Independent Market Operator

# REVIEW OF THE SWIS FORECASTING PROCESSES

# FINAL REPORT

**November 2007**

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## Executive Summary

Long-term forecasts of the maximum demand for electricity and the annual energy consumption are critical to the planning of operations and investment by a range of market stakeholders. Each year, in July, the Independent Market Operator (IMO) publishes 10-year forecasts in the Statement of Opportunities (SOO) Report.

The operation of the Wholesale Electricity Market is governed by the Wholesale Electricity Market Rules (the Market Rules). One of the requirements of the Market Rules is that the IMO must undertake regular reviews of the processes through which the long-term forecasts are prepared. This document reports on the first such review that has been undertaken by the IMO with the assistance of an Advisory Group comprising Market Participants and other industry stakeholders. This review has been undertaken in parallel with a review of the appropriate reliability criteria to be used within the South West Interconnected System.

The IMO published a draft report on its website in September and sought submissions from Market Participants prior to preparation of a final report. The IMO did not receive any formal submissions but input was received from the Advisory Group and this has been taken into account in this final report.

This report considers the purposes for which forecasts are prepared and examines how well the various process functions are undertaken. It identifies areas where the IMO is currently making changes, particularly in the area of electricity usage data, and notes areas where further work is to be undertaken. The report includes a number of recommendations for actions to improve the overall forecasting processes.

The most significant issue raised in this draft report is the substantial changes in the base point for forecasts of maximum demand that have occurred from year to year. While the forecast rate of increase in maximum demand has remained stable at around 3% per annum over a 10-year horizon, there have been step changes in the forecast demand for the initial forecast year. These changes have been of similar magnitude to the year-on-year forecast increases, effectively doubling the rate of forecast increase.

As a consequence, the IMO has recently appointed Frontier Economics to undertake a review of the forecasting processes utilised by the IMO's forecasting consultant.

This draft report recommends a number of process improvements, particularly in respect to:

- The transparency of the forecasting process.
- Assessment of forecasting accuracy.
- Provision of additional historic data.

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# 1. Introduction

Accurate forecasts of maximum demand and electricity usage are crucial for meeting the market objectives of reliable supply and economic efficiency. Forecasts are particularly significant for the SWIS because they are used, through the Reserve Capacity Mechanism, to set the target level of capacity for the system (the Reserve Capacity Target). The Reserve Capacity Target is then used to determine the number of Capacity Credits that will be assigned to generation and demand side management (DSM) facilities.

Accurate forecasts are essential to the Independent Market Operator (IMO) in:

- Determining the quantity of generation and DSM capacity required.
- Providing confidence to the community that adequate capacity will be available to meet demand by providing robust electricity forecasts.

Accurate forecasts are also essential to Market Participants in:

- Determining fuel, staffing and other operational requirements for existing facilities.
- Developing and assessing investment strategies for additional facilities.
- Determining the type of capacity required.

The IMO publishes two sets of forecasts each year in July as part of the Statement of Opportunities Report (SOO). These forecasts cover:

- The maximum demand which is the measure of the highest level of power consumption, measured in megawatts (MW), at any time over the year. This is measured over one half-hour trading interval.
- Sent out energy which is the amount of energy, measured in gigawatt–hours (GWh), consumed within the SWIS over a financial year. This is measured over the full year and is also referred to as electricity sales.

The IMO places considerable emphasis on the shorter-term forecasts that are used to determine the requirement for generation and DSM capacity in accordance with the Reserve Capacity Mechanism. Market Participants also have a strong focus on the 2-3 year timeframe in:

- Finalising strategic decisions such as whether new facilities should be offered into the certification and capacity credit processes.
- Determining their level of exposure to the capacity market and how much capacity they should bilaterally contract.

- Confirming whether older facilities should be retained in service.

However, because of the long life of electricity assets and the time required to bring new facilities on stream, Market Participants must also take a long-term outlook when considering strategic decisions. The IMO and Market Participants therefore need to have confidence that both the shorter-term and-longer term forecasts are reliable if the Market Objective of providing economically efficient and reliable electricity supplies is to be realised.

The Market Rules recognise the importance of the forecasts by requiring the IMO to undertake reviews of the processes by which the IMO forecasts maximum demand. A review must be undertaken at least once every five years. Even though the IMO has not prepared forecasts for five years, a review is being undertaken at this time because:

- At the commencement of the market, the IMO essentially continued the forecasting approach that Western Power had utilised for some years, so the core processes have been in place for around five years.

- The key data gathering processes are being changed because the IMO now has direct access to meter data and information from Western Power's Supervisory Control and Data Acquisition System (SCADA), along with other information, through the Wholesale Electricity Market Systems (WEMS).

- Some obligations for the provision of data, which have previously been imposed only on Western Power and, later, Synergy, may need to be placed on other retailers as they expand their market share.

- It was considered that new Market Participants should be given the opportunity to comment on their requirements for forecast information which may be provided by the IMO.

The IMO has been assisted in this review of the forecasting process by an Advisory Group comprising representatives of Market Participants and other significant stakeholders. The composition of the Advisory Group is provided in Appendix A.

The role of the IMO, and hence the forecasting function, is limited to the South West Interconnected System (SWIS). This covers the area generally bounded by Kalbarri, Kalgoorlie, Albany and the Perth metropolitan region. There are a number of electricity producers and consumers located within this geographic region who do not rely on the SWIS for the majority of their energy. Their demand is excluded from the forecasts. This is explained more fully later in this report.

This report is structured as follows:

- Chapter 2 provides a description of the existing forecasting processes.
- Chapters 3 and 4 address four key issues:
    - What is the purpose of the forecasts that are being prepared.
    - Is the input data correct.
    - Is the forecasting process being undertaken appropriately.
    - How can the accuracy of the forecasts be assessed.
- As part of the review process, the IMO invited submissions from stakeholders. Chapter 5 summarises these along with an assessment of whether information published by the IMO meets users' requirements.
- Chapter 6 summarises the recommendations for change.

# 2. Overview of the Existing Forecasting Process

The forecasting process comprises several distinct processes:

- Collection and collation of data pertaining to historic electricity demand, economic factors and possible future electricity demand.
- Detailed modelling to develop estimates of economic growth for Australia, Western Australia and the region served by the SWIS.
- Detailed modelling to develop estimates of electricity consumption and maximum demand based on the economic modelling and estimates of appliance use (particularly air conditioning).
- Adjustments to include anticipated major new loads and to accommodate different measurement processes.

Each of these processes is discussed below, however, to put the processes in context, a brief discussion is first provided on the actual coverage of the forecasts.

## *2.1 Forecast Coverage*

The forecasts cover the output from all generators that provide electricity into the Wholesale Electricity Market and the demand from all customer loads supplied by the Market namely:

- All electrical loads (ie customers) connected to the SWIS.
- The township of Kambalda, which is supplied from the SWIS via the Southern Cross Energy network.

As indicated above, some major industrial generators and loads are not included within the SWIS forecasts. These generators are referred to as “embedded” as they are directly connected to an industrial facility which consumes most of their generated output. From time to time, these facilities may buy some electricity from, or sell some electricity to, the SWIS. These net electricity quantities are taken into account in the forecasting process but not the gross load quantities.

Industrial loads which are not included within the IMO’s forecasts include:

- The four large alumina production facilities at Kwinana, Pinjarra, Wagerup and Worsley.
- The BP oil refinery at Kwinana.
- The Southern Cross Energy and Goldfields Power systems in the Eastern Goldfields.

## *2.2 Data Collection and Collation*

Much of the forecasting process relies on regression analysis to identify and project trends in economic factors and electricity demand. This detailed modelling is undertaken for the IMO by a consultant, the National Institute of Economic and Industry Research (NIEIR), who have developed historic databases of maximum demand and energy sales. NIEIR has broad experience in the forecasting of electricity demand and provides forecasts for several of the utilities operating within the National Electricity Market. The key data required by NIEIR are the actual electricity demand and actual economic activity over the previous year.

