Parsons Brinckerhoff Associates

Technical Appraisal of Western Power's Major Augmentation Proposal for a 330kV Transmission Line & Associated Works in the Mid-West region of Western Australia

Prepared for

ECONOMIC REGULATION AUTHORITY
OF
WESTERN AUSTRALIA

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EXECUTIVE SUMMARY

PB Associates (PB) has reviewed Western Power's regulatory test submission for a 330kV transmission line and associated works in the Mid-West region of Western Australia on behalf of the Economic Regulation Authority of Western Australia (ERA).

In undertaking the review PB examined three critical issues addressed in Western Power's regulatory test submission:-

1. The robustness of supply and demand forecasts;

2. The comprehensiveness of the range of alternatives; and

3. The robustness of the 'net benefits' analysis, including the reasonableness of costs.

Our findings are summarised as follows:-

1. Robustness of Load Forecasts

The load forecasting method employed by Western Power is suited to general load growth but less suited to dealing with the uncertainty associated with 'block loads'. Analysis using uncertainty methods suggests that demand increases are likely to occur more gradually than anticipated by Western Power in which case an opportunity may exist to defer the decision to proceed with a major augmentation for one to two years.

Supply capacity forecasts are based on new embedded generation proposals. PB considers that some additional technical studies may be warranted to justify the choice of a 330kV augmentation over a 132kV option given that proposals that would add a 400MW capacity (coal-fired power station) and a 168-240MW capacity (gas-fired power station) have the potential to significantly reduce the power flows in both directions.

2. Comprehensiveness of Range of Alternative Options

The alternative transmission augmentation options identified by Western Power represent a comprehensive set of options. The long distance between Perth and the Mid-West region load centres, and the constraint on transfer capacity (due to synchronous stability concerns), means that the only feasible options in the medium to long term involve a transmission network augmentation. Some refinement of the analysis of non-network options may be warranted, particularly in relation to a proposal to supply block loads via an island grid, and also in relation to the use of demand side measures (interruptible contracts, etc) which could potentially defer the decision to augment the transmission network for 12-24 months. A deferral would provide more time for block load proposals to mature and reduce the risk of stranded transmission assets.

3. Robustness of the Net-Benefits Analysis

Western Power has determined 'net benefits' using a rank ordering approach. This means that the determination of relative net benefits collapses to a determination of net present costs. PB considers that this approach is justified for two reasons.

Firstly the identification of alternative options is predicated on the need to meet minimum performance standards (as per the Technical Rules) at least cost.

Secondly, in this case the transmission transfer capacity limits mean that local supply capacity additions cannot be accepted and consequently feasible non-network alternatives are only those alternatives that potentially reduce demand (either by deferral or removal). This means that the optimal alternative will be the alternative that meets demand at least cost and rank ordering of net present costs is appropriate. (However if the additional studies of local generation recommended in this report are undertaken it may demonstrate that the 132kV and 330kV options deliver different benefits in terms of fuel cost savings in which case a net benefits approach would be warranted for these options.)

1. INTRODUCTION

PB Associates has undertaken a high level review of Western Power's formal regulatory test submission. This section of our report identifies the critical issues from the perspective of the regulatory test, and describes the methodology and approach taken to each of these issues. This section concludes by describing the report framework.

1.1 METHODOLOGY AND APPROACH IN DETAIL

PB Associates has reviewed some of the critical issues that feature heavily in the regulatory test assessment:-

- The robustness of supply and demand forecasts;
- The comprehensiveness of the range of alternatives; and
- The robustness of the 'net benefits' analysis, including the reasonableness of costs.

Herewith we describe the methods we employed to assess each of these critical issues.

1.2 ROBUSTNESS OF FORECASTS

1.2.1 Demand Forecasting Methods

In traditional methods of demand forecasting, future increases in demand are estimated based on historical patterns. This approach works when the demand growth is stochastic so that overall growth is continuous or smooth in nature.

These methods produce uncertain results when a substantial component of the expected demand increases comprises relatively large block loads.

Western Power has dealt with this uncertainty by using a probability weighting method to adjust the expected forecasts for block loads.

PB Associates considers that this approach may give misleading results because block loads cannot be reduced to 'partial' demand increases. A 100MW block load with a load expectation of 70% is not equivalent to a 70MW increase. The addition of a 100MW block load will be 0MW or 100MW. As the block load is a discontinuous variable it can be modelled using a Markov state method in which each 'state' is assigned a discrete probability. Using our example if we could check the state of a network at some future time we would expect to observe a 0MW increase in 30% of our spot checks and a 100MW increase in 70% of the checks. These probabilities can be used to determine an 'expected' demand increase, wherein a common practice would be to determine an expected load increase that is at least 50% certain for a given year in question.

Forecasting the demand increase due to block loads is further complicated by a need to produce a time-series forecast spanning several years. The complication arises because there is uncertainty associated with the commencement date on which the block load will be drawn from the network. This form of uncertainty can be modelled using a triangular probability distribution wherein the load is set at zero outside two boundary years with the triangle peak corresponding to the year with the highest probability. This distribution simulates a common real world situation whereby the likelihood of a project going ahead reaches a peak and then falls away.

An analytical technique that can deal with these demands is known as the Monte Carlo technique. While the above descriptions of the problems faced in forecasting demands may appear intractable, the power of modern computing can be used to conduct thousands of simulations in which the load states and their commencement dates are determined through repeated random draws from their respective probability distributions. Using this technique it is straightforward to produce an ‘expected’ demand forecast for each year of the forecast period that takes into account uncertainty.

PB Associates has developed such a load forecast using the Monte Carlo technique as a check against the forecasts submitted by Western Power.

