Verification of Western Power Corporation forecasts of demand and energy for the Access Arrangement for the SWIN

A report for
Western Power Corporation

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While the National Institute endeavours to provide reliable forecasts and believes the material is accurate it will not be liable for any claim by any party acting on such information.

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Executive summary

NIEIR reviewed Western Power Corporation (WPC) forecasts for transmission network demand, transmission network energy and distribution network energy.

All WPC forecasts appear to be reasonable and consistent with each other. Although NIEIR suggests some methodological improvements to their preparation, the forecasts appear to be suitably accurate for their intended use.

All WPC forecasts will be required to be updated within the Access Arrangement review period as more recent actual data become available.

Transmission Demand

Of the in-house network demand forecasting models which NIEIR has reviewed for various businesses across Australia, the WPC model appears to be one of the best.

Transmission Energy

WPC previously engaged NIEIR to prepare forecasts, which were methodologically consistent with some of the NEMMCO forecasts published in its Annual Statement of Opportunities for the National Electricity Market. NIEIR developed the 2004 GSR, including system energy and peak demand forecasts for the SWIS which are methodologically consistent with the approach adopted in various other utilities across Australia. NIEIR reviewed relevant high level inputs and reiterates the forecasts in the 2004 GSR.

Distribution Energy

The distribution energy forecasts are based on the current distribution energy and the projected energy growth directly from the GSR.

1. Introduction

Western Power Corporation (WPC) invited the National Institute of Economic and Industry Research (NIEIR) to undertake a verification of Western Power's forecasts of demand and energy for the upcoming Access Arrangement for the SWIN.

The WPC forecasts cover three main areas:

(i) transmission demand;

(ii) transmission energy; and

(iii) distribution energy.

The scope of works for this study, prepared by WPC, is reproduced in Appendix A.

2. Transmission demand forecasts

2.1 Introduction

Transmission demand forecasts at the zone sub-station level are required for 2006-07 to 2008-09. These forecasts are required to prepare and verify capital budget forecasts and initial transmission access prices for regulatory purposes.

The Network Business Unit of WPC currently prepares zone sub-station forecasts for the SWIS out 20 years. It is these forecasts that underlie the network planning and analysis contained in the WPC's "*Transmission and Distribution Annual Planning Report*" (TDAP).

This section outlines the methodological approach used by WPC in developing forecasts of peak demands at WPC zone sub-stations. Some background material is also reproduced below from the WPC TDAP document.

2.2 Network description

The SWIS is grouped into 12 load areas primarily along geographical lines – Northern Terminal, Muja, Kwinana, Cannington, Bunbury, Western Terminal, East Perth, Southern Terminal, South Fremantle, East Country, Eastern Goldfields and North Country. A new load area called Guildford will be created by the end of 2005 with the construction of Guildford Terminal. A number of existing sub-stations, including Midland Junction, Forrestfield, Darlington and Kalamunda will be allocated to the Guildford load area. The bulk transmission network inter-connects these load areas.

Historically, these load areas tended to consist of a number of zone sub-stations centred on a major terminal station. However, with increasing numbers of sub-stations being cut into inter-connecting transmission lines to minimise zone sub-station establishment costs, the network is becoming increasingly meshed.

Each load area has its own unique characteristics and load growth in the area tends to be influenced by them. For example, the load areas supplying the northern and southern coastal areas are experiencing rapid load growth due to residential housing developments, whereas growth in the Eastern Goldfields area is highly sensitive to the activities of mining companies in response to world metal prices. As might be expected, the greatest distinctions are between load areas that cover urban and rural load areas.

Bulk transmission network

Power is transferred over the 330 kV and 132 kV bulk transmission networks from five major and a number of smaller inter-connected power stations to twelve bulk supply terminals for transformation to lower voltages. Electrical energy is then distributed to a host of zone sub-stations supplying localised areas via the sub-transmission networks operating at 132 kV and 66 kV voltages.