The amount of electricity flowing through the SWIS at any instant is measured at numerous locations by Western Power's Supervisory Control and Data Acquisition System (SCADA). In addition, meters measure the amount of electricity produced by independent power producers and net flows to and from major industrial sites.

Figure 1, below, illustrates the major electricity flows that are measured by the IMO for development of the load forecasts. Data is drawn from four main groups of facilities:

- Generators that are directly connected to the transmission system (Including all of the generation facilities registered to Alinta, Emu Downs Wind Farm and Verve Energy).

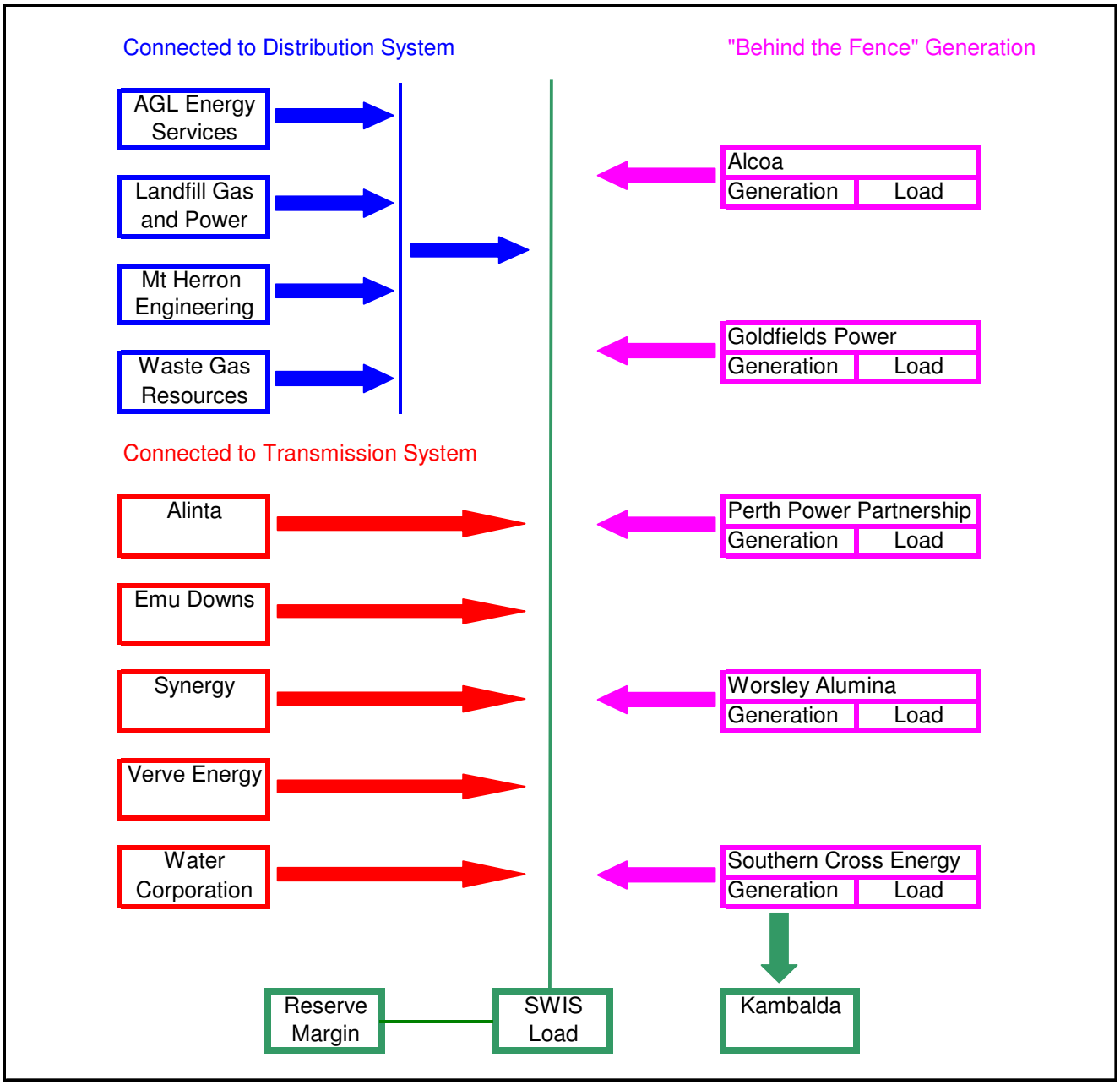
- Generators that are connected through the distribution system (Small landfill gas and biomass generators).

- Demand Side Management facilities (Currently registered to Synergy and the Water Corporation).

- Behind-the-fence generators which supply on-site or local loads and export only a portion of their output into the SWIS (Including the Alcoa and Worsley alumina refinery cogeneration plants, the Perth Power Partnership cogeneration plant and the privately owned generation facilities in the Goldfields).

This data was previously supplied to the IMO by the System Management Branch of Western Power, but most is now directly available through the WEMS. Data is gathered each year after the Hot Season which finishes at the end of March.

**Figure 1. Configuration of Generation and DSM Facilities**




In addition to this load data, NIEIR uses an estimate of the breakdown of demand into various customer categories (eg domestic customers, small and medium enterprises, large industries, etc). This is required because changes in the underlying economic growth within the SWIS region will have different impacts on different sectors of the market.

To date, this customer breakdown has been provided by Western Power or Synergy and this was appropriate when they supplied virtually all customers. However, as the

proportion of customer demand that is supplied by other retailers increases, changes will be required in the data gathering processes. This is discussed in section 3.2.

NIEIR gathers economic data for its economic modelling from the Australian Bureau of Statistics, the Australian Tax Office and the Department of Human Services along with information on economic activity in other countries. This latter data is made available to NIEIR in its role as Australia's representative on the United Nations International Forecasting Review Group.

For electricity forecasting, NIEIR also gathers data on sales and installation of air-conditioning units in Western Australia. This is linked to estimates of utilisation rates and power consumption based on data gathered from the eastern states.

The IMO gathers data directly on expected changes to electricity demand that may arise as major new loads are brought on-stream. The Market Rules specify a formal procedure through which the IMO gathers this information from Market Participants and this is complemented through an informal process of industry networks and press and internet monitoring.

As noted above, there are a number of industries that have both generation and load collocated "behind the fence". These facilities generally export their surplus electricity into the SWIS. From time to time, however, they may draw electricity from the SWIS to cover maintenance of their embedded generation plant. These occasional demands are referred to as intermittent loads and they are identified by the IMO through the facility registration process.

### *2.3 Modelling of the Economic Environment*

The core tool used by NIEIR is their national quarterly econometric model of the Australian economy which provides economic forecasts at the national level. Base, high and low economic scenarios are developed and these are then disaggregated into forecasts at the state level taking into account the individual state projections that have been built into the national forecast.

The State model is used to forecast Gross State Product and other indicators. These are then further disaggregated into the statistical sub-divisions that make up the region served by the SWIS.

### *2.4 Electricity Sales Forecasts – Sent Out Energy*

The term "electricity sales" or "sent out energy" refers to the amount of electricity, measured in GWh, which is produced and sold within the SWIS. The forecasting approach used by NIEIR comprises a combination of:

- A top-down approach based on assessment of national economic factors.
- Cross correlation with historic electricity demand within the SWIS.

