

# 2011



## NATIONAL ELECTRICITY FORECASTING

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# FOREWORD

AEMO is changing the way it develops and publishes demand forecasts for the electricity industry.

In the past, AEMO has published demand forecasts in a series of AEMO publications, namely the Electricity Statement of Opportunities (ESOO), the Victorian Annual Planning Report (VAPR), and the South Australian Supply and Demand Outlook (SASDO).

In these publications, AEMO has developed demand forecasts for South Australia and Victoria, whilst the regional Transmission Network Service Providers (TNSPs) have developed demand forecasts for the remaining three states in the National Electricity Market (NEM), namely Queensland, New South Wales (including the Australian Capital Territory), and Tasmania.

These forecasts are used for both operational purposes, including the calculation of marginal loss factors, and as a key input into AEMO's national transmission planning role. It is therefore crucial for AEMO to understand how these forecasts are developed, and to ensure forecasting processes and assumptions are consistent across regions, to make certain they are fit for purpose.

Moving forward, AEMO aims to develop demand forecasts for all five regions in the NEM. As part of this process, AEMO is initiating a new stakeholder engagement campaign to work together with members of the electricity industry to produce a set of representative and reliable demand forecasts. This will involve ongoing contact between AEMO and members of the electricity industry through a series of newly established reference and regional stakeholder networks.

This report is the first information paper in a series that represents AEMO's work in developing new demand forecasts for the NEM. This paper discusses how demand is defined and quantified, and challenges and key drivers of demand. The report also provides a short description of AEMO's process for developing annual and maximum demand forecasts for all NEM regions.

The aim of this paper is to set the groundwork that will underpin ongoing forecast development work, and be the foundation paper that will commence collaborative work with industry. Over the next couple of years, AEMO will work in partnership with industry to improve the way these forecasts are developed, and expand AEMO's access to representative and reliable industry data that will ensure the continued delivery of high quality forecasts.

I look forward to working more closely with our stakeholders to ensure this process is a success.

Matt Zema

**Managing Director and Chief Executive Officer**



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# CHAPTER 1 - INTRODUCTION

This report provides an overview of how AEMO plans to develop electricity demand forecasts for the NEM as a whole, and for each of the five NEM regions. It highlights the areas of key focus in undertaking the work as a prelude to AEMO publishing a complete set of updated forecasts by mid 2012.

This package of work, referred to as the National Electricity Forecasting Project, aims to deliver greater clarity and transparency in the area of demand forecasting. The success of this project will be measured by the value of the information AEMO makes available, including historical datasets, forecasting models, input assumptions and methodology, all published with updated forecasts. AEMO also wants to improve the timeliness of the published information, such that a number of information papers, reports and data packages will be made available throughout the forecast development process, which feeds the creation of national electricity forecasts.

This information paper is an introduction to the demand forecasting issues and process that will lead to AEMO developing in-house forecasts for the NEM.

The three focus areas presented in this paper (Chapters 2 through 5) are:

- Improving the clarity of demand data and definitions
- Economic forecasts, a key driver for demand, and
- Methodology used to forecast annual and maximum demand for electricity.

Chapter 2 of this paper outlines AEMO's objectives for this project.

The National Electricity Forecasting Project is a high priority for AEMO. To ensure the project is a success, AEMO has committed internal resources to undertake this work, and is also in the process of establishing a stakeholder engagement strategy to ensure that the forecasts are developed in conjunction with industry. This initial report signals the commencement of this project, and will be used to set the direction for the foundation meetings of the stakeholder engagement process.



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## CHAPTER 2 - PROJECT OBJECTIVES

AEMO as an independent body is responsible for the management of the National Electricity Market (NEM), and the retail and wholesale gas markets of eastern and south-eastern Australia. It also oversees system security of the NEM electricity grid and the Victorian gas transmission network, and is responsible for national transmission planning and the establishment of a Short Term Trading Market for gas.

To undertake these roles, AEMO needs to be responsive to changing conditions in electricity and gas markets, and requires access to representative and reliable information, including accurate demand forecasts, to operate these markets effectively and efficiently.

Over the last few years, a number of electricity industry stakeholders have questioned the accuracy of demand forecasts reported in AEMO publications, and have requested further work be undertaken to improve these forecasts. This has led to AEMO identifying the need and attaching a high priority to the National Electricity Forecasting Project.

The aim of this project is to develop a set of independent electricity demand forecasts for all five regions of the NEM. This work will be undertaken collaboratively with industry stakeholders through a series of newly established reference and regional stakeholder networks, which will include formal forums and informal meetings.

In recent years, consumers have displayed an increased awareness of energy consumption, its cost and its potential impacts on the environment, meaning end consumers are more actively involved in energy markets. With energy consumers being more dynamic, forecasting energy consumption has become more difficult.

Table 2-1 lists broad focus areas aimed for review by AEMO as part of this project. Obtaining good quality information for a number of these items is critical before AEMO is able to develop representative annual and maximum demand forecasts for each NEM region and the NEM as a whole. Some of these issues will form part of AEMO's ongoing energy forecasting activities post publication of the National Electricity Forecasting Report in mid-2012.

**Table 2-1 — Focus areas requiring further work**

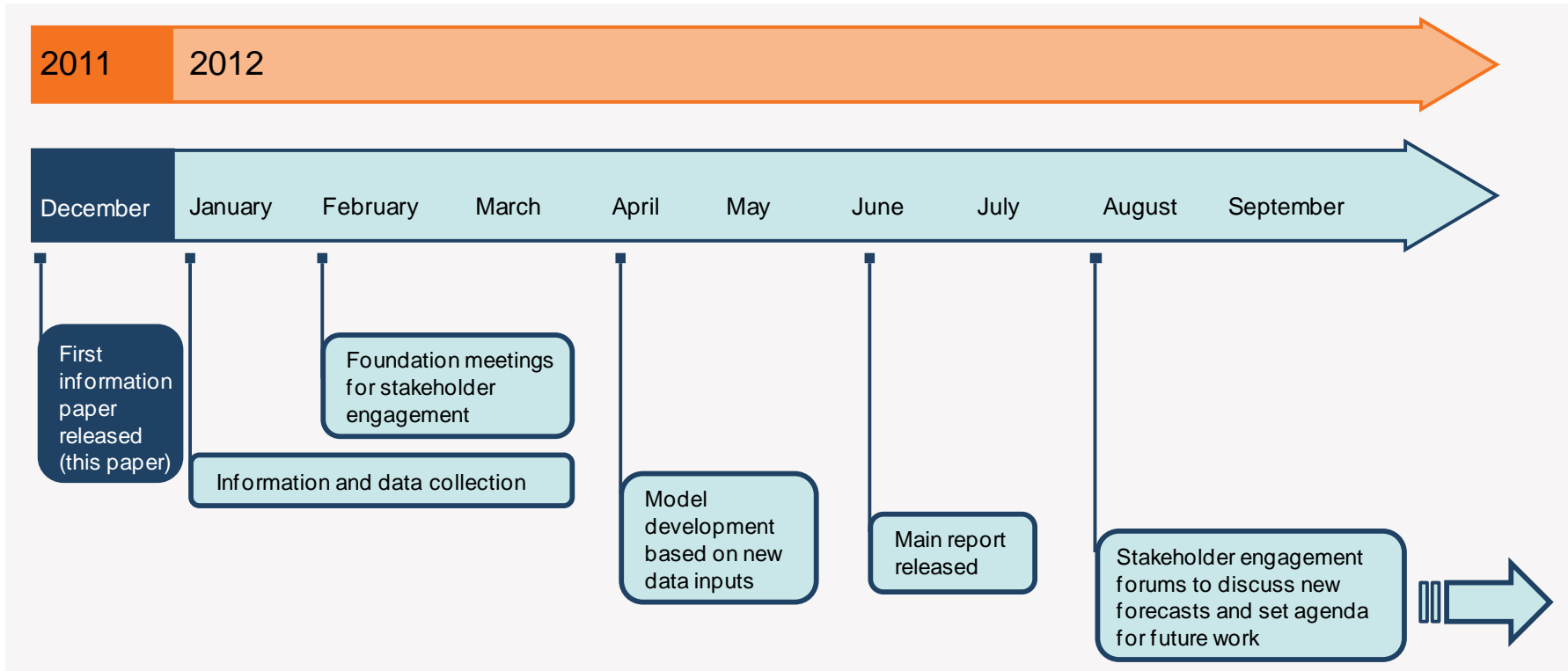
Forecasting Area	Focus
Historical data and information	Consistent definitions of electricity demand
	Penetration of small scale distributed generation, especially rooftop solar systems and their impact on demand shape and peak demand
	Historical data-sets including breakdown by load category (e.g. industrial, commercial and residential) made publically available
	Estimating the impact of historical demand reductions as a result of energy price increases and existing energy efficiency programs
Economic, demographic and energy price forecasts	Comparing multiple economic and demographic forecasts, and explaining the impact of different economic forecasts in demand forecast models
	Better use of scenario forecasting to present the level of uncertainty beyond the medium term
	Improved representation of actual and forecast energy price



Forecasting Area	Focus
Demand models	<ul style="list-style-type: none"><li>Clear, transparent and publically available peak and annual demand models</li><li>Industry discussion about forecasting methodologies and processes to be used</li><li>Development of robust approaches to assess the accuracy of forecasts and forecast models</li></ul>
Publication of forecasts	<ul style="list-style-type: none"><li>Information made available in a timely manner and progressively as actual outcomes occur</li><li>Forecasts, assumptions and datasets all located in one section of AEMO's website</li><li>Notification of forecasts updates, distributed to forecasting community</li></ul>

Figure 2-1 provides an overview of AEMO's timeline to address the first phase of this project.

