Delivering better value

Appendix B – Powerlink's forecasting methodology

A discussion of Powerlink's forecasting methodology is presented below. Powerlink is publishing its forecasting model with the 2015 Transmission Annual Planning Report (TAPR) which should be reviewed in conjunction with this description.

Powerlink's forecasting methodology for energy, summer maximum demand and winter maximum demand comprises the following three steps:

1. Transmission customer forecasts

Customers other than Energex and Ergon Energy that connect directly to Powerlink's transmission network are assessed based on their forecast, recent history and direct consultation. Only committed load is included in the medium economic outlook forecast while some speculative load is included in the high economic outlook forecast.

2. Econometric regressions

Forecasts are developed for Energex and Ergon Energy based on relationships between past usage patterns and economic variables where reliable forecasts for these variables exist.

3. New technologies

The impact of new technologies such as solar photovoltaic (PV), battery storage, electric vehicles, energy efficiency improvements, smart meters are factored into the forecast for Energex and Ergon Energy.

The discussion below provides further insight to steps 2 and 3, where Distribution Network Service Provider (DNSP) forecasts are developed.

Econometric regressions

DNSP forecasts are prepared for summer maximum demand, winter maximum demand and energy.

To prepare these forecasts, regression analysis is carried out using native demand and energy plus solar PV as this represents the total underlying Queensland DNSP load. This approach is necessary as the regression process needs to describe all electrical demand in Queensland, irrespective of the type or location of generation that supplies it.

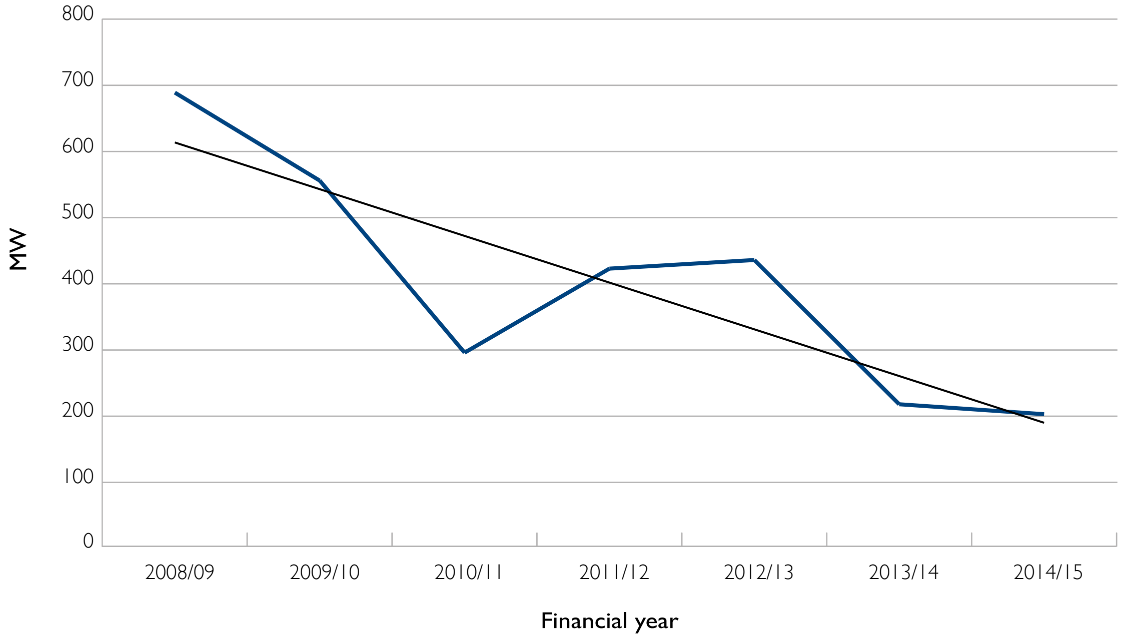
The first step in the regression analysis is to assemble historical native energy and maximum demand values as follows:

a) Energy. Determine DNSP native energy for each year going back to 2000/01. As this work is done in March, an estimation is prepared for the current financial year which will be updated with actuals 12 months later when preparing the next TAPR.