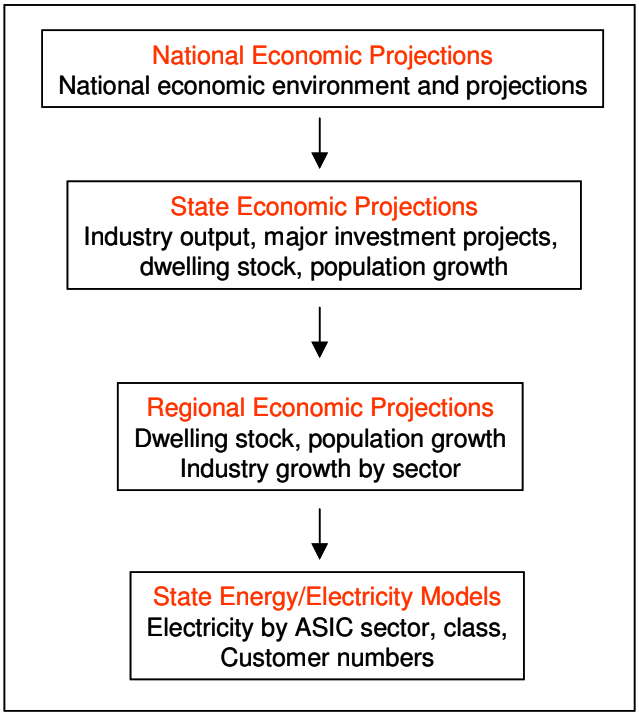
Forecasts for industrial electricity sales within the SWIS are then developed from this data by:

- Identifying the major industry activity within the SWIS based on the Australian Standard Industrial Classification.
- Consideration of the change in output for each industry.
- Assessment of the impact of changes in real electricity prices on each industry.

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 that incorporates real household disposable income and real residential electricity prices. Residential customer numbers are estimated from the forecasts of changes to dwelling stocks derived from the regional economic models.

Once raw estimates have been prepared, NIEIR links these with historical data for electricity sales to residential customers and industry. The gross product for the SWIS region is calculated by industry class and electricity demand is then estimated using energy intensity data for each industry. This forecasting process is shown in Figure 2 below.

**Figure 2. National Economics' Regional Energy Model**




The IMO currently publishes the Expected Forecast which is derived from the base economic assumptions and this is used to determine generation and DSM

requirements. High and Low Forecasts are also published as a guide to possible divergences from the Expected case.

### *2.5 Forecasts of Maximum Demand*

Maximum demand is strongly influenced by ambient temperature with the highest maxima in the SWIS occurring in summer and lower maxima occurring in winter. The influence of temperature requires forecasting of maximum demand to be undertaken using an approach that separately assesses demand from:

- Non-temperature dependent load.
- Temperature dependent load.
- Major industrial load.

Non-temperature dependant load refers to residential, commercial and industrial load that is not influenced by the ambient temperature. The major drivers for growth in this portion of demand are similar to those driving electricity sales, in particular:

- The number of new dwellings.
- The level of economic activity.
- The availability of disposable income.

Temperature dependent load refers to that portion of demand that is strongly influenced by the ambient temperature. In the SWIS, this portion of the load is dominated by air conditioning and other space cooling equipment during summer. In winter, it is mainly electric strip heaters, reverse cycle air conditioning and other heating appliances.

Major industrial loads are separately identified in the forecasting process because their growth is determined by specific industry factors and is generally known with a good degree of accuracy in advance.

The proportions of demand that are temperature or non-temperature dependent are estimated by analysing total demand on days of differing temperature. The demand on a cool summer day generally reflects an underlying level of demand. On a hot summer day, demand will be much higher and the dominant driver for this difference will be cooling appliances. The difference in demand gives a good estimate of the portion of demand that is driven mainly by the temperature.

The penetration of space cooling has risen significantly in the SWIS region over the past few years reflecting:

- The reduced cost and technical improvements in air conditioning.
- Higher disposable income levels.

- Increased construction in both the commercial and residential sectors due to population increases and buoyant economic conditions.

- The increased popularity of townhouses, apartments and retirement villages that are more reliant on artificial cooling.

The annual increase in summer temperature dependent load has been substantially higher over the past few years than in the period ten years ago. As such, it is not possible to rely solely on trend analysis to estimate future demand and NIEIR has developed a quite different approach.

This approach:

- Uses industry sales data to estimate the actual number of space cooling units.

- Projects future sales.

- Assesses the electrical inputs and levels of utilisation at different temperatures.

- Reconciles the increase in temperature dependent electricity load with space cooling capacity estimates.

Forecasts of new units are based on the level of building activity, real income growth and replacement demand. In addition, ambient temperatures are also taken into account as it appears that some 20% to 40% of sales are directly related to past and current summer temperatures.

Because summer maximum demands are so strongly influenced by the ambient temperature, a number of forecasts are prepared for the IMO. Each group of forecasts is based on three sets of temperature conditions:

- The 10$^{th}$ percentile temperature condition which is expected to be exceed only once in every ten years.

- The 50$^{th}$ percentile temperature condition which is expected to be exceeded once in every two years.

- The 90$^{th}$ percentile temperature condition which is expected to be exceeded nine times in every ten years.

The 10$^{th}$, 50$^{th}$ and 90$^{th}$ temperature conditions have been determined by analysis of historic weather data to be those when the mean daily temperature in Perth is 34.9°C, 29.4°C and 27.1°C respectively (note that this is the average of the maximum and minimum and is not time weighted).

As well as being affected by the temperature on a given day, maximum demand is also influenced by the sequence of summers. Forecasts are therefore prepared for 10$^{th}$, 50$^{th}$ and 90$^{th}$ percentile days that occur within a year that is part of a sequence of hot,

average or cool summers. This gives a total of nine maximum demand forecasts for each of the Expected, High and Low economic scenarios.

The maximum demand used to estimate the requirement for generation capacity is the forecast applicable to:

- A 10$^{th}$ percentile temperature condition (ie once in 10 years).
- In a sequence of average temperature years.
- In a year with expected economic conditions.

NIEIR also prepares a winter peak demand forecast. This had been relatively flat for some years but has increased recently due to:

- The higher penetration of reverse cycle air conditioning that is also used for winter heating.
- Renewed popularity of convection heaters such as panel heating units.
- Restrictions on the use of wood fires and non-ducted gas fires.

The winter peak demand is still substantially less than the summer maximum demand in the SWIS.

### *2.6 Timetable for Preparation and Publication of Forecasts*

The forecasting process is an integral part of the Reserve Capacity Mechanism (RCM), a set of processes through which the IMO facilitates the provision of sufficient capacity in the SWIS to meet the reliability criterion (ie maximum demand plus a reserve margin). There are several key dates within this process that define the timetable within which the forecasts must be produced.

- The forecasts should, if possible, be based on the most up-to-date data. The process should not, therefore, commence until generation production data for the Hot Season is available and until the National Accounts figures are available for the previous financial year. This currently sets the process start date at the beginning of April.
- Forecasts are required to be available for the end of May to allow the IMO to prepare the Statement of Opportunities Report, including undertaking the necessary power system modelling, by 1 July.
- The 1 July publication date was set to ensure that Market Participants had the most current data before applying for certification of capacity (which must be undertaken by 20 July). However, Market Participants may have finalised their certification decisions well before this date and actual forecast data may not influence these decisions.

- Market Participants must apply for Capacity Credits through bilateral trade by August 10 so the IMO must have its forecasts completed by this date to determine the quantity of Capacity Credits to be assigned.

- Facilities that undergo the above certification and capacity credit application processes apply are required to be available for service in the reserve capacity year commencing in October two years hence.

- The period of two years from the assignment of Capacity Credits through to the commencement of operation is considered the minimum that should be allowed for major new facilities to be developed.