Figure 2-1 — Short-term project timeline





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# CHAPTER 3 - FORECASTING DEMAND

## 3.1 Introduction

Currently the electricity industry defines demand in a number of different ways. As a result, this can be confusing when stakeholders are reviewing demand data and/or publications which report historical actual and forecast demand.

An important component of the National Electricity Forecasting Project is to facilitate a better understanding of the different demand definitions used by industry, and provide both historical datasets and demand forecasts which are separated into a number of key components that can be aggregated to create demand information designed for a particular stakeholder's requirement.

Perhaps the biggest challenge for the project is sourcing the data, information and knowledge needed to support the production of high quality / useful demand forecasts. AEMO is proposing to undertake this project with significant stakeholder interaction to ensure this work adds value to the industry. This will be addressed by establishing a forecasting community that will be used to collect data and collaborate on developing forecasting methodologies.

The following sections highlight some of the key definitions and forecasting areas that AEMO will be looking to address as part of its stakeholder engagement and consultation processes.

## 3.2 Using supply data to define demand

The NEM central dispatch mechanism adjusts supply to meet demand through the dispatch of scheduled generation every five minutes. An outcome of this process is that demand data in the NEM is calculated by aggregating all of the supplies within a region (including local generation and interconnector flows).

Supply metering has a high degree of accuracy, and calculating demand in this way automatically includes the energy lost transporting the electricity (network losses) and the electricity used by customers. Refer to Chapter 3 of the ESOO 2011 for a description of three commonly used definitions of demand – “as generated”, “sent out” and “customer load”.

A prerequisite to developing accurate demand forecasts is to understand the basis of the demand being analysed and the data that is aggregated to calculate that demand. Figure 3-1, which shows different categories of generation connected to different parts of the electricity network, highlights how the addition of extra supply data leads to the creation of three commonly used demand definitions.

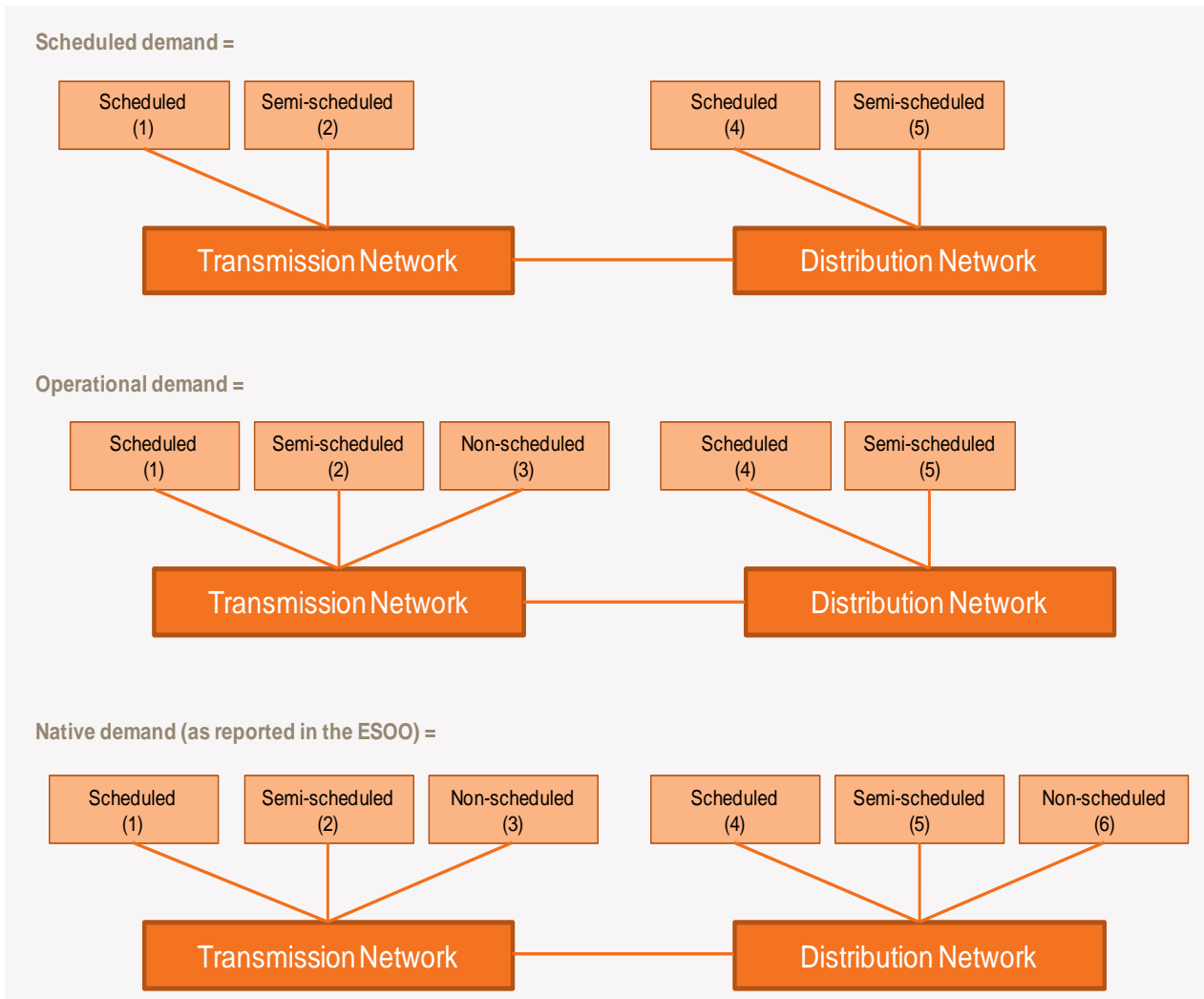
Even these high-level representations of demand do not provide a full description of what is included or excluded from the demand definition. One of the biggest information gaps occurs where a customer is offsetting their consumption from the network, via their own generation. This can occur on a large-scale for customers connected to the transmission network, and at a distributed-scale where residential customers are installing rooftop solar generation systems.

From a forecasting perspective, where supply data for these own-use generators is available, it is included in the definition of native demand. However, if the data is unavailable, such is the case with rooftop solar systems in most regions, it is not.

Given the significant uptake of rooftop solar systems across the NEM over the past 2 to 3 years, this data gap needs to be addressed, and is already a key focus of AEMO's efforts in the initial stages of this project.

AEMO would also like to engage with industry on the issue of demand definition to ensure the information provided is of use to all parties across the industry, and welcomes any suggestions as to how this could be better achieved.

Figure 3-1 — Demand definitions



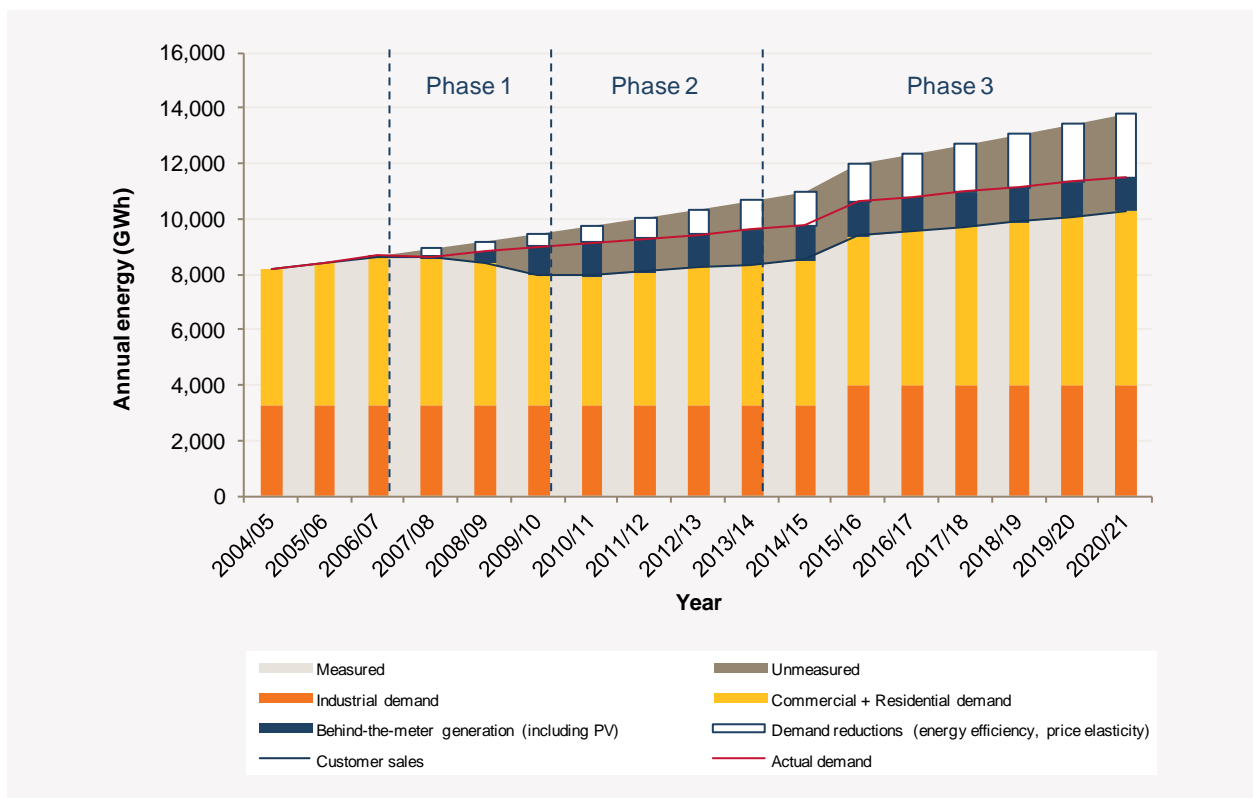
### 3.3 Understanding the components of demand

In order to accurately forecast demand it is necessary to break down the aggregate supply data into the various components that are subject to different trends or drivers. The purpose of this section is to discuss some of these issues and techniques in detail, and to improve stakeholders' understanding of some of the forecasting assumptions and methodologies used by AEMO in electricity forecasting.