2.3 WPC transmission zone sub-station forecasts

Aside from the Generation Status Review (GSR) by WPC, the network development planning process also requires forecasts for each sub-station and terminal station. To determine system augmentation, the Networks Business Unit (NBU) assesses the network capability against electricity demand forecasts by:

- direct comparison with each network element's thermal rating; and
- computer analysis to identify thermal, voltage, stability and fault rating constraints.

The NBU forecast methodology produces three different demand forecasts for the network. These are:

(i) a coincident summer network peak demand forecast across all zone sub-stations to 2024. That is, a coincident forecast when the overall bulk transmission system is at its peak. This would usually be consistent with when the SWIS system peaks on a generated basis and, therefore, the forecasts should approximately match the GSR forecasts;

(ii) a non-coincident summer peak demand forecast for all zone sub-stations to 2024; and

(iii) a non-coincident summer peak demand forecast for SWIS terminal stations.

The coincident peak forecast is basically the sum of the individual sub-station forecasts at the time of the peak in the bulk transmission network. This is then compared to the GSR forecasts for qualitative assessment.

The non-coincident peak forecasting methodology is based on statistical analysis of historic load information for every sub-station and terminal station. Expected unusual (out of the ordinary) block loads are also explicitly taken into account by WPC when developing these forecasts.

All data used in the WPC in-house forecasting model was obtained from an IRIS database of 5 minute SCADA readings for every feeder at every zone sub-station on the Network. Logarithmic, linear, exponential and power curve fits are calculated from the historical data for each sub-station and terminal station. The equation with the highest multiple regression coefficient (or fit) is automatically selected. Some trends are adjusted to reflect historical load transfers and past/future block loads at sub-stations.

Only sub-stations that have at least four years of historical values are trended forward. Sites with less data or new sub-stations are checked against the system peak trend and further adjusted, if required. The forecasts are also compared against the Contracted Maximum Demand (CMD) for particular sub-stations.

In the WPC document "*Substation Summer Load Trends*", it is also noted that:

(i) load data is not corrected for temperature, weather or day of week;

(ii) load transfers will affect future peak demands at sub-stations. Notes have been made to inform the user of why these transfers occurred;

(iii) the forecasts contained in this document were developed based on the known state of the network at the time of producing the report, other information may come to light in subsequent investigations and the forecasts need to be considered in the light of this

information. Subsequent studies and investigations may require that the forecasts be revised. In such cases the revised forecast supersedes this forecast; and

(iv) these load forecasts also include the **estimated** reinforcement plans and estimated distribution capacity to provide an indication of the available capacity and estimated timing of future works. However, detailed subsequent investigations may result in revised plans. The load transfers and system reinforcements must be confirmed before relying on this forecast (see disclaimer on cover). The plan contained in this document is a preliminary assessment and detailed investigation of reinforcement options will occur.

Figure 2.1 compares the 2004 10 per cent medium forecasts with the generated GSR forecast and the input to network forecasts (WPC summer system peak loads). Table 2.1 shows the 10 per cent medium GSR 2004 forecasts and the input to network forecasts prepared by the NBU of WPC.