We caution that PB has taken care to produce a forecast that can be compared fairly against the forecast prepared by Western Power, but PB has not had an opportunity to validate the forecast. Consequently the comparison should be considered as indicative from which some broad conclusions can be reached.

1.2.2 Supply Forecasting Methods

The methods described above can also be applied to supply capacity forecasting, particularly in relation to new capacity.

The timing and quantum of new capacity can be forecast using probability distributions for each factor.

Wind generation poses greater difficulties in predicting year round capacity and as a consequence it is common to assume a low peak demand contribution from such sources. However transfer capacity must cater for the peak output of wind farms.

In this report we have fallen short of preparing a supply capacity forecast. We consider that the uncertainty in new generation supply capacity is relatively insignificant when compared to demand forecasts which drive the need for a major transmission augmentation.

1.3 COMPREHENSIVENESS OF RANGE OF ALTERNATIVES

PB has examined the range of alternatives presented by Western Power, taking into account alternatives presented by interested parties during the consultation process run by Western Power. PB has applied engineering judgement to the best of our abilities based on the information provided in the Western Power regulatory test submission.

1.4 ROBUSTNESS OF THE NET BENEFITS APPROACH

PB has examined the net benefits approach presented by Western Power (as rank ordering method) and made comments in relation to practices adopted in other jurisdictions.

1.5 FRAMEWORK OF THE REPORT

This report comprises an Executive Summary and 3 sections.

The Executive Summary is provided at the beginning of this report.

Section 1 comprises this brief introduction.

Section 2 discusses supply capacity forecasts.

Section 3 discusses demand forecasts.

Section 4 discusses alternative options.

Section 5 discusses net-benefits.

2. SUPPLY CAPACITY FORECASTS

The case supporting Western Power's proposal for a major augmentation rests to a large extent on supply capacity forecasts in the Mid-West region. In this regard the potential to increase capacity is limited by the transfer capacity of the transmission network feeding the Mid-West region.

2.1 CAPACITY CONSTRAINTS IN THE MID-WEST REGION

2.1.1 Stability

Western Power has identified that the capacity of the Mid-West region network cannot be increased due to stability concerns. Additional sources of reactive power are required to ensure that voltage collapse does not occur.

Such concerns arise due to the distance between Perth and Geraldton.

The classic situation that gives rise to instability is a high power transfer over long distances with few transmission lines from low inertia thermal generators, possibly coupled with the need to supply large motor loads remote from the generators.

Sophisticated analysis is required to determine the amount of reactive support required under changing system conditions. Western Power and Hydro Consulting Tasmania have undertaken such modelling and determined the additional reactive power requirements. PB considers that the analytical methods are robust but is unable to comment on the results due to insufficient information.

2.1.2 Transmission Line Surge Impedance (SIL)

Western Power has also identified that the transfer capacity of transmission lines is limited by the transmission line surge impedance. Again this limit is a function of the reactive power conditions at the sending and receiving ends of the line.

Western Power, Hydro Tasmania and CRA have referred to a method developed by Westinghouse to quantify the power transfer capacity of a long transmission line.

To validate the figures presented in Table 1 below, PB has referred to an alternative method for establishing the power transfer capacity of a long line.

As Western Power has not provided exact design details of the proposed line, it is not possible to determine the exact transfer capacity, however as a practical point of reference, PB is able to compare the capacity tabled by Western Power against capacities established elsewhere using a 'circle diagram' technique.

PB has previously computed the maximum permissible loading for a 330kV line of 200km length (twin conductors, double circuit, 2 x 508 sq mm ACSR conductor) to be 388MW per circuit.

Table 1: Transmission Line Surge Impedance Parameters

Line voltage	Parameters for 400 km (250 miles) long line:					
	Line X (pu)	Xbase (ohms)	Line X (ohms)	Transmission limit w/out generation (MW)	SIL (MW)	Maximum permissible-loading based on SIL (MW)
1	2	3	4	5	6	7
132 kV	0.8	174	140	125	43	50
330 kV	0.12 (twin olive)	1,089	127	833	272	313

Note: *Using Fig. 60 on page 482 of Westinghouse, deliverable power is about 1.15 in pu of SIL for a line of 400 km (250 miles) long.*

According to the Western Power (Westinghouse) method the maximum permissible loading is 313MW.

While the PB method affords a reasonable approximation for any transmission line of moderate length (200km) with large conductor the lower loading limit identified by Western Power arises because at 400km the line can no longer be categorised as a moderate length line. Nevertheless the PB analysis is indicative that the Western Power and Hydro Tasmania Consulting analysis is robust.

2.2 SUPPLY CAPACITY FORECASTS

The implication of the synchronous stability and transfer capacity constraints is that no new generation capacity can be accepted until the transmission network capacity is upgraded or costly reactive power sources are provided; this is the case whether the transfer is from south to north or north to south.

Existing firm generation capacity is about 100MW.

Western Power has identified new embedded generation as follows:-

- A total of 322MW of windfarm developments;
- Dongara Gas Turbine at 4 x 42MW or 168MW total capacity; and
- Eneabba Coal at 400MW.

Along with other potential developments new embedded generation capacity could total 900MW to 1100MW. If such generation projects develop then the Mid-West region is likely to become a net exporter of energy to the south. If windfarm output is variable and considered as not firm in terms of peak capacity requirements and is discounted from consideration, the export potential is significantly reduced.

A PB forecast has determined that the load in the Mid-West region will grow to about 350MW by 2014 (refer to Section 3.1).

Overall the picture of supply and demand balance suggests that in the future there may be significant potential to export to the south.

