

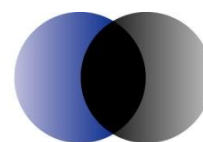


# Review of Demand Forecasts for Envestra Victoria

Victorian Gas Access Arrangement Review for  
the period 2013 – 2017

Prepared for the Australian Energy Regulator

**Final Report – August 2012**



**ACIL Tasman**

Economics Policy Strategy

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# 1 Introduction

## 1.1 Background

The *National Gas Rules* (NGR), rule 72(1)(a)(iii) require the access arrangement information provided by the service provider to include usage of the pipeline over the earlier access arrangement period showing:

- minimum, maximum and average demand
- customer numbers in total and by tariff class.

In making a decision whether to approve or not to approve an access arrangement proposal, the Australian Energy Regulator (AER) is required under rule 74 of the NGR to be satisfied that forecasts required in setting reference tariff(s) are arrived at on a reasonable basis and represent the best forecast or estimate possible in the circumstances.

## 1.2 Scope and approach

The AER has engaged ACIL Tasman to provide independent advice through written reports on the demand forecasts contained in the access arrangement proposals submitted by the Victorian transmission and distribution businesses to assist it in its decision about whether to approve the access arrangement proposals.<sup>1</sup>

The process followed by the AER for assessing proposed access arrangements and access arrangement revisions is set out in the Final Access Arrangement Guideline published in March 2009 (AER, 2009).

### 1.2.1 Requirements of the Terms of Reference

The Terms of Reference for the review of demand forecasts are set out in Appendix B. In summary, the Terms of Reference require ACIL Tasman to provide advice on whether the demand forecasts for each business have been arrived at on a reasonable basis and represent the best forecasts for demand in the circumstances.

More specifically, the Terms of Reference require ACIL Tasman to:

1. undertake a desktop review of the demand forecasts
2. formulate questions on areas where further information or clarification is required

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<sup>1</sup> Envestra Victoria, Envestra Albury, Multinet, SP AusNet and APA GasNet.

3. analyse all material provided and prepare separate reports for each service provider, including recommendations on whether the demand forecasts have been arrived at on a reasonable basis and represent the best forecasts for demand in the circumstances.
4. provide alternative forecasts if necessary (that is, if the review of the forecasts submitted by the service provider finds that they have not been arrived at on a reasonable basis and do not represent the best forecasts for demand in the circumstances).

### 1.2.2 Approach to the review

A key part of the information submitted by a service provider in support of a proposed access arrangement is a forecast of the level of demand for the reference services provided over the course of the access arrangement period. This typically involves forecasting demand for services for a period of five years from the commencement date of the new access arrangement. It is important to ensure that the forecasts represent best estimates arrived at on a reasonable basis because:

- Demand forecasts may impact the forecast capital expenditure required to meet the new demand of prospective users or the increased demand of existing users and may therefore influence forecast revenue.
- Demand forecasts influence the tariffs set to meet forecast revenue in each year of the access arrangement period, and how this revenue is to be allocated between tariff classes for different reference services.

In undertaking this review, ACIL Tasman has considered the following issues:

1. the adequacy of the overall approach and methodology
2. the reasonableness of the assumptions
3. the currency and accuracy of the data used
4. the account taken of key drivers
5. whether the methodology has been properly applied.

The review has been undertaken as a desktop analysis into the methodology, data and parameters, and assumptions used to develop the demand forecasts. ACIL Tasman has used its own knowledge of Australian gas markets to test assumptions.

### 1.2.3 Data sources

In preparing this review, ACIL Tasman has relied on the following data sources:

- The National Gas Rules
- The Access Arrangement Information submitted by Envestra (Envestra, 2012)

- The demand forecast prepared by Core Energy Group (Core, 2012)
- Requests for additional information to Envestra Victoria
- Various specialist reports as detailed in the Bibliography

#### 1.2.4 Structure of the report

This remainder of this report is structured as follows:

Chapter 2 sets out the key findings of the report. To the extent that the review takes issue with particular elements of the forecast, it described the nature of those concerns and recommends action to be taken to address those concerns.

Chapter 3 described the scope of the Envestra Victoria operations.

Chapter 4 describes the forecast methodology and assumptions.

In Chapter 5 we consider whether the application of the methodologies and assumptions described in Chapter 4 has produced forecast results for the Envestra Victoria network that are reasonable in light of historical patterns of demand as well as current and anticipated influences on retail gas demand in the distribution area. We consider separately the forecasts for the Volume and Demand sectors of the market.

Finally, in Chapter 6, we set out our conclusions regarding the acceptability of the forecasts, and the actions that the AER should require to address identified deficiencies in the forecasts as submitted.

## 2 Key findings and recommendations

### 2.1 Core Energy Group forecast

In preparing the demand forecasts for the Envestra Victoria network, Core has used a forecasting approach that basically assumes that the combined effect of the individual drivers of demand is largely represented in the linear trend of weather adjusted historic data, and that it is not necessary (or practical) to separately estimate each of the individual demand drivers given the limitations of the available data.

The analysis prepared by Core on behalf of Envestra assumes that three factors will drive increases in gas prices during the regulatory period: carbon price; other influences on the wholesale gas market; and network prices. The analysis accounts for the impact of the carbon price on retail gas prices (reweighted for non-residential customers) based on Commonwealth Treasury modelling of the carbon trading scheme.



The analysis also takes into account anticipated increases in wholesale gas prices based on the same Australian Treasury modelling from which it drew the impact of the carbon price. We agree with Envestra that the price of gas is likely to increase noticeably over the regulatory period and that this is an important factor to take into account in forecasting gas demand. In our view the assumed increases in wholesale gas price are reasonable and may be conservative in the light of growing demand for gas in the power generation sector and the potential impact of LNG exports on domestic gas prices in the eastern Australian market.

Core has adjusted the Envestra Victoria demand forecasts to take into account the anticipated effects of the 6-star building standard for new homes in Victoria. This is a new policy the effects of which could not be expected to be reflected in the historical data on gas demand. Drawing on a Regulatory Impact Statement (RIS) prepared by the Centre for International Economics (CIE) for the Council of Australian Governments, Core has estimated that the average impact of the 6-star energy efficiency requirement across all new residential connections on the Envestra Victoria network will be a reduction in demand of approximately 5.3 GJ/a per connection. We consider this assumption to be reasonable.

We accept that it is appropriate to take into account the whole of the (anticipated) network price increase in determining the expected future delivered price of gas to customers on the Envestra Victoria network.

The analysis has assumed a value of -0.30 for the own-price elasticity of demand for gas, consistent with the AER's recent decision regarding its access arrangement in South Australia. This is broadly supported by analysis undertaken by Core which found an estimated price elasticity of about -0.27 for all customer classes on the Envestra Victoria network, and is generally consistent with the estimates used by the other distribution businesses.

Envestra and its consultant Core do not appear to have considered the impact that higher electricity prices will have on gas demand (assumed a cross-price elasticity of zero). We consider that Envestra's reliance on own-price elasticity estimates alone is not unreasonable because of the lack of other relevant contrary evidence. In its report to SP AusNet, CIE concluded that the price of electricity should not be included in its models of gas demand (CIE, 2012). This is further discussed in section 4.5.2.

Normalisation of historical weather data has been carried out using a conventional approach based on Effective Degree Day (EDD) trends and weather sensitivities estimated, for each class of customer, using regression analysis. The key issue arising from this analysis is the assumption regarding "normal" weather between 2005 and the present. The Envestra forecasts are

based on projections of EDD prepared by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in 2007 (updated to include data to 2010 but with no change to the trend functions) as the benchmark for “normal” weather. The scenario used to establish the “normal” weather benchmark for the Envestra Victoria forecasts is “CSIRO Urban Heat Island plus medium anthropogenic global warming”—a scenario that projects a “normal” EDD level of 1278 for 2012. AEMO’s recent review of Victorian EDD as part of its weather standards for gas forecasting, found the same rate of decline in historical EDD as the CSIRO study, but a significantly higher 2012 EDD value of 1309.

ACIL Tasman considers that it would be more appropriate for Envestra to weather normalise the historical data on the basis of the AEMO EDD standard which is based on actual temperature outcomes for the period 1970 to 2011, rather than the CSIRO forecast which represents modelled temperature outcomes based on data for the period 1970 to 2005 (Suppiah & Whetton, 2012a, p. 23). We estimate that, based on EDD data from 1970 to the present, this change would increase total forecast demand levels in the Envestra Victoria system by around 0.4 PJ/a or 0.75%. This is further discussed in section 4.4.

There are a number of methodological issues with the forecasting approach used by Core to develop the Envestra demand forecasts (see section 4.2.3). These issues have the potential to introduce bias and distortions to the modeling results. Core has acknowledged that, ideally, the forecasting model would be more comprehensive and rigorous, containing “a variable for every factor significantly influencing gas demand”. However it has opted to use a simpler approach on the basis that the limited data available does not support a more comprehensive econometric analysis.

Notwithstanding the methodological issues identified, we have concluded that a more rigorous approach would not necessarily produce a more reliable forecast. This is because of the limitations of available data and the difficulties involved in reliably estimating the coefficients associated with each of the variables in a fully specified demand function.

Accordingly, while recommending that consideration be given in future to the methodological issues identified, we consider that in the circumstances the approach used by Core to develop the Envestra Victoria demand forecasts is acceptable.

## 2.2 Assessment of the forecasts

We have reviewed the forecasts themselves, to consider whether the application of the methodologies and assumptions used by Core has produced

forecast results for the Envestra Victoria network that are reasonable in light of historical patterns of demand as well as current and anticipated influences on retail gas demand in the distribution area.

Based on a comparison with historical trends and statistical confidence intervals around those trends, together with consideration of recent policy and market developments, we find that the forecasts of customer numbers, average demand per customer and total demand by customer class are not unreasonable, with the proviso that we consider that the AER should require Envestra Victoria to modify the forecasts by adopting the current AEMO EDD standard of 1309 EDD for 2012, declining at 7.8 EDD per year, as the basis for weather normalising the historical data.

### 3 Scope of Envestra Victoria operations

The Envestra Victoria gas distribution operations comprise almost 10,000 kilometres of mains delivering gas to around 575,000 customers. The network includes the distribution mains, inlets, meters, regulators and ancillary equipment used to provide pipeline services. The network serves the northern, outer eastern and southern areas of Melbourne, Mornington Peninsula, rural communities in northern, eastern and north-eastern Victoria (Benalla, Shepparton, Echuca and Wodonga) and south-eastern rural townships in Gippsland (Sale, Moe, Bairnsdale). The Envestra Victorian distribution business comprises around 45% of the company's total gas distribution business in Australia. The Network is divided into four zones: North, Central, Murray Valley and Bairnsdale.

The network, which has been constructed over a period of more than 100 years, consists of a variety of pipe materials. The predominant pipe material used for gas mains up until the 1970s was cast iron and unprotected steel. In the newer parts of the network, polyethylene (PE) has been used as the predominant pipe material. The type of pipe material dictates the maximum allowable operating pressure of the constituent parts of the network. Since cast iron can only be operated at relatively low pressures compared to PE, the ongoing replacement of cast iron pipe with PE pipe means that the capacity of the Network is improving over time in many areas.

As at 30 June 2011, the total network length was 9,917 km of which 5,620 km (57%) was PE, 3,064km (31%) coated steel, 695 km (7%) cast iron or non-coated steel and 5% PVC (Envestra, 2012, pp. 9-10, Table 1.1). The network operates at a wide range of pressures: Transmission mains that form the backbone of the network operate at pressures greater than 1,050 kPa, with the reticulation network comprising pressure tiers ranging from High Pressure

(515 to 1,050 kPa) to Low Pressure (1.4 to 7 kPa) (Envestra, 2012, pp. 10, Table 1.2).

### 3.1 Historical gas demand

The historical customer numbers for the Envestra Victoria distribution network are shown in Table 1.

Table 1 **Envestra Victoria gas networks—historical customer numbers, by class**

Calendar Year	2008	2009	2010	2011	2012
Residential	501,200	514,180	527,983	541,152	553,604
Commercial	22,559	22,674	22,644	22,798	22,967
<b>Volume Customer Total</b>	<b>523,759</b>	<b>536,854</b>	<b>550,627</b>	<b>563,950</b>	<b>576,571</b>
Demand Customers	229	228	231	231	233
<b>Total customers</b>	<b>523,988</b>	<b>537,082</b>	<b>550,858</b>	<b>564,181</b>	<b>576,804</b>

Data source: (Envestra, 2012)

Historical gas demand, by customer class, is summarised in Table 2.

Table 2 **Envestra Victoria gas networks—historical customer demand (TJ), by class**

Year ended 30 June	2008	2009	2010	2011	2012
Residential	26,368	27,011	26,848	27,248	27,598
Small business	6,981	6,823	6,788	6,772	6,768
<b>Volume Customer Total</b>	<b>33,349</b>	<b>33,834</b>	<b>33,636</b>	<b>34,020</b>	<b>34,367</b>
Demand Customers	22,286	20,414	21,876	21,484	21,126
<b>Total customers</b>	<b>55,635</b>	<b>54,248</b>	<b>55,511</b>	<b>55,504</b>	<b>55,493</b>

Data source: (Envestra, 2012)

## 4 Forecast methodology and assumptions

The demand forecasts contained in the Envestra Victorian Access Arrangement Information document (Envestra, 2012) are based on the forecasts developed by Core Energy Group (Core) the results of which are detailed in Attachment 13.4 of the access arrangement submission (Core, 2012). The forecasts cover a period from 1 January 2013 to 31 December 2017 and are based on a combination of assumptions and econometric regression models.

## 4.1 Scope of the demand modelling study

The scope of the demand study undertaken by Core for Envestra is detailed in Appendix 1 of the Core report (Core, 2012). The key points in the Terms of Reference for the study are:

- To provide forecasts over the 2013-2017 period for
  - Customer numbers
  - Energy
  - Demand
  - Average use per customer
- The forecast needs to be specific to
  - Tariff Zones
  - Tariff Class (Residential, Non-Residential and Large Industrial)
- The forecast also needs to satisfy the overarching criteria set out in the National Gas Rules, namely:-
  - 1) Information in the nature of a forecast or estimate must be supported by a statement of the basis of the forecast or estimate.
  - 2) A forecast or estimate:
    - a. must be arrived at on a reasonable basis; and
    - b. must represent the best forecast or estimate possible in the circumstances.
- Criteria earlier expressed by the AER in previous forecasting decisions:
  - Be accurate and unbiased
  - Transparent and repeatable
  - Incorporate key drivers
  - Address model validation and testing
  - Be accurate and consistent at all forecast levels
  - Use the most recent input information
  - Clearly state assumptions and have backing for these
  - Account for weather normalization
  - Adjust for temporary transfers
  - Adjust for discrete block loads

The scope of the consultancy brief also includes a list of candidate inputs which may be used in generating the forecasts, including:

1. Gross State Product (GSP)
2. Inflation
3. Disposable income

4. Housing approvals
5. Population growth
6. Alternative energy uptake
7. Appliance uptake
8. Price elasticity
9. Policy changes
10. Weather projections
11. Household composition

The Terms of Reference note that all inputs should be properly referenced to independent sources.