Figure 3-2 is a hypothetical annual demand forecast which has been developed to highlight these challenges. The figure shows seven years of historical data from 2004-05 to 2010-11, and a ten year forecast period from 2011-12 to 2020-21. Annual demand has been broken into several components to demonstrate how changes in these factors impact demand and the shape of the forecast.

Industrial demand has been considered separately from residential and commercial demand, as typically it represents the largest proportion of demand and has a greater capacity to change forecasts compared to other sectors. It is also subject to different drivers than residential demand. In combination, these make up the total customer sales. Actual demand also includes behind-the-meter generation, such as supply from rooftop solar and other small generators.

Figure 3-2 — Example forecast showing components of demand



The aspects of demand forecasting highlighted in Figure 3-2 that are discussed in this chapter are:

- **Forecasting industrial demand:** The figure shows the difference in growth characteristics between industrial demand and other customers (residential and commercial demand). The process of separating out industrial demand from the historical data and forecasting is discussed in Section 3.4.
- **Accounting for behind-the-meter generation:** The figure shows how the output of small generators who are not measured in the demand data has the potential to obscure underlying growth rates in residential and commercial demand. The challenges associated with estimating and forecasting these impacts are discussed in Section 3.5.
- **Estimating the impacts of demand drivers:** The 'demand reductions' in the figure represent changes from historical growth trends in residential and commercial demands. These reductions result from the combination of a range of different drivers including energy efficiency and increasing electricity prices. These drivers and the challenges associated with estimating and forecasting them are discussed in Section 3.6.

### 3.4 Forecasting industrial demand

The industrial demand component of Figure 3-2 shows the basic characteristics of major industrial loads. The load does not change significantly from year-to-year in Phases 1 and 2. In Phase 3, there is an increase of 700 MW, representing a new facility which is forecast to connect. This change has a significant impact on the annual demand which is a departure from previous growth trends.

Similar trends in industrial demand are common in the NEM. In each region, a relatively small number of customers account for a very large proportion of annual demand. Incremental changes to these loads from year to year are insignificant in comparison to the changes when existing customers expand, downsize or close down, or new loads are connected.

In order to forecast demand from as many of these customers as possible, their historical consumption must be separated out from the demand data. These loads must then be forecast separately. Table 3-2 lists some of the challenges associated with both of these processes. The challenges listed do not necessarily affect the forecasts in all states, but cover the range of issues AEMO is facing in developing consistent national forecasts.

**Table 3-2 — Challenges for industrial load forecasting**

Challenges for collecting historical load data	Challenges for generating forecasts
<ol style="list-style-type: none"> <li>1. Difficulty determining who the major users are.</li> <li>2. In some cases metering data is difficult to obtain once the customer has been identified. Engaging with individual businesses to collect data on their usage is a cumbersome process.</li> <li>3. Some information is commercially sensitive or confidential and cannot be made publically available.</li> <li>4. Some information must be collected from NSPs who also have confidentiality obligations to their customers.</li> </ol>	<ol style="list-style-type: none"> <li>1. Some new loads will be from new customers with no historical data. AEMO will not necessarily be aware of all of these new loads, to incorporate them into the forecasts, particularly when these projects are speculative.</li> <li>2. Each facility is subject to different commercial and economic pressures so changes to their operation are very difficult to predict. In particular, plant closures can be very abrupt and information on them is closely held by businesses.</li> <li>3. If the industrial loads are forecast to expand, this increase in output in the forecast period represents a growth in gross state product (GSP) for that region. This growth needs to be accounted for in the economic scenario which is being applied to the non-industrial load, so that it is not double-counted. This requires assumptions to be made to translate a certain level of electricity consumption by a facility to economic output in dollars.</li> </ol>

#### AEMO’s approach to industrial demand forecasting

Because of the differences between individual loads, industrial demand is generally forecast using a discrete approach. These forecasts are based on the best available public information or information gathered directly from NSPs or customers.

Given the issues discussed in Table 3-2 there is significant benefit in AEMO presenting industrial loads’ historical consumption and forecast demand separately from the other components of demand, so that users of the forecasts can apply their own expectations about individual facilities and their future operation. This is current practice in some regional forecasts, but does present possible confidentiality issues.

Another method for dealing with the uncertainty is to diversify the industrial forecast in line with changing economic assumptions. For example, a high economic growth would coincide with higher output from industry. The current economic assumptions used by AEMO are described in Chapter 4.

When the industrial loads are separated out from the demand data, the remaining demand approximately represents residential, commercial and small industrial customers. The more industrial facilities which can be separated from the historical data and modelled independently, the more accurate the econometric analysis of the remaining demand becomes.

### 3.5 Accounting for behind-the-meter generation

In Phase 1 of Figure 3-2 residential and commercial demand growth is partially offset by growth in behind-the-meter generation which is not measured in the demand data<sup>1</sup>. This has also been the case in some regions of the NEM in recent years. Over the past two to three years there has been exponential growth in the uptake of rooftop solar systems in these regions, which is contributing a significant amount of the energy supply for annual demand.

If the annual demand data does not include rooftop solar generation and other non-scheduled generation, the underlying growth trends in residential and commercial demands will not be understood and the ability to forecast long-term changes to these sectors will be compromised. This is shown in Phase 1 and Phase 2 of Figure 3-2. In this figure there is rapid growth in behind-the-meter generation in Phase 1, which exceeds the total growth in residential and commercial demand. As a result customer sales are relatively flat in this period. In Phase 2, behind-the-meter generation remains stable while commercial and residential demand continues to grow steadily. Customer sales start increasing again from 2011/12 onwards. If the distinction between growth in rooftop solar generation and growth in residential demand had not been made, this change in the trend would not have been forecast.

In most NEM states rooftop solar generation is not being measured because the systems are connected to a net meter, which measures the difference between generation and household consumption<sup>2</sup>. Even in the states where the total output of the PV is measured, the number of installed systems (over 150,000 in NSW and ACT alone) makes monitoring of all systems' output problematic.

An alternative option is to estimate the total output of systems, based on the generation capacity installed and the expected output of systems in the different regions of the NEM. Data on the capacity of systems is collected by various parties, but is not reported to one central collection point. AEMO has begun collecting this capacity data from various sources including the distribution businesses (DBs) who collect data for feed-in tariffs and other compliance reasons which vary between the states. In some regions there are a considerable number of systems for whom this data has not been collected, so their capacity will have to be estimated.

Once the historical output of behind the meter generation has been estimated and incorporated into the annual demand data for the regions, the future generation from these sources will also need to be forecast. To produce such a forecast the following drivers will need to be considered:

- **Electricity price increases** which improve the viability of rooftop solar systems as an investment.
- **Technology costs for solar** which have also dropped rapidly in recent years, increasing the affordability of solar systems for households.
- **Other technological developments** which may lead to other behind-the-meter generation technologies becoming popular.
- **Government subsidies for solar and other small generators** which are being or have been wound back in most states and at the federal level, reducing the affordability of systems and increasing their payback times.
- **Other government policies** which may affect the uptake of these systems. An example of these policies is Green Star building standards which reward developers for using private generation to offset electricity use from the grid.

Taking these factors into consideration to produce a forecast for behind-the-meter generation will be an area of focus for AEMO in 2011-12, and reported in the National Electricity Forecasting Report in mid-2012.

<sup>1</sup> For commercial loads, an example of this is cogeneration in commercial buildings or at small industrial facilities. For residential loads, rooftop solar systems are reducing the power people consume from the grid. In both cases the use of these generators does not necessarily reduce the customers' overall demand. This was discussed in Chapter 2.

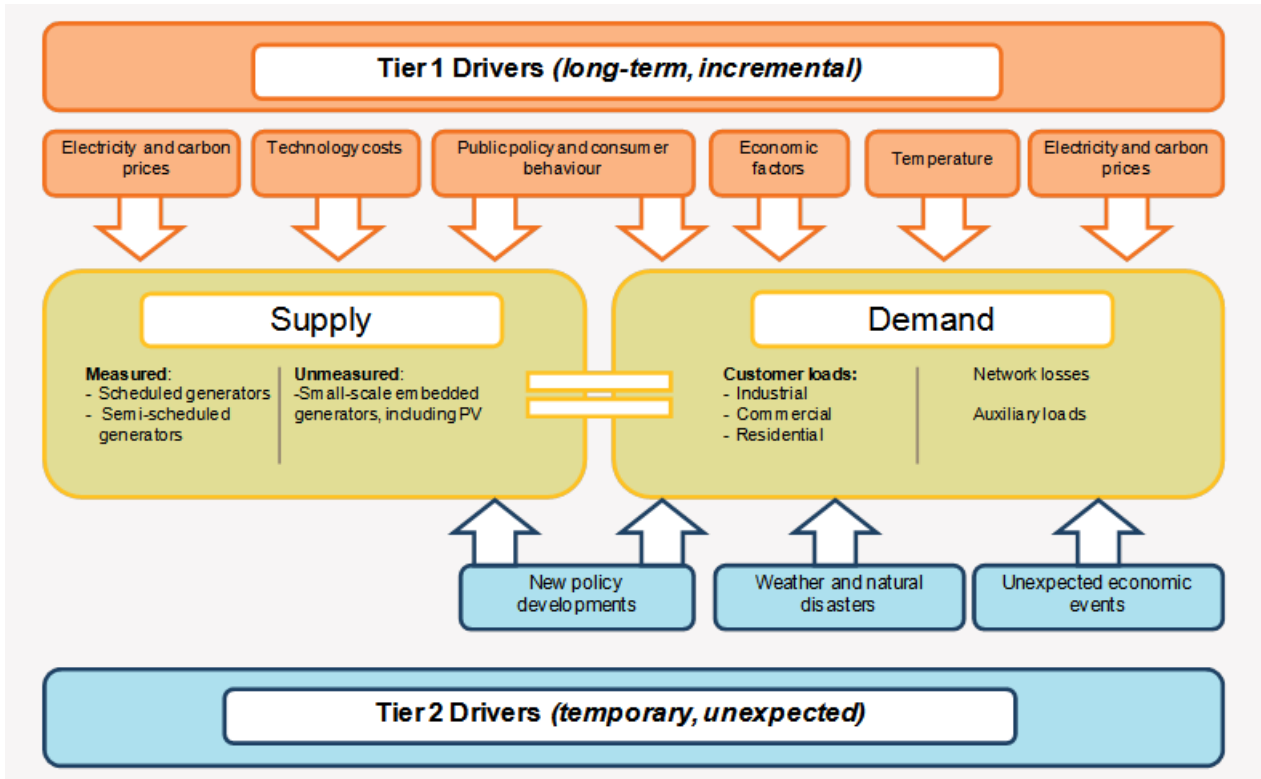
<sup>2</sup> The feed-in tariff policies that were offered in recent years measure net rooftop solar generation in all regions except NSW and the ACT, where the gross output is measured.