b) Winter maximum demand. The DNSP native demand at the time of winter state peak is collated back to winter 2000. These demands are then corrected to average weather conditions. Powerlink has enhanced its method for weather correction as described later in this appendix.

c) Summer maximum demand. The DNSP native demand at the time of summer state peak is collated back to summer 2000/01. These demands are then corrected to average weather conditions. DNSP native demand at the time of summer state evening peak (after 6pm) is also collated back to summer 2000/01. These demands are also corrected to average weather conditions. This evening series is now used as the basis for regressing as evidence supports Queensland moving to a summer evening peak network due to the increasing impact of solar PV. This move to an evening peak by 2017/18, is supported through an analysis of day and evening trends for corrected maximum demand as illustrated in Figure B.1.

Figure B.1 Difference in summer day and summer evening corrected maximum demand



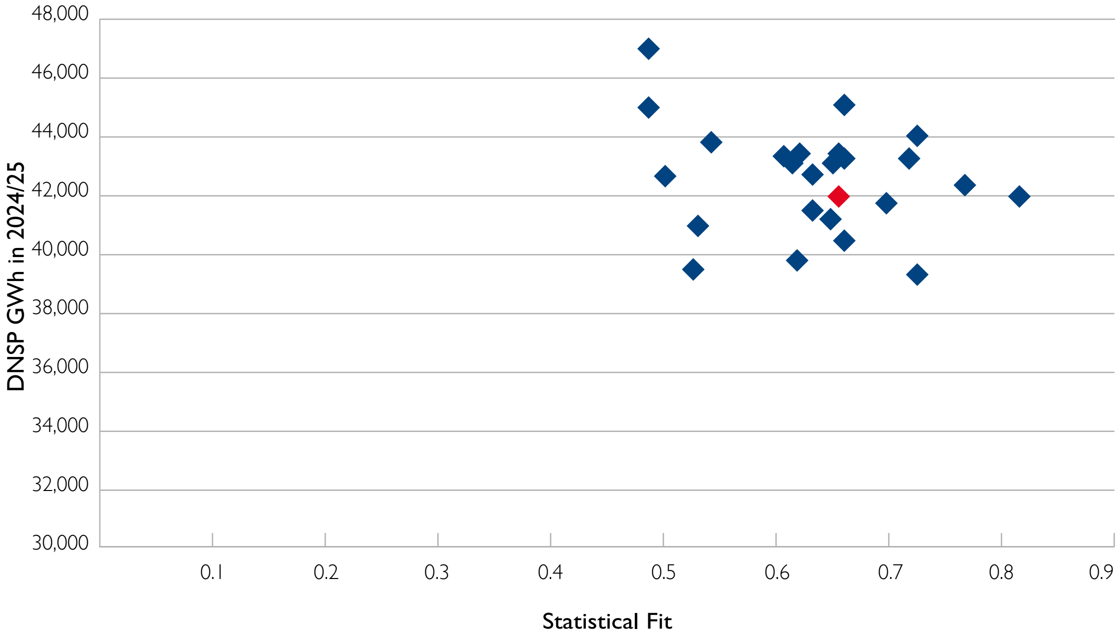
Before the energy data can be used in a regression, it is necessary to make appropriate adjustments to account for solar PV. This ensures that the full underlying DNSP load is being regressed. As forecast summer maximum demand is now based on an evening regression and winter maximum demand occurs in the evening, only an adjustment for energy is needed. This energy adjustment assumes that solar PV output averages 15% of capacity. The 15% figure is based on observations through the Australian PV Institute. Following the regression for energy, the forecast is then adjusted to take into account future solar PV contributions based on forecast solar PV capacity.

Energy regression

An energy regression is developed using historical energy data (described above) as the output variable and a price and economic variable for inputs. This regression represents the relationship between input and output variables. A logarithmic relationship is used in keeping with statistical good practice.