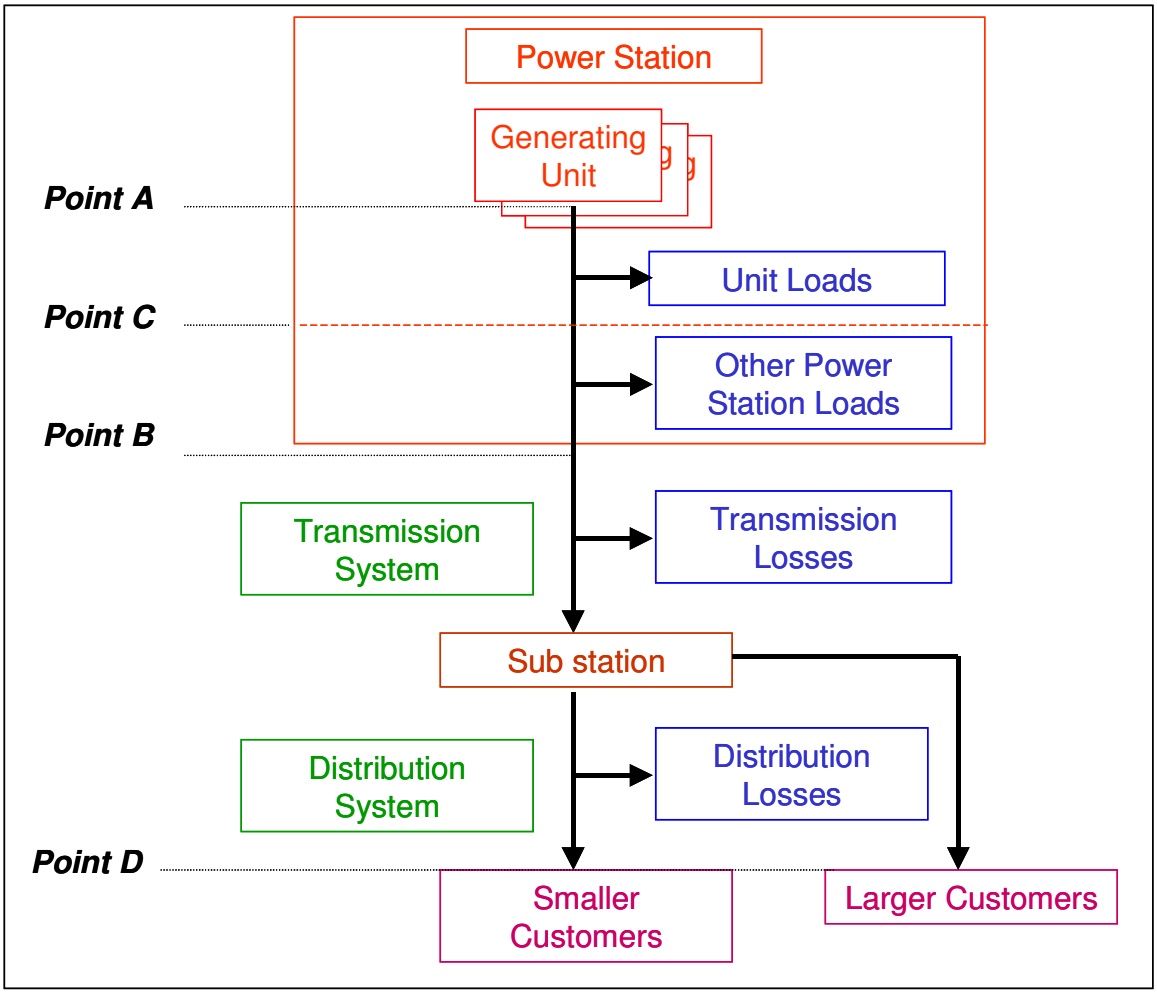
# 3. Review of Input Data

## *3.1 Electricity Load Data*

The introduction of a competitive market has had a marked impact on electricity load data requirements. When the bulk of electricity was supplied by a vertically integrated monopoly, data was mainly required for system control. The only data required for revenue purposes was provided by meters at customers' premises. With several generation companies now competing directly, it is necessary to separately measure the output from each power station.

Electricity usage is measured at a number of locations throughout the SWIS either by meters or through Western Power's SCADA. By monitoring different measurement locations, it is possible to measure various electricity flows to meet specific purposes. One of the results of this is that a number of different figures are published, all of which can be referred to as electricity consumption or maximum demand. This is illustrated in Figure 3, below.

**Figure 3. Electricity Flows and Losses**



This figure illustrates the flow of electricity from power stations through to customers and shows the losses that occur in this process.

Electricity is produced by each of, generally, several generating units within a power station complex. The amount of electricity that is produced at the generator terminals of each unit is referred to as the "generated" quantity and this represents the gross output of each unit. In the diagram, this is shown as being measured at Point A.

Historically, the normal measure of electricity production and demand in Western Australia was this generated quantity. However, a significant amount of electricity, in the order of 5-8% for a coal-fired power station, is used within the power station complex.

Most of this usage is linked to the operation of the individual generating units where it is consumed by the electrically powered auxiliaries such as coal crushers, water pumps or air fans. These auxiliaries will generally be supplied by the transformer that is associated with the individual generating unit, the Unit Transformer. The remaining electricity will then be delivered to the power station switchyard from where it will be injected into the SWIS.

As well as all of the unit auxiliaries, power will be taken for various other loads within the power station complex which could include offices, workshops and lighting.

In Figure 3, Point B represents the point at which electricity is sent out from the power station into the SWIS. For most power stations on the SWIS, this sent out figure measures the net amount of electricity that the power station actually injects into the transmission system for on-sale. This electricity, less any losses within the transmission and distribution system, is available for sale to retailers or major customers.

The electricity flows at each of these various locations can be measured by SCADA and, as indicated in Section 2, different combinations of these readings can be combined to give varying measures of electricity usage. At Muja and Kwinana power stations, the sent out energy figure is recorded at the Unit Transformers at Point C. All of the electricity used for the auxiliary plant associated with each generator is netted out but the consumption over the remainder of the power stations is recorded as part of the SWIS load.

With this approach, the sent out electricity figures published by the IMO, and previously published by Western Power:

- Exclude all electricity used within generating units such as that used to drive coal mills, pumps or fans.

- Include some electricity that is used within power stations, where this is supplied through a separate connection, as part of the system load. (This electricity is used for power station buildings, lighting and similar requirements).

- Differ from the figures published by System Management as those figures include all electricity used in power stations. (System Management figures are a few percent higher than the IMO figures).

- Differ from the sent out metered figures published by Western Power because those figures exclude all electricity used in power stations and exclude generation connected to the distribution system. (Western Power figures are a few percent lower than the IMO figures).

- Differ from the Operational Load figures published by the IMO as these figures are loss factor adjusted to the Muja reference node. (The Operational Load figures are a few per cent higher than the IMO sent out figures).

Each measurement approach has been adopted for a specific purpose and none is inherently better than any other. The IMO considers that the raw sent out figures are appropriate for the purpose of determining the requirement for generation and DSM capacity because:

- Sent-out measurements are used as the basis for determining the Reserve Capacity Target, and for assigning Capacity Credits within the Wholesale Market.

- Most output data provided by generation facilities is provided on a sent-out basis.

- Market Participants, and prospective developers, need information on the amount of electricity that they can provide from their power stations.

- This approach readily accommodates inputs from, and exports to, major industrial sites.

- Forecasts currently published by the IMO and, previously, by Western Power Corporation are aligned to the IMO sent out figures.

The forecasts that are published by the IMO cover all generation and consumption that is identified as “SWIS load” in Figure 1. However, the electricity usage data that has historically been supplied to NIEIR, and which make up the historic databases used for forecasting, does not exactly correspond with this. There are a number of key differences:

- It includes all electricity produced by Verve Energy including that portion which is used within the generating units and not provided into the SWIS.

- The electricity generated by embedded generators is measured but the electricity used by on-site loads, where these are co-located, is not measured.