### 3.6 Estimating the impacts of demand drivers

Figure 3-3 shows the components of supply and demand. It also shows the main drivers such as economic, policy and technology factors which have an impact on both the level of demand, and the future mix of generation.

This section will focus on the drivers of demand, rather than the drivers of supply. Section 3.5 explained why it is important to consider the drivers for the uptake of behind-the-meter generation which can change supply and reduce how much is measured from significant generators.

**Figure 3-3 — Tier 1 and Tier 2 drivers of demand**



In Figure 3-3 the drivers of demand are divided into two categories: tier 1 (long-term, incremental) and tier 2 (temporary or unexpected). Tier 1 drivers are the main parameters used to develop forecasts. Tier 2 drivers are unexpected or extreme events which have the potential to significantly disrupt energy use. These unexpected events are not normally included in the forecasts unless they occur before collecting input data for the modelling process.

The tier 1 drivers of demand have varying impacts on residential, commercial and industrial demand. This section focuses on these drivers' impacts on residential and commercial demand. While industrial loads are affected by some of the tier 1 factors shown in Figure 3-3, these drivers are more likely to be considered on a case-by-case basis for individual loads, as described in Section 3.4.

### 3.6.1 Policy, price and behaviour impacts on demand

The tier 1 drivers of demand in Figure 3-3 vary in how they impact demand. Over the past few decades there has been strong growth in demand, due mainly to the positive correlations between demand, population and economic growth. In recent years the growth trends have become less clear as several drivers which reduce energy use have become more prevalent than they were previously. These include energy efficiency policy and rising electricity prices. The impact of these drivers was shown in Figure 3-2 by the white bars indicating 'demand reductions'.

As a result of these changes, demand forecasting models must be able to incorporate a wide range of drivers and determine their short-term and long-term impacts on demand. The available options for this modelling depend on the drivers themselves and their characteristics, such as whether they can be measured numerically, how they impact demand, and how accurately they can be forecast. These issues are discussed below for the policy, price and behaviour drivers.

#### Climate change and energy efficiency policies

Considering the effects of energy efficiency and climate change policies is important as they reduce overall demand from levels that would have been reached in the absence of those policies. The main policies included in this category are Minimum Energy Performance Standards (MEPS) and building energy efficiency codes. These policies generally lead to long-term energy savings because new appliances or buildings targeted by them will use less electricity over their entire lifetimes.

Energy efficiency policies in the form of appliance standards have been implemented in Australia since 1999. As a result historical demand data already incorporates incremental improvements in the efficiency of many appliances over the years. For current forecasts it is necessary to distinguish between the policies which are consistent with historical improvements and those that represent a step change in efficiency that should be modelled explicitly.

For those policies that must be modelled explicitly, their impacts are at the building or equipment level so it is extremely difficult to measure them in the demand data. In some cases policymakers estimate the energy savings that will result from a specific policy, but they are generally difficult to determine through estimation as well. Predictions of the impacts of these policies must also take into account policies which may overlap. For example, there are various state and federal measures currently in place to reduce electricity consumption for water heating. The overall impacts of these policies on demand will be less than the combined estimates of the impact of each individual measure.

The rebound effect is another factor which must be considered in estimating the impacts of energy efficiency policies, which is very difficult to measure. Rebound is where consumers respond to an increase in efficiency, by increasing their use of appliances. An example of this would be increased air conditioner use when a more efficient model is installed, with the knowledge that the cost will probably be less than with the previous appliance.

#### Price elasticity

In most states residential electricity prices are set by an independent regulator, meaning historical price data is available for these prices. Non-residential price data is not very reliable because business electricity prices are negotiated in confidential contracts. Historical business prices must be estimated based on the best available information.

It is evident in the electricity data that there is some degree of price elasticity in electricity demand in the NEM states. However, given the variations in behaviour between households and businesses, it is impossible to quantify one definitive value for price elasticity. It is also difficult to determine how price elasticity changes over time. For example, when there is a sudden, significant price increase, people may react more strongly to reduce their energy usage than they have to incremental price changes in the past. Differentiating between short-term and long-term price elasticity changes is therefore an important input for forecasting models.

Detailed analysis of price elasticity has not been undertaken in all states. An accurate estimation of price elasticity will rely on the demand data being broken down into residential and business components, so that the two price categories can be modelled separately. Determining price elasticity for the business component is also problematic due to the lack of reliable historical data for non-residential prices.

### Consumer behaviour and preferences

Changes in consumer behaviour and preferences can drive changes in demand. The behavioural changes which are evident in some NEM regions includes an increasingly economical approach to energy use by many consumers, in response to uncertain economic conditions, media attention to energy issues, and a general increase in the awareness of the environmental impacts of electricity generation.

Whilst some of these changes can be classified as price elasticity, described above, other changes are not necessarily borne out of economically rational behaviour. These changes are extremely difficult to measure, estimate or quantify.

Behavioural impacts are extremely difficult to measure in the historical or forecast data. It is impossible to predict whether an individual's consumption patterns may change permanently or if behaviours will revert to historical patterns if the economy improves and energy issues become less prominent in the public debate.

#### 3.6.2 Other Tier 1 drivers of demand

Table 3-3 describes AEMO's current approach to data collection and forecasting the remaining tier 1 drivers of demand. The first drivers listed in the table are macroeconomic variables, including GSP and population. These variables are key inputs to the forecasts and are explained in greater detail in Chapter 4.

Table 3-3 — Tier 1 drivers of demand

Driver	Data sources for driver	Impact on demand	Forecasting the driver
Macroeconomic variables (GSP and population)	Australian Bureau of Statistics data. Historical data is regularly revised which can be problematic.	Positive correlation. Increases in GSP and population generally increase the amount of electricity being consumed, by increasing the housing stock, and increasing business activity.	AEMO currently receives forecasts of these variables from an external consultant, updated annually.
Electricity prices	Residential price data available from regulators in states with regulated prices. Non-residential prices and prices in non-regulated states must be estimated based on the best available information.	There is some price elasticity for electricity demand, meaning price increases lead to decreased demand. Measuring elasticity is difficult in cases where reliable price data is not available. Elasticity may also change from year-to-year, so studies of elasticity must be updated.	Electricity price projections are difficult because of the lack of reliable historical data. It is also difficult because price projections need to incorporate various government policies whose future development is uncertain. AEMO currently receives annual forecasts of electricity prices from an external consultant.
Carbon price	The carbon price will be set by the government during the initial fixed price period and then will be available from the carbon permit market. Following the introduction of a trading scheme for permits, the permit market will continue to provide data on the carbon prices being paid.	Since residential and commercial electricity customers will not be paying the carbon price directly, its impact on demand is expected to occur through the electricity price increases that result from it being passed through by generators. Therefore its impact will be measured through price elasticity, as described above.	There are several government forecasts available for the expected carbon price levels beyond the fixed price period.
Temperature	Bureau of Meteorology data in half-hourly intervals, for the major load centres in the NEM. The heating degree days (HDD) and cooling degree days (CDD) can be measured from this historical data.	Electricity demand increases as temperatures rise above or fall below a certain 'comfortable' range. For annual demand models, the number of days when temperatures are outside this range will have an impact on the overall energy used. This is expressed using the measures HDD and CDD. For each region the energy use associated with both of these measures can be estimated and incorporated into demand forecasts.	Historical trends are used to forecast HDD and CDD for annual models. Large variations from the historical average are considered a tier 2 driver (an unexpected variation).



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# CHAPTER 4 - ECONOMIC FORECASTS

## 4.1 Introduction

One of the largest drivers for growth in electricity consumption is economic growth. Historically, forecasting models have been able to correlate economic growth to demand growth relatively easily, and the accuracy of a demand forecast could be explained in relation to the accuracy of the economic forecasts. In recent years both the accuracy of economic forecasts, and divergence in the correlation of economic growth to demand growth, has put increasing focus on problems with current forecasting practices.

Energy price forecasts have also under-forecast rises in electricity retail prices across the NEM, leading to a compounding effect, with economic forecasts being too high, leading to electricity forecasts being much higher than actual demand.

This chapter provides an overview of the current economic assumptions AEMO uses to develop annual and maximum demand forecasts. These economic forecasts relate to the 2011 update released in August 2011.

A range of economic factors are discussed including economic and population growth, electricity prices and new carbon price assumptions based on the Australian Government's Clean Energy Future policy announced in July 2011. These are discussed for Australia and each of the five regions of the NEM, and represent assumptions for the medium scenario.