#### **4.1.1 Modelling approach**

The approach taken to development of the demand forecasts can be summarized as follows:

- Base Forecast – developed by Core using trend analysis of weather normalized historical data
- Minus adjustment for impact of 6-Star Building Standard Policy (residential demand only)
- Minus adjustment for impact of carbon price
- Minus adjustment for impact of changes in wholesale gas price
- Plus adjustment for network development activities (Envestra adjustment, outside Core model)
- Plus adjustment for new town connections (Envestra adjustment, outside Core model)
- Minus adjustment for (anticipated) network price increase.

## **4.2 Econometric modelling**

In this section we review the data sources used by Core in developing the Envestra demand forecasts, as well as its econometric and forecasting approach. The section concludes with a detailed discussion of the issues that ACIL Tasman has identified with the demand forecast prepared by Core for Envestra.

### **4.2.1 Data sources**

Table 3, Table 4 and Table 5 summarise the sources of data used by Core in developing the demand forecasts for Tariff V Residential, Tariff V Non-residential (commercial and small industrial) and Tariff D (large industrial) customers respectively.

Table 3 **Data Sources – Tariff V, Residential**

Parameter	Source
Historic – gas demand by region	Envestra
Historic – connections by region	Envestra
Historic – connections by age of connection	Envestra
Historic – GHDI - VIC	ABS 5220.0 Table 13 Series ID A2335042J
Forecast – households	ABS 32360DO001_20062031 Household and Family Projections, Australia, 2006 to 2031; August 2010
Historic – new dwelling starts	Housing Industry Association (HIA)
Normalised – Effective Degree Days (“EDD”)	CSIRO
Historic – Actual EDD	AEMO
Historic – Albury Temperature	Bureau of Meteorology (“BOM”); 072160 - Albury Airport Weather Station
Forecast – GHDI	SACES
Forecast – new dwelling starts	HIA
Forecast – households	ABS 32360DO001_20062031 Household and Family Projections, Australia, 2006 to 2031; August 2010
Forecast – effect of 6-Star Building Standard	CIE; Final Regulation Impact Statement for residential buildings (class 1, 2, 4 and 10 buildings), Table 6.2 p.80 ; December 2009
Forecast – new connections Murray Valley and Bairnsdale	Envestra
Own price elasticity of gas demand	AER; Final Decision Envestra Limited Access Arrangement Proposal For The SA Gas Network 1 July 2011 – 30 June 2016
Retail gas price components	Core Energy Group
Forecast – carbon price impact on retail gas prices	Australian Treasury Strong Growth, Low Pollution - Modelling; July 2011; Table 5.19: Effects on weekly expenditure and the consumer price
Forecast – network price	Envestra
Forecast – wholesale gas prices	Australian Treasury Strong Growth, Low Pollution - Modelling a Carbon Price; July 2011; Chart B6: Domestic Australian gas prices

Source: (Envestra, 2012)

Table 4 **Data Sources – Tariff V, Non-Residential**

Parameter	Source
Historic - gas demand by region	Envestra
Historic - connections by region	Envestra
Historic – GSP	SACES
Normalised – EDD	CSIRO
Historic – EDD	AEMO
Historic – Albury Temperature	BOM; 072160 - Albury Airport Weather Station
Forecast - GSP	SACES
Forecast – new connections Murray Valley and Bairnsdale	Envestra
Price elasticity of gas demand	AER; Final Decision Envestra Limited Access Arrangement Proposal For The SA Gas Network 1 July 2011 – 30 June 2016
Retail gas price components	Core Energy Group
Forecast – carbon price impact on retail gas prices	Australian Treasury Strong Growth, Low Pollution - Modelling a Carbon Price; July 2011; Table 5.19: Effects on weekly expenditure and the consumer price
Forecast – network price	Envestra
Forecast – wholesale gas prices	Australian Treasury Strong Growth, Low Pollution - Modelling a Carbon Price; July 2011; Chart B6: Domestic Australian gas prices

Source: (Envestra, 2012)



Table 5 **Data Sources – Tariff D, Large Industrial**

Parameter	Source
Historic - gas demand by region	Envestra
Historic – MHQ by region	Envestra
Historic - connections by region	Envestra
Historic – GSP	SACES
Normalised – EDD	CSIRO
Historic – EDD	AEMO
Historic – Albury Temperature	BOM; 072160 - Albury Airport Weather Station
Forecast - GSP	SACES
Price elasticity of gas demand	AER; Final Decision Envestra Limited Access Arrangement Proposal For The SA Gas Network 1 July 2011 – 30 June 2016
Retail gas price components	Core Energy Group
Forecast – carbon price impact on retail gas prices	Australian Treasury Strong Growth, Low Pollution - Modelling a Carbon Price; July 2011; Table 5.19: Effects on weekly expenditure and the consumer price
Forecast – network price	Envestra
Forecast – wholesale gas prices	Australian Treasury Strong Growth, Low Pollution - Modelling a Carbon Price; July 2011; Chart B6: Domestic Australian gas prices

Source: Envestra (2012)

#### 4.2.2 Modelling approach

Core describes its modeling approach as follows:

“Ideally, a model would contain a variable for every factor significantly influencing gas demand, however, due to the limited availability of information on appliance usage and penetration in VIC, as well as only 6 years of actual gas demand observations, alternative methods were required. Given the constraints on available data, Core considers its methodology to be appropriate.

The precise effect of individual factors such as government policy, changing consumer attitudes and increases in efficiency are difficult to identify on a stand-alone basis, as such, Core has opted to represent the combined effect of all factors through a linear trend of weather adjusted historic data. This type of model contains the implicit assumption that all factors which have affected gas demand historically, will continue to affect gas demand in the future. Core believes this to be a reasonable assumption

with the exception of four additional factors that have not been present historically but will become present over the forecast period, namely the demand response to:

- the Clean Energy Bill 2011 – the introduction of a price on carbon in July 2012
- distribution network price increases
- wholesale gas price increases – as a result of the introduction of a price on carbon (July 2012), the start up of an export industry (2014) and increases in the underlying extraction costs
- 6-Star Building Standards – introduced in May 2011, but not accounted for in the historic trend.

In addition to the linear trend, Core combined an income component for households and an economic growth component for commercial / industrial customers. This was done in the form of GHDI for households and GSP for commercial / industrial customers. These measures are appropriate as they are both publicly available from the ABS and geographically relevant to Envestra’s VIC network. The following figure displays the model specification used for demand per connection.”

The approach taken by Core to develop the demand forecasts involved estimation of a number of regression equations and identification of key drivers of the variable to be forecast. The resulting regression equations were then used to generate forecasts by feeding projections of independently generated inputs. More specifically, the forecasts were arrived at through a sequence of steps, as follows:

- 1) Account for weather abnormalities and rebase historical demand.
- 2) Forecast the number of customers by using
  - a) the relationship between dwellings starts and the net change in connections (for Tariff V Residential customers)
  - b) a time trend and Gross State Product, GSP (for Tariff V Non-residential (commercial and industrial) and Tariff D customers).
- 3) Forecast demand per customer using a regression relating usage per customer to:
  - a) a time trend
  - b) Gross Household Disposable Income, GHDI (for Tariff V Residential customers)
  - c) GSP (for Tariff V Non-residential and Tariff D customers).
- 4) Adjust the demand per customer forecast to account for other impacts, specifically:
  - a) Clean Energy Bill, introduced in 2011
  - b) distribution network tariff increases
  - c) wholesale gas price increases
  - d) 6-Star Building Standards (only for Tariff V Residential customers).

- 5) Multiply the number of customers by the (policy adjusted) demand per customer to obtain the total demand forecast.
- 6) For large industrial (Tariff D) customers, apply historical load factors to obtain Maximum Hourly Quantity (MHQ) forecasts.
- 7) Allocate total demand to each tariff zone –
  - a) Central
  - b) North
  - c) Murray Valley
  - d) Bairnsdale.

The key regression equations proposed by Core to establish average demand per customer connection are of the following form:

$$\text{Log} \left( \frac{\text{Demand}}{\text{Customer}}_t \right) = \beta_0 + \beta_1 \text{Log}(\text{Trend}_t) + \beta_2 \text{Log}(\text{Income}_t) \quad (1)$$

Where:

- $t$  represents the time period for the corresponding variable
- $\text{Demand}/\text{Customer}_t$  is the gas demand per connection in year  $t$
- $\text{Trend}_t$  is a time trend corresponding to year  $t$
- $\text{Income}_t$  is GHDI for Residential or GSP for Commercial/Industrial in year  $t$
- $\beta_0$  is the intercept term
- $\beta_1$  is the coefficient on the time trend
- $\beta_2$  is the coefficient on the income factor

Since variables are in logarithms, the coefficients can be interpreted as the per cent change in the dependent variable associated with a one per cent change in the corresponding explanatory variable. In other words, the coefficients represent elasticities.

Equation (1) looks like the typical regression used to estimate demand functions, except for the fact that it excludes price information (own price and the prices of substitutes). The implications of excluding price information are discussed in the following section of this report dealing with the main issues ACIL Tasman has identified in relation to the forecasting methodology (see equation (2) below and related discussion).

### 4.2.3 Methodological Issues

This section presents the main issues identified by ACIL Tasman as related to the forecasting methodology.

### Issue 1 – Simultaneity Problem

When generating the forecast, a two-step approach has been taken. The first step was to generate demand forecasts without regard for price. This assumes (implicitly) that price remains unchanged through the forecast period (refer to Steps 1-3 in section 4.2.2). The second step is to subtract a demand adjustment component from the above forecast (Step 4(b) in section 4.2.2). This is achieved by applying the own price elasticity of demand to a given network price increase.

This approach suffers from what can be described as a ‘Simultaneity Problem’. The problem arises because the proposed network price increase is calculated by feeding the unadjusted demand forecast through a tariff model, which will then calculate the tariff level necessary for the distributor to achieve a given rate of return. Own demand price elasticity is then applied to these preliminary tariffs, and the resulting fall in quantity demanded is subtracted from the initial forecasts. The problem with this approach is that the revised forecasts then need to be fed again through the tariff model and a new set of tariffs need to be calculated. This will lead to higher tariffs, which will lead to lower demand forecasts. The process needs to be iterated until the system converges to equilibrium.

There are two ways in which the simultaneity problem could be resolved. The first would be to integrate the forecast model and the tariff model, so that the two models can be solved as a simultaneous system of equations. The second would be to iterate the process between the two models until convergence is achieved. The first option is time consuming due to the modelling efforts required to integrate the models. The second option may also be time consuming due to the iterative nature of the process.

The impact of this problem will be that the current forecasts tend to over-estimate demand, leading to upward bias in the demand forecasts. It is difficult to ascertain the size of the impact this issue might have, but it is clear that it will tend to lead to relatively high demand forecasts and under-estimated tariffs, which, holding everything else constant, will cause realised revenue to be less than forecast revenue for Envestra.

### Issue 2 – Non-linearities in Demand

The regression equations specified in equation (1) do not capture non-linear aspects of demand. In particular, as income rises or falls, it does not necessarily follow that demand per customer will track income by a constant per cent change. At high/low income levels, a given per cent change in income will not necessarily lead to the same per cent change in gas demand per customer. For example, businesses or households will not necessarily continue to increase

heating their environments as their incomes grow: There are upper thresholds in demand, above which the intensity of demand tapers off. Likewise, there are also lower thresholds. For example, consumers are likely to maintain consumption for heating at a minimum level to keep environmental conditions liveable, notwithstanding falling income levels.

The non-linearities discussed above exist not just in relation to income: they can also be present in prices of gas as well as substitutes. There may be thresholds in gas and electricity prices above or below which a larger or smaller customer response is triggered. For example, if electricity prices rise beyond a certain level, then it may become optimal for customers to switch to gas heating, and given that the electricity price thresholds may be common to many customers, this could have an ‘avalanche effect’, which should be reflected in larger cross-substitution coefficients for high electricity price levels. The same logic applies to lower thresholds, as well as own price.

This issue could be ameliorated by introducing non-linear terms into the regression equations. In particular, introducing higher powers of the relevant variables would capture non-linearities present in the data.

As income continues to grow, not accounting for non-linearities in demand (particularly not accounting for the presence of upper thresholds) may result in demand being overstated, tariffs under-estimated, realised revenue for Envestra being lower than forecast. The analysis for price thresholds is more complex and it is difficult to ascertain *ex-ante* the magnitude or direction of any impact.

Accounting for non-linearities in demand becomes particularly important when there are large impacts to the explanatory variables. Whilst policy changes are on-going, ACIL Tasman does not envisage substantial and unaccounted for shocks to the drivers of demand. Hence not accounting for non-linearities in demand is not expected to be a fundamental cause for error in the forecast.

### **Issue 3 – Absence of Dynamics and Price Elasticities in Estimation**

The regressions in equation (1) omit a treatment of dynamic aspects of demand and exclude price information. In the presence of dynamic behaviour, it is often the case that the dependent variable (for the case under consideration, gas demand) is a function of past values of itself<sup>2</sup>. This can arise because the dependent variable may exhibit a sluggish adjustment process; hence past values will continue to affect values in the present.

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<sup>2</sup> In econometric terms, the time series for the dependent variable exhibits a certain degree of autocorrelation.

To account for this, it is customary to introduce a lagged dependent variable among explanatory variables. In a demand function that takes dynamic aspects of demand into account, the regression equation would take the following form:

$$\begin{aligned} \text{Log} \left( \frac{\text{Demand}}{\text{Customer}}_t \right) = & \beta_0 + \beta_1 \text{Log}(\text{Trend}_t) + \beta_2 \text{Log}(\text{Income}_t) \\ & + \beta_3 \text{Log}(\text{OwnPrice}_t) + \beta_4 \text{Log}(\text{SubsPrice}_t) + \\ & \beta_5 \text{Log} \left( \frac{\text{Demand}}{\text{Customer}}_{t-q} \right) \end{aligned} \quad (2)$$

Where:

- $t$  represents the time period for the corresponding variable
- $q$  represents the number of time lags on a variable
- $\text{Demand}/\text{Customer}_t$  is the gas demand per connection in year  $t$
- $\text{Demand}/\text{Customer}_{t-q}$  is the gas demand per connection in year  $t-q$
- $\text{Trend}_t$  is a time trend corresponding to year  $t$
- $\text{Income}_t$  is GHDI for Residential or GSP for Commercial/Industrial in year  $t$
- $\text{OwnPrice}_t$  is the gas price in year  $t$
- $\text{SubsPrice}_t$  is the price of a key substitute in year  $t$  (for example, electricity)
- $\beta_0$  is the intercept term
- $\beta_1$  is the coefficient on the time trend
- $\beta_2$  is the coefficient on the income factor
- $\beta_3$  is the coefficient on own price (“own-price short-run elasticity”)
- $\beta_4$  is the coefficient on the price of a substitute (“cross-price elasticity”)
- $\beta_5$  is the coefficient on the lagged dependent variable

Estimation of a regression such as equation (2) would allow the definition of short-run and long-run elasticities of demand. In particular, the coefficient  $\beta_3$  represents the short-run own-price elasticity of demand. The long-run elasticity is calculated as  $\beta_3/(1 - \beta_5)$ .

However, the regression used by Core in the Envestra forecasts, namely equation (1), omits price information and dynamic aspects of demand. As a result, it does not allow the estimation of price or demand elasticities either as static (linear) estimates or as short and long run elasticities that take dynamics into account.

Ideally this problem would be resolved by specifying a demand function which contains prices of gas as well as substitutes (in particular, electricity) as explanatory variables, alongside other explanatory variables such as income. Incorporating a lagged dependent variable into the demand function would

allow estimation of short and long run demand elasticities. Note, however, that the inclusion of prices as explanatory variables would mean that endogenous variables are being treated as exogenous variables, leading to further econometric estimation problems. Nonetheless, standard econometric techniques are available to address these<sup>3</sup>.