However the amount of export will depend on the competitiveness of these new generation sources with those in the south (after taking into account transmission losses). In practice the amount of export may not be high given that theory suggests that generation sources close to load centres will be more efficient.

This means that the Mid-West region load will be largely supplied by local sources, notably by thermal generation, and the transmission network will provide reactive power with minimal active power transfer under system normal conditions. As new embedded local generators will also provide a source of reactive power it appears likely that the transmission lines between the Mid-West region and Perth will only see significant power flows during abnormal system conditions (i.e. when local power stations are operating on reduced output during maintenance periods or during forced outage conditions).

These considerations suggest the need to understand the need for a higher capacity 330kV transmission line augmentation if a 400MW coal-fired power station and 168-240MW gas-fired power station are developed in the Mid-West region.

PB suggests that the following analysis could provide this understanding:-

- Estimation of the fuel cost savings associated with export from the Mid-West region to the south. Such benefits may or may not vary materially according to the transfer capacity of the transmission augmentation;

- A study into the reactive power requirements of the interconnected system with the aforementioned power stations in service; and

- A reliability study for each of the 132kV and 330kV options. A 132kV transmission line augmentation may provide a sufficient transfer capacity if local generation is reliable and reactive power is available locally. The study should determine the expected energy not served.

3. DEMAND (LOAD) FORECASTS

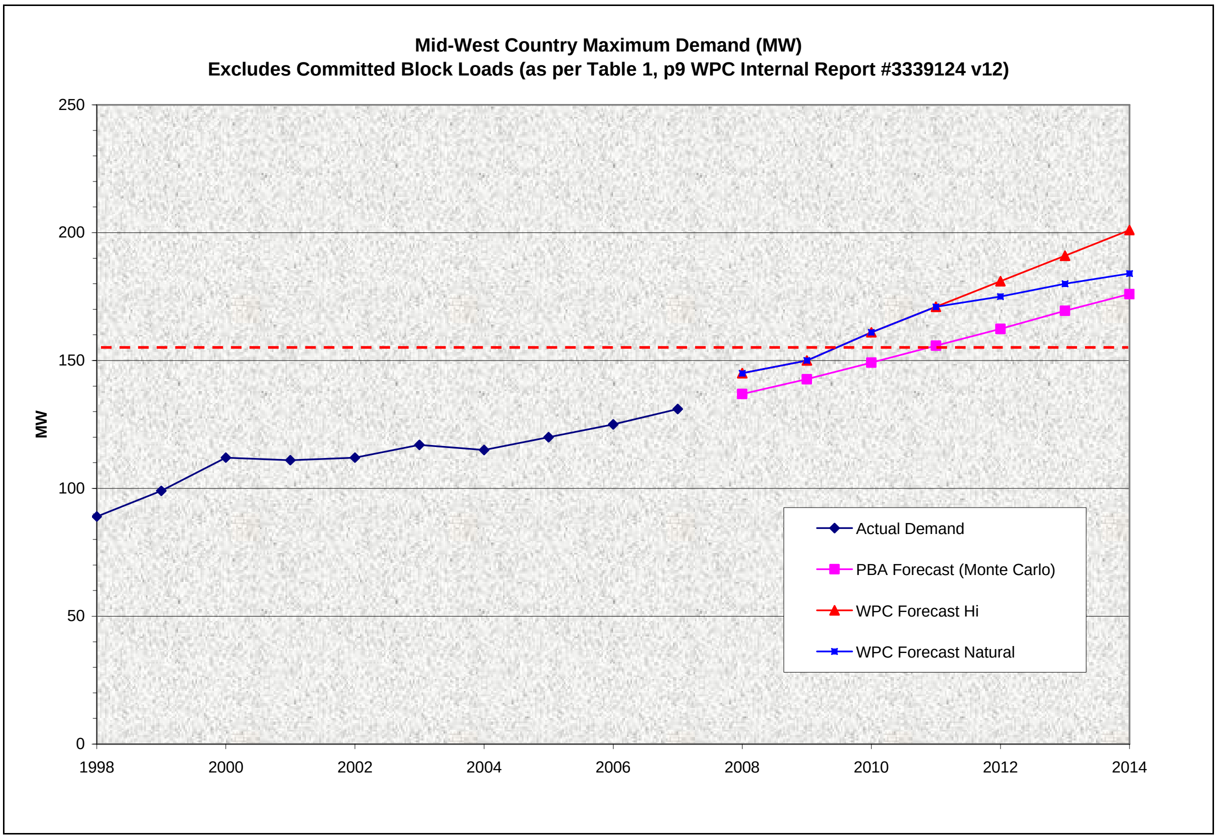
The case supporting Western Power's proposal for a major augmentation rests to a large extent on demand growth forecasts in the Mid-West region. PB has examined Western Power's forecasting methodology and has undertaken further analysis using Monte Carlo techniques to provide a check on the validity of the results obtained by Western Power.

3.1 PB ASSOCIATES FORECASTS FOR THE NCR

PB has produced a forecast for a natural load growth using the Monte Carlo technique.

In this technique we simply predicted the future demand based on historical rates of growth. In this case the future growth rates are drawn randomly many times from a probability distribution to arrive at the most likely demand increases, using the mean and standard deviation of the logarithm of the year-on-year growth rates between 1998 and 2007.

Figure 1: Maximum Demand Growth Forecasts



The chart shows that the natural demand growth is lower than that predicted by Western Power, particularly in the early years. However by the year 2014 the gap has narrowed to within less than 10%.

The chart also shows that according to the PB forecast demand exceeds the current capacity of the NCR (155MW) about one year later than expected according to the forecast of Western Power.

PB Associates has undertaken a further Monte Carlo analysis based on the principles described in Section 3.1 above.