## 4.2 Economic assumptions

### 4.2.1 Global economic outlook

Global economic growth performance has a large influence on projecting changes in Australian domestic output. It is assumed that global growth is 4.5% over the period from 2011 to 2015, in line with the International Monetary Fund (IMF) forecast. Throughout the remaining outlook period, global growth is assumed to be 3.3%, in line with average annual growth over the period from 1980 to 2010. This assumes a slow, steady recovery in the United States and Western Europe, and moderate commodity prices.

Domestic activity in Australia for the last two quarters of 2010-11 was severely affected by the natural disasters in Queensland and Western Australia. In particular, exports of commodities decreased, affecting the trade balance and economic growth.

### 4.2.2 Demographic assumptions

Demographic variables related to population growth are driven by growth in the working-age population which directly influences the size of the labour force and the economy's long-term growth. Immigration levels and the natural rate of increase (fertility rate versus mortality rate) are the main sources of uncertainty within the demographic projections.

### 4.2.3 Carbon price assumptions

Carbon price assumptions are based on the Australian Government’s Clean Energy Future policy announced in July 2011<sup>3</sup>. These are:

- Fixed carbon pricing starting from 2012–13, at a nominal price of \$23/t CO<sub>2</sub>-e, rising at 2.5% in real terms for the subsequent two years.
- A flexible price phase introduced on 1 July 2015 with the carbon price determined through an emission trading scheme (ETS) with a transitional price cap and floor applied.
- Real growth in the carbon price of 5% per year on average plus inflation from 2015-16 onwards.

The higher real growth rates of the carbon prices assumed in the recent Federal Government Treasury modelling reflects growth in the foreign currency carbon price, determined in the world market, and a gradual depreciation of the Australian dollar.

## 4.3 Economic forecasts

This section provides a summary of some key macroeconomic variables at the national and state level, and discusses the key factors affecting changes in these forecasts over the outlook period.

Table 4-1 provides average annual growth rates for economic growth measured by Gross Domestic Product (GDP) at the national level and Gross State Product (GSP) at the state level. Economic growth for all states, except Queensland ranges between 2.2% and 2.4% per year. Queensland is forecast to be higher at 3.2% per year, with economic growth for Australia at 2.7% per year over the outlook period from 201-11 to 2034-35.

**Table 4-1 — National and state economic growth<sup>a</sup>**

	2010/11 to 2014/15 (%)	2015/16 - 2024/25 (%)
Australia <sup>b</sup>	3.3	2.6
Queensland <sup>c</sup>	4.2	3.1
New South Wales (incl. ACT) <sup>c</sup>	2.7	2.3
Victoria <sup>c</sup>	2.6	2.5
South Australia <sup>c</sup>	3.2	2.2
Tasmania <sup>c</sup>	3.3	1.9

a. Average annual growth rate.

b. Economic growth measured by Gross Domestic Product (GDP).

c. Economic growth measured by Gross State Product (GSP).

<sup>3</sup> The Commonwealth Treasury and the Department of Climate Change and Energy Efficiency modelled the potential economic impacts of reducing emissions over the medium and long term proposed in the Strong Growth, Low Pollution, Modelling a Carbon Price Report, released on 10 July 2011. <http://www.treasury.gov.au/carbonpricemodelling/content/default.asp>

### 4.3.1 Key factors affecting national economic forecasts

For the short to medium term (from 2010-11 to 2014-15), the outlook for economic growth in Australia is optimistic, in line with recent forecasts by the Reserve Bank of Australia. This is driven by solid growth in exports, heavy investment in the resource sector and recovering growth in household consumption.

The international economic context was one of the main factors that influenced the domestic Australian economic performance. Natural disasters in Japan reduced trade flows over the first half of 2011, whilst government budget concerns within both the United States and the European Union have weakened investor confidence and triggered a round of volatility in global financial markets. These events have contributed to a marked decline in consumer and business sentiment within the Australian economy.

In the short term, growth forecast for exports has been revised down to reflect a larger than expected dip in export volumes in 2010/11, due to natural disasters. Consequently, coal production in Queensland was disrupted by flooding in early 2011, whilst a severe cyclone season in West Australia disrupted iron ore production.

In addition, Japanese demand for coal is likely to be weaker than expected in the short run, as industrial production in Japan has been disrupted by the recent earthquake and tsunami. In this context, Australian mine production is not expected to fully recover until 2012. From 2011-12, exports are expected to recover;

Business investment, on the other hand has been revised up, reflecting an expectation of sustained growth in mining investment over the next few years. Over the medium to long term further investment is expected to be supported by commodity prices, which are expected to remain at historically high levels.

Over the next five years, the average annual growth rate for the consumer price index (CPI) is forecast to be 2.8%, again in line with recent forecasts by the Reserve Bank of Australia.

### 4.3.2 Key factors affecting state economic forecasts

This section is a summary of the information provided by KPMG, AEMO's 2011 economic forecaster, in their August report which is available on the AEMO website (in the Planning section).

#### Queensland

Unexpected natural disasters that occurred in Queensland in January 2011 caused significant damage to the state's infrastructure, with mining and agricultural production abruptly coming to a temporary halt.

In the last two quarters of 2010-11 activity showed signs of recovery, with agricultural production likely to fully pick up by the end of the financial year. However, mining production has been slower to recover, with the removal of floodwaters from coalmines taking longer than initially expected. Coal trade with Japan has also been affected by the recent tsunami, which disrupted industrial production (and hence annual demand) within Japan. Consequently, exports are likely to remain depressed in 2011.

The rebuilding of homes and businesses has seen construction and related service activities grow. Going forward, the introduction of the Queensland Building Boost grant for new homes should support further activity in residential construction over the next few years. However, growth in non-residential construction is expected to be slow, reflecting continued tight credit conditions and slow growth in retail industry construction.

Over the medium term, recovering commodity exports will be a key driver of GSP growth within the state. On the whole, the outlook for Queensland's mining sector is positive<sup>4</sup> whilst business investment in the sector is expected to increase from 2011/12 onwards, driven by investment in a number of LNG projects.

Furthermore, Chinese demand for raw materials continues to surge ahead, despite a recent tightening of Chinese monetary policy in reaction to rising inflation.

<sup>4</sup> Queensland Government (14 June 2011), State Budget 2011-12.

### **New South Wales, including the Australian Capital Territory**

Infrastructure spending is likely to be a key driver of activity over the medium term, based on the development of a new long-term infrastructure plan for the state economy, which is expected to be delivered in late 2011.

Firms are expected to benefit from the NSW Government's decision to cut payroll taxes. This will boost hiring activity, but will be offset to some degree by soft household consumption growth in NSW, as the global economic uncertainty dampens consumer spending, and as households continue to rebuild balance sheets.

Over the short to medium term, the NSW mining sector is expected to reap the benefits of high prices for key commodities, such as iron ore and coking coal, which have made up a significant portion of the state's mining exports.

### **Victoria**

Activity in Victoria has started to recover from the damages suffered due to flooding in early 2011. Overall, the state has shown healthy population growth, along with solid growth in employment. However, the state economy faces a number of challenges going forward, including slow productivity growth, skill shortages, failing infrastructure and high housing costs.

The Victorian Government is planning to invest heavily in various infrastructure projects. The 2011-12 state budget promised funding towards rebuilding flood-damaged areas, which will boost activities in the short term.

Furthermore, the Victorian Government has decided to invest in the state's transport system to try to keep pace with its population growth.

Growth in dwelling construction is being supported by state government incentives announced in the 2011-12 state budget. Declining housing affordability within Melbourne has become a concern for potential migrants. Over time, this will impact net migration into the state, putting further pressure on the labour market.

The Victorian manufacturing sector continues to struggle with the high exchange rate, and is forecast to grow at an average rate of only 0.5% per annum over the next five years.

### **South Australia**

In the short term, the agricultural sector is forecast to experience a record volume in winter agricultural crops, with income in the sector expected to be boosted by rising grain prices in the world market.

Other key industries, such as defence and mining continue to attract investment, and are likely to continue expanding over the forecast period.

Consequently, GSP is estimated to grow at a healthy pace over the short term, supported by agricultural activity, the Olympic Dam mine returning to full production and other ongoing construction projects such as the Adelaide Desalination Plant. Whilst the natural disasters in Japan have dampened the state's commodity export growth, there is still strong global demand for the state's key exports of metal ores and wheat.

On the downside, the strong exchange rate is estimated to dampen activity by making the state's exports of manufacturing and wine more expensive. Also, a number of economically important sectors in South Australia are greenhouse-gas intensive, meaning the roll out of the carbon tax presents challenges for the local economy. However, many firms have already taken initiatives to assist their adaptation to carbon pricing.

Over the medium to long term, growth in mining exports will partly offset slower growth in wine and automobile exports. The South Australian Government is also working on strategies aimed to remove barriers to trade and facilitate export growth. Consequently, the overall outlook for the state's export market over the long term appears positive.

## Tasmania

Difficult conditions in manufacturing and forestry have impacted growth in Tasmania. Whilst the exchange rate is expected to remain at a high level over the medium term (hindering manufacturing activity), the agricultural sector looks set to recover from losses incurred due to flooding in early 2011. Notably, the Tasmanian government has planned to implement the Midlands Irrigation Scheme, which is expected to improve the abundance of water, and boost future agricultural production.