In practice—and as alluded to by Core in the previously-quoted explanation of its methodology—limited availability of detailed (connection level) information on consumer behaviour, together with the short time series of available gas demand observations (in this case six years) are likely to make it difficult if not impossible to establish a fully-specified demand function supported by reliable data.

Not having price information in equation (1) means that Core, in developing the Envestra Victoria forecasts, had to rely on estimates of demand elasticities from other sources. This in turn leads to potential problems arising from heterogeneous sources for inputs assumptions: the sources may not be consistent amongst themselves. Core did in fact attempt to calculate own price elasticity, with a resulting estimate of -0.27 for short-run elasticity (Core 2012, section 5.4.2). However, the regression equation used in this analysis only contains an intercept and own price as explanatory variables for gas demand per customer. This approach suffers from the well-known “identification problem”: the regression equation cannot be ascribed to either a demand or a supply function, both of which constitute a relationship between markets prices and quantities. The demand function is downward sloping, leading to a negative coefficient for own price. The supply function is upward sloping, with a positive coefficient on own price. The coefficient estimated in Core (2012, section 5.4.2) is neither a demand nor supply elasticity. Furthermore, the absence of dynamics means that it cannot be ascertained whether it is a long or short run coefficient. Having undertaken this analysis, Envestra instead adopted an estimate from a prior AER determination (AER, 2012), which is higher than its own estimate (the estimates in AER (2012) are -0.30 for Residential and -0.35 for Commercial/Industrial demands).

To some extent, the assumption of a high elasticity estimate will ameliorate the impact of Issue (1), the Simultaneity Problem, since it will lead to a greater reduction in forecast demand, thereby mitigating the upward bias of the forecast. Whether the effects will cancel out or one will tend to dominate is difficult to determine *ex-ante*.

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<sup>3</sup> The problem being referred to is Endogeneity Bias. The solution is to use Instrument Variables estimation procedures.

#### Issue 4 – Potential for Spurious Correlation and Stationarity Testing

When conducting estimation using time series, it is desirable to test whether the time series being used are stationary or not. Intuitively, a time series is stationary if its fundamental statistical properties do not change over time. A non-stationary time series typically exhibits exponential growth, and its behaviour is dominated by its non-stationary component<sup>4</sup>. Running regressions using non-stationary time series may lead to problems due to spurious correlation, since the regression may be capturing the relationship between the underlying non-stationary components of the variables, as opposed to the variation in the dependent variable explained by the explanatory variables.

Because the demand forecasts in Envestra (2012) are dealing with time series econometrics, it would be appropriate to conduct stationarity tests to establish whether the regressions can be run in levels or whether it is necessary to shift to “differences-on-differences” estimation<sup>5</sup>. No such tests are reported. If the time series prove to be non-stationary, then any correlation found between the variables might be spurious.

In the case of non-stationary variables, the next step would be to seek a cointegrating relationship between the variables. If such a relationship can be found, then an Error Correction Model (ECM) can be estimated. Alternatively, “differences-on-differences” estimation could be an acceptable option. However, since differencing the variables reduces the degrees of freedom, it would be preferable to find a cointegrating relationship and conduct the estimation in this manner.

Spurious correlation is a very common problem in time series analysis. The consequence would be that little reliability could be ascribed to the estimated regressions.

#### Issue 5 – Omitted Variable Bias

The regression models used in the Envestra analysis are highly simplistic. The only explanatory variables used are a time trend and proxies for income.

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<sup>4</sup> In intuitive terms, the non-stationary component of a time series is akin to the underlying trend of the time series, although the comparison is not a precise definition.

<sup>5</sup> Difference-on-differences estimation refers to running the regression using the differenced variables instead of the variables in levels. To obtain the differenced variables, the procedure is to subtract the previous period’s value of the variable from the current period’s value. This is a means to remove some of the non-stationary components present in the levels of the variable. Depending on the degree of non-stationarity, it may be necessary to difference the variable once or twice.



In selecting variables Core sought to identify the potential drivers of residential gas connection numbers. They tested a number of potential variables (population, households, government policy, trend, retail gas prices, income, historic disconnections and dwelling starts (both detached and other) but ended up using only dwelling starts on the basis that:

“Dwelling starts was found to be the best driver of new connections. This is explained by the observation that other tested variables such as population and income are in fact drivers themselves of the level of dwelling starts. Dwelling starts are further defined through two distinct building types, these are; Detached (Houses) and Other (Apartments/Units). Since there is marked difference in the proportion of Detached and Other dwellings that have a gas connection, it was necessary to include both variables separately. This is considered to provide significant explanatory power to the results determined by the model).<sup>6</sup>

It would be reasonable to expect a demand function to include a number of other explanatory variables which would account for customer characteristics and pricing of substitutes. Such explanatory variables might include customer-specific characteristics, year of connection (customer cohort), price of substitutes (in particular, electricity), proxies for policy changes, etc.

Omitting explanatory variables may lead to bias in the estimated coefficients. *Ex-ante*, it is unclear whether the coefficients might be upward or downward biased.

### **Issue 6 – Degrees of Freedom**

The statistical analysis is conducted using annual data for the period from 2005 to 2011. At best, this yields six data points, leaving most of the regression equations with four degrees of freedom at best. It is widely accepted that for Ordinary Least Squares (OLS) regression coefficients to exhibit convergence to their true population values, at least 15-20 degrees of freedom are necessary. Any regression analysis using fewer degrees of freedom is likely to yield coefficients that are distant from the true population values.

### **Issue 7 – Discrete Dependent Variable: Tariff D Customers**

When estimating the number of connections for Tariff D Customers (industrial), no attempt is made to account for the fact that these are discrete decisions which have a significant impact on the demand forecast. The econometrics methods used are the same as for the other customer types (residential and commercial), which are better suited to problems with a continuous dependent variable. However, there are better methods for

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<sup>6</sup> Core Energy Group, *AER Question Responses, Envestra Limited – Gas Access Arrangement Review, Victorian Network (2013 to 2017)*, May 2012, pp. 4-5.

problems with discrete dependent variables. In particular, a model designed for count data may be more appropriate<sup>7</sup>. Attempting estimation using a standard Ordinary Least Squares linear regression approach will lead to a variety of statistical problems, including biased coefficients.

### 4.3 Conclusions arising from the methodology review

As discussed in Section 4.2 there are a number of methodological issues with the forecasting approach used by Core to develop the Envestra demand forecasts. Issues that have the potential to introduce bias and distortions to the modeling results include:

- the Simultaneity Problem which may introduce an upward bias in the demand forecast
- no accounting for non-linearities
- reliance on external estimates of elasticity
- potential for spurious correlation and the absence of statistical testing for non-stationarity in the variables
- omission of variables potentially affecting demand
- regressions on short time series data.

Core has acknowledged that, ideally, the forecasting model would be more comprehensive and rigorous, containing “a variable for every factor significantly influencing gas demand”. However it has opted to use a simpler approach on the basis that the limited data available does not support a more comprehensive econometric analysis. In effect, Core assumes that the combined effect of the individual drivers of demand is largely represented in the linear trend of weather adjusted historic data, and that it is not necessary (or practical) to separately estimate each of the individual demand drivers given the limitations of the available data.

The key question is whether a more elaborate and more theoretically rigorous approach addressing the issues identified would be likely to produce a better or more reliable forecast. Given the short time series of available data and the difficulties involved in reliably estimating the coefficients associated with each of the variables in a fully specified demand function, it is not clear that a more rigorous approach would necessarily produce a more reliable forecast.

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<sup>7</sup> As an example, the Poisson regression model is typically used for estimation when the dependent variable takes the form of count data (0,1,2,...). There are various estimation methods which are applicable, with Maximum Likelihood being the most common.

Accordingly, while recommending that consideration be given in future to the methodological issues identified, we consider that in the current circumstances the approach used by Core to develop the Envestra Victoria demand forecasts is acceptable.

#### 4.4 Weather normalization of historical data

Weather has a significant impact on gas demand. The need to adjust historical data on gas consumption to take account of variations in weather has been noted, for example, by AEMO who in commenting on the Victorian gas distribution system observed that:

“Understanding the factors that affect the consumption of gas is central in evaluating future energy demands. When temperatures are lower than normal, energy demand for residential heating increases. This strong relationship between gas demand and climate highlights the need to identify the weather conditions assumed when calculating forecast demand. In gas forecasts, the actual demand needs to be adjusted for weather before the underlying growth can be calculated. These weather adjustments can be simplified through the use of Effective Degree Day (EDD) variable.” (AEMO, 2009, p. 55)

There are two measures of weather commonly used in forecasting gas demand, Heating Degree Days (HDD) and EDD.

The HDD approach uses a single measure of weather, namely temperature. HDD is calculated from meteorological data as the sum, over a year, of the negative differences<sup>8</sup> between the average temperature on each day and 18° Celsius.

The EDD approach is a multifactor method that includes HDD and also takes account of wind velocity, sunshine hours and seasonal variations in demand. EDDs can be calculated on various different bases by incorporating weather conditions at different times of day. In a recent review, the AEMO recommended that the EDD<sub>312</sub>2009 index should continue to be used (Australian Energy Market Operator, 2012).

Generally speaking, an inverse relationship between gas demand and temperature is to be expected, with demand increasing as temperatures decrease because gas is commonly used for space heating.

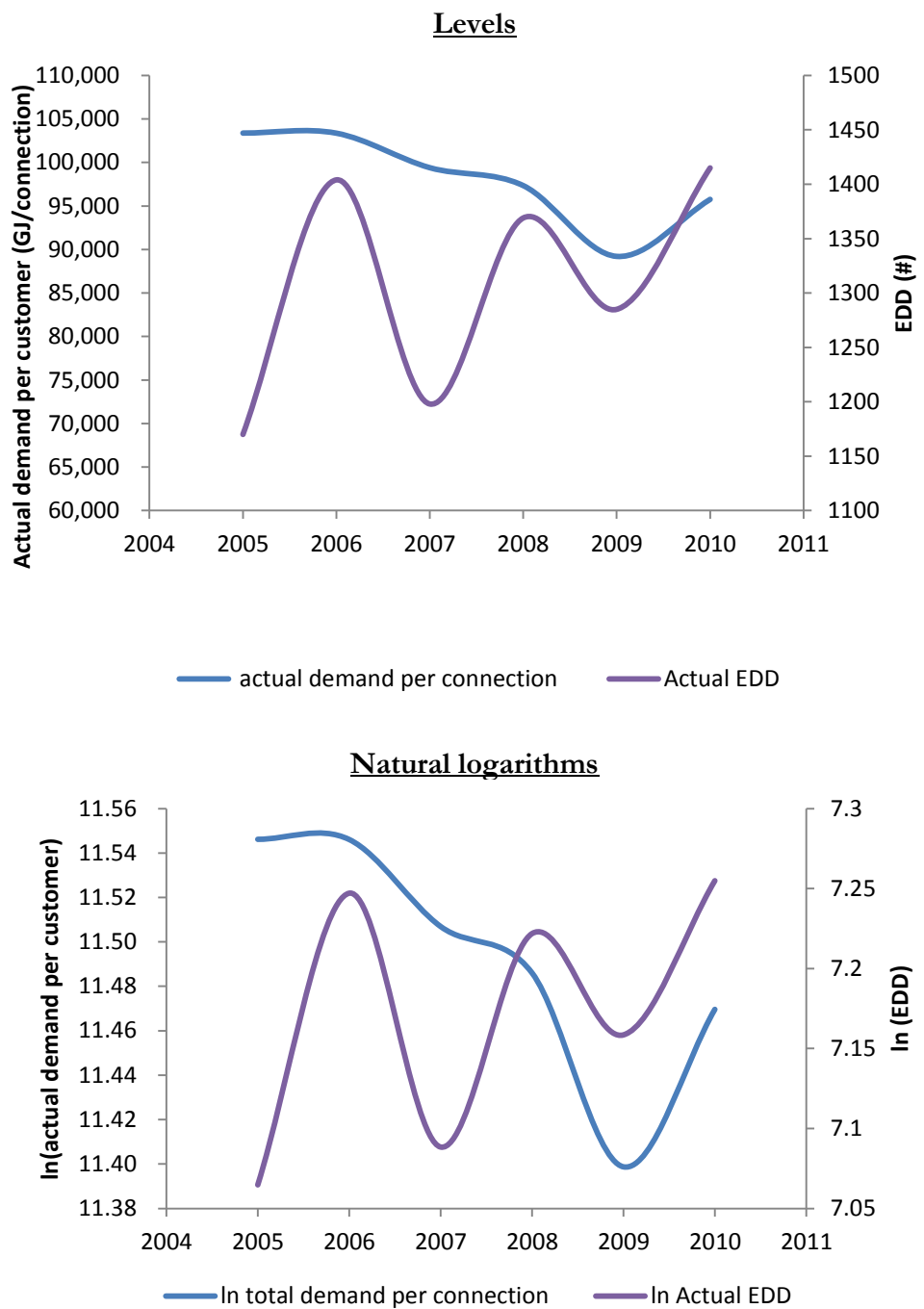
Figure 1 shows the annual volume of gas supplied to Envestra’s Tariff D industrial customers on a per customer basis from 2005 to 2011 along with the

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<sup>8</sup> If the average temperature on a particular day is greater than or equal to 18°C, then HDD for that day is zero.

number of EDDs observed in each of those years. The lower pane shows the natural logarithms of the same data.

Figure 1 **EDD and gas demand per connection - Tariff D industrial customers**



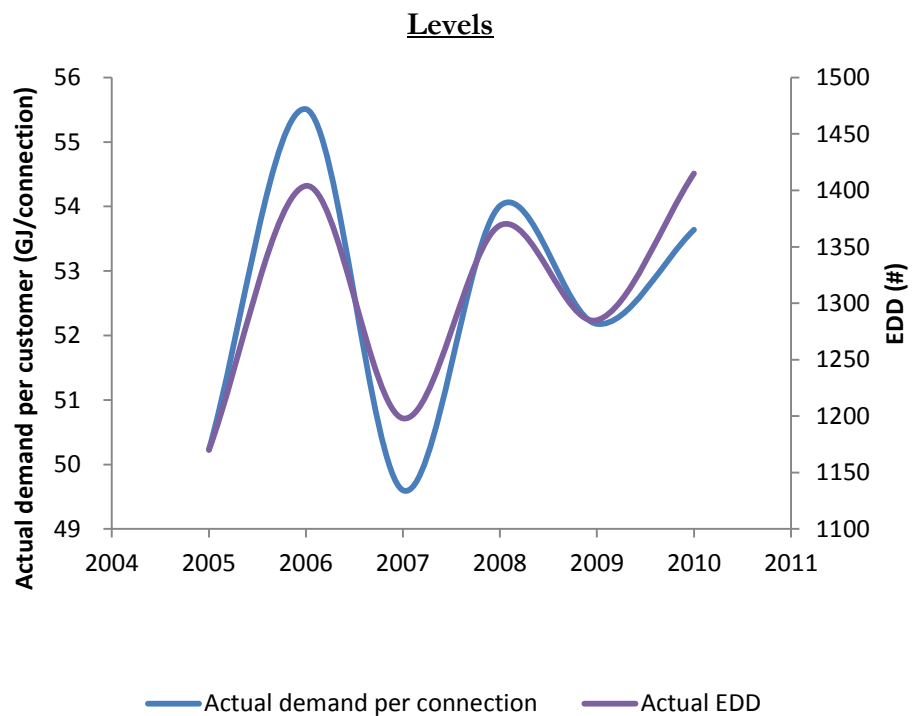
Data source: (Core, 2012)

Figure 1 appears contradictory regarding the relationship between temperature and gas demand by industrial customers. It indicates that, between 2008 and 2011, these two items were positively related as would be expected. However, before 2008, the relationship is less clear. EDDs increased from 2005 to 2006 and then decreased in 2007. In contrast, average gas demand per industrial customer was approximately flat from 2005 to 2006 and then declined steadily to 2008. This is consistent with the likely effect of the economic slowdown during this period and does not necessarily contradict the notion that average gas demand per industrial customer and EDDs are positively correlated.