For the quantum of load and probability that the load will proceed we have adopted the figures provided by Western Power. There is insufficient information at our disposal to make assumptions that are at variance with the assumptions made by Western Power.

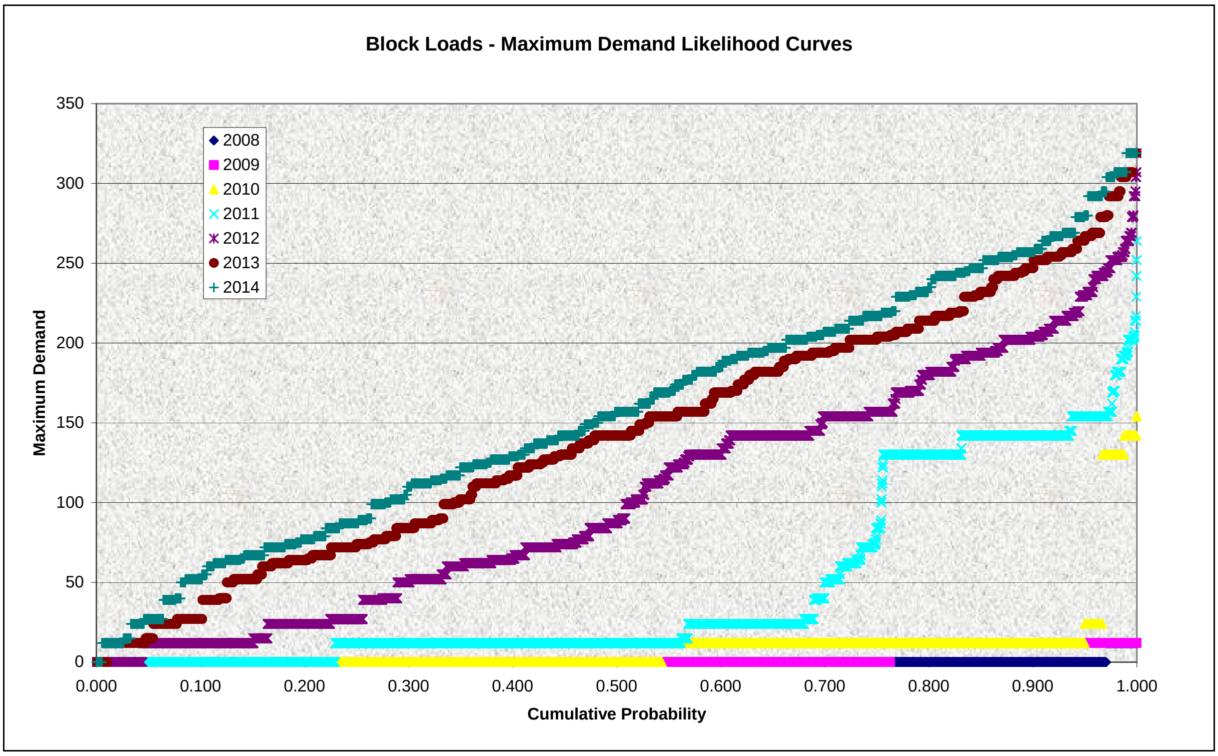
As previously described Western Power has probability-weighted the forecast of supply capacity and block load additions in an attempt to deal with the uncertainty associated with these developments.

However neither the CRA nor Western Power documents provide a detailed explanation of the basis for the assignment of probability, and details regarding likely commencement dates are scant. This reflects the uncertainty faced by developers within their project approval processes including many exogenous factors that could impact the plan of developers.

PB has modelled the year in which the block load may commence as a triangular probability distribution with a peak probability of 50% assigned to the year of commencement identified by Western Power, and with 25% probability of commencing assigned to each of the following two years. Outside of this three year window, on either side, the probability of commencement is constrained to zero. This probability distribution reflects a real-world situation wherein a development window exists for a defined period after which the opportunity may be lost to competition or fail to gain internal approval.

The results of our simulation forecasts for the combined block loads are shown in the following chart for each of the years 2008 to 2014:-