Figure 2.1: Comparison of load forecasts and historical data

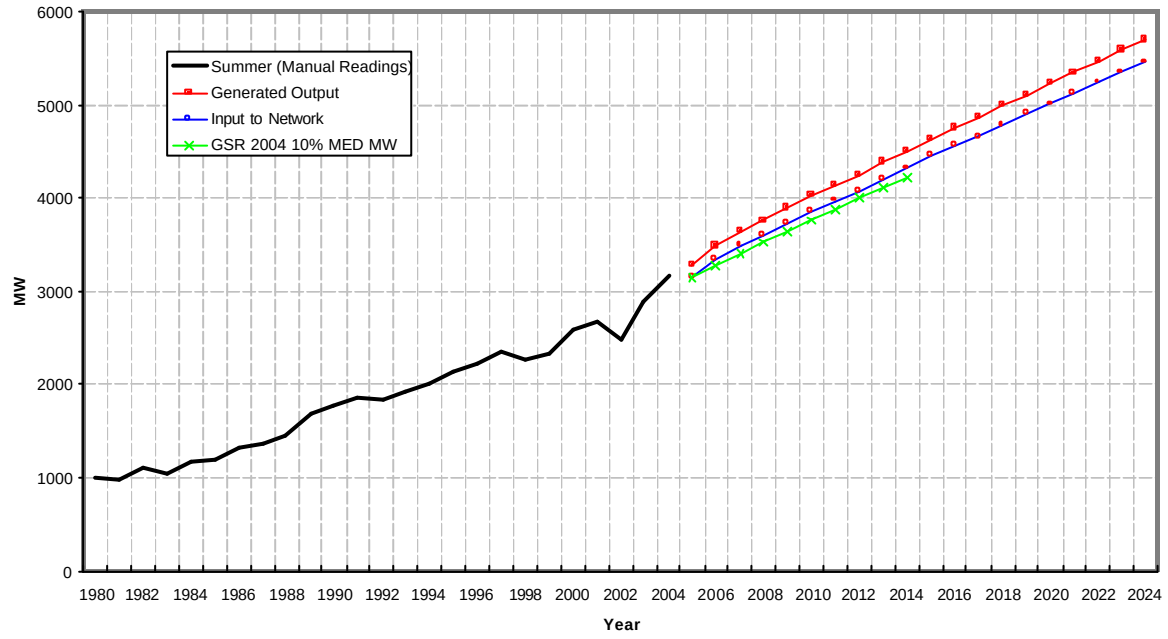


Table 2.1 Comparison of 2004 medium 10 per cent GSR forecast with WPC – NBU input to network forecast (MW)

	Input to network	GSR 2004 10% medium
2005	3149	3148
2006	3339	3276
2007	3484	3403
2008	3597	3528
2009	3725	3639

2.4 Comments on the transmission demand forecasts

The WPC sub-station forecasts are broadly consistent with the 10th percentile GSR medium case forecasts (2004). The sub-station forecasts match the GSR forecast in 2004-05 and then move above the GSR forecast over the 2005-06 to 2008-09 period by between 63 and 85 MW, or between 1.9 and 2.4 per cent. WPC explained this difference was likely to be due to two factors. The sub-station demand forecasts include more recent data on unusual block loads, and they are also based on 5 minute data which would be expected to more accurately capture the maximum demand at a sub-station than if 30 minute data was used, as in the case of the GSR.

The reconciliation of the WPC sub-station forecasts with the GSR forecasts is based on the 2004 network and generation losses. It would be useful to examine these losses over a number of years in order to ascertain whether these loss factors are reasonable in the long term.

2.4.1 Overall, from NIEIR's meeting with officers of WPC, their modelling approach is sound. They have a good understanding of the input data which is of high quality and is quality controlled during processing.

2.4.2 The purpose built model for demand forecasting contains a comprehensive (but possibly inflexible) framework for forecasting zone sub-station peaks. Of the in-house network demand forecasting models, NIEIR has reviewed for various businesses across Australia, the WPC model appears to be one of the best.

2.4.3 WPC does not correct the raw data for temperature, however, the trend lines calculated for each sub-station are upwardly offset to allow for one in ten summers. WPC advise that the method to determine the upward offset has been developed using statistical techniques and has been separately reviewed by John Henstrige from Data Analysis Australia. Details of this review were not made available to NIEIR as this report had been archived by WPC.

2.4.4 Whilst the weather adjustment appears to approximate one in ten conditions, the method may not exactly match the one in ten forecasts contained in the GSR.