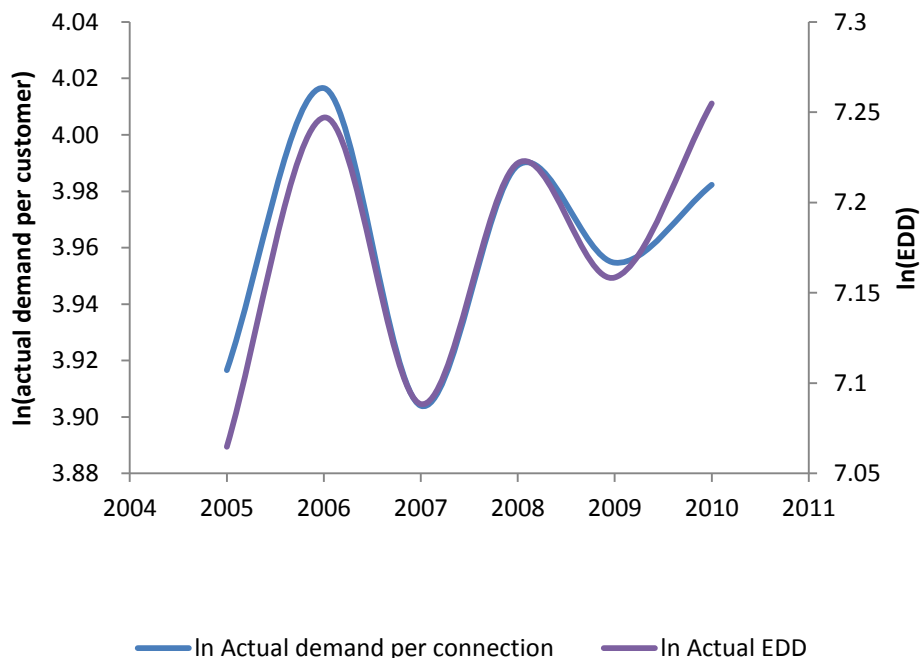
Figure 2 shows the corresponding data for residential customers.

It shows a much clearer relationship between EDDs and average gas demand per residential customer than Figure 1 showed for industrial customers. That relationship is relatively constant throughout the period, suggesting that the economic drivers that influenced industrial demand were less important for residential demand. These observations are consistent with the notion that residential gas demand is more sensitive than industrial gas demand to changes in weather (temperature).

Figure 2 **EDD and gas demand per customer – Tariff V residential customers**



### Natural logarithms



Data source: (Core, 2012)

#### 4.4.1 Envestra's approach to weather normalization

Envestra's forecasts are based on the following five-step approach to weather normalisation (Core, 2012, p. 12):

1. Obtain actual EDD data for Victoria from AEMO
2. Obtain 'normalised' EDD data for Victoria from CSIRO (2012)
3. Calculate abnormal EDD by comparing actual and normalised EDD
4. Use regression analysis to estimate the sensitivity of each tariff segment to EDD
5. Multiply abnormal EDD by the sensitivity to EDD to determine abnormal gas demand attributable to weather

Using this approach and monthly consumption data, Core estimated weather sensitivities for each class of Envestra's customers. Those sensitivities are shown in Table 6.

Table 6 **Envestra Victoria – submitted weather sensitivities**

Customer segment	Weather sensitivity (GJ/EDD/connection)
Tariff D industrial	2.2035
Tariff V Residential	0.0229
Tariff V Non-Residential	0.0734

Data source: Core, Table 2.1

The weather sensitivity coefficients in Table 6 were estimated using linear regressions on monthly data.

For residential and commercial (Tariff V) customers, those regressions had the form shown in equation (1) below:

$$\text{demand per customer} = a + b(\text{abnormal EDD}) \quad (3)$$

Where:

*demand per customer* is gas consumption per customer by tariff class

*abnormal EDD* is the difference between actual EDD as reported by AEMO and projected EDD as reported by CSIRO

*a* is an intercept term

*b* is the weather sensitivity coefficient from Table 6

For Tariff D demand, the regression included the lag of usage, i.e. they had the form shown in equation (2) below:

$$\begin{aligned} \text{demand per customer}_t \\ = a + b(\text{abnormal EDD}) \\ + c(\text{demand per customer}_{t-1}) \end{aligned} \quad (4)$$

Where:

*Demand* is gas consumption per customer on Tariff D

*abnormal EDD* is the difference between actual EDD as reported by AEMO (and Core) and projected EDD as reported by CSIRO

*t* is a time index

*a* is an intercept term

*b* is the weather sensitivity coefficient from Table 6

*c* is 0.5482

The regressions relating to Tariff V Residential and Commercial demand each have statistically significant coefficients and explain more than 95 per cent of the variation in historical data. These regressions support the notion that, for these customers, gas consumption varies mainly with the weather.

The regression for tariff D demand also has statistically significant coefficients, but it explains only slightly more than half of the variation in historical

demand. This suggests that, while weather is an important determinant of demand for Tariff D customers, other factors significantly influence demand within this customer group.

The key issue arising from this analysis is the assumption regarding ‘normal’ weather between 2005 and the present. This is discussed in the next section.

#### 4.4.2 Normal weather – the choice of EDD inputs

Demand for gas varies significantly from year to year driven by weather. Some years are colder than others and some are hotter. Gas is commonly used for heating so, in colder years, demand for gas is higher and in warmer years it is lower. The purpose of weather normalisation is to remove this year by year variation from the historical data to allow underlying trends in consumption to be observed. Projections of those trends are then prepared on the assumption that weather conditions will be “normal” because it is not possible to know in advance whether a particular year will be colder or hotter than “normal”.

To do this requires an assumption as to what are “normal” weather conditions.

One approach to determining “normal” weather is to take the median weather conditions from a time series. The median of a series is a constant number (for a given series) so using it as a projection of normal weather conditions assumes that these are stationary. In other words, it amounts to an assumption that, over time the median weather conditions (EDD in this case) will not change.

Envestra has argued that the long term data shows a warming trend and that assuming that the historical median weather will be repeated (on average) is inappropriate. This is consistent with arguments made by Envestra and the other distribution businesses that were accepted by the Essential Services Commission in its Final Decision in relation to the current access arrangement period (Essential Services Commission of Victoria, 2008).

Analysis conducted by CSIRO and provided by Envestra in support of its access arrangement proposal supports this argument. That analysis shows that historical weather data for Victoria exhibits a warming trend (and a corresponding upward trend in the number of EDDs) over approximately the last 60 years. According to CSIRO this historical trend has been largely due to the Urban Heat Island (UHI) effect.<sup>9</sup>

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<sup>9</sup> In very simple terms the UHI effect is the result of increased ‘urbanisation’ and thus increased numbers of buildings and other man-made structures in urban areas. Those structures themselves radiate heat thus preventing minimum temperatures from being as low as they may otherwise have been.

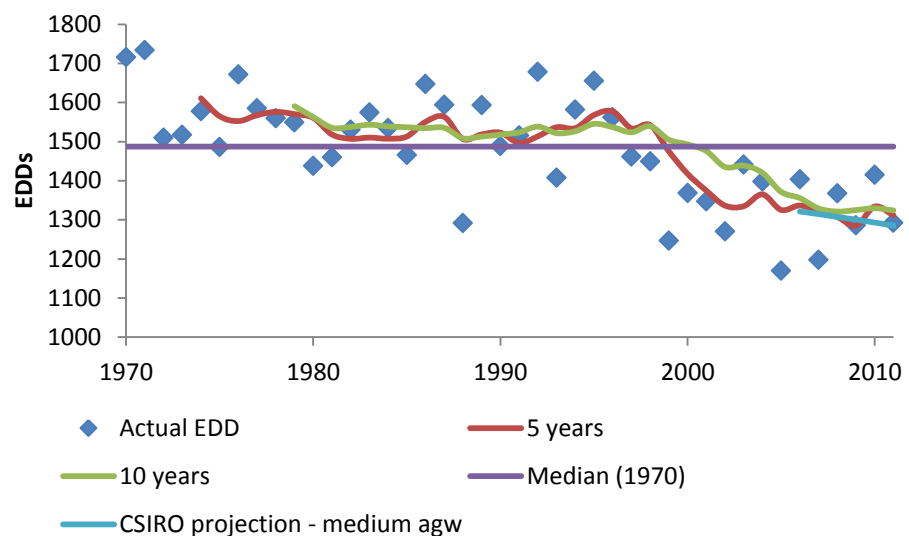


Envestra and Core have accounted for this trend by using CSIRO’s medium anthropogenic global warming projection, which was prepared in 2007. In effect, they have assumed that this projection reflects “normal” or 50 per cent probability of exceedence weather conditions between 2005 and 2010.<sup>10</sup>

In our experience it is unusual to use a projection as the basis for weather normalising historical data. It is not clear from CSIRO’s report that CSIRO intended its projections to be used this way or that this is an appropriate use for them. A more usual approach would be to base an assumption about normal weather conditions on historical data.

AEMO has published EDD data for the period from 1 January 1970 to 31 December 2011. Those data are plotted in Figure 3 along with the median and five and ten year rolling averages. The CSIRO’s medium agw projection is shown for comparison.

Figure 3 **EDDs in Victoria 2000 to 2011**



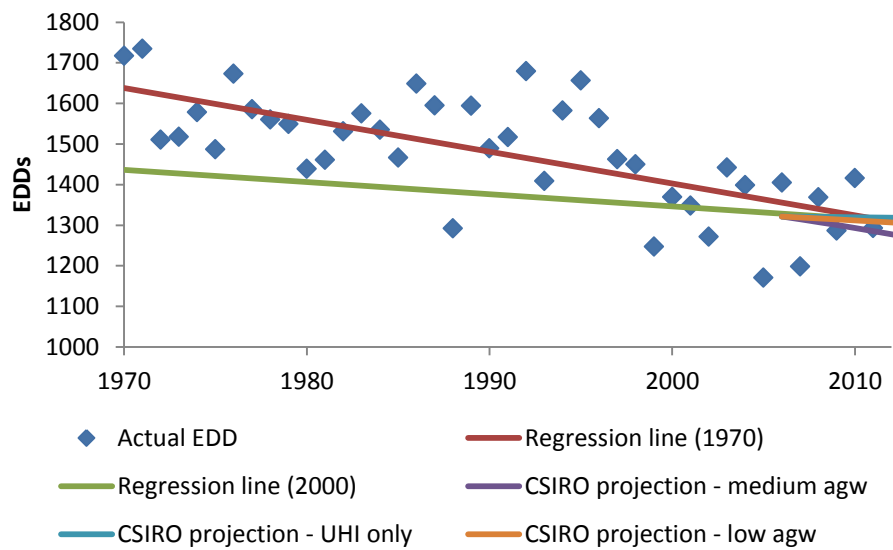
Data source: AEMO

Figure 3 shows that the number of EDDs observed each year has clearly declined over the period since 1970. It also suggests that weather conditions in the last decade were warmer than either of the decades beforehand (that is, fewer EDD’s were observed). It is evident that average EDD declined sharply through the late 1990s to mid 2000s (a period during which severe drought conditions were experienced in south-eastern Australia). The moving averages suggest that the rate of EDD decline may have eased over the past five years.

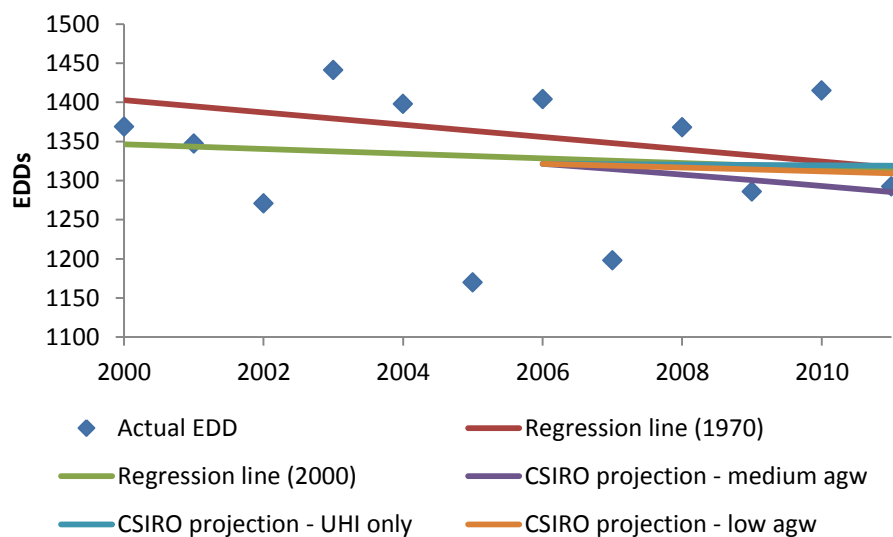
<sup>10</sup> CSIRO’s report included a projected number of EDDs for 2006, although it was published in 2007. Envestra calculated normal EDDs for 2005 by extending the trend in CSIRO’s projection back one year.

The downward trend in EDD is supportive of Envestra’s choice to weather normalise to a trend rather than a static view of ‘normal’ weather conditions. However, in our view, by using CSIRO’s medium agw projection for weather normalisation Envestra may have understated the “normal” number of EDDs in recent history. To the extent that it has done this, it would have “over corrected” gas demand in a downward direction.

Figure 4 **Alternate projections of EDDs in Victoria**



Smaller scale



Data source: AEMO

As shown in Figure 4, the rate of decline of EDDs over the past decade appears to have been slower than CSIRO projected in 2007. In addition to CSIRO's medium agw projection, Figure 4 shows two linear regression lines projected through the historical EDD data and CSIRO’s two more moderate

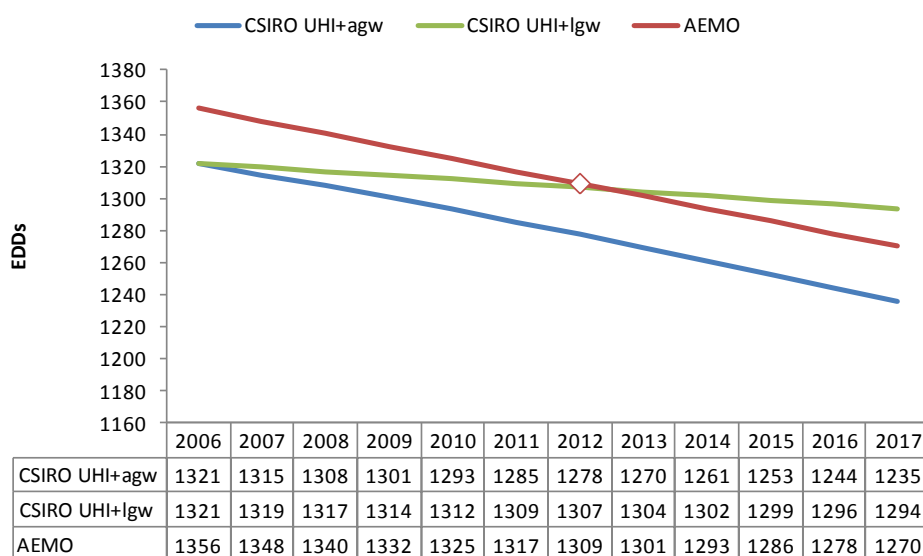
projections.<sup>11</sup> The two regressions were estimated the same way, but differed in their starting year. One regression line is fitted to all EDD data since 1970, while the other is fitted to data since 2000.