Figure 2: Simulation Forecasts for Total Block Loads

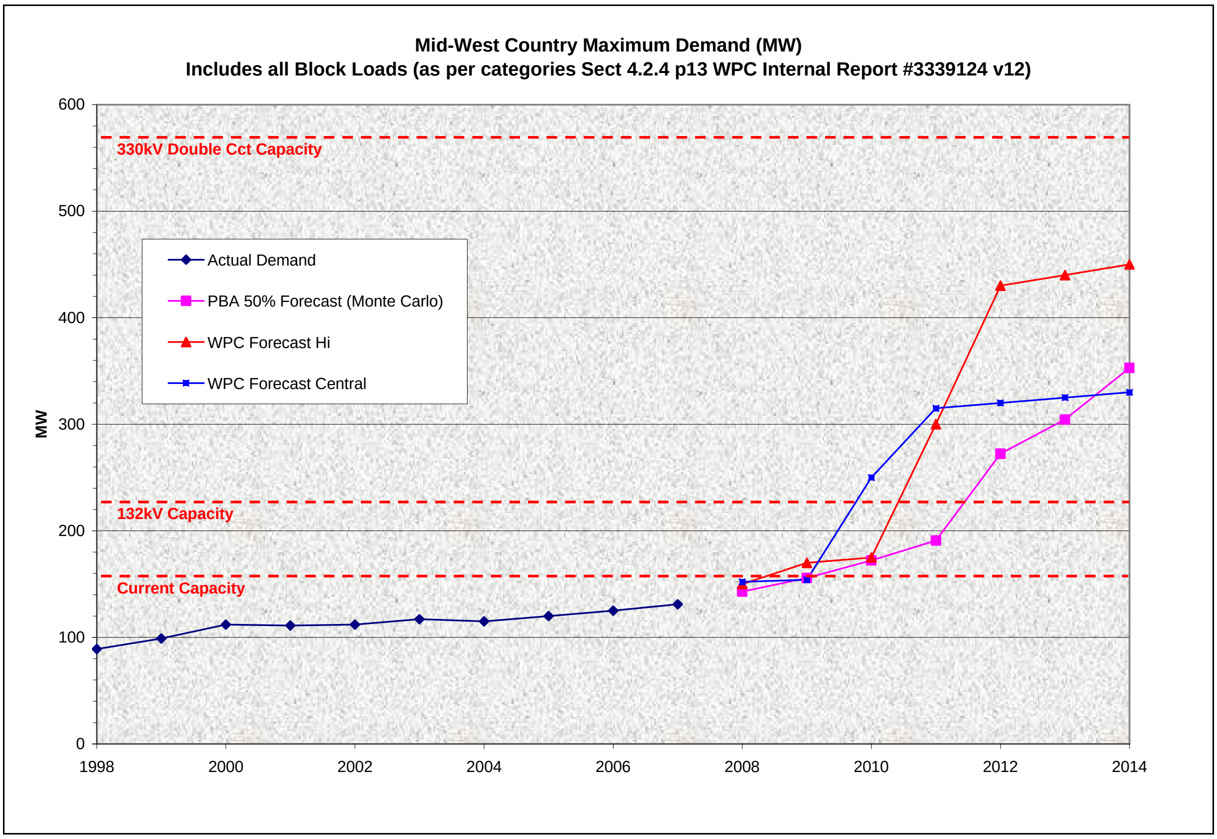


It is important to understand that this chart predicts the likely block load increase as the commencement year is varied randomly over a 3-year window weighted in accordance with the triangular distribution. As previously stated PB has accepted the block load MW increases tabled by Western Power and assigned a 50% weighting to the year of commencement predicted by Western Power.

This means that Western Power's high forecast for the block loads will be represented by a cumulative probability of 100% meaning that all block loads commence in the year forecast by Western Power. PB has used the Monte Carlo simulation results to prepare an overall forecast based on a total block load increase at the 50% level of expectation that is based on the assumption that half of the block loads will commence in the year forecast by Western Power.

The result is shown in the following chart:-

Figure 3: Overall Forecast (50% block load expectation)

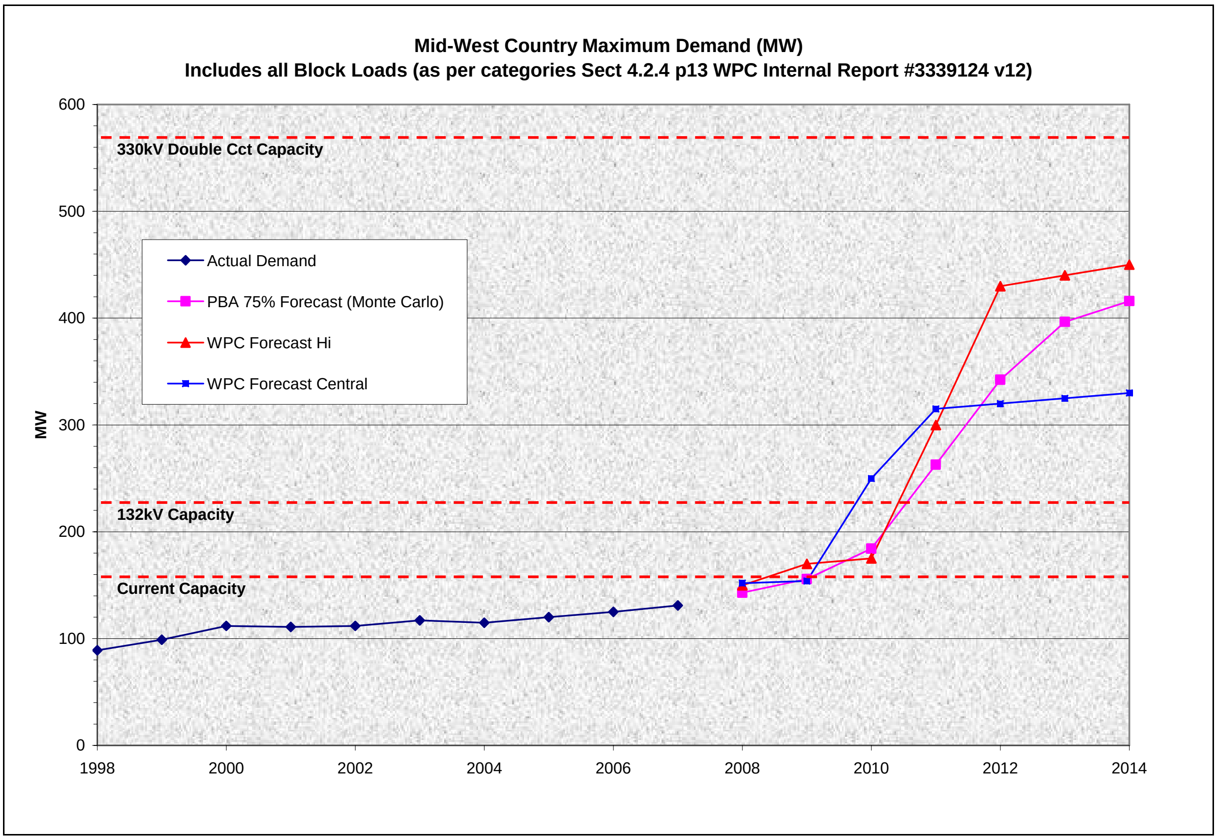


It can be seen from this chart that the PB load forecast is smoother than the forecast provided by Western Power. We suggest that a smooth and increasing rate of demand is intuitively more likely than the sudden increase in the rate of demand growth predicted by Western Power. (This sudden increase is a result of the probability weighting method used by Western Power).