Input variables are selected from three price variables (supplied by Australian Energy Market Operator (AEMO)) and 17 economic variables (supplied by AEMO and Deloitte Access Economics). This provides 51 combinations. For each of these 51 combinations the option of a one year delay to either or both input variables is also considered leading to a total of 204 regressions being assessed. Of these, the top 25 are selected and placed on a scatter plot as shown below where the statistical fit and energy forecast at the end of the forecast period are assessed. The statistical fit combines several measures including R squared, Durbin-Watson test for autocorrelation, mean absolute percentage error and mean bias percentage. All top 25 regressions shown in Figure B.2 qualify as statistically good regressions.

Figure B.2 Energy regression results



The selected regression shown above in red uses Queensland gross state product and total electricity price each with a one year delay. The regression selected reflects a central outcome at the end of the regression period and uses broad based input variables.

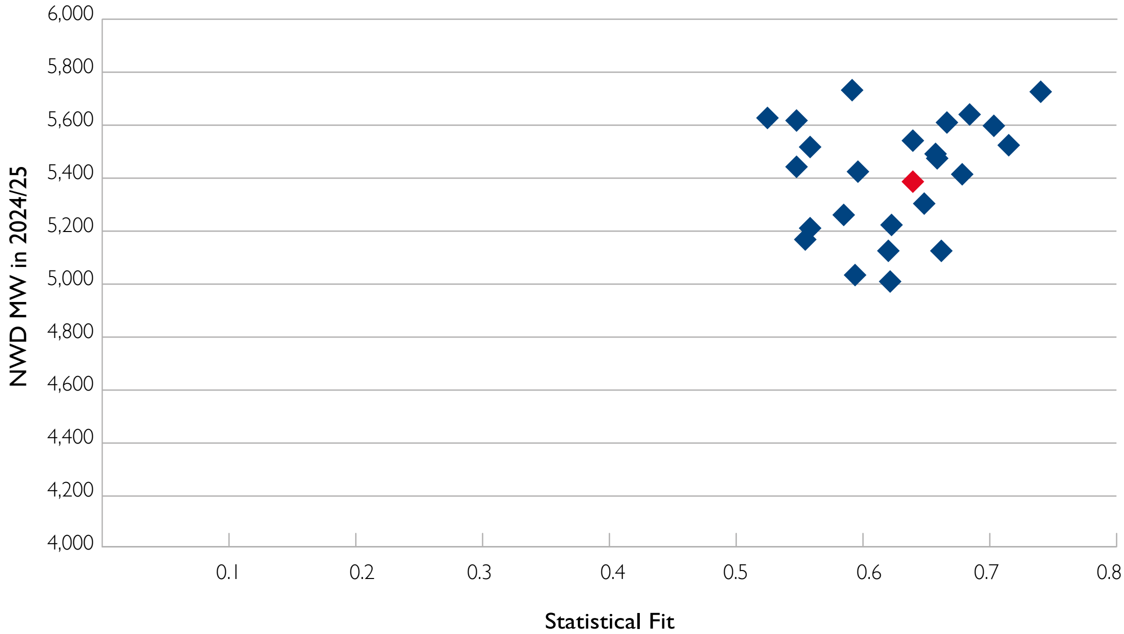
Economic forecast data supplied by AEMO has been provided for low, medium and high economic outlooks. The regression is carried out using medium data leading to the medium energy forecast. High and low energy forecasts are then determined by applying the appropriate forecast economic data to the model.

Summer and winter maximum demand regressions

Maximum demand forecasts are based on two regressions. The corrected historical demands are split into two components, non-weather dependent (NWD) demand and weather dependent (WD) demand. NWD demand is determined as the median weekday maximum demand in the month of September. This reflects the low point in cooling and heating requirements for Queensland. The balance is the WD demand. For summer, this is the difference between the corrected maximum demand and the NWD demand based on the previous September. For winter, this is the difference between the corrected maximum demand and the NWD demand based on the following September.

The forecast NWD demand is therefore used for both the summer and winter maximum demand forecasts. The regression process used to determine the NWD demand is the same as used for energy with the results illustrated in Figure B.3.