The two panes of Figure 4 show the same data, with the lower pane showing higher resolution (data only from 2000 onwards).

Figure 4 suggests that the warming trend has not been as great in recent years as projected in CSIRO's medium agw projection. The regression line (2000) shown in Figure 4 lies close to CSIRO's low agw and UHI only projections which are close to one another.

AEMO has recently released a review of Victorian EDD as part of its weather standards for gas forecasting. (AEMO, 2012). That study concluded that, based on Melbourne EDD data for the period 1970 to 2011, the trend-projected annual EDD standard for calendar year 2012 is 1309 – some 31 EDD higher than the value based on the CSIRO UHI plus medium agw projection and similar to the current value based on the CSIRO UHI plus low agw projection (see Figure 5). The rate of decline in EDDs since 1970 observed by AEMO has been close to that in CSIRO's medium agw projection at around 7.8 EDD/year. The difference between the two lines is that CSIRO's projection appears to 'start from a lower base'.

Figure 5 **Comparison of CSIRO EDD projections with AEMO EDD trended values**



Data source: (AEMO, 2012), (Suppiah, 2012)

<sup>11</sup> Given our view that the medium agw projection appears to understate the number of EDDs, CSIRO's high agw projection, which projects even fewer EDDs, is omitted.

We have adjusted CORE's weather normalisation models to examine the impact of weather normalising on the basis of the AEMO EDD standard (that is, to the 1970 regression line). The implications are shown in Table 7.

Table 7 **Impact of redefining 'normal' weather**

	2013	2014	2015	2016	2017
<b>Normal is regression from 1970</b>					
Residential (GJ)	-368,187	-359,799	-351,709	-343,824	-336,650
Commercial (GJ)	-48,248	-45,698	-43,414	-41,478	-39,690
Industrial (GJ)	-14,717	-13,937	-13,302	-12,788	-12,317
Total impact (GJ)	-431,152	-419,434	-408,425	-398,090	-388,657
Total impact (%)	-0.78%	-0.76%	-0.75%	-0.75%	-0.75%
<b>Normal is regression from 2000</b>					
Residential (GJ)	-441,245	-489,982	-538,252	-586,119	-634,509
Commercial (GJ)	-58,040	-62,841	-67,542	-72,399	-77,230
Industrial (GJ)	-17,038	-18,121	-19,192	-20,274	-21,295
Total impact (GJ)	-516,323	-570,944	-624,986	-678,791	-733,034
Total impact (%)	-0.93%	-1.03%	-1.15%	-1.28%	-1.41%
<b>Envestra's total demand forecasts</b>					
Envestra total projected demand (GJ)	55,504,085	55,421,173	54,545,418	53,068,267	51,836,537

The upper pane of Table 7 shows the impact on Envestra's forecasts of changing the basis of weather normalisation from the CSIRO medium agw projection to a regression line using all data since 1970, consistent with the AEMO EDD standard. The first three rows of that pane show the amount by which Envestra's projection of demand is lower than it would have been if weather normalisation was on that basis in each of the three tariff classes. The fourth row is the sum of these rows. The fifth row, 'Total impact (%)' shows this impact as a percentage of Envestra's total demand forecast, which is reproduced at the bottom of the table for reference.

The second pane of Table 7 corresponds to the first pane, but uses a regression on data since 2000 (which is similar to the CSIRO low agw projection) as the basis for weather normalisation.

In summary, Envestra's demand forecasts are, on average, 0.76% lower in each year of the regulatory period than they would have been if the 1970 regression line was used as the basis of weather normalisation. They are, on average, 1.16% lower than they would have been if normalised to the 2000 regression line.

We consider that it would be more appropriate for Envestra to weather normalise the historical data on the basis of the AEMO EDD standard which

is based on actual temperature outcomes for the period 1970 to 2011, rather than the CSIRO forecast which represents modelled temperature outcomes based on data for the period 1970 to 2005 (Suppiah & Whetton, 2012a, p. 23).

## 4.5 The impact of rising energy prices

Each of the DNSPs has made assumptions regarding changes in the price of gas over the regulatory period. Each has projected that gas prices will increase. Envestra's assumptions regarding gas price increases are set out in Table 8.

Table 8 **Envestra Victoria – assumed gas price increases 2013 to 2017**

Price Impacts Not Seen In Historic Trend	2013	2014	2015	2016	2017
Carbon price impact on residential retail price	9.00%	0.66%	0.66%	0.66%	
Wholesale gas price increase	1.04%	2.06%	3.03%	3.92%	3.77%
Network price increase	13.47%	11.37%	6.37%	6.37%	6.37%

Table 8 shows that Envestra's forecasts are based on its assumptions that:

1. the retail price of gas will increase as a result of the impending carbon price
2. the wholesale gas price will increase in addition to the impact of the carbon price
3. network price increases will exceed those seen in the past.

Each of those assumptions is weighted by Envestra's assumed 'structure' of the typical bill of different types of customer. For example, Envestra has assumed that the majority (90 per cent) of the gas bill of an industrial customer is the wholesale cost of gas, so impacts on the wholesale gas price are weighted more heavily for Tariff D customers than others. The assumptions are set out in Table 9.

Table 9 **Envestra Victoria – assumed structure of gas bill for different customer types**

Tariff V Residential	Residential	Commercial	Industrial
Network cost share of retail gas price	35%	30%	5%
Retail cost share of retail gas price	20%	10%	5%
Wholesale gas cost share of retail gas price	45%	60%	90%
Total retail gas price	100%	100%	100%

Data source: (Core, 2012)

The three components of Envestra's assumed price increase are discussed in section 4.5.1. The impact that those assumptions have on the gas demand forecasts is strongly influenced by Envestra's assumed price elasticity of demand, which is discussed in section 4.5.2.

#### 4.5.1 Envestra's price change assumptions

Envestra has assumed that three factors will drive increases in gas prices during the regulatory period: the carbon price, other influences on the wholesale gas market and network prices.

Envestra's forecasting approach essentially involves two steps. First, demand is projected forward on the assumption that factors other than economic activity and Gross Household Disposable Income will be constant. Second, adjustments are made for other factors not taken into account in step 1.

It is reasonable, therefore, for Envestra to make adjustments to its forecasts to take account of price changes that are unlike those observed in the last regulatory period.<sup>12</sup>

The assumptions made by Envestra are discussed in turn in this section.

##### The impact of carbon price

The Commonwealth Government is in the process of introducing a carbon pricing scheme to address the externality cost of greenhouse gas emissions associated with energy use (and other sources). The carbon pricing scheme will begin with a period of fixed prices from 1 July 2012 until 30 June 2015. The intention is that it will then transition to a cap and trade type scheme where a finite quantity of greenhouse gas emissions are permitted and the carbon price is determined by the market.

The carbon trading scheme is designed to deliver reductions in Australia's greenhouse gas emissions at the lowest possible cost. The carbon price is designed to do this by internalising the cost of greenhouse gas emissions, thus giving emitters an incentive to reduce their emissions using the most cost-effective technologies available.

The carbon price will influence consumers' choices regarding energy use and suppliers' choices regarding technology. It will do this by increasing the cost (and thereby the price) of fuels, particularly electricity and gas.

As the price of gas increases customers will face incentives to reduce gas use, either by improving the energy efficiency of their appliances or by other means.

However, the greenhouse emissions intensity of Australia's electricity supply is such that, in many applications, replacing electrical appliances with gas

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<sup>12</sup> Of course, to take account of anticipated network price increases Envestra must make an assumption as to the AER's final decision, making this an inherently circular discussion. This circularity is unavoidable.

alternatives would reduce greenhouse gas emissions. Therefore, the relative impact of the carbon price on gas will be less than on electricity. To some extent energy customers will face an incentive to ‘fuel switch’ from electricity to gas.

Envestra has accounted for the impact of the carbon price on retail gas prices (reweighted for non-residential customers) based on Commonwealth Treasury modelling of the carbon trading scheme. There is significant uncertainty surrounding the carbon trading scheme and the impact it will have on prices. Therefore, there is a substantial risk that the impact on gas prices will be different than Envestra has assumed. Nevertheless, it is necessary to make an assumption for these purposes and, in our view, it is reasonable for Envestra to assume that price impacts will be in line with the Commonwealth Treasury modelling.

### The impact of wholesale gas price increases

Envestra’s forecasts are based on the assumption that the wholesale price of gas will increase as shown in Table 10. That assumption is based on the same Australian Treasury modelling from which it drew the impact of the carbon price.

Table 10 **Envestra Victoria – assumed increases in wholesale gas price**

	2013	2014	2015	2016	2017
Projected Annual wholesale gas price increase (%)	1%	2%	3%	4%	4%

*Data source: Core, Table 5.7*

As Core states in its report to Envestra, “there is a high degree of variation in projected wholesale gas prices.” Both ACIL Tasman and Core have projected, under certain assumptions, larger increases than Envestra. Such increases may be driven by growing demand for gas in the power generation sector and by the potential impact of LNG exports on domestic gas prices in the eastern Australian market. In our view Envestra’s assumed increases in wholesale gas price are reasonable.

### The impact of network price increases

The third component of upward impact on gas price that Envestra has assumed is the impact on network prices.

Envestra has adjusted its demand forecasts to account for its entire proposed increase in network charges, which are as shown in Table 11.<sup>13</sup>

Table 11 **Envestra Victoria – assumed increases gas network prices**

	2013	2014	2015	2016	2017
Projected increase in gas network charges	13.47%	11.37%	6.37%	6.37%	6.37%

This approach raises the question whether all of Envestra’s proposed network price increase should be treated as an adjustment. To the extent that Envestra’s customers have experienced increases in gas network prices in recent history, this would be reflected in the trend data and it would be unnecessary to make an adjustment.

However, in 2008 the Essential Services Commission determined that, for the previous regulatory period, Envestra Victoria should be allowed an increase in real prices in 2008. After that, Envestra was not provided with an increase in real prices.

Therefore, in weighted average terms across the customer base, Envestra’s customers have not experienced increases in real gas network prices for several years.<sup>14</sup> Before that, prices were increased by 5.7 per cent (real) in 2008, which is significantly less than the price increases proposed now.

Under these circumstances, we accept that it is appropriate to take into account the whole of the (anticipated) network price increase in determining the expected future delivered price of gas to customers on the Envestra Victoria network.

#### **4.5.2 The price elasticity of demand – quantifying the impact of gas price increases**

Our views regarding Envestra’s assumed changes in gas prices are outlined in the previous section. We agree with Envestra that the price of gas is likely to increase significantly over the regulatory period and that this is an important factor to take into account in forecasting gas demand.

In addition, ACIL Tasman expects that the price of electricity will also increase over the regulatory period. While Envestra makes no mention of this, we also consider this to be an important factor in forecasting gas demand over the regulatory period.

<sup>13</sup> The assumed increases in retail prices due to this factor are less than the figures shown in Table 11 as they are weighted by the proportions in Table 9.

<sup>14</sup> Individual customer classes may have experienced increases during the regulatory period but, in weighted average terms, these have ‘balanced’ out.



In summary, increases in gas price are likely to lead to a reduction in gas demand through the price effect. Increases in electricity price are likely to lead to an increase in demand for gas as an alternative (substitute) to electricity through the substitution effect. It is difficult to estimate the likely size of these competing effects with any confidence.

Each of the relationships can be described using an elasticity. The price effect is summarised using the “own price elasticity of demand for gas”. The substitution effect is summarised using the “cross price elasticity of demand for gas”. These two elasticities are discussed in turn below.<sup>15</sup>

### Own price elasticity of demand for gas

The own price elasticity of demand, (commonly ‘price elasticity’) describes the relationship between the price of a good and the quantity of it that will be demanded. Being an elasticity it is expressed in percentage terms. For example a price elasticity of -1 suggests that for a one per cent increase (decrease) in price, the quantity demanded will decrease (increase) by one per cent.

The price elasticity of demand is an important input into the forecasting process. Given the price increases forecast for the coming regulatory period, an overly high elasticity estimate would lead to gas demand forecasts being understated and, in turn, to gas prices being higher than necessary.

Each of the DNSPs has used its own assumed price elasticity in preparing forecasts. The assumptions are shown Table 12.

Table 12 **Price elasticity assumptions**

DNSP	Price elasticity	Source/ Basis
SP AusNet – Residential SP AusNet - Commercial	-0.17 -0.77	CIE analysis of SP AusNet data
Multinet – All customer classes	-0.28	Not specified
Envestra (Victoria and Albury)	-0.30	AER determination for Envestra in South Australia and literature review

The fact that the different DNSPs have made different assumptions regarding price elasticity is not surprising. Each DNSP is independent of the others and the regulatory proposals were prepared independently as well.

Envestra’s assumption of a –0.30 elasticity is consistent with the AER’s recent decision regarding its access arrangement in South Australia. It is also broadly

<sup>15</sup> The own price elasticity of demand is relevant to the estimated impact of the carbon price as well as to the impact of rising gas prices generally.

supported by analysis undertaken by Core which resulted in an estimated price elasticity (stated to be “short run” – but see discussion at page 16) of about  $-0.27$  for all customer classes.

The basis for Multinet’s assumed elasticity of  $-0.28$  for all customer classes is not explained by Multinet or its consultant NIEIR (Multinet, 2012), (NIEIR, 2011).

CIE for SP AusNet has produced elasticity estimates based on recent experience with SP AusNet’s own customers (SP AusNet, 2012), (CIE, 2012). That experience led CIE to conclude that the price elasticity of demand for gas is  $-0.17$  for SP AusNet’s residential customer group (that is, Tariff V Residential) and  $-0.77$  for its commercial customer group (that is Tariff V Non-residential). The reason for the large difference in price elasticity between the two customer groups was not discussed by CIE. However we note that on a volume-weighted average basis (using the above elasticity estimates and actual consumption data for residential and non-residential Tariff V customers) the price elasticity across all Tariff V customers would be  $-0.27$ . On this basis, the CIE price elasticity estimates can be viewed as being comparable to the assumptions made by Envestra and Multinet. The CIE report makes no specific reference to price elasticity for Tariff D customers.

In light of the foregoing, we consider that Envestra’s own-price elasticity assumption of  $-0.3$  can be regarded as being consistent with the estimates used by the other distribution businesses and with recent precedent. Accordingly we consider the assumption to be not unreasonable.

### **Cross price elasticity of demand**

The cross price elasticity of demand summarises the relationship between the price of one good and the quantity demanded of another. In this case, the cross price elasticity of interest summarises the relationship between the price of electricity and the quantity of gas demanded.

A positive cross price elasticity suggests that as the price of one good increases demand for the other good also increases. These goods are defined as substitutes.<sup>16</sup>

Neither Envestra nor its consultant Core has directly addressed the issue of whether rising electricity prices are likely to mitigate the price elasticity effect of rising gas prices on gas demand.