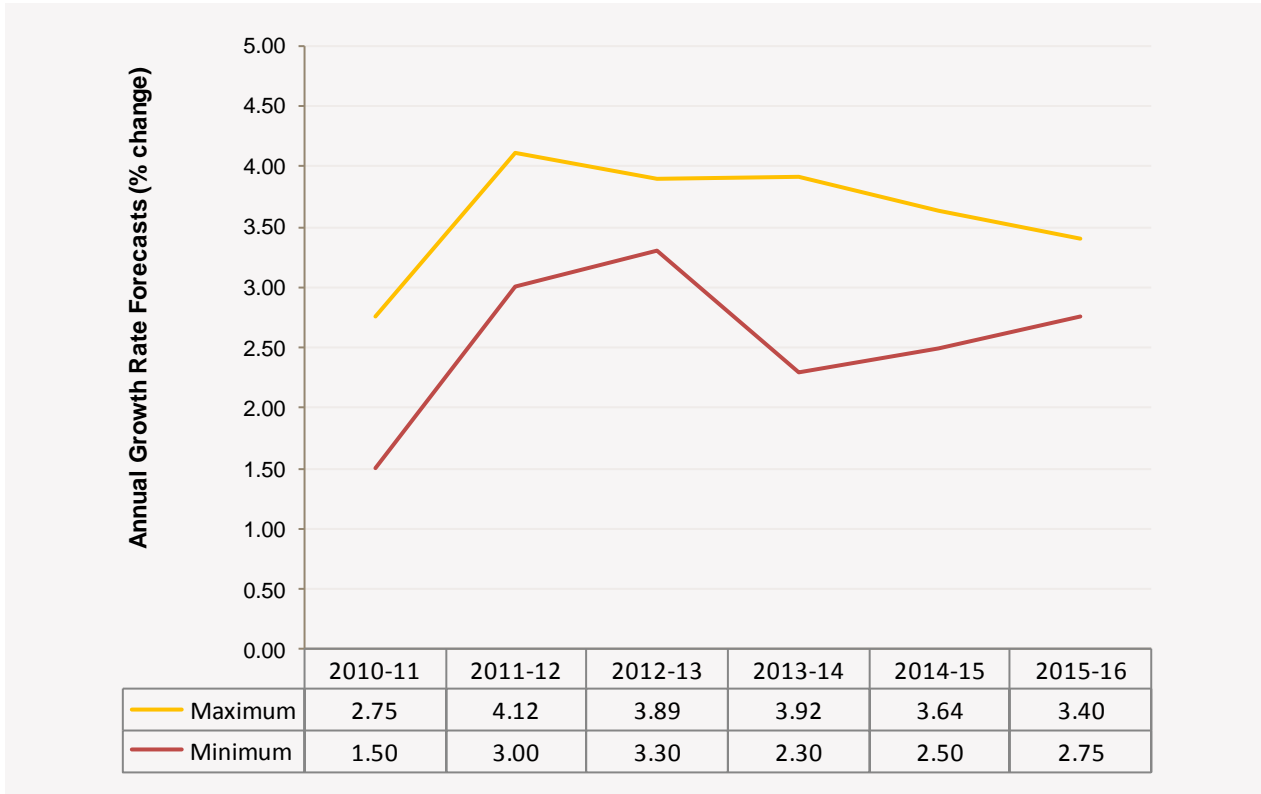
The mining boom has boosted mineral exploration activities in Tasmania to an extent. However, despite having a wide variety of high-grade mineral deposits – including iron ore, copper and a range of precious metals - large increases in the volume and value of the state's mining exports have yet to come. Looking ahead, greater production of non-ferrous metals and iron ore should underpin growth in commodity exports over the medium term.

Dwelling investment in Tasmania has begun to recover, growing by 6% in the year to March. This is in stark contrast to most other states and territories, which have seen an ongoing decline in dwelling investment. As such, the construction sector is expected to experience healthy growth over the next few years.

## 4.4 Comparison of economic forecasts

Figure 4-1 presents the range of economic forecasts of Australian GDP growth as developed by KPMG, NIEIR, Deloitte, Reserve Bank of Australia, Goldman Sachs, Federal Treasury and the International Monetary Fund.

Figure 4-1 — Range of GDP forecasts



The comparison of the forecasts demonstrates the level of uncertainty in economic growth projections. The majority of regional demand forecasting models include GSP and/or GSP by industry sector as drivers of demand. To improve the transparency of the forecasting processes, and to ensure the most appropriate economic forecasts are used as part of that process, AEMO is investigating the possibility of using a wider variety of economic inputs to forecast regional demand, to better present the range of possible outcomes of future electricity demand.

As has already been occurring across a number of AEMO planning publications, the use of scenarios is seen as a valuable tool for developing forecasts used within AEMO and across the energy industry. With so many factors impacting on electricity consumption, and an increasing rate of change in consumer behaviour, the production of scenario forecasts is aimed at providing industry with an improved package of information from which to base business decisions.

# CHAPTER 5 - DEMAND FORECASTS

## 5.1 Introduction

This chapter provides a short analysis and discussion of historical trends, demand drivers and overview of the forecasting methodology used to develop preliminary annual and maximum demand forecasts. In a future information paper, a more detailed explanation of AEMO's forecasting methodology will be provided.

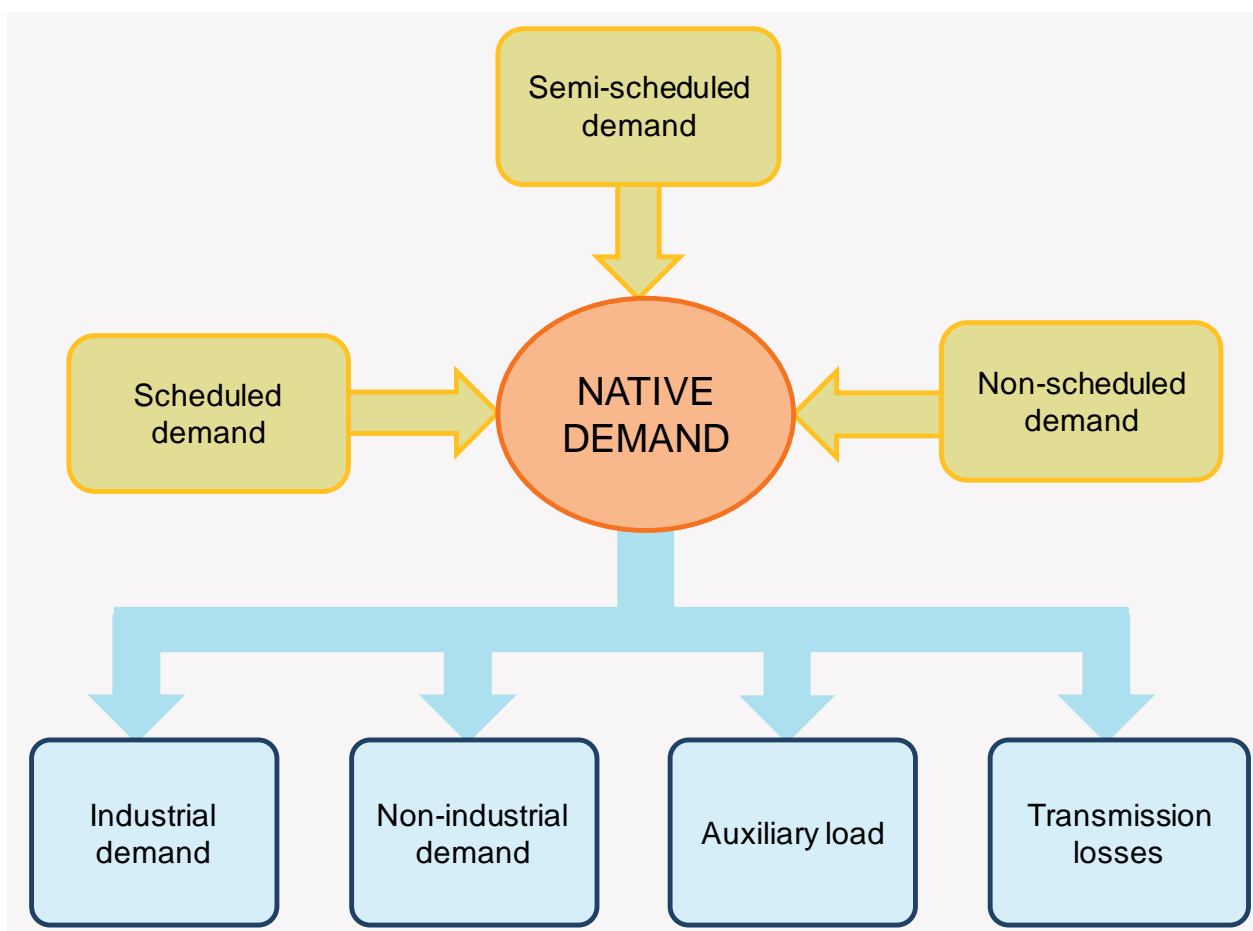
The demand forecasts are not presented in this paper as further work is required before AEMO adopts them for use in its operational and planning processes (this major milestone is currently targeted for mid-2012). The key areas of refinement for each jurisdiction are also presented as part of the process of developing robust forecasting methodologies in consultation with industry.

## 5.2 Annual demand forecasts

### 5.2.1 Annual demand forecasting methodology

AEMO acknowledges the need for improved documentation in all areas of forecasting methodology. To ensure a consistent and transparent modelling approach for all five regions of the NEM, native demand (as reported in the ES00) is modelled according to Figure 5-1.