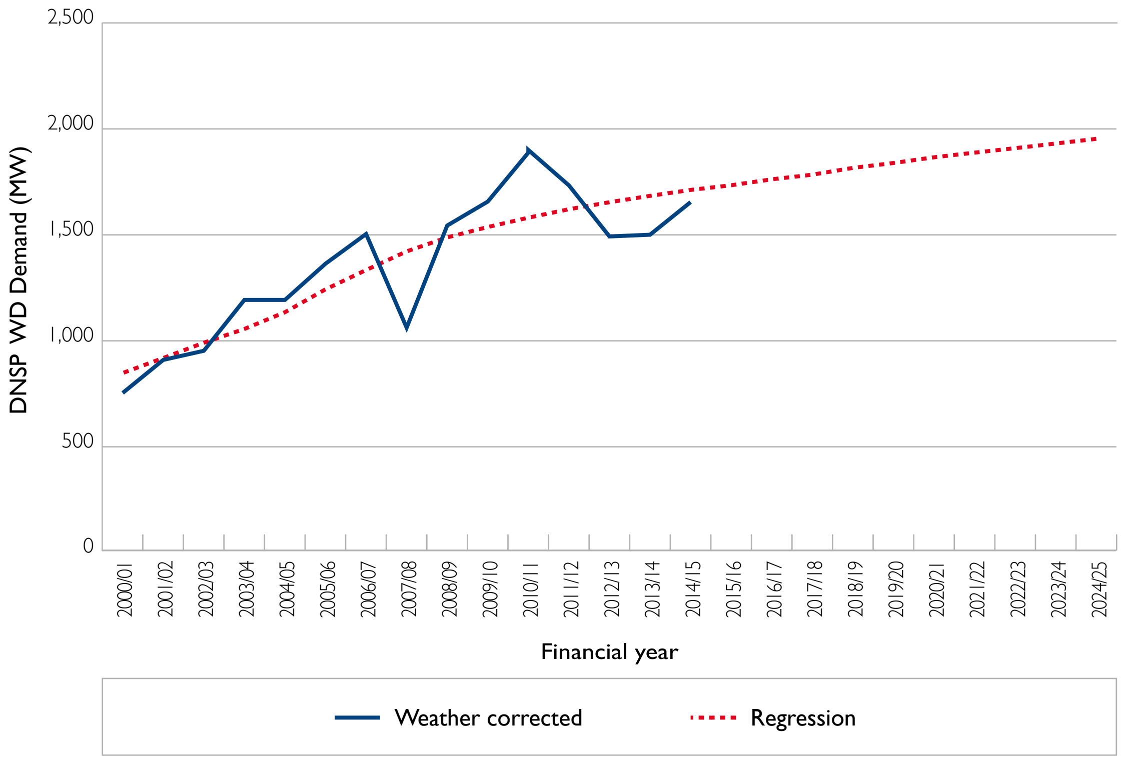
Figure B.3 Non-weather dependent demand regression results



The selected regression shown above in red uses Queensland gross state product and business electricity price each with a one year delay.

The WD demand is mainly a reflection of air conditioning usage. These regressions have been based on one input variable – population multiplied by Queensland air conditioning penetration. This variable is a measure of the air conditioning capacity in Queensland and demonstrates a good statistical fit as illustrated in Figure B.4 by the summer regression below. Historical and forecast air conditioning penetration rates are provided annually in the Queensland Household Energy Survey.

Figure B.4 Weather dependent demand regression – summer



Similar to the energy analysis, low, medium and high economic outlook forecasts are produced for maximum demands by applying the appropriate economic forecasts as inputs. For maximum demand it is also necessary to provide three seasonal variation forecasts for each of these economic outlooks leading to nine forecasts in total. These seasonal variations are referred to as 10% probability of exceedance (PoE), 50% PoE and 90% PoE forecasts. They represent conditions that would expect to be exceeded once in 10 years, five times in 10 years and nine times in 10 years respectively. WD analysis described above is applied to historical demands temperature corrected to 50% PoE conditions. It therefore leads to the 50% PoE forecast. The analysis is repeated using historical demands corrected to 10% PoE and 90% PoE conditions to deliver the other forecasts.