2.4.5 NIEIR reinforces and agrees with the approach that planning should be undertaken at the lower level, in order to take into account regional specific information. WPC forecast sub-station peak demands and also the constituent coincident sub-station demands at the time of the system peak. The coincident sub-station demands are added in future years to forecast an overall system demand which can be compared with the GSR forecasts. The correlation between the two forecasts (prepared with two different methods) is very good. WPC's view is that the two approaches consequently provide mutual support within acceptable accuracy for the same result. NIEIR's view is that the coincident and the non-coincident forecasts could be more formally mathematically constrained to the GSR forecasts.

2.4.6 The modelling approach takes no direct account of socioeconomic and demographic trends as they affect each sub-station. WPC implemented and used socio-economic and demographic adjustments previously, however, this approach was abandoned approximately 15 years ago. WPC's experience was that the results using this approach were not consistent from year to year, and with the introduction of SCADA on almost every feeder at every sub-station, the data available made numerical extrapolation more reliable and accurate.

2.4.7 WPC produces load trend reports for both winter and summer (for both system and sub-station peak). Only a handful of sub-stations are in fact winter peaking, however, WPC appear diligent to prepare forecasts for the network under all conditions.

2.4.8 WPC transmission demand forecasts are reasonable and consistent with the GSR and would be expected to have suitable accuracy for their intended use.

3. Transmission energy forecasts

3.1 Introduction

Transmission energy forecasts are required for financial years 2006-07 to 2008-09 to determine the MARY (Maximum Average Revenue Yield) for the transmission network for regulatory purposes.

The Network Business Unit of WPC previously contracted NIEIR to prepare energy and peak demand forecasts for the SWIS to be included in the Generation Status Review report. Transmission energy forecasts are part of this NIEIR work for WPC.

This section briefly outlines the methodological approach used by NIEIR in developing forecasts of transmission energy.

3.2 NIEIR transmission energy forecasting methodology

This section briefly outlines NIEIR's forecasting methodologies and the provision of historical energy data by WPC.

General methodology

Forecasts of SWIS electricity sales were developed within a regional economic model of the Western Australian economy.

This model effectively takes NIEIR's State forecast of gross State product (by industry) and disaggregates it into statistical sub-divisions across Western Australia. As indicated in Figure 3.1, the economic forecasts are consistent with NIEIR's national and state economic models.

Forecasts of regional industry electricity sales

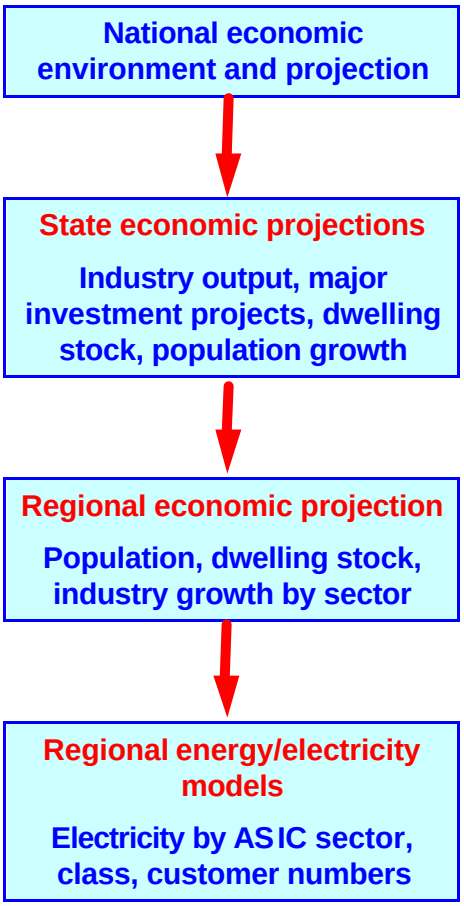
Forecasts of SWIS electricity sales were developed on an industry basis and the region covered is consistent with the relevant electricity distribution area. An outline of the data supplied by WPC to NIEIR is provided further below.