The PB demand forecast is not presented as a diversified demand forecast as there was insufficient information available to determine a diversification factor. What can be said is that the PB peak demand forecast will be reduced after allowing for load diversity, possibility by about 10%.

For completeness, PB has also produced a total forecast using a 75% level of expectation for the block loads, i.e. it is assumed that Western Power forecast the commencement of the block loads in 3 out of 4 cases. If the actual commencement year was to occur as forecast in 3 out of 4 cases it would represent a highly unusual degree of foresight. PB considers that the information regarding potential block loads (presented in Western Power's regulatory test submission) does not support a 75% expectation.

Figure 4: Overall Forecast (75% block load expectation)



As expected, Figure 4 shows that the rate of demand growth is greater than that expected for a 50% expectation and aligns more closely with Western Power's high forecast.

PB considers that the result of the overall forecast suggests the following outcomes fall within a reasonable planning scenario:-

- The current capacity of 155MW will be exceeded in 2009 and action is required to address the risk of capacity shortfall (i.e. a 'do nothing' option is not supported by our analysis);
- The capacity of a 132kV augmentation option will be exceeded by the middle of 2011 about two years later than the year predicted by Western Power; and
- A capacity of near 400MW will be required by 2014 based on anticipated developments.

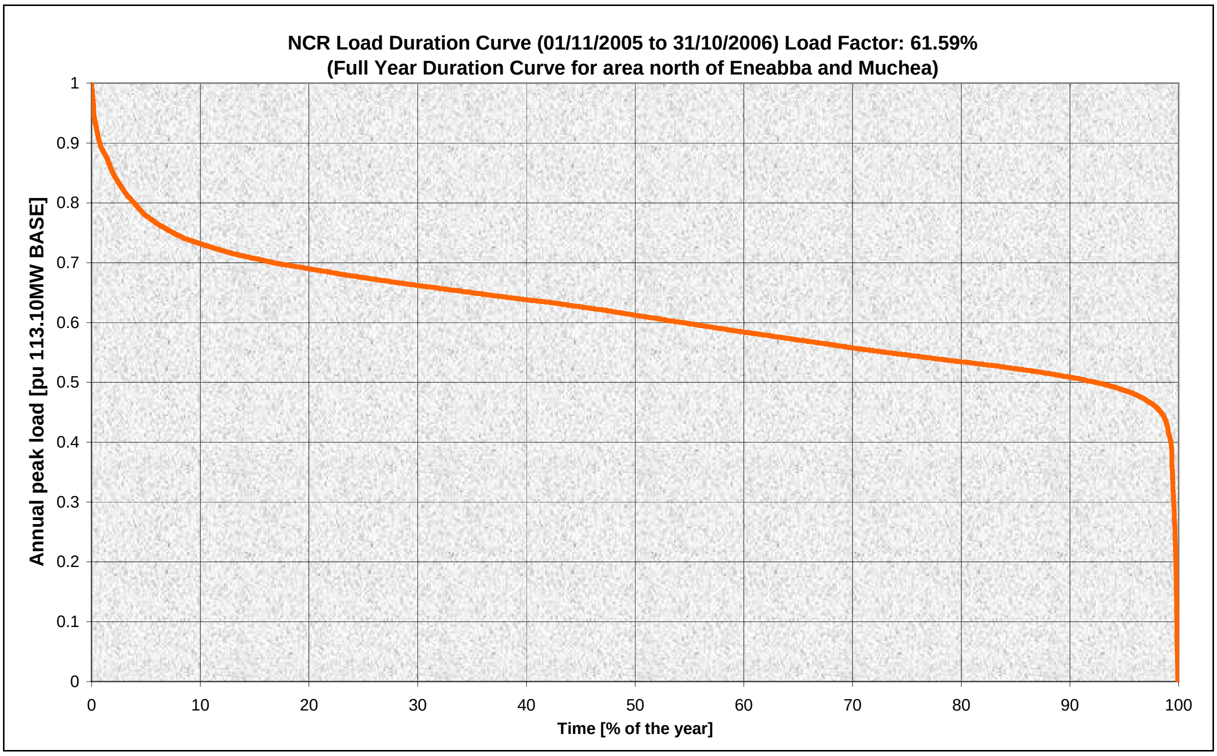
The PB forecast deals with uncertainty in a robust manner and suggests that the potential exists for low asset utilisation in the short to medium term.

The PB load forecast suggests that an opportunity exists to use instruments such as interruptible load contracts supplemented by other energy conservation measures to defer the decision point.

A modest reduction of 10 to 20MW (about 5 to 10% of capacity) could potentially defer the need from 12 to 24 months during which time a constant reassessment of the block loads could be undertaken.

The load duration curve shows that a 10MW reduction would be needed for less than 1% of the time (under 4 days each year).

Figure 5: Mid-West Region Load Duration Curve (by Western Power)



In conclusion PB considers that the load forecasting techniques employed by Western Power are suitable for general load growth but fall short of dealing with the uncertainty of block loads forecasts. Accordingly we would expect that some further refinement of the forecasts would be required in order to meet the expectations of the regulatory test.

4. IDENTIFICATION OF ALTERNATIVE OPTIONS

Western Power has identified 12 alternative options (16 options including sub-options).