New technologies

Developing an understanding of future impacts for new technologies is crucial to robust and meaningful demand and energy forecasts. In the past, Powerlink has incorporated the impact of solar PV into its forecasting process, while making no explicit allowance for other technologies. Recognising the importance that these technologies will play in shaping future demand and energy, Powerlink is committed to furthering its understanding of these drivers for change.

Driven by this commitment, Powerlink recently conducted a forum of industry experts to learn more about new technologies and the impacts that they may have on future electrical demand and energy. Based on the information shared for the 2015 TAPR, Powerlink adopted technology and other inputs as summarised in Table B.1. Other than assessing the impact of solar PV, this is a new approach for Powerlink.

Table B.1 Impact of new technologies on Powerlink forecast

	Solar PV	Battery Storage (1)	Energy Efficiency	Electric Vehicles	Tariff Reform / DSM
GWh (2)	3,154	0	1,686	0	0
MW (3)	200	185	315	0	100
Installed Capacity MW in 2024/25	3,700	370			
First Year of Impact	now	2017/18	now		2018/19

Notes:

(1) Take up of all technologies is assumed linear, except battery storage with growth more skewed to the later part the forecast period.

(2) This is the energy reduction In financial year 2024/25 compared to 2014/15.

(3) This is the maximum demand reduction in summer 2024/25 compared to summer 2014/15.

Powerlink recognises there is considerable uncertainty regarding the impact of new technology and other inputs on the demand and energy forecasts. Further, Powerlink recognises a range of other outcomes could have been adopted. Due to these uncertainties Powerlink has provided this additional information to provide transparency and allow other levels to be factored into the demand forecasts if desired.

Solar PV

The installed capacity of solar PV in Queensland as at the end of 2014 was 1,300MW. Installations are being added at a rate of 20MW[1] per month, predominately residential. While the residential installation rate is expected to decline as saturation effects begin, it is expected that commercial and industrial installations will make up the shortfall to maintain this rate over the 10-year forecast period. Therefore by the end of the 10-year forecast period, total Queensland capacity is expected to rise to 3,700MW.

[1] Based on information from the Clean Energy website

Analysis has revealed that Queensland will move to a summer evening peak by 2017/18 and so further solar PV which is predominantly installed facing north is expected to have little impact on maximum demand after this time. Energy impacts have been based on an average output of 15%[2] capacity.

Powerlink has recently become a member of the Australian PV Institute which supplies real time data for solar PV. This new information has significantly enhanced the ability to analyse a range of PV effects and in particular its impact on peak demand.

Battery storage

Battery storage technology has the potential to significantly change the electricity supply industry. In particular, this technology could flatten electricity usage and thereby reduce the need to develop transmission services to cover short duration peaks. By coupling this technology with solar PV, consumers may have the option to go off grid. A number of factors will drive the uptake of this technology, namely;

- affordability
- introduction of time of use tariffs
- continued uptake of solar PV generation
- practical issues such as space, aesthetics and safety
- whether economies of scale favour a particular level of aggregation.

Consumer feedback[3] indicates that around 10% of solar PV owners are considering to purchase a battery storage system. Assuming that 10% of solar PV owners purchase battery storage and the battery storage systems contribute in aggregate 50% of the installed solar PV capacity at the time of system peak, then maximum demand will be cut by the equivalent of 5% of installed solar PV capacity, that is, 185MW. It is further assumed that battery storage itself will have little impact on energy as usage will just be 'moved in time'.

Energy efficiency

Energy efficiency improvements have been ongoing and include a range of initiatives associated with appliances and building standards. Therefore the regression inherently includes an energy efficiency forecast in line with past gains. The following two papers examine this area in further detail and support a case that future energy efficiency gains will be greater than those of the past.

- *Appliances: George Wilkenfeld and Associates. Review of Impact Modelling for E3 Work Program. March 2014.*
- *Buildings: Pitt and Sherry. Qualitative Assessment of Energy Savings from Building Efficiency Measures Final Report. March 2013.*

The proposed forecast takes into account findings summarised in these reports leading to a reduction (beyond trend) at the end of the 10-year forecast period of around 1,686GWh pa and 315MW reduction to summer peak demand.