- It does not fully account for some intermittent generation supplied to the SWIS by large industrial generators.

The forecasts provided by NIEIR in past years do not fully correspond with the IMO's current requirements and the IMO adjusts these to effect the correction. However, with the enhanced data provision that is now available through the WEMS, NIEIR are changing over to preparation sent-out forecasts directly.

The final adjustment made by the IMO is to include any major new loads that are expected to be brought on line over the period of the forecast.

***It is recommended that the forecasts prepared for the Statement of Opportunities Report continue to be provided on a sent-out basis (while acknowledging that this does not include all electricity used within Muja and Kwinana Power Stations).***

### *3.2 Customer Sales Data*

At present, Synergy provides data to the IMO in respect to the numbers of customers that fall into each of its various tariff classes. This data is used to allow differing growth rates to be applied to the various market segments (eg domestic customers, small commercial enterprises, etc).

When Synergy, or its predecessor Western Power, supplied electricity to virtually all customers it was appropriate that they provide this information but several factors now make this less suitable:

- Approximately half of all energy sold in the SWIS is to customers who are eligible to choose their supplier so it is likely that a significant proportion of sales will be made by retailers other than Synergy.

- As competition increases within the SWIS, it is likely that customers will be encouraged to move away from tariffs and onto contracts so that the current tariff classes will be less meaningful.

- Classification of customers by tariff class does not necessarily provide the level of granularity required for good forecasts to be developed. Similarly, defining customers just as "contract customers" will only provide limited information.

A new approach is required which provides the depth of information necessary to forecast growth of customers who are supplied through contracts as well as those who remain on tariffs. The first step in this would be to determine the actual classification groupings that are required and to classify all customers.

It is important that this process use a common classification basis as well as being undertaken in a manner that does not impose significant burden on Market Participants. The IMO proposes to work with other Market Participants to scope the extent of this work and determine the most efficient approach. The IMO will also seek advice from the Australian Bureau of Statistics in respect to classification.

***It is recommended that the IMO and Market Participants jointly determine the most efficient mechanism to classify customers for the purposes of identifying energy usage by customer groups.***

### *3.3 Major New Loads and Intermittent Load Data*

The Market Rules require the IMO to seek information from Market Participants, and others, in respect to generation and intermittent load facilities as part of the process for developing the SOO. The IMO has expanded this requirement to cover information in respect to any major new loads that the market participant anticipates will be brought on-line. This is covered in a Market Procedure.

The IMO also liaises with Western Power to identify potential new loads. This process is limited, however, by confidentiality obligations on both parties. It is considered that the IMO and Western Power should seek to identify mechanism whereby information can be shared without jeopardising the commercial interests of stakeholders.

***It is recommended that the IMO continue to work with Western Power to identify ways in which information about potential new customers can be shared.***

### *3.4 Air Conditioning Data*

The impact of air conditioning load has been identified throughout Australia as a major factor in developing forecasts of electricity demand. There is insufficient historical data to develop projections of demand and it is necessary to rely on estimates of unit sales and usage. To date, NIEIR has developed demand estimates using data provided by equipment retailers and manufacturers. In addition, the IMO is liaising with the Load Forecasting Reference Group (LFRG), which represents planning groups throughout Australia, in seeking to determine an appropriate course of action to:

- Validate current air conditioning data sets.
- Enhance forecasts of the penetration levels.
- Identify potential saturation rates.

***It is recommended that the IMO continue to work with the Load Forecasting Reference Group to identify ways in which air conditioning data can be enhanced.***

# 4. Review of the Modelling Processes and Outcomes

## *4.1 Review of NIEIR Forecasting Processes*

The IMO has not undertaken a formal review of the forecasting processes used by NIEIR. However, in 2005, KEMA Consulting undertook such a review on behalf of the National Electricity Market Management Company, NEMMCO. The KEMA report was published in July 2005 and is available at http://www.nemmco.com.au/nemgeneral/kema.htm.

In its report KEMA states [p1] that *"[t]wo particular concerns on the part of users and the developers of the forecasts provided an impetus for this study:*

1. *The appropriateness of the "probability of exceedence" (POE) forecasts. In particular, some Market Participants have questioned whether the 10% POE forecast (expected to be exceeded 1 year in 10) is unreasonably greater than the base or 50% POE forecast. This question is a concern because various applications of the 10% POE forecast drive costs to Market Participants.*

2. *How the increase in air conditioning use is being handled in the forecasts. Rising air conditioning use is the chief reason for the divergence between the 10% and 50% POE forecasts, and for uncertainty in these forecasts."*

KEMA's report [p2] indicates that the forecasting processes and methods use internationally recognised good practices. It states that *'[t]he overall approaches used by the parties involved in developing the forecasts process are sound, and combine good technical methods with good judgement and experience. No major flaws have been found."*

It identifies [p2] two primary areas for improvement:

- "*validation, interpretation and communication of results; and*

- *potential refinements to the models to address some challenges and subtleties of the processes*."

KEMA describe [p2] this improvements as *"'tying up loose ends' to bring the overall good practices to a 'world's best practice' level*".

In respect to modelling of weather sensitivity, KEMA state [p4] that *"[t]he NIEIR and TransGrid [the NSW transmission system owner and operator] approaches both involve explicit modelling of weather sensitivity, and projection of increased weather sensitivity reflecting growth in air conditioning loads. The methods differ in the specifics of how weather sensitivity is addressed. Both NIEIR and TransGrid have given considerable attention to these modelling steps, testing alternative modelling specifications. While this review has identified some potential improvements to the modelling approaches, the overall structure and the attention given to details represents good practice. Care with the weather sensitive load is important given that air conditioning is the main source of the divergence between the 10% and 50% POE forecasts for any given year,*

*and growth in air conditioning is a key source of uncertainty regarding even the base 50% POE forecast".*

In considering the strengths of NIEIR's method, KEMA state [p4] that *"NIEIR's top-down forecasts are derived from its IMP [Institute Multi Purpose] model. This is a large econometric model of the Australian economy that captures inter-relationships among national and state economic indicators, energy demand, and energy prices. The model has been developed and refined over the past 20 years, and is used by NIEIR in a variety of applications. Assessment of the model itself was beyond the scope of this evaluation. However, use of such an integrated and highly developed modelling system represents an advanced forecasting approach*."

KEMA identified a number of areas for potential improvement.

***Documentation -*** KEMA commented [p5] that the "*level of documentation of load forecasting methods contained in the SOO, APRs [Annual Planning Reports], and publicly available NIEIR documents is adequate for users to have a general understanding of the types of data used, analysis performed, assumptions, and rationale. However, KEMA recommends a higher level of documentation and transparency, with appropriate protections for proprietary methods and information. A higher level of documentation will both establish greater credibility among Market Participants, and help ensure that the process can be maintained in the future*."

***Backcasting –*** KEMA recommended [p6] "*more complete and consistent presentation of model validation results via 'back-cast' analysis."* KEMA further recommended [p7] that *"the back-casts should take into account actual economic conditions as well as actual temperatures. In addition, back-casts should validate more than the first projected year of each set of 10-year projections."*

***Staff –*** KEMA noted [p6] that forecasting processes are always subject to disruption and discontinuities in the event of retirement or other departure of key staff. It noted that many of the forecasting staff are of an age when retirements within the next few years are not unlikely.