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<sup>16</sup> A negative cross price elasticity suggests that as the price of one good increases demand for the other good falls. These goods are defined as complements.

Given that electricity and gas can be used similarly it would be reasonable to expect that they are substitutes (with a positive cross price elasticity of demand). The need to change appliances to allow substitution to occur suggests that the cross price elasticity of demand may become larger as it is measured over a longer time frame.

However, the extent to which rising electricity prices are likely to offset the reduction in gas demand caused by higher gas prices is not clear. In the next regulatory period, all of the DNSPs are anticipating that the price of both electricity and gas will increase significantly, largely due to the carbon trading scheme. However, with the exception of SP Ausnet, none of the DNSPs appear to have considered the impact that higher electricity prices will have on gas demand.

In its report to SP AusNet, CIE examined the substitution effect using two different measures of the price of electricity. The results were contradictory. In one model the relationship CIE found between electricity price and gas demand<sup>17</sup> was positive, as would be expected, and very small. In the second model the relationship was negative, which is contrary to the theoretical expectation.<sup>18</sup> On this basis, CIE concluded that the price of electricity should not be included in its models of gas demand.

Given the ambiguous nature of the results and the low absolute cross-elasticity values observed in the CIE analysis, as well as the lack of other relevant evidence, we consider that Envestra's reliance on own-price elasticity estimates alone is not unreasonable.

#### **4.5.3 Policy factors affecting the forecasts - 6-star building policy**

Aside from the introduction of the carbon price, discussed in the previous section, the only policy factor that Core took into account explicitly in preparing the Envestra Victoria forecasts was the introduction of the 6-star building standard for new homes in Victoria.

A key factor in projecting gas demand in the residential sector is the likely gas requirement of new homes. For a gas DNSP growth in residential customer numbers can take one of only three forms:

1. Existing home connected to gas due to 'infill' of customers in gas connected areas without gas access without major renovation or new home construction.

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<sup>17</sup> In this case the estimated cross price elasticity was 0.001.

<sup>18</sup> In the second model the cross price elasticity was -0.019 whereas the own price elasticity was -0.133.

2. Existing home connected to gas due to extension of gas network into a new area.
3. New home (or substantial renovation), either replacing an existing home without gas supply or in a newly developed residential area.

In most cases the number of new customers in the first two categories is likely to be relatively small compared to the third category.

Therefore, the majority of a gas DNSP's new customers are likely to be customers with newly built homes (or substantially renovated homes).

Each of the DNSPs has taken a broadly similar approach to projecting growth in demand by residential customers. That approach is to forecast the number of new customers expected to connect to gas supply in the region and to multiply that number by the estimated average gas demand per customer. The source of new customer projections varied. In Envestra's case it was a trend based model.

Conceptually it would be possible to produce a forecast of demand from new residential customers by multiplying the projected number of new customers by the average gas demand of the existing (residential) customer base. However, each of the DNSPs has argued that this would be inappropriate.

While the approaches differ, each DNSP has argued that, on average, their new residential customers use less gas than 'older' customers. The reasons are, broadly, that new houses and the appliances they contain are more energy efficient than older houses and appliances.

The gradual replacement of existing houses and appliances with more efficient options is a contributing factor to the gradual decline in gas usage by existing customers. Another factor is the replacement of gas fuelled appliances with alternatives that use different fuels, in particular substituting (electric) reverse cycle air conditioners for gas space heaters and solar water heaters for gas alternatives.

An additional factor that each of the DNSPs argues should be considered is the introduction of mandatory 6-star energy efficiency ratings for new homes.

In 2009, the Council of Australian Governments (COAG) requested the Australian Building Codes Board to modify the Building Code of Australia (BCA) to require that all new homes and major renovations would achieve a six-star energy efficiency rating (or equivalent). The necessary changes were included in BCA 2010 and subsequently enacted in State and Territory legislation.

The Victorian Government was reported to have reconsidered that commitment in early 2012 as part of a drive to reduce red-tape. However, in

mid-April 2012, the Premier of Victoria reaffirmed his government's commitment to the mandatory 6 star energy efficiency rating. Therefore, the DNSPs have argued that new homes (and major renovations) in the distribution regions will use significantly less gas, on average, than older homes.

In deciding to implement the 6-star energy efficiency requirement, COAG had regard to a Regulation Impact Statement (RIS) prepared by the Centre for International Economics (CIE).<sup>19</sup> In that RIS, CIE estimated that the introduction of the 6-star energy efficiency requirement would cause new house in Victorian to use on average approximately 6.561 GJ/a less gas than they would if the energy efficiency requirement remained at 5-star.

Core has adopted this estimate and assumed that from 2013 new homes in the Envestra Victoria distribution area will use less gas than they would have used without the 6-star energy efficiency requirement. The assumed reductions are:

1. 6.561 GJ for detached houses
2. 2.728 GJ for townhouses
3. 2.613 for flats

Taking into account Core's assumptions regarding the proportion of new homes that are detached, the average impact of the 6-star energy efficiency requirement across all new residential connections will be a reduction in demand of approximately 5.8 GJ/a per connection.

We consider this assumption to be reasonable in light of the RIS on the 6-star energy efficiency requirement prepared by CIE.

#### **4.5.4 Adjustments to the Base Forecast**

The forecasts for Tariff V residential and non-residential gas demand developed by Core have been adjusted to take into account the impacts of network development and New Town connection activities planned by Envestra (both expected to increase demand), and the effect of anticipated network price increases.

##### **Network development**

Network development activities increase residential gas demand by either:

- enabling the connection of previously unconnected homes to the gas network; or
- by promoting a wider application of gas use in the home.

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<sup>19</sup> CIE prepared the demand forecasts for SP AusNet.

Envestra is proposing a network development program that continues to offer consumers an incentive to connect to and increase usage of gas.

The incremental impacts on gas demand of the proposed network development programs form a separate component of Envestra's overall gas demand forecast.

Envestra expects network development activities to increase Tariff V Residential consumption by 8 TJ/a across the Victorian network in 2013, rising to 49 TJ/a by 2017.

### **New Towns program**

Envestra has submitted to Regional Development Victoria proposals for the network to be expanded to the towns of Lakes Entrance, Orbost, Koo Wee Rup and Wy Yung as part of the Victorian Government's "Energy for the Regions" program. Envestra expects the expansion of the network to these towns to occur in 2016. As a result Tariff V Residential demand is forecast to increase by 8 TJ/a in 2016 and by 27 TJ/a in 2017. The corresponding increase in Tariff V Non-residential demand is 20 TJ/a in 2016 and 30 TJ/a in 2017.

### **Network Price Increase**

The last adjustment made to reach the Final Forecast for Tariff V demand takes into account the fact that Envestra's proposed network price increases will reduce customer demand in accordance with the assumed own-price elasticity of demand for gas. Core has used a process whereby an intermediate demand forecast is created and applied to the Post Tax Revenue Model (PTRM) to determine the X factors. These X factors are then fed back into Core's model to arrive at the final demand forecast (a similar process was used in the last review of Envestra's South Australian and Queensland networks). The network price adjustment results in a reduction in Tariff V Residential demand of 173 TJ/a in 2013, rising to 1,091 TJ/a in 2017. The corresponding reduction in Tariff V Non-residential demand is 18 TJ/a in 2013, rising to 242 TJ/a in 2017.

## **5 Assessment of the forecasts**

In this chapter we review Envestra’s forecasts themselves, to consider whether the application of the methodologies and assumptions has produced forecast results that are reasonable in light of historical patterns of demand as well as current and anticipated influences on retail gas demand in the distribution area. We consider separately the forecasts for the Volume and Demand sectors of the market.

### **5.1 Use of trend extrapolation for forecast verification**

In the following analysis we have used historical trend analysis as a cross-check on the results generated using the Core methodology. ACIL Tasman recognises that forecasting on the basis of extrapolation of historical trends involves a risk of overlooking changes in market drivers that could result in future trends differing from historical trends. The fact that a forecast diverges from the historical trend cannot in itself be taken as proof that the forecast is unreasonable. Rather, such divergence may prompt us to ask whether there are good reasons for the break in trend.

Note that the scale of the Y axis in the following charts has been chosen to allow the relationships between forecasts, historical trends and confidence intervals to be seen clearly. This has the effect of exaggerating the apparent extent of deviations from historical trends, when in fact the changes may be much less pronounced when viewed in absolute terms. Care should therefore be exercised in interpreting the charts.

### **5.2 Tariff V Customer forecasts**

#### **5.2.1 Tariff V customer numbers**

The forecast of total customer numbers for the Tariff V customer sector is summarised and compared with historical actual customer numbers in Figure 6.

Forecast growth in customer numbers is greater than the historical trend rate, which was generated using an Ordinary Least Squares (OLS) regression on actual customer numbers from 2003 to 2011.

By 2017 the forecast is around 11,500 or 1.8% higher than the upper bound of the 90% confidence interval around the historical trend. This can be in part attributed to the combined effects of Envestra’s Network Development and New Town extension activities. The Network Development program includes

activities aimed at increasing utilization of the network and arresting the declining trend in gas usage. Envestra expects Network Development to increase residential gas use (compared to the Base Forecast) by 49TJ/a by 2017. The New Towns program impact on the Base Forecast gas use is projected to be 57 TJ/a (includes 27 TJ/a for residential and 30 TJ/a for non-residential) by 2017. The combined increase equates to around 1,900 customers at average rates of consumption per customer.

Core explains the approach to forecasting the number of Tariff V Residential Customers as follows:

“The methodology adopted to arrive at forecast connections was:

1. Use regression analysis to determine the historical relationship between detached dwelling starts, other dwellings starts and the net change in total connections.
2. Forecast total connections by applying the historical relationship between detached dwelling starts, other dwelling starts and the net change in connections against [Housing Industry Association] HIA dwelling starts forecasts.” (Core, 2012, p. 38)

The forecast therefore relies heavily on the growth trend in the HIA dwelling starts forecasts.

In response to a request for further information on the HIA forecasts, Envestra advised as follows:

“In determining HIA’s national and state-based housing start forecasts HIA use a combination of:

- quantitative analysis of a range of leading new housing indicators such as land sales volumes, HIA’s new home sales series, ABS local government building approvals and new home loan approvals;
- wider economic forecasts and views such as Deloitte Access Economics (DAE) GSP forecasts, an exchange rate view, and an interest rate outlook;
- consultation within the HIA Economics Group;
- liaison with HIA’s Regional Executive Directors;
- liaison with HIA members.

HIA have noted an increase in the number of new home building contracts ‘falling over’. This situation is probably most conspicuous in Victoria given that contract volumes, approvals, starts, and completions **are all declining from record highs in a climate of weak consumer confidence** *[emphasis added]*.”

In these circumstances it is difficult to see why the rate of increase in Tariff V residential connections would significantly exceed historical growth rates.

There are significant inconsistencies in the HIA Building Forecast data for Victoria set out in Table 5.3 of the Core report (Core, 2012, p. 45). Specifically, we would expect the ‘Total Dwelling Starts’ for each year to be equal to the sum of the ‘Dwelling Start – Detached’ and ‘Dwelling Starts – Other’ forecasts,



but they are not. In most (but not all) cases the totals are significantly lower. We have assumed that the indicated totals are in error and that the correct totals are the sums of the ‘Dwelling Start – Detached’ and ‘Dwelling Starts – Other’ values.

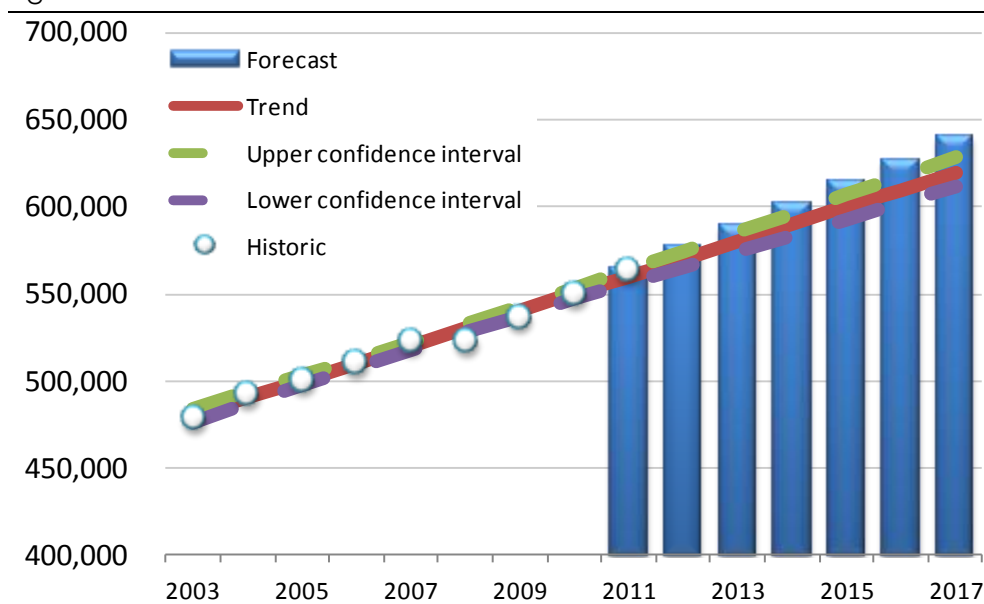
On this basis, and also using data from the Victorian Department of Planning and Community Development (DPCD) on population and total residential housing stock, the HIA dwelling starts data implies a forecast annual average rate of growth in Victorian housing stock over the period 2013 to 2017 of 1.93%.

The DPCD population data shows an expected annual average population growth rate of 1.21% over the same period.

According to the data presented in Table 6.1 of the Core report (Core, 2012, p. 56) the average annual rate of increase in Tariff V Residential customer numbers over the period 2013 to 2017 is 2.12%, compared to an average over the period 2003 to 2012 of 2.11%.

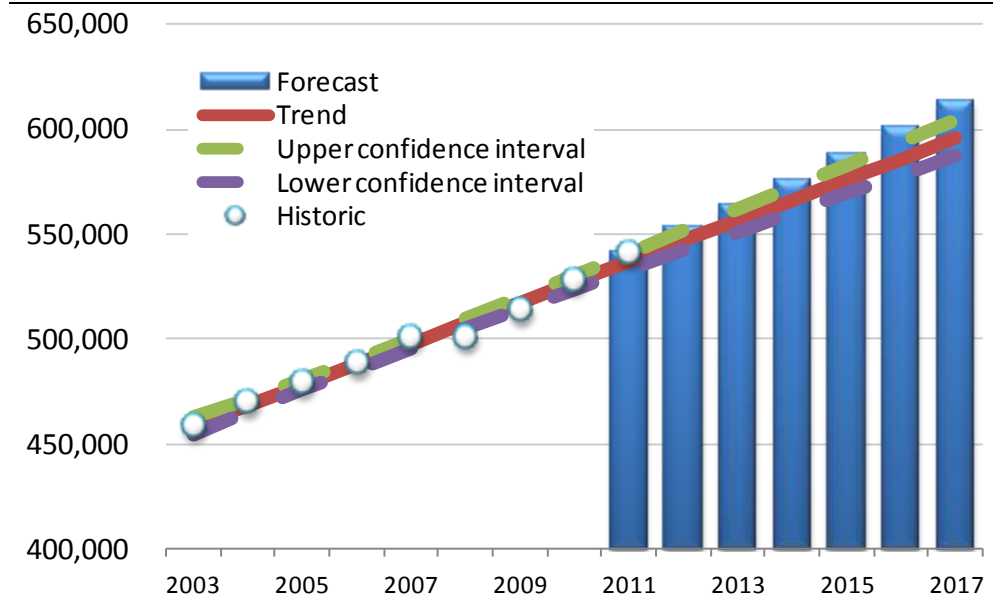
The higher rate of residential dwelling growth may be explained by an ongoing reduction in average household size. On this basis we consider that the forecast Tariff V customer numbers are not unreasonable but may be somewhat overstated in light of the HIA comments regarding declining completion rates and weak consumer confidence.