Electric vehicles

Compared to world leading countries in electric vehicle uptake such as Norway and the Netherlands, the uptake of electric vehicles in Australia is low. Without significant government policy changes to actively encourage their purchase this is not expected to change in the short-term. Ultimately, lower battery costs and improved performance will drive up sales. In the meantime, Powerlink has not included a specific allowance in its demand and energy forecast for electric vehicles but will continue to monitor progress in this area. In the event that there is a significant update in electric vehicles it is expected that most owners will be incentivised to charge their cars at off peak times resulting in minimal increase in peak demand. Similarly it is estimated a 1% penetration of electric vehicles on the road would result in approximately 0.3% increase in total energy usage.

[2] Based on information obtained from the Australian PV Institute
[3] 2014 Queensland Household Energy Survey

Tariff reform and demand side management

Network tariff reforms will influence consumer behaviour, shifting energy usage away from peak times. In addition to this maximum demand reduction, it is anticipated that network tariff reforms will also influence future use of battery storage technology, encouraging consumers to draw from the batteries during peak demand/high price times. The extent to which this occurs will depend on how quickly new tariffs are offered and the adoption rate.

"In Australia and internationally there is evidence that customers will significantly reduce their demand in response to well-designed price signals that reward off-peak use and peak demand management. Sixty per cent of trials internationally have resulted in peak reductions of 10 per cent or more."[4]

Some of this peak reduction will already be captured through the energy efficiency and battery storage factors above. An additional 100MW has been assumed within this forecast and represents a further 1.5% of the total maximum demand from the Energex and Ergon Energy networks. As tariff reform is likely to result in load shifting, the impact on energy is expected to be low.

Weather correction methodology

Peak demand is strongly related to the temperature. To account for the natural variation in the weather from year to year, temperature correction is carried out. This results in two measures:

- 50% PoE demand, which indicates what the demand would have been if it was an average season
- 10% PoE demand, corresponding to a one in 10-year season (i.e. a particularly hot summer or cold winter).

Temperature correction is applied to historical metered load supplied to connection points with Energex and Ergon Energy. Powerlink's other direct-connect customers are largely insensitive to temperature.

Powerlink's temperature correction process is described below:

- Develop composite temperature: The temperature from multiple weather stations is combined to produce a composite temperature for all of Queensland. The weighting of each weather station is based on the amount of Energex and Ergon Energy supplied load in the vicinity of that weather station.
- Exclude mild days and holidays: To ensure that the fitted model accurately describes the relationship between temperature and peak demand on days when demand is high, days with mild weather, and the two-week period around Christmas (when many businesses are closed) are filtered out of the dataset.
- Calculate a regression model for each year: A regression model is calculated for each year, expressing the daily maximum demand as a function of: daily maximum temperature, daily minimum temperature, daily 6pm temperature, and whether the day is a weekday.
- Determine the 10% and 50% PoE thresholds using 20 years of weather data: The model calculated for each season is then applied to the daily weather data recorded since 1995. This effectively calculates what the peak demand would have been on each day if the relationship between peak demand and temperature described by the model had existed at the time. A Monte-Carlo approach is used to incorporate the standard error from each season's regression model. The maximum demand calculated for each of the twenty years is recorded in a list, and the 10th and 50th percentile of the list is calculated to determine the 10% PoE and 50% PoE thresholds.
- Final scaling to avoid bias: To ensure that temperature correction process does not introduce any upward or downward bias, for each summer since 2000/01 and winter since 2000, the ratio of the calculated 50% PoE threshold to the actual maximum demand is calculated. The calculated PoE thresholds are divided by the average of these ratios.

Applying this methodology, the 2014/15 summer was hotter than average. Therefore, the 50% PoE demand is 242MW lower than the observed peak demand. The 2014 winter was warmer (i.e. more mild) than average, resulting in an upwards adjustment to the observed winter peak demand.

[4] Towards a National Approach to Electricity Network Tariff Reform (page 6) – ENA Position Paper December 2014