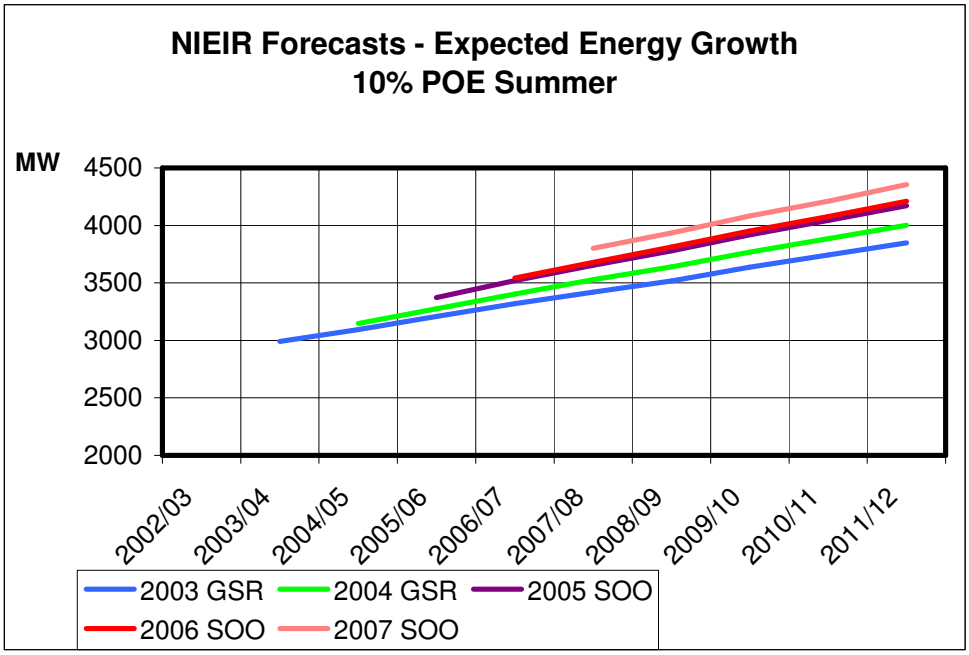
***Modelling increasing air conditioning ownership –*** KEMA noted [p6] that *"[a]ll forecasters recognise the uncertainty in air conditioning growth as a key source of uncertainty in the base forecasts, and temperature variation as the basis for the difference between the 10% and 50% POE forecasts. All use some judgement in defining the shape of the growth trajectory."*

KEMA noted [p6] that there are no ideal solutions to this problem. They recommended "*the JPBs [Jurisdictional Planning Bodies] continue to investigate alternative approaches. We further suggest that the JPBs consider establishing a framework for making assumptions and/or trajectories explicit and comparable even if different modelling approaches are used'.*

In summary, the KEMA review indicates that the overall processes used in developing forecasts for NEMMCO, including NIEIR's processes, are sound. However, the IMO is

concerned that the forecasts provided by NIEIR over the past few years have not been consistent over time. Figure 4 below shows the forecast maximum demand through to 2011/12 as forecast in the 2003 and 2004 Generation Status Reviews (GSR), published by Western Power, and the 2005, 2006 and 2007 SOO reports published by the IMO.

**Figure 4 – Forecasts of Maximum Demand**




*Note that the demand from the Boddington Gold Mine has been excluded for comparison purposes as this load was not included until the 2006 forecast.*

It can be seen from this figure that there have been substantial step changes in the maximum demand forecasts in most years over the period from 2003 to 2007. The most recent forecast of the 2007/08 maximum demand is 11% (391 MW) higher than the 2007/08 forecast prepared in 2003. These step changes are of a similar order of magnitude to the forecast year-on-year growth. In other words, whilst the peak demand has been forecast to grow at an average of just over 3% per year in each of the forecasting reports, the base point from which that growth will occur has also been rising at close to 3% per year.

NIEIR has indicated that the major factor in these changes is underestimation of the demand increases arising from air conditioning units. A second factor is that growth in economic activity in Western Australia was much higher than had been forecast (not only by NIEIR but by other reputable agencies).

The IMO has now appointed Frontier Economics to undertake an independent review of the forecasting process and to identify any underlying issues, and identify potential improvements.

The main objectives of this review are to:

- Determine whether there are any systemic issues that are leading to incorrect forecasting of the maximum demand.
- Identify practical ways in which the forecasts can potentially be improved.
- Identify any mechanisms that NIEIR and/or the IMO can put in place to gain a better estimate of air conditioning demand.
- Estimate the possible error bounds of the existing forecasting process.

***It is recommended that the IMO work with NIEIR, and other forecasting jurisdictions, to develop more comprehensive documentation of the forecasting process.***

***It is recommended that the IMO work with NIEIR, and other forecasting jurisdictions, to investigate improvements to the air conditioning models.***

### *4.2 Backcasting*

Forecasting accuracy is affected by two main factors:

- The values contained in the input data.
- The veracity of the forecasting models.

Backcasting is a process that seeks to assess the veracity of the models by using known data to forecast a known result. In essence, a forecast is prepared for a year that has already occurred and the forecast outcome is then compared to the results actually recorded. The actual data from a recent year is fed into the modelling system and forecasts will be developed from these. If the modelling is accurate, the forecasts that are prepared should correspond to the actual figures that have been recorded for that year.

The maximum demand during any summer will depend primarily on two factors:

- How high the temperature is on any particular day.
- How hot the whole summer has been.

Air conditioning equipment, which has a major impact on the level of electricity demand, will tend to be used more on a day that falls within a sequence of hot days. This is probably because under these conditions, buildings tend to store heat and not cool down overnight. It may also be that the media stresses the duration of the hot weather and people's tolerance of the heat reduces. This is reflected in higher usage of air conditioning and other cooling facilities.

If a similar day were to occur during a cool summer, buildings are not as hot, peoples' tolerance may be higher and air conditioning usage is reduced. As a result, the maximum electricity demand is likely to be much lower.

NIEIR provides a matrix of nine maximum demand forecasts reflecting the combinations of hot, medium and cool summers and 10th, 50th and 90th percentile days. In the backcasting process, actual maximum demand data can be plotted against these various forecasts to assess how well they correlate.

NIEIR has undertaken this work in some detail for both Victoria and South Australia over the past couple of years and this has indicated that their forecasts are generally robust. Details of this work are available at the NEMMCO website (www.nemmco.com.au). The IMO understands that backcasting is being undertaken in the other states within the NEM though the results have not been made public.

Half hourly load data, which is required for backcasting, is only available in the SWIS for the years since 2000/01. However, NIEIR has indicated that even with this limited amount of data, backcasting could still provide useful information in respect to the accuracy of past forecasts. The IMO considers that a backcasting exercise should be undertaken in time to ensure that the results can feed into the preparation of forecasts for the 2008 SOO.

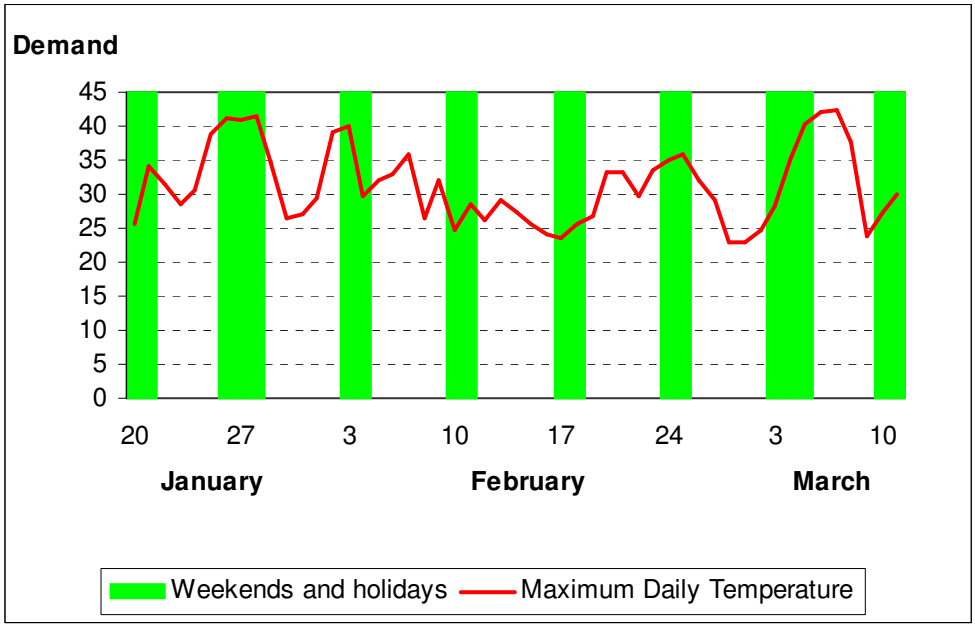
***It is recommended that the IMO consider requesting NIEIR to undertake backcasting as a regular part of the forecast preparation process and that the results of this be published by the IMO. This should be undertaken prior to preparation of the 2008 SOO***