Figure 6 **Historical and forecast customer numbers—Tariff V Total**



Data source: (NIEIR, 2007); (Core, 2012); ACIL Tasman analysis

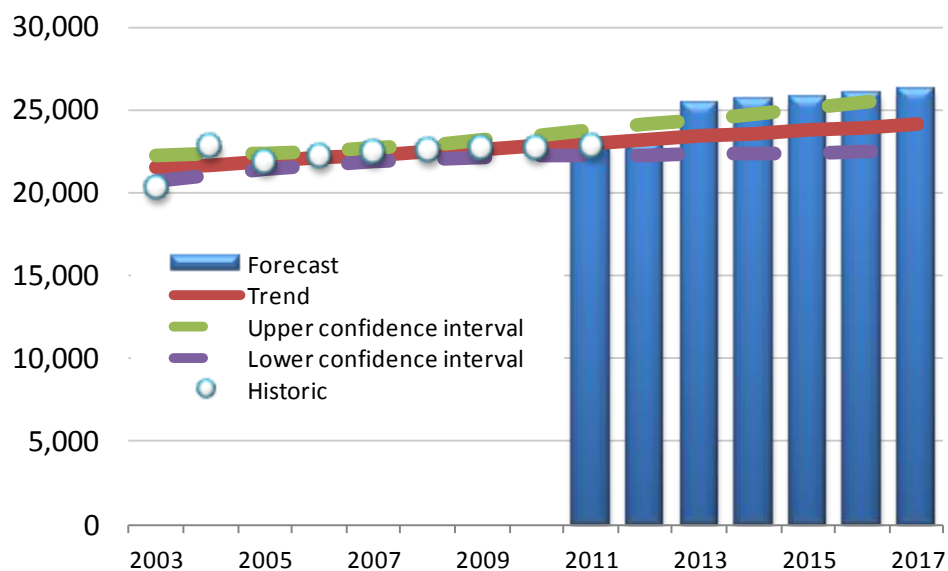
Figure 7 **Historical and forecast customer numbers— Tariff V Residential**



Data source: (NIEIR, 2007); (Core, 2012); ACIL Tasman analysis

Figure 7 shows the corresponding data and forecast trends for residential customer numbers as a subset of the Tariff V customer class. As might be expected given the high proportion of residential customers in the total Tariff V customer base, the residential customer forecast show a similar pattern to total Tariff V. While Core documents a reduction in the compound annual growth rate of residential customer numbers of 0.4 per cent for the projection period relative to the period from 2005-2010, trend analysis using data from 2003 shows that the projected growth rate in residential customer numbers is above the historical linear trend. By 2017 the residential forecast is around 10,500 or 1.7% higher than the upper bound of the 90% confidence interval around the historical linear trend. Again we consider that the forecast Tariff V residential customer numbers are not unreasonable but may be somewhat overstated.

Figure 8 **Historical and forecast customer numbers—Non-residential Tariff V**



Data source: (NIEIR, 2007); (Core, 2012); ACIL Tasman analysis

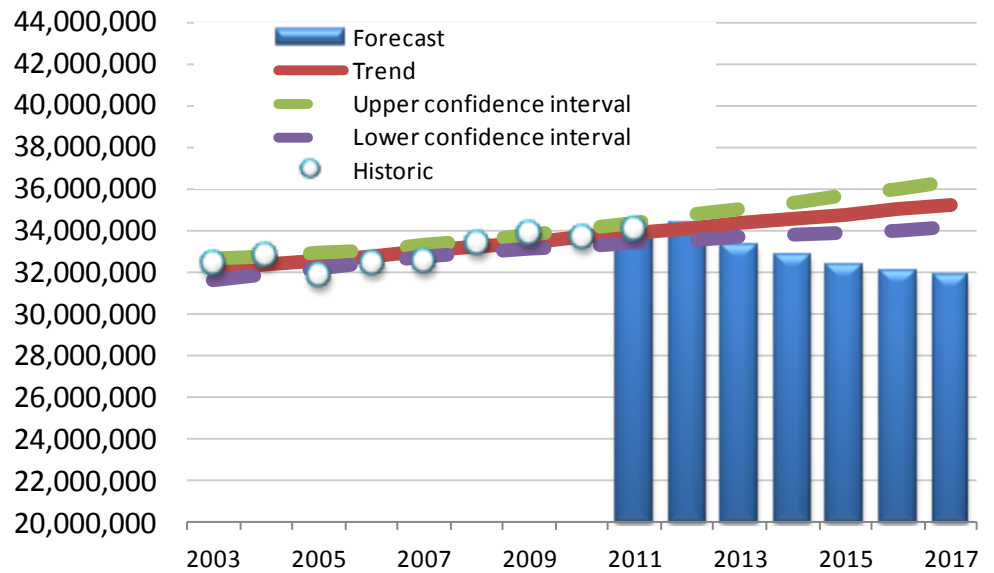
Figure 8 shows the corresponding results for the Non-residential Tariff V customers. The historic values for 2003 and 2004 are taken from (NIEIR, 2007) and the historic value from 2005 on are taken from (Core, 2012) which explains why the first two observations are inconsistent with the subsequent historical data. The forecast shows a projection of growth in commercial customer numbers which is somewhat above the historical trend. Core projected an increase in the growth commercial customer numbers based on a projected GSP growth which is expected to return to a long-run trend, which has dropped moderately in recent times

On this basis the forecast customer numbers for Non-residential Tariff V do not appear to be unreasonable.

### 5.2.2 Tariff V gas demand

The forecast of gas demand for the Tariff V Customer sector in total is summarised and compared with weather normalised historical data in Figure 9. The corresponding comparisons for the Tariff V Residential and Tariff V Business (Commercial and Industrial) customer groups are shown in Figure 10 and Figure 11 respectively.

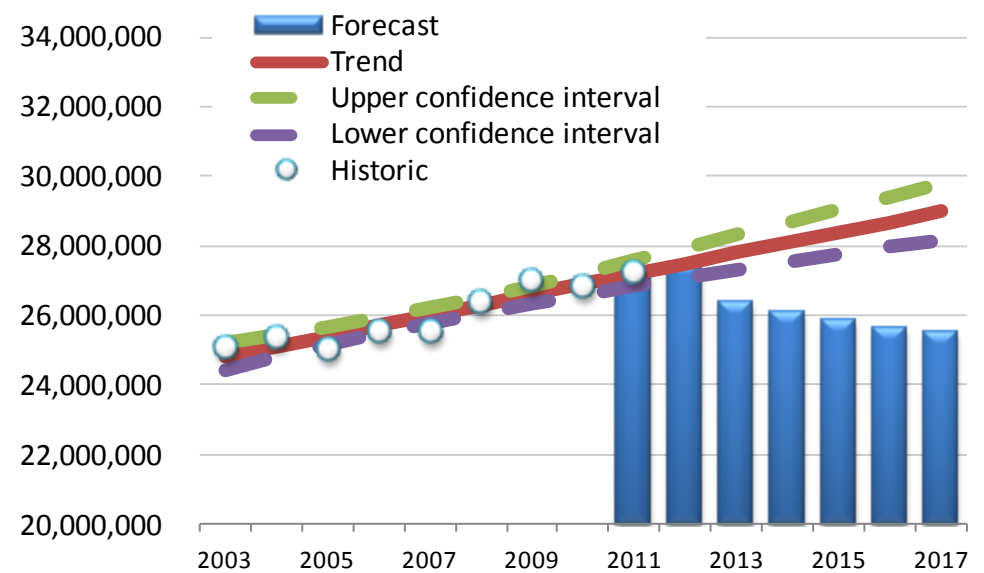
Figure 9 **Forecast consumption compared to weather-adjusted historical trend—Tariff V customer sector**



Note: Consumption in GJ/year.

Data source: (NIEIR, 2007); (Core, 2012); ACIL Tasman analysis

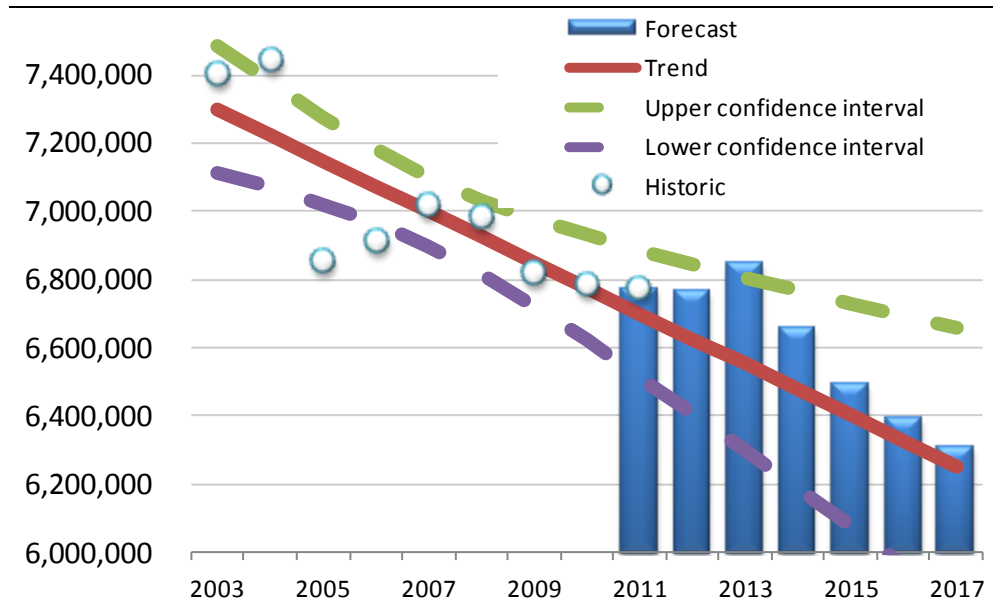
Figure 10 **Forecast consumption compared to weather-adjusted historical trend—Tariff V Residential customers**



Note: Consumption in GJ/year

Data source: (NIEIR, 2007); (Core, 2012); ACIL Tasman analysis

Figure 11 **Forecast consumption compared to weather-adjusted historical trend—Tariff V Non-residential customer**



Note: Consumption in GJ/year

Data source: (NIEIR, 2007); (Core, 2012); ACIL Tasman analysis

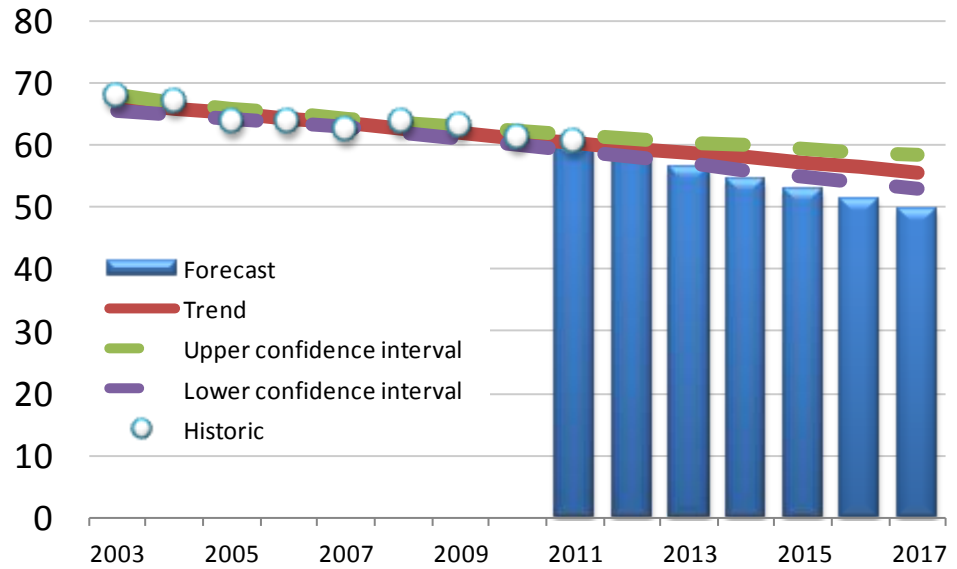
The forecast demand levels for residential customers and for the Tariff V customer group as a whole fall well below the historical trend lines and are well outside the 90 per cent confidence interval by the end of the forecast period. This reflects the combined impacts of the 6-star building standard, carbon pricing and wholesale gas price increases (none of which are reflected in the historical data). By 2017, forecast Tariff V residential demand is around 10% below the historical trend. This is generally consistent with the corresponding forecasts for SP AusNet (8% below) and Multinet (12% below).

The forecast demand for Tariff V Non-residential customers is initially above the historical trend but after 2013 reverts to the historical trend. The inflection in the forecast numbers between 2013 and 2014 reflects the fact that the adjustments for policy and external changes (carbon price and wholesale gas price) are having a significant influence.

### 5.2.3 Tariff V forecast average consumption

Assumptions regarding average gas consumption per customer for the Tariff V sector are critically important to the overall demand forecasts because the forecasts are generated by applying average gas consumption rates to the projected customer numbers in each demand segment. The implied average gas consumption per customer in the Tariff V sector as a whole is shown in Figure 12.

Figure 12 **Actual vs forecast average gas consumption per Volume Customer, after weather normalisation**

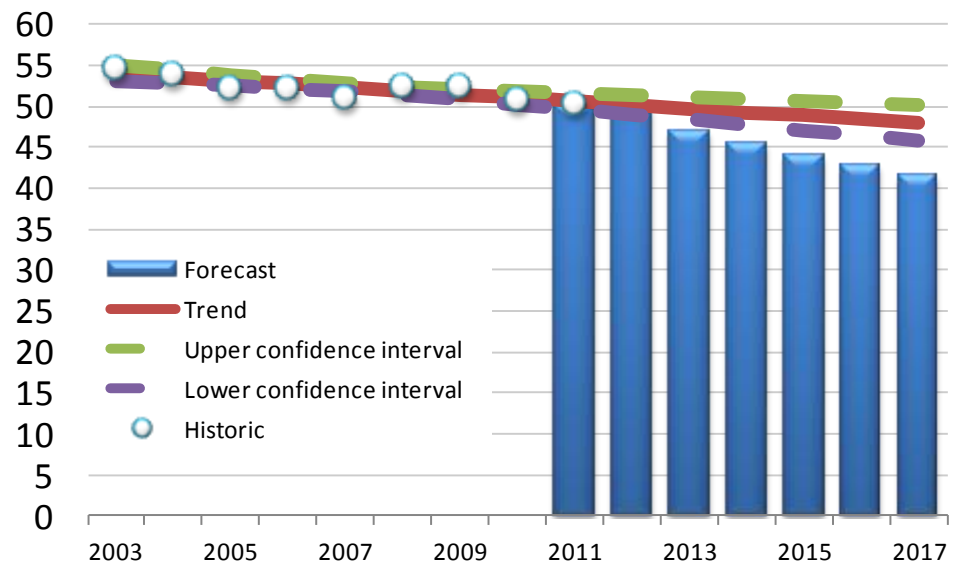


Note: Annual demand in GJ/connection

Data source: (NIEIR, 2007); (Core, 2012); ACIL Tasman analysis

The corresponding comparisons for the Tariff V Residential and Tariff V Non-residential (Commercial & Industrial) customer groups are shown in Figure 13 and Figure 14 respectively.