SWIS electricity sales models were parameterised using NIEIR's existing State electricity forecasting model. The structure of this model in terms of industry coverage is shown in Table 3.1.

The industry regression models specifically relate electricity consumption to:

- the change in output for that industry within the electricity distribution area; and
- the change in real electricity prices for that industry (incorporating lags in real prices to proxy the long run response or price elasticity).

Figure 3.1: NIEIR's regional energy model



The output and price elasticities at the regional level were adjusted to reflect differences in the electricity intensity between industries and regions.

Residential electricity sales forecasts are determined from a regression model based on average electricity sales. Average electricity sales per customer are determined from a regression model incorporating real household disposable income per capita, real residential electricity prices and a weather adjustment variable (relevant only for one year out). The relevant income and price elasticities of demand for the residential sector are again taken from NIEIR's Western Australian electricity model.

Residential customer number forecasts are simply linked to NIEIR's forecasts of the dwelling stock for the relevant distribution area. NIEIR's regional economic models include projections of population, household formation, dwelling construction activity and the dwelling stock for each sub-region.

Table 3.1 Reconciliation of major customer class categories with ASIC industries

Customer class category	ASIC
Residential	
Commercial	Water and sewerage
	Construction
	Wholesale and retail trade
	Transport and storage
	Communication
	Finance, property, business services
	Public administration and defence
	Community services
	Recreation, personal and other services
Industrial	Mining
	Food, beverages, tobacco manufacturing
	Textiles, clothing and footwear manufacturing
	Wood, wood products manufacturing
	Chemicals, petroleum, coal manufacturing
	Paper, paper products manufacturing
	Non-metallic minerals manufacturing
	Basic metal products manufacturing
	Fabricated metal products manufacturing
	Transport equipment manufacturing
	Other machinery and equipment manufacturing
	Miscellaneous manufacturing
Farm[1]	Agriculture, forestry, fishing, hunting

Notes: ASIC refers to Australian Standard Industrial Classification.
1. The farm class which excludes residential farm is included in the industrial sector.

Time series regression models were not determined for the SWIS distribution region itself. This reflected a lack of historical industry based sales data. Instead, the SWIS region industry based data could be super-imposed on NIEIR's existing Western Australian industry based electricity forecasting model. This model relates industry electricity demand to specific industry outputs and class based electricity prices. All these equations include distributed lag structures on prices.

The electricity projections by ASIC category for SWIS regions are therefore determined by:

- the outlook for ASIC industry growth in the SWIS region; and;
- the structural parameters and relationships embodied in NIEIR's industry based Western Australian electricity demand model.

Western Power Corporation provided NIEIR with the following data:

- electricity sales by tariff from 1995-96 to 2003-04 for the SWIS;
- electricity sales to the top five customers for 2000 to 2004;
- electricity generated for the SWIS from April 2000 to April 2004; and
- electricity use by the four independent power producers on an annual basis.

From the WPC tariff data, NIEIR aggregated the sales data into the following classes:

- residential;
- business; and
- public lighting.

In order to link the SWIS data appropriately with NIEIR's existing industry based models, NIEIR then disaggregated business sales for the SWIS into industry classes.

NIEIR calculated gross product for the SWIS region by industry class. Then, using the ABARE (obtained by private communication directly with ABARE) electricity consumption data, the State-wide electricity intensity by industry was applied to the SWIS output data. Additional adjustments were required to basic metals and mining electricity use in the SWIS. The basic metals sector includes a number of major cogeneration plants at alumina plants which are not supplied by the SWIS. Industry based sales estimates for the SWIS were estimated for 2001-02.

Forecasts of transmission energy

Forecasts of transmission energy were then estimated from the sales forecast data.

Total sent out = SWIS end-use (customer) sales:

Less Embedded buyback;

Plus Embedded losses;

Plus Distribution losses;

Plus Transmission losses.