### *4.3 Back Assessment of Actual Loads versus Forecasts*

In April 2007, the IMO undertook a review of the 2006/07 summer peak demands to assess whether the forecast provided in the 2006 SOO was consistent with actual recorded demands in the period from mid-January to March on business days. This period is chosen because electricity demand is generally lower during the remainder of the Hot Season, due to school and industry holidays, and on non-business days.

There were two sequences of above 40°C days during the 2006/07 summer as shown in Figure 4 below. Over the period of January 26, 27 and 28 the sequence of daily maximum temperatures was 41.2°C, 40.9°C and 41.6°C. The minima between these peaks was 23.2 °C. Over the period of March 5, 6 and 7 the temperature sequence was 40.4°C, 42.0°C and 42.4°C. However, the overnight temperature on the morning of March 7 was only 18.6°C.

**Figure 4 – 2007 Summer Temperatures**




The first of these hot sequences occurred over the Australia Day long weekend which meant that the maximum demand was much lower than if it had occurred over a series of business days. The second hot sequence also commenced on a public holiday but the next two hot days were business days. Despite the relatively low overnight temperature on March 7, the system maximum demand was recorded on that day.

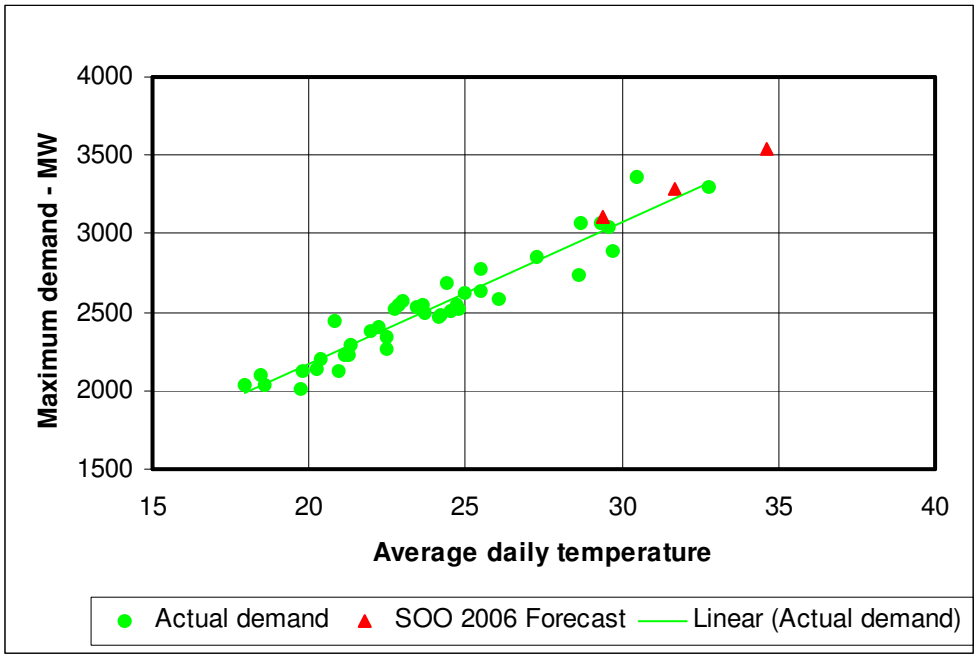
Figure 6 provides a comparison between the actual maximum demands and the forecasts provided within the SOO. The three forecast points representing the maximum demands associated with the 10th, 50th and 90th percentile average daily temperatures are shown as red triangles.

The actual data and the linear trend line, which are shown in green, are for business days during the period mid-January through to mid-March and so are aligned with the forecast figures.

The maximum of 3,364 MW recorded in the 2006/07 summer was some 180 MW below the 10$^{th}$ percentile maximum forecast of 3,541 MW. However, the data point for this day, March 7, is above the linear trend line. This may be because the overnight temperature was quite low, thereby lowering the daily average. However, it may be an indication that the actual figure exceeds the forecast due to a systemic issue. This will be examined during the independent review of the forecasting process.

**Figure 6. Maximum Demand v Average Daily Temperature**

**Actual and Forecast**




Information on actual temperatures and loads, along with a comparison of the forecasts, is likely to be of interest to stakeholders. To date, the IMO has not published this information but it is recommended that this be done in future.

***It is recommended that the IMO publish a comparison of actual maximum demands compared to forecasts at the end of each Hot Season.***

### *4.4 Review of Economic Forecasts*

The maximum demand and energy forecasts are currently prepared on a very tight timeframe due to the desire to use the latest available data while publishing results ahead of the certification and capacity credit assignment processes. To achieve this timetable, NIEIR provides the IMO with summaries of the economic and electricity forecasts as soon as these are available whereas the text that describes the process drivers is provided somewhat later. The IMO is provided limited opportunity to review the economic forecasts .

This situation also applies for the other utilities that use the NIEIR forecasts and this is discussed in the KEMA report. KEMA noted [p32] that *"NIEIR must do a large volume of work in a very compressed timeframe. In practice, this means that the JPB [Jurisdictional Planning Bodies] staff typically receive estimates without accompanying documentation just in time to produce the APRs [Annual Planning Reports], with the reports following sometime later. The lack of documentation with the delivered*

*estimates makes it more difficult to review them and refine assumptions prior to finalizing the numbers for the SOO".*

Providing a mechanism through which the economic forecasts could be reviewed before the electricity forecasts are prepared would provide greater transparency and allow potential issues to be resolved. While consideration could be given to extending the timeframe for preparation of the SOO, this is not favoured by the IMO.

The national accounts data used by NIEIR is published every three months. NIEIR base their economic forecasts on the full year data because this includes any revisions made to correct inaccuracies in the three monthly data sets. It would be possible, however, to use the nine-month figures to develop preliminary economic forecasts and provide these to the IMO. This could be done in sufficient time for a high level reasonableness check to be undertaken and any major differences of opinion to then be resolved. The full year national accounts data could then be used to finalise the economic forecasts.

This approach would require additional work to be undertaken by NIEIR. While there may be some additional costs incurred as a result, it is considered that the opportunity for stakeholders to review and make comment on the economic forecasts may be of value.

Backcasting of the economic data could also be used as a mechanism to assess the veracity of the forecasting processes.

***It is recommended that NIEIR be contracted to prepare a preliminary economic forecast, based on nine-month national accounts data, for review and comment by the IMO and stakeholders.***

***It is recommended that NIEIR be asked to provide comment on its backcasting of its economic modelling at a National, State and Regional level prior to preparation of the 2008 SOO.***

# 5. Meeting the Requirements of Users

In November 2006, the IMO invited interested parties to provide submissions in respect to both the forecasting process and system reliability. All key stakeholders were advised by email of this request and submissions were received from:

- Alinta Sales Pty Ltd.
- Synergy.
- Western Power (covering both Networks and System Management perspectives).