Figure 5-1 — Annual demand modelling framework

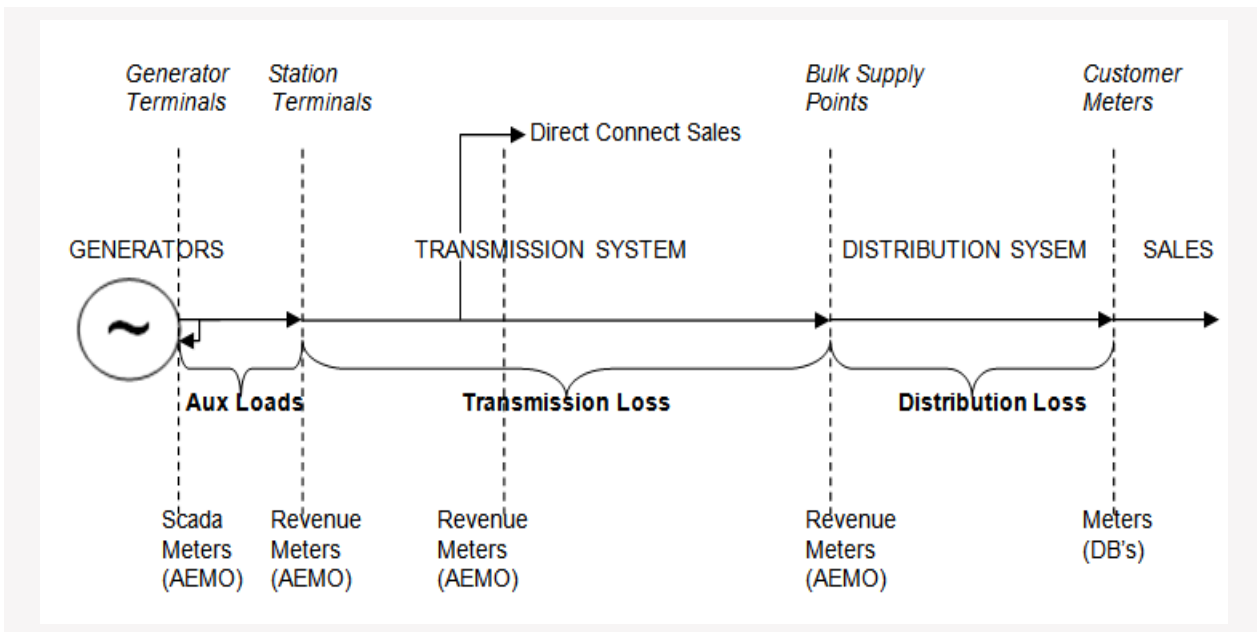


Separate models are developed for large industrial and non-industrial demand which are then added to models for auxiliary load and network losses to develop annual demand forecasts. In particular,

- Industrial demand accounts for the most significant proportion of demand in each region
- Non-industrial demand consists of demand from residential, commercial and small industrial customers
- Auxiliary load is defined as the difference between as generated electricity (at generator terminals) and sent out electricity (revenue meters)
- Network losses is the sum of both transmission and distribution losses.

These components are measured at metered points in the flow of electricity from generation to customer sales. Figure 5-2 shows that AEMO and distribution businesses collect data at these metered points, which forms the input data into these models. Gaining access to good quality, representative data is a high priority for AEMO to ensure the development of robust forecasts.

**Figure 5-2 — Data inputs to measure components of demand**



As part of the modelling process, a range of inputs need to be considered:

- Historical data for demand, as shown in Figure 5-2, including estimating distribution losses due to lack of raw data availability
- Key drivers including economic and temperature data
- A range of economic scenarios that are defined according to carbon price and economic growth assumptions
- Major industrial load information that has a significant impact on the forecasts
- Government policies and energy efficiency programs that impact changing consumer behaviour and preferences
- Impact of new forms of energy, such as rooftop solar systems
- Introduction of new emerging technologies, such as electric vehicles.

Collectively these factors are used to develop annual demand forecasts using econometric modelling techniques.

In the following sections, historical forecasting trends and key issues are briefly discussed for each of the five NEM regions.

## 5.2.2 Queensland

### Historical analysis

Annual electricity demand in Queensland has been below forecast for a number of years. The 2010/11 fiscal year, was significantly below forecast, primarily due to extreme weather events over the most recent summer. The Queensland region presents a number of complex challenges when developing demand forecasts.

Electricity consumers in Queensland can be segmented into two distinct groups: large industrial customers (e.g. mining and LNG production) and residential / commercial / small industrial customers.

The first segment has the potential for significant demand growth over the short-to-medium term. It appears these large projects in Queensland are expected to contribute significantly to economic growth for the region. The second segment, namely smaller users, appear to be actively managing their electricity consumption as a result of rooftop solar system subsidies, energy efficiency schemes and rising electricity prices.

### Key issues

The key issues AEMO is looking to address for Queensland are:

- Significant uptake of rooftop solar systems
- Differing economic growth projections for the two demand segments being modelled
- Recent electricity tariff increases
- Industrial, commercial and residential energy efficiency policies.

AEMO has already commenced engaging with Queensland participants to develop a complete set of forecasting inputs and assumptions needed to create a robust forecast for this region. AEMO thanks those participants for the initial assistance and looks forward to continue this work with them, and others, going forward.

## 5.2.3 New South Wales, including the Australian Capital Territory

### Historical analysis

Annual electricity demand in New South Wales has fallen for two consecutive years, trending against forecast. In this region, the mining, metals and manufacturing sectors have a large influence on changing demand in the industrial sector, where there is uncertainty with the potential for plant closures and outsourcing overseas.

The three factors that appear to be the major contributors to reduced demand are slow economic growth, significant uptake of rooftop solar systems and rising electricity costs. The main demand drivers for the region are electricity prices, temperature, GSP per capita and employment.

### Key issues

The key issues AEMO is looking to address for New South Wales are:

- Reconciliation of sectoral energy sales data with regional demand data
- Variance in economic growth forecasts compared to actual economic growth
- Significant uptake of rooftop solar systems
- Recent electricity tariff increases.

AEMO has already commenced engaging with participants in New South Wales to develop a complete set of forecasting inputs and assumptions needed to create a robust forecast for this region. AEMO thanks those participants for the initial assistance and looks forward to continue this work with them, and others, going forward.

## 5.2.4 Victoria

### Historical analysis

Annual demand in Victoria has remained relatively flat for the past three years. As with other states, this trend is against forecast which has assumed a number of large industrial customers, which have reduced production as a

result of economic slowdown, to return to their historical consumption levels. For at least the past two years, including the forecasts contained in the 2011 VAPR (and the 2011 ESOO), the annual demand forecasts in Victoria have assumed consumption patterns observed prior to 2009 return in the short-to-medium term.

Since publication of the Victorian demand forecasts in the 2011 ESOO, AEMO has been advised by a few large industrial customers that these businesses are planning to remain at their current reduced operating level indefinitely. This has prompted AEMO to make adjustments for these large industrial customers who have announced plans not to return to previous levels of consumption.

### Key issues

Similarly to other regions, the key issues AEMO is looking to address in an improved model for Victoria are:

- The high Australian dollar, which has suppressed manufacturing output
- Reduced demand over the 2010-11 summer due to mild temperatures and flooding in regional areas
- Increased penetration of rooftop solar power systems.

The degree to which these factors affect Victorian energy sales in the long-term is uncertain. Current economic forecasts suggest a return to relatively strong growth from 2012-13 onwards.

## 5.2.5 South Australia

### Historical analysis

Annual demand has been relatively stable in South Australia for the past five years, with the slow economic conditions during these years contributing to this trend.

For the forecasts, with similar assumptions to the other NEM regions, it is estimated that during the forecast period the economic growth to demand growth relationship will return to the patterns seen before the global financial crisis.

The demand forecasts for South Australia, published in the 2011 SASDO (and 2011 ESOO) have been reviewed against the most up-to-date economic projections, but remain unchanged.

### Key issues

The focus of South Australia demand forecasting model improvements are:

- Stability of economic forecasts for the South Australian region
- Penetration of rooftop solar systems
- Significant increases to the industrial load forecast from 2013–14 onwards because of revisions to mining expansion plans in South Australia.

## 5.2.6 Tasmania

### Historical analysis

In Tasmania, demand from the industrial sector typically accounts for two-thirds of all energy sales in the state, and is reliant on several large customers. Historically, demand has varied according to the frequency of new projects either coming online or retiring. In 2008-09, the retirement of a large industrial customer contributed to the decline in demand for this year.

Tasmania key industrial sectors include aluminium and zinc smelting, and the forestry industry. There has been recent uncertainty regarding the forestry sector, with reduction in global demand, the collapse of some investment schemes and the announcement by Gunn's Ltd that the company would exit the forest industry the following year.

### Key issues

The key issues AEMO is looking to address in an improved model for Tasmania are:

- Assumptions on new and retiring large industrial customers
- Reconciliation of sectoral energy sales data with regional demand data.

## 5.3 Maximum demand forecasts

The timing of investment, both in the generation and the network areas of the electricity supply chain, is critically dependent on the probability of exceedence maximum demand forecasts. We estimate that the long term capital cost of providing an additional MW of capacity in generation, transmission and distribution is between \$2m and \$4m in the NEM. The information that AEMO publishes on the maximum demand forecasts therefore can have a major impact on either the cost of infrastructure or the cost of not supplying load. This area of forecasting is critical to minimising the infrastructure cost while maintaining a reliable power system and therefore requires considerable attention in our planning process.

Prior to 2007, each jurisdictional planning body developed MD forecasts by determining POE temperatures before translating these into demands expected at those temperatures. For example, the Victorian 10% POE summer MD was based on an average daily temperature of 32.9°C, which is the temperature not expected to be exceeded more than 1 in 10 years.

In 2004/05, the KEMA report:

- Concluded that the POE of the forecast 10%, 50% and 90% POE MDs based on POE temperatures did not reflect the defined and target POE for the forecast POE MD; and
- Recommended that the definitions and methodologies used by the Jurisdiction Planning Bodies (JPBs) for forecasting summer and winter POE be reviewed.

Implementation of these findings has seen a divergence in forecasting methodologies between regions, as well as significant confusion around the now apparent disconnect between POE temperatures and POE demands.

AEMO and its predecessor organisations commissioned Professor Rob J Hyndman of the Department of Econometrics and Business Statistics, Monash University in 2006 to develop a forecasting approach which provided a statistically accurate measure for the 10%, 50% and 90% POE maximum demands for Victoria and South Australia. This methodology has been used since that time with strong evidence of accurate results.