NIEIR's forecasting methodology includes assumptions about cogeneration and embedded IPP in the SWIS. Forecasts of embedded buyback are a product of this component of the work. Distribution and transmission energy losses are estimated from a single and constant loss factor rate for each component.

The WPC forecasts of transmission energy, taken directly from the 2004 GSR, are provided in Table 3.2.

Table 3.2	**Projected transmission energy – WPC**
Financial year	Medium (GWh)
2000-01	12,700
2001-02	12,793
2002-03	13,298
2003-04	13,742
2004-05	14,372
2005-06	14,844
2006-07	15,388
2007-08	15,954
2008-09	16,368
2009-10	16,938
2010-11	17,503
2011-12	18,121
2012-13	18,673
2013-14	19,287
Average growth (per cent)	
2004-05 to 2013-14	3.3

Source: 2004 GSR, pp.47.

3.3 Comments on the transmission energy forecasts

3.3.1 WPC approached NIEIR in 2003 to review their internal forecasting methodologies and prepare independent forecasts of maximum demands for the SWIS. The forecasting component of this exercise was repeated in 2004 and the forecasts were subsequently used in the 2004 GSR.

3.3.2 We understand it was the desire of WPC to obtain forecasts, which were methodologically consistent with some of the NEMMCO forecasts published in its Annual Statement of Opportunities for the National Electricity Market. NIEIR developed energy and peak demand forecasts for the SWIS which are methodologically consistent with the approach adopted by NIEIR for the following States:

- Victoria (VENCorp);
- South Australia (ESIPC);
- Tasmania (Transend Networks); and
- Queensland (Powerlink, QLD).

3.3.3 NIEIR reviewed the transmission energy forecasts for WPC and they are consistent with the transmission energy forecasts in the 2004 GSR.

3.3.4 The transmission energy forecasts for WPC will be required to be updated within the Access Arrangement review period as more recent actual data become available.

4. Distribution energy forecasts

4.1 Introduction

Distribution energy forecasts are required for financial years 2006-07 to 2008-09 to determine the MARY for the distribution network for regulatory purposes.

Distribution energy forecasts were prepared by the Network Business Unit within Western Power Corporation.

This section outlines the approach adopted by WPC in preparing their distribution energy forecasts and also their suitability and accuracy.

4.2 WPC methodological approach – distribution energy

There are two key elements to the methodological approach adopted by WPC. These are:

(i) estimating actual sales for total distribution energy; and

(ii) forecasting these energies to 2008-09.

Actual distribution energy sales are estimated by WPC by the following relationship:

> Total distribution energy **equals** Retail sales **plus** Third Party sales **minus** Direct transmission sales

Third Party sales represent around 13 per cent of total distribution energy. These represent lost retail customers from the retail arm of WPC. Direct transmission customers are generally connected to the HV network and, therefore, their tariffs exclude distribution tariffs.

Forecasts of distribution energy to 2008-09 were developed by growing the total distribution energy by the medium sent out energy forecast contained in the 2004 GSR (GSR 2004, Appendix C, Table C.1, pp.47).

For its current submission, the Network Business Unit also estimated total distribution energy for 2004-05 by using a retail forecast from the retail section of WPC and then, as explained above, adding Third Party sales and deducting direct transmission sales. It was assumed that Third Party customer energy for 2004-05 would not change from their historical load. Effectively, this approach estimates the base year of 2004-05 for distribution energy. Thereafter, for 2005-06 to 2008-09, the growth rates from the 2004 GSR are applied as explained above.

Table 4.1 Forecast distribution energy sales (GWh)

Financial year	Forecast sales
2004-05	11,591
2005-06	11,971
2006-07	12,410
2007-08	12,867
2008-09	13,200

4.3 Comments on the NBU forecasts of distribution energy

4.3.1 The distribution energy forecasts are consistent with the 2004 GSR in the sense they use the projected energy growth directly form this document.