Copies of the submissions, which also provided comment on the parallel review of the SWIS reliability criteria, are available on the IMO website at www.imowa.com.au. The main issues raised in respect to forecasting are discussed below.

## *5.1 Forecast Peak*

Alinta advised that it considers the current approach to demand forecasting, which uses the 1 in 10 year peak demand as a guide to system maximum demand, to be a good balance between security/reliability and cost efficiency. Alinta does not support a more onerous criterion for forecasting the system peak.

The IMO notes this and confirms that the 1 in 10 year peak is to be retained.

Western Power suggested that use of the one-in-two-year forecast would be superior to using the one-in-ten-year forecast because it is based on a larger number of data points. However, both forecasts should still be published.

The IMO notes this comment and will address the matter with NIEIR. However, an initial comparison of the 1 in 10 year and 1 in 2 year forecasts prepared by NIEIR shows a virtually constant relationship between the two. This suggests that the gain in accuracy from changing would be minimal.

## *5.2 Forecasting Approach*

Synergy sought further detail on the forecasting approach utilised by the IMO and its consultant. It also asked for more information on the details of the forecasting models along with comparisons between forecast and actual demands over recent years.

Western Power sought further information about the methodology used by the IMO to produce its published values. It noted that the methodology used by Western Power to prepare the ST PASA and MT PASA does not give the same results for the peak day demand as the IMO approach.

The IMO notes these comments and this report recommends that further documentation of the NIEIR processes be prepared. It is anticipated that the independent review of NIEIR's processes will provide further transparency and information on the models.

### 5.3 Base Data used for SWIS Forecasts

Western Power sought clarification of the exact make up of the base load that is used in preparing the system load forecast. In particular, clarification as to whether generators connected at the distribution level, which have been assigned Capacity Credits, have been included in the past forecasts or whether this embedded generation has been seen as a reduction in system load.

Western Power also sought further data on the measurement points used by the IMO to ensure consistency with the transmission system planning.

The IMO has sought to define the generators and connection points through this report. It notes that all generators connected at both the transmission and distribution systems are separately metered and so are separately included within the forecast data published within the SOO. It is noted that some distribution-connected generation was included as negative loads within earlier forecasts prepared by Western Power, however, the total output of these generators was small.

### 5.4 Changing Environment

Western Power commented on the need to be aware of changes due to changes in climate and lifestyle. It noted that using older historic data could lead to errors and that restricting data to the past 10 years may give better estimates of future demand.

The IMO will raise this issue with NIEIR. This comment is particularly relevant in respect to the treatment of air conditioning load and the IMO notes NIEIR's approach to using other approaches to ensure that demand from air conditioning is better understood, and is effectively forecast.

### 5.5 Further Market Participant Information

In general discussions with the IMO, other stakeholders have also indicated that they would like additional information to be included within the SOO. In considering the requests for further information the IMO notes that past versions of the SOO have contained less data than the GSR that was published by Western Power prior to establishment of the IMO largely reflecting the vertically integrated and largely monopoly role of the previous Western Power.

Data that has been specifically requested includes typical load shapes and load duration curves. Some additional data has been provided in the 2007 SOO and the IMO will assess what further data can be provided in future years.

The GSR provided significant information about the actual performance of Western Power's generation facilities, including their actual output, which would not be appropriate for publication in the competitive market environment. This was published as part of Western Power's obligation to secure new capacity through a power procurement process. The information allowed prospective developers to determine the most appropriate type of facility to offer.

Chapter 10 of the Market Rules requires the IMO to publish:

- Names and capacities of all Registered Facilities registered to each market Participant.

- The total amount of Capacity Credits held by each supplier (at the Market Participant level).

Some stakeholders have indicated that they would like the Capacity Credits assigned to each Facility to be published. It has been pointed out that this information can be deduced for Market Participants that have only a single facility, or which add new facilities to the system. Keeping this information confidential is seen as providing a benefit to operators of multiple facilities. It is recommended that a change be proposed to the Market Rules such that this information is provided to all Market Participants.

Stakeholders have also asked that details of proposed facilities that are included within Expressions of Interest (EOI) be made available. While some of these facilities have made public announcements of their plans, a number have not and the IMO considers that requiring this information to be made confidential may discourage persons from responding to the EOI request.

Synergy sought further data on the quantities of electricity produced by each credited generator with estimates of future production.

The IMO is not in a position to estimate future production from generators as it is does not have access to the requisite cost information nor does it have appropriate power system models. (The power system modelling undertaken as part of development of the SOO considers only reliability.) Forecasting of future operations would not be an appropriate function for the IMO.

***It is recommended that further system information, including typical load shapes and the annual load duration curve, be published within the Statement of Opportunities Report.***

***It is recommended that the IMO progress a Rule Change to allow it to publish the quantity of Capacity Credits that are assigned to each generation facility and each DSM program.***

# 6. Summary of Recommendations

***It is recommended that the forecasts prepared for the Statement of Opportunities Report continue to be provided on a sent-out basis (while acknowledging that this does not include all electricity used within Muja and Kwinana Power Stations).***

***It is recommended that the IMO and Market Participants jointly determine the most efficient mechanism to classify customers for the purposes of identifying energy usage by customer groups.***

***It is recommended that the IMO continue to work with Western Power to identify ways in which information about potential new customers can be shared.***

***It is recommended that the IMO continue to work with the Load Forecasting Reference Group to identify ways in which air conditioning data can be enhanced.***

***It is recommended that the IMO work with NIEIR, and other forecasting jurisdictions, to develop more comprehensive documentation of the forecasting process.***

***It is recommended that the IMO work with NIEIR, and other forecasting jurisdictions, to investigate improvements to the air conditioning models.***

***It is recommended that the IMO consider requesting NIEIR to undertake backcasting as a regular part of the forecast preparation process and that the results of this be published by the IMO. This should be undertaken prior to preparation of the 2008 SOO.***

***It is recommended that the IMO publish a comparison of actual maximum demands compared to forecasts at the end of each Hot Season.***

***It is recommended that NIEIR be contracted to prepare a preliminary economic forecast, based on nine-month national accounts data, for review and comment by the IMO and stakeholders.***

***It is recommended that NIEIR be asked to provide comment on its backcasting of its economic modelling at a National, State and Regional level prior to preparation of the 2008 SOO.***

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## Appendix A – Composition of the Advisory Group

| Organisation | Representative |
|---|---|
| Alinta Sales | Mark McKinnon |
| Chamber of Commerce and Industry WA | Jessica Shaw |
| Griffin Energy | Shane Cremin |
| Independent Market Operator | Patrick Peake |
| Independent Market Operator | Troy Forward |
| Office of Energy | Matthew Martin |
| Synergy Energy | Stephen MacLean |
| Verve Energy | Andrew Everett |
| WA Chamber of Minerals and Energy | Rob Swan |
| Western Power (Networks) | Peter Ang |
| Western Power (System Management) | Murray Caston |

Note: The Department of Treasury and Finance declined an invitation to join the Advisory Group.

## Appendix B – Glossary

| | |
|---|---|
| APR | Annual Planning Report |
| DSM | Demand Side Management |
| EOI | Expression of Interest |
| GSR | Generation Status Review |
| GWh | Giga Watt hour (one million kilo watt hours) |
| IMO | Independent Market Operator |
| JPB | Jurisdictional Planning Body |
| LT PASA | Long Term Projected Assessment of System Adequacy |
| MW | Mega Watt (one thousand kilo watts) |
| NEMMCO | National Electricity Market Management Company |
| NIEIR | National Institute of Economic and Industry Research |
| POE | Probability of Exceedance |
| RCM | Reserve Capacity Mechanism |
| SCADA | Supervisory Control and Data Acquisition System |
| SOO | Statement of Opportunities Report |
| SWIS | South West Interconnected System |
| WEMS | Wholesale Electricity Market System |