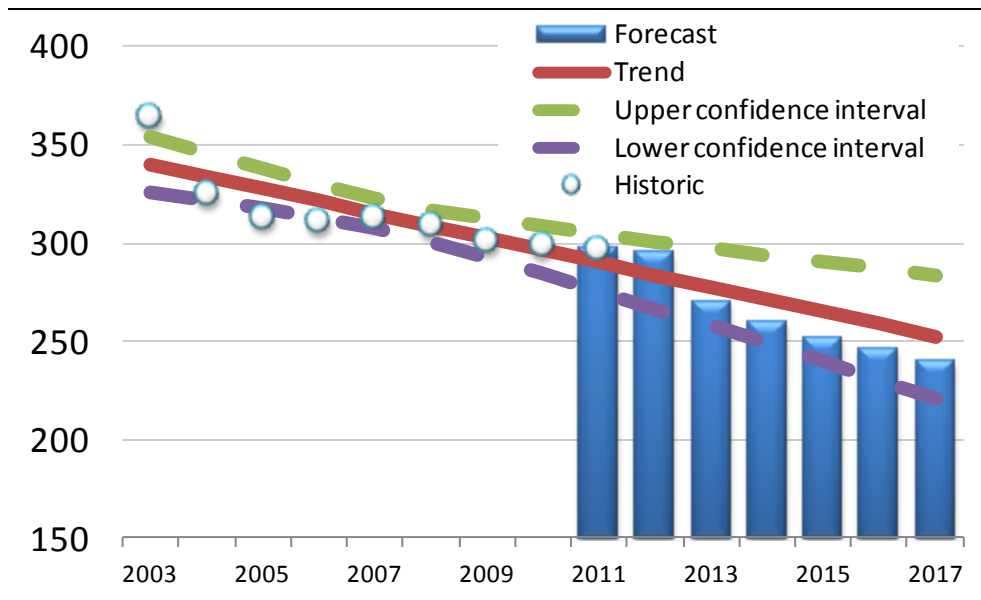
Figure 13 **Actual vs forecast average gas consumption per customer, after weather normalisation—Tariff V Residential customers**



Note: Annual demand in GJ/connection

Data source: (NIEIR, 2007); (Core, 2012); ACIL Tasman analysis

Figure 14 **Actual vs forecast average gas consumption per customer, after weather normalisation—Tariff V Non-residential customer**



Note: Annual demand in GJ/connection  
Data source: (NIEIR, 2007); (Core, 2012); ACIL Tasman analysis

The forecast average consumption per customer for both residential and non-residential Tariff V customers shows an acceleration of the long term downward trends, driven by improved appliance efficiency and government policies aimed at reducing energy consumption and associated greenhouse gas emissions.. The increased rate of decline in average consumption can be attributed to the combined effects of the 6-star Building Standard, carbon pricing and wholesale gas price increases, none of which are reflected in the historical trends. As previously discussed, we have concluded that the assumptions made regarding the impacts of these factors on gas demand and average gas use per connection are reasonable. We therefore consider that the forecasts of average consumption for Tariff V customers are not unreasonable.

### 5.3 Tariff D customer forecasts

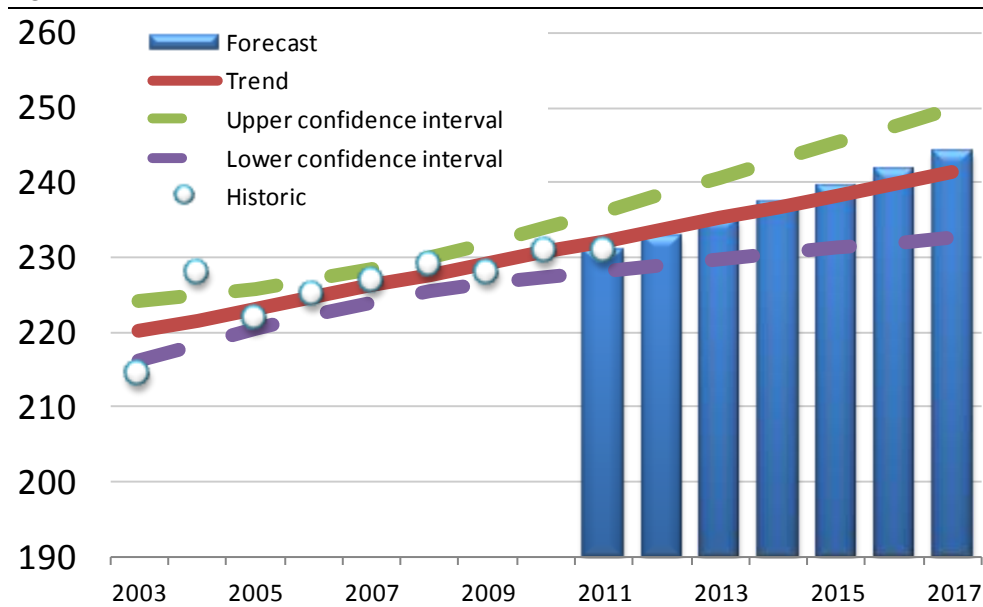
#### 5.3.1 Tariff D customer numbers

The Tariff D customer class represents large gas users (>10TJ/year), and includes both commercial and industrial gas users.

Historical and forecast customer numbers for the Tariff D class are shown in Figure 15. This data reflects the Tariff D customer numbers shown in Core’s demand report (Core, 2012) and in the Regulatory Impact Notification (RIN), both of which indicate that the number of Tariff D customers will reach 244 by 2017. The Envestra Victoria access arrangement information states that the number of Tariff D customers will reach 290 by 2017 (Envestra, 2012, p. 206).

The discrepancy may reflect switching of customers between Tariff V Non-residential and Tariff D. We have assumed that the numbers presented in the Core report and RIN are correct.

Figure 15 **Actual and forecast Tariff D customer numbers**



Data source: (NIEIR, 2007); (Core, 2012); ACIL Tasman analysis

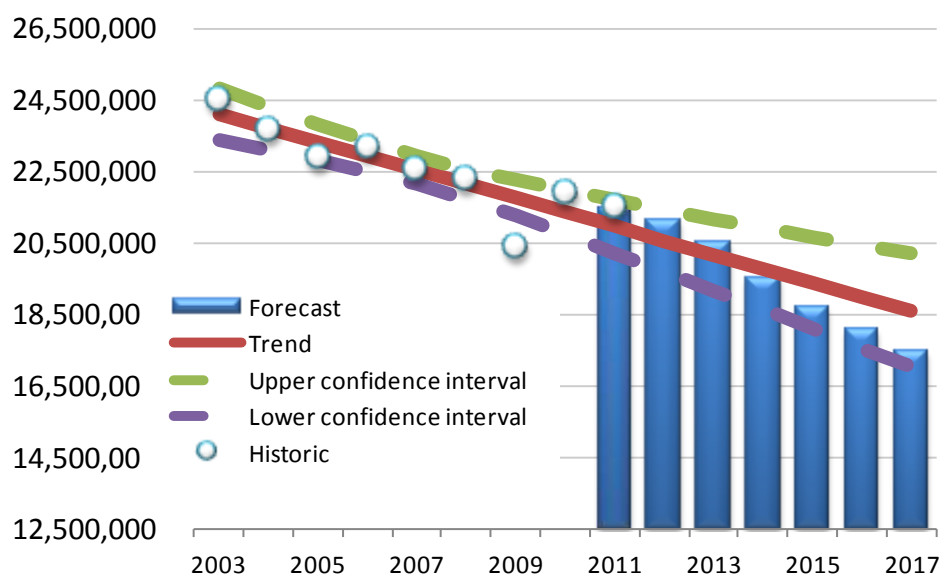
The forecast growth of around 10 Tariff D customers over the forthcoming access arrangement period is consistent with the slow but fairly steady growth that has occurred since 2003. Based on the similarity to historical trend, the forecast does not appear to be unreasonable.

### 5.3.2 Tariff D gas demand

The demand forecasts for the Tariff D customer group in aggregate are shown in Figure 16. The historical data shows that while Tariff D customer numbers have grown slowly over the past decade, total gas consumption within the customer group has fallen steadily, from around 24 PJ/a in 2003 to a little over 21 PJ/a in 2011. This can be attributed to a combination of energy and environmental policies that have driven efficiency improvements, as well as to weak economic circumstances that have affected the manufacturing sector in particular. Envestra’s forecast for gas consumption in the Tariff D customer sector sees this downward trend continue and accelerate.



Figure 16 **Tariff D aggregate demand forecast**



Note: Gas demand in GJ per year

Data source: (NIEIR, 2007); (Core, 2012); ACIL Tasman analysis

The faster rate of decline in consumption (notwithstanding continued growth in customer numbers) represents a response to the combined effects rising wholesale gas prices and carbon pricing which are expected to put downward pressure on gas demand in the industrial sector, as will the ongoing influence of energy efficiency and emission reduction policies. We therefore consider that this forecast is reasonable.

### 5.3.3 MDQ forecasts for Tariff D customers

#### Relationship between MDQ and gas demand

While it is important to consider the volume forecasts for Tariff D customers, it is the forecasts of Maximum Hourly Quantity (MHQ) bookings that are critical in terms of implications for tariff setting. This is because the charges for Demand Customers are calculated on the basis of the system capacity (MHQ) used, rather than the physical quantity of gas delivered.

The relationship between gas demand and MHQ is complex. The ratio of average hourly throughput to peak hourly throughput (that is, the “load factor”) varies widely from customer to customer. MHQ is directly related to peak daily requirements, rather than average daily requirements.

Hence the loss or gain of a demand customer has an impact on aggregate system MHQ requirements that is not necessarily proportional to the corresponding impact on total gas demand. A very low load factor customer

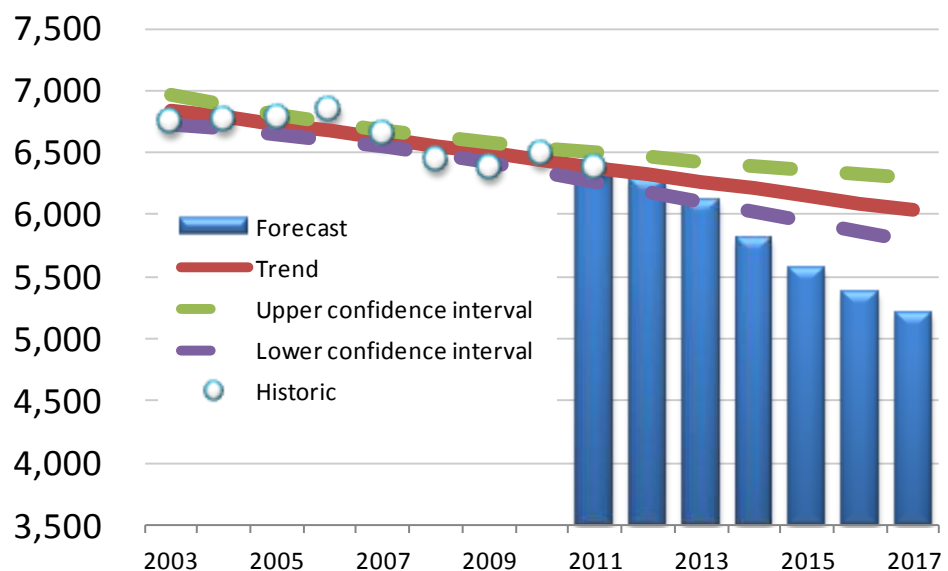
such as a peaking electricity generator may have a large MHQ requirement, but may consume only a small quantity of gas over the course of a year.

The impact of changes in MHQ is further complicated by the fact that capacity is not uniform throughout the pipeline network. Hence the cost impact of adding or subtracting a customer with a given MHQ requirement may vary depending on where that requirement is located within the system.

### MDQ history and forecast

Historical and forecast MHQ for the Tariff D customer group as a whole is shown in Figure 17.

Figure 17 **Tariff D Customer Maximum Hourly Quantity (MHQ)—TOTAL**



Note: Maximum Hourly Quantity in GJ/hour

Data source: (NIEIR, 2007); (Core, 2012); ACIL Tasman analysis

Core appears to have assumed that there is a direct proportionate relationship between industrial gas consumption and MHQ, such that MHQ is equal to 2.60 times Average Hourly Quantity (AHQ). Over the period 2005 to 2011 the ratio MHQ/AHQ ranged between 2.53 and 2.74, averaging 2.60. On this basis, the assumption that MHQ will equal 2.60 times AHQ for each year of the forecast period appears reasonable.

## 6 Conclusions

Notwithstanding the methodological issues identified, we have concluded that a more rigorous approach would not necessarily produce a more reliable forecast. This is because of the limitations of available data and the difficulties

involved in reliably estimating the coefficients associated with each of the variables in a fully specified demand function.

Accordingly, while recommending that consideration be given in future to the methodological issues identified, we consider that in the circumstances the approach used by Core to develop the Envestra Victoria demand forecasts is acceptable.

Normalisation of historical weather data has been carried out using a conventional approach based on EDD trends and weather sensitivities estimated, for each class of customer, using regression analysis. The key issue arising from this analysis is the assumption regarding “normal” weather between 2005 and the present. The Envestra forecasts are based on projections of EDD prepared by CSIRO in 2007 (updated to include data to 2010 but with no change to the trend functions) as the benchmark for “normal” weather. The scenario used to establish the “normal” weather benchmark for the Envestra Victoria forecasts projects a “normal” EDD level of 1278 for 2012. AEMO’s recent review of Victorian EDD as part of its weather standards for gas forecasting, found the same rate of decline in historical EDD as the CSIRO study, but a significantly higher 2012 EDD value of 1309.

We consider that it would be more appropriate for Envestra to use the current AEMO EDD standard as the basis for weather normalising the historical data. We estimate that, based on EDD data from 1970 to the present, this change would increase total forecast demand levels in the Envestra Victoria system by around 0.4 PJ/a or 0.75%.

We agree with Envestra that the price of gas is likely to increase over the regulatory period and that this is an important factor to take into account in forecasting gas demand. Envestra has taken into account anticipated increases in wholesale gas prices based on the same Australian Treasury modelling from which it drew the impact of the carbon price. In our view Envestra’s assumed increases in wholesale gas price are reasonable and may be conservative in the light of growing demand for gas in the power generation sector and the potential impact of LNG exports on domestic gas prices in the eastern Australian market.

Envestra has accounted for the impact of the carbon price on retail gas prices (reweighted for non-residential customers) based on Commonwealth Treasury modelling of the carbon trading scheme. In our view this is reasonable.

We accept that it is appropriate to take into account the whole of the (anticipated) network price increase in determining the expected future delivered price of gas to customers on the Envestra Victoria network.

Envestra has assumed a value of  $-0.30$  for the own-price elasticity of demand for gas, consistent with the AER's recent decision regarding its access arrangement in South Australia. This is broadly supported by analysis undertaken by Core which found an estimated price elasticity of about  $-0.27$  for all customer classes on the Envestra Victoria network, and is generally consistent with the estimates used the other distribution businesses.

Envestra does not appear to have considered the impact that higher electricity prices will have on gas demand. In its report to SP AusNet