Transmission solutions:

1. Establish a double circuit 330 kV line (with one side initially energised at 132 kV) between Perth and Geraldton by November 2010.

   Three sub-options identified are 1a), 1b) and 1c).

2. Establish 132 kV lines from Eneabba to Three Springs, and Mungarra to Rangeway Substation located in the Geraldton CBD with the 330 kV line (as in Option 1) deferred until Nov 2014.

   One sub-option identified 2a).

3. Establish 132 kV lines from Eneabba to Three Springs, and Mungarra to Rangeway with the 330 kV line (as in Option 1) deferred until Nov 2014.

4. Reinforce existing network using lines of 132 kV construction only.

5. Establish a single 220 kV line between Perth and Geraldton by November 2010.

6. Build reinforcement with line towers designed for 500 kV initially insulated and operated at 330 kV.

7. Build a Direct Current Perth to Geraldton line.

8. Do nothing.

Generation solutions:

9. Add more generation at Mungarra Power Station.

10. Additional generation at Dongara.

11. Permanently island the Mid-West region from the SWIS at Three Springs.

Other solutions:

12. Rely solely on a demand management program to reduce peak demand.

From a planning perspective PB considers that this list of alternatives represents a reasonable range of alternatives.

Alternative options involving different routes can be considered as sub-options and are not likely to have a material impact on the costs given constraints on the available corridors and the necessity to serve the main load centres defined by the most significant population centres.

Table 2: Alternative Options

Option	Description	Western Power Hypothesis	PB Comment
1	Establish a double circuit 330 kV line (with one side initially energised at 132 kV) between Perth and Geraldton by November 2010.	400MW capacity increase. New corridor lower risk re timing. All sub-options delivered post Nov 2011.	Timing based on supply and demand forecasts without consideration of deferral using demand side measures. Risk of stranded capacity if new embedded generation or block loads do not develop or are deferred for extended periods.
2	Establish 132 kV lines from Eneabba to Three Springs, and Mungarra to Rangeway Substation located in the Geraldton CBD with the 330 kV line (as in Option 1) deferred until Nov 2014.	40MW capacity increase.	As per Option 1 except that risk of stranded capacity replaced by risk of load curtailment.
3	Establish 132 kV lines from Eneabba to Three Springs, and Mungarra to Rangeway with the 330 kV line (as in Option 1) deferred until Nov 2014.	As per option 2.	As per Option 2.
4	Reinforce existing network using lines of only 132 kV construction.	Caters for natural load growth only.	As per Option 2.
5	Establish a single 220 kV line between Perth and Geraldton by November 2010.	100MW capacity increase with dependence on local generation.	Demand forecasts (Western Power and PB) suggest that the capacity increase is likely to be insufficient. The Net Present cost does not support this option on a $ / MW basis. PB understands that 330kV is a standard EHV voltage in Western Australia. A 220kV line would create operational management issues.

Option	Description	Western Power Hypothesis	PB Comment
6	Build reinforcement with line towers designed for 500 kV initially insulated and operated at 330 kV.	1000MW capacity.	Demand forecasts based on reasonable assumptions do not indicate the need for the capacity available from a 500kV line.
7	Build a Direct Current Perth to Geraldton line.	500MW bipole HVDC link.	Economics of a HVDC link is determined as a trade-off between the cost savings per unit line length versus the relatively high cost of converter stations.
8	Do nothing.	Breach of Technical Rules.	Agree. Do nothing option is not supported.
	Generation solutions:		
9	Add more generation at Mungarra Power Station.	No increase in local generation capacity feasible due to transmission transfer limit.	Agree. Western Power and HTC analysis is robust.
10	Additional generation at Dongara.	Similar to Option 9.	Agree. HTC analysis is robust.
11	Permanently island the Mid-West region from the SWIS at Three Springs.	Breach of Technical Rules. Security and reliability of supply requirements onerous. Loss of economy of scale. Loss of competition benefits.	Agree there would be a potential loss of economy of scale and potential for competition benefits to be reduced. There is an opportunity for private grid proponents to demonstrate viability.
	Other solutions:		
12	Rely solely on a demand management program to reduce peak demand.	Unlikely to be sufficient peak reduction to be considered as a viable option.	Agreed that sole dependence infeasible. However, demand side measures may be used to defer the decision to construct a major transmission augmentation.

Amongst the submissions received from Western Power's public consultation process there are three suggested options identified:

- An option raised by Energy Visions Pty Ltd and Sky Farming Pty Ltd is constructing new lines with capacity of 1000MW (presumably referring to capacity for 1000MW of generation).

  Western Power has indicated that these suggested options are addressed by the identified alternative option (Option 7) of constructing the 330kV line with towers for a 500kV line. However according to reasonable forecasts the additional capacity is not required within the planning horizon and PB supports this view.

- Options raised in the submission from Eneabba Gas Limited include limited reinforcement of the 132kV lines and islanding of the Mid-West network. Western Power indicates that these suggested options are addressed as Options 2, 3 and 11.

  Islanding of the mid-west network would result in a loss of scale economy which would be expected to result in higher fixed costs, and would potentially reduce competition thereby leading to higher variable costs (likely if new generation in the north supplies Perth).

  An 'island' supplying block loads on a third party commercial basis is a technically feasible alternative. This option would impact Western Power's demand forecast. However Western Power is not well placed to determine the likelihood that the prospective block loads would choose an 'island' alternative over connection to the Western Power transmission grid. PB Associates considers that proponents of a private transmission island should provide sufficient evidence of the likelihood that block loads would take up this option so that Western Power can factor such a development into demand forecasts. If such evidence cannot be provided then Western Power would be justified in assuming that prospective block loads will opt to connect to the Western Power grid.

- An option raised in the submission by Transfield Services is the termination of the 330kV line at Three Springs. Western Power has dismissed this option out of hand.

  PB considers that this alternative is based on Transfield Services understanding that Three Springs is likely to become the load centre for the region. Western Power maintains that the load centre will continue to be located at Geraldton referencing the probability-weighted demand increases as supporting this contention. PB agrees that the Western Power analysis leads to this conclusion.

- An option raised in the submission by Transfield Services is the use of small scale gas-fired reciprocating engines with a unit size of 15MW. Western Power maintains that the addition of capacity to the Mid-West region is constrained by the current transfer limits irrespective of the generation type. PB agrees with this conclusion.

  There may be an economic case in certain locations in the Mid-West region for small scale gas-fired reciprocating engines to function as stand-alone power plant (i.e. such power plant may be more economical than grid supply if the cost of the connection augmentation is high). While PB considers that Western Power has built their demand forecast on prospective block loads that are unlikely to adopt such a solution, it would be worthwhile to confirm that developers of block loads have considered and rejected such a stand-alone power plant option.

PB considers that there may be a case to support the use of demand-side management measures for deferral of the transmission augmentation for one to three years, particularly if there is potential for the use of interruptible contracts.

5. NET-BENEFITS

Western Power has enunciated the prospective benefits of a major transmission augmentation as follows:-

1. Ability to accommodate natural load growth in the region;
2. Increase in transmission capacity to enable connection of customers with new loads and also connection of new generation;
3. Improvements in reliability of power supply to all customers in the region;
4. Ability to connect new wind farms, which will reduce CO_2 emissions;
5. Support industrial and mining developments in the North Country (providing new opportunities for economic growth);
6. Ability to connect new base generation located north of Perth;
7. Facilitation of entry of lower cost generation in the region;
8. Reduction in generation costs by removing the need for operation of the gas turbines at Mungarra;
9. An opportunity to retire old and inefficient gas turbines at Geraldton and Mungarra; and
10. A reduction in transmission losses (lower in % at higher voltage).

PB understands that Western Power considers that these benefits are common to all of the identified options.

We consider that many of these benefits are closer to statements of compliance against the Technical Rules. The Technical Rules requirements are minimum standards against which all options should be measured. Options that deliver benefits in excess of the minimum standards may be in breach of the Technical Rules.

In the case of benefits 1 through 9, Western Power has forecast supply and demand, and taken into account capacity transfer limits in order to establish the minimum capacity required to avoid load curtailment.

In the case of benefit 10, Western Power has quantified the savings in transmission losses at different voltage levels. PB considers that the quantum of losses appears reasonable. It is not possible for PB to validate the figures without access to the detailed results of the analysis, as the quantification of losses requires a detailed model of the transmission network and sophisticated analytical tools.

Western Power has adopted a rank ordering approach to compare the cost of alternative options on the grounds that the benefits of alternative options do not differ materially.

The difference in benefits between alternative options involving different voltage levels will be mainly seen in losses. However this difference is not material, particularly given the accuracy of the capital cost estimates.

In the case of non-network options the benefits of the option impacts on the supply and/or demand forecasts which are then taken into account when identifying the quantum and timing of additional capacity required from the transmission network. As a consequence the identification of alternative options collapses to a consideration of the optimal transmission augmentation and the rank ordering method is suitable as it is only costs that differ between options.

There are precedents for the use of rank ordering in the National Electricity Market, for example this approach was taken by Transgrid when assessing alternative options for a major transmission augmentation in the Newcastle-Sydney-Wollongong area in 2006.

PB considers that the use of the rank ordering method is justified.

Western Power has undertaken a reasonable range of sensitivity tests on key input variables, notably the discount rates.

PB notes that the use of a pre-tax real discount rate may result in misleading results in a high inflation environment, however Western Power has also computed nominal discount rates and demonstrated that the rank order is unchanged.

5.1 COST ESTIMATES

Western Power has provided benchmark unit costs upon which it has computed the costs of alternative options.

PB maintains a database of unit costs applicable to Australian conditions and has compared these costs against the benchmark unit costs tabled by Western Power. As the actual costs are commercially sensitive our comparison is made on a relative basis.

Benchmark unit costs were provided for the following plant and equipment:-

Table 3: Plant & Equipment Given Unit Costs by Western Power

132 kV Line circuit	each
132 kV Transmission Line SC (Country)	per km
330 kV Line circuit	each
330 kV Single Cct Transmission line	per km
330 kV Double Cct Transmission line	per km
330/132 kV Terminal with single 490 MVA Transformer (Installed)	each
330/132 kV 490 MVA Transformer (Transformer + Installation)	each

A relative cost comparison follows:-

Table 4: Relative Unit Cost Comparison by PB

	PB Benchmark Cost relative to Western Power Benchmark Cost
132 kV Line circuit	1.04
132 kV Transmission Line SC (Country)	0.74
330 kV Line circuit	1.08
330 kV Single Cct Transmission line	1.00
330 kV Double Cct Transmission line	0.88
330/132 kV Terminal with single 490 MVA transformer (Installed)	1.27
330/132 kV 490 MVA Transformer (Transformer + Installation)	1.00

Transmission line costs vary according to the conductor size and rating and there is insufficient detail in the Western Power submission to be certain that the cost comparison is accurate.

Nevertheless, based on the benchmark unit cost comparisons, and an examination of the financial model provided by Western Power for each of the options, PB considers that the Net Present Cost analysis and rank ordering of alternatives is within reasonable bounds of accuracy for a regulatory test submission.