4.3.2 The base year 2004-05 distribution energy was estimated using forecasts prepared by the Retail Business Unit.

4.3.3 The calculation of distribution energy for the base year for distribution energy will need to be updated within the Access Arrangement review period.

4.3.4 The forecast for distribution energy growth to 2008-09 will have to be updated within the Access Arrangement review period.

4.3.5 The distribution energy forecasts for WPC will be required to be updated within the Access Arrangement review period as more recent actual data become available.

5. Conclusion

All WPC forecasts appear to be reasonable and consistent with each other. Although NIEIR suggests some methodological improvements to their preparation, the forecasts appear to be suitably accurate for their intended use.

All WPC forecasts will be required to be updated within the Access Arrangement review period as more recent actual data become available.

Appendix A: Scope of works

General

WPC requires NIEIR to verify WPC forecasts for energy and demand, for both transmission and distribution, for each year of the Access Arrangement (2006-07 to 2008-09 inclusive).

Under the proposed Access Arrangement, the total revenue allowed for both transmission and distribution businesses will be directly proportional to the energy transported over the respective networks. Correctly forecasting the energy transported is consequently necessary to ensure the correct revenue is recovered.

Also, the proposed Access Arrangement will include forecasts for operating and capital expenditures for the determination of network access prices. The capital expenditure forecasts for both network businesses will need to be supported by forecasts for energy and demand growth over the regulatory period and are central to the regulatory process.

The ERA, or its consultant, will examine WPC's energy and demand forecasts which will also be subject to scrutiny during the public consultation phases of the regulatory approval process for the Access Arrangement.

Energy and demand forecasts

It is necessary that each of the required forecasts demonstrate consistency in particular between the transmission and distribution energy and demand forecasts and also between those forecasts contained in the Generation Status Review. Any apparent discrepancies must be suitably reconciled.

Forecasts of energy and demand are required to meet the following scope.

1. Transmission demand

Demand forecasts at transmission zone sub-stations are required for 2006-07 to 2008-09. These forecasts are required to verify relevant capital budget forecasts and determine initial transmission access prices. WPC currently prepares forecasts for zone sub-station demand but there is a requirement that these forecasts be independently scrutinised. NIEIR shall review the methodology of preparing these forecasts and all relevant inputs and report on their suitability and accuracy.

2. Transmission energy

Energy forecasts for the transmission network are required for the financial years 2006-07 to 2008-09 inclusive. These are required to determine the MARY (Maximum Average Revenue Yield) for the transmission network for regulatory purposes. WPC currently publishes this information annually in the 'Generation Status Review' document. NIEIR shall review the methodology of preparing these forecasts and all relevant inputs and report on their suitability and accuracy.

If necessary NIEIR will amend the forecasts in the 'Generation Status Review' document after consideration of the most recent available input data.

3. Distribution energy

Energy forecasts for distribution connected customers are required for the financial years 2006-07 to 2008-09. These forecasts are required to determine the MARY for the distribution network for regulatory purposes and to verify relevant capital budget forecasts. NIEIR will review the methodology of preparing these forecasts and all relevant inputs and report on their suitability and accuracy.

Resources

In undertaking the above tasks, NIEIR is required to liaise closely with Western Power. Western Power will make relevant staff available for discussions etc. as required, upon reasonable notice. Western Power will provide all currently available energy and demand data, including historic and forecast data, anticipated major loads additions/removals etc., and also the current 'Generation Status Review' document.

Additional advice

NIEIR will provide, on a needs basis, additional support services during the regulatory consultation and approval phase, in the form of either minor written or verbal submissions or clarifications etc., as requested from time to time.

Deliverables

NIEIR will compile a brief report containing a review of the findings and also all relevant energy and demand forecast data for both the transmission and distribution network businesses. The report shall be a standalone document that may be submitted to the ERA as a supporting document to the proposed Access Arrangement. Please note that the report may be made available to the public and be accessible from the internet sites of the ERA and Western Power Corporation.