The National Electricity Forecasting Project, in regard to MD forecasting, aims to clarify AEMO's MD forecasting processes before engaging with stakeholders to ensure improved understanding of this approach across the electricity industry, such that a review of the appropriateness of AEMO's approach can be undertaken.

The following explanation introduces AEMO's MD forecasting methodology.

### 5.3.1 MD forecasting methodology

Figure 5-3 presents a broad outline of the MD forecast methodology. The forecast methodology generates Probability of Exceedence (POE) projections of seasonal maximum demand that encompass:

- Variations in economic, financial and industrial conditions
- Current and forecast energy market conditions
- Existing and proposed energy and environmental policy measures
- Existing and likely technological developments
- Developments in stock and usage of electrical appliances (e.g. cooling, heating and lighting loads)
- Variations in temperature patterns (climate variations due to urban and global warming), and
- Random variations in residential, commercial and industrial consumption.

The forecasts approach uses half hourly demand and temperature data from 1996-97 to the most recent seasonal data. Separate models have been estimated for every half hourly period during the day. Major loads have been modelled separately.

Temperature spanning the period 1973 to 2011 has been simulated on a half hourly basis to generate thousands of synthetic temperature traces. Synthetic distributions of demand are then generated from the estimated models for each half hour using re-sampled residuals and the temperature traces.

Key drivers into the derivation of synthetic demand are:

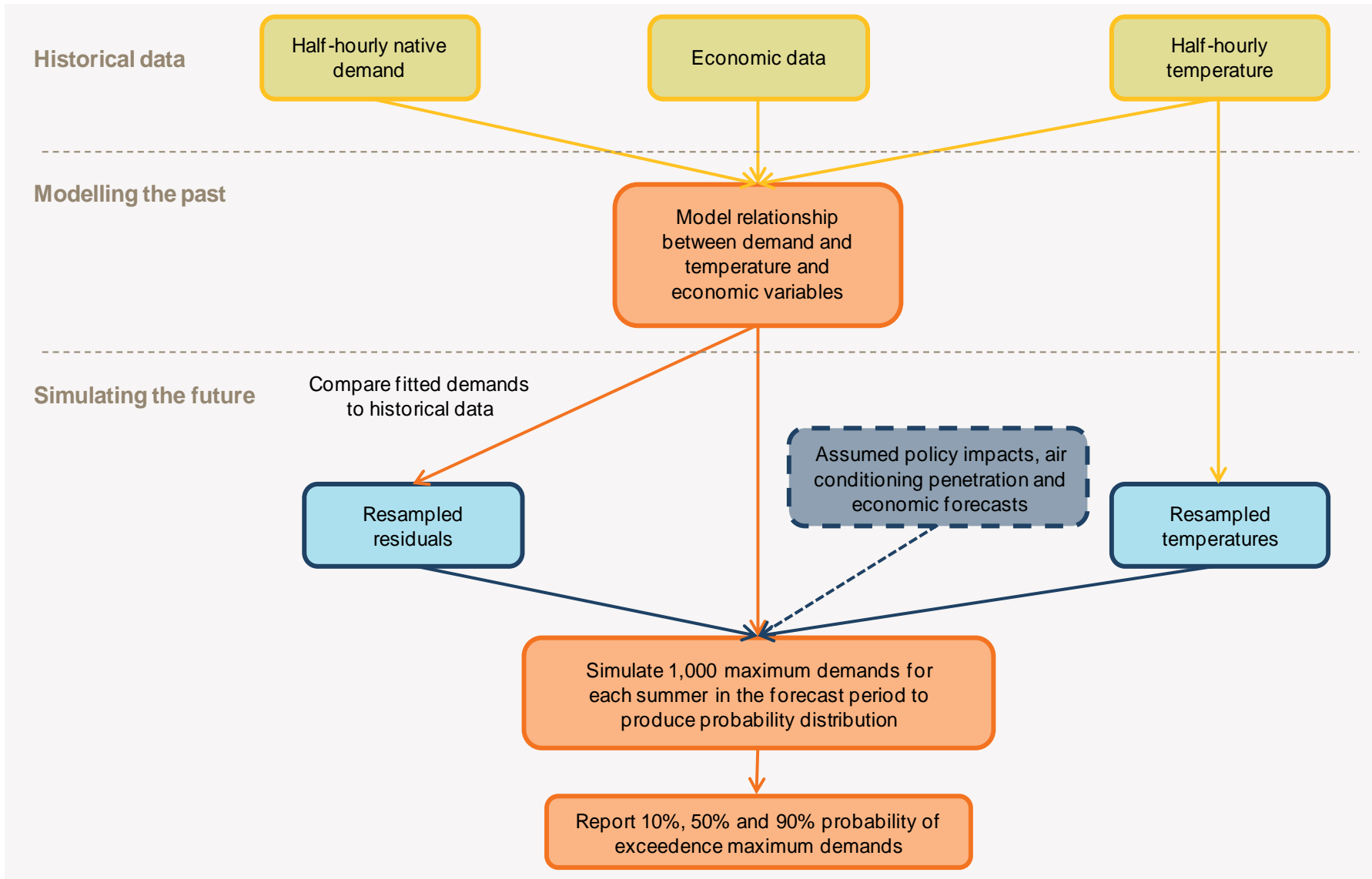
- Annual consumption projections, and
- Forecast air conditioning sales based on actual industry sales data (for the summer MD projections)

The baseload (weather-insensitive) demand component is projected forward using growth in weather insensitive consumption projections which reflect economic conditions and the electricity price assumptions.

Weather sensitive demand component is based on growth projections of weather sensitive consumption which is directly related to forecast air conditioning sales, and adjusted for policy changes such as direct load control and peak power pricing impacts.

There are 1,000 synthetic demands separately simulated for each half hourly period. The POE forecasts of demand are then drawn directly from the simulated distributions. 10%, 50% and 90% POE demand levels are reported for summer and winter.

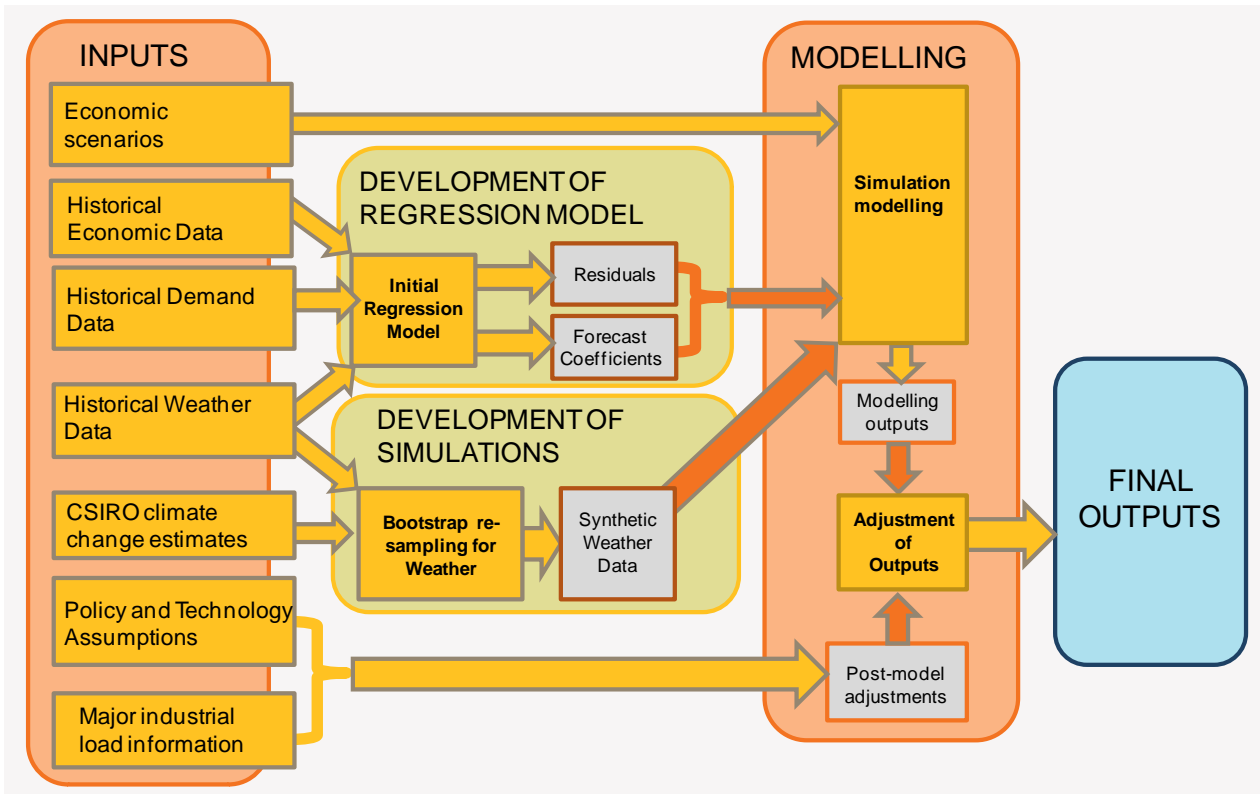
Figure 5-3 — Outline of MD forecast approach



The outputs are also adjusted to take account of new Australian and state government policies which impact on the electricity demand forecasts. Some of these policies are directly reflected in electricity prices, such as the proposed Emissions Trading Scheme and the expanded MRET. Other policies such as changes to Minimum Energy Performance Standards (e.g. lighting and air conditioners) are directly taken account of in the demand forecast process.

AEMO acknowledges the need for improved documentation in all areas of forecasting methodology, and has developed Figure 5-4 to compliment the modelling description provided above.

**Figure 5-4 — MD modelling framework**



Developing new forecasts for each NEM region, and for the whole NEM, is a significant exercise for AEMO, and there is still a lot of work to be done to get these forecasts as robust as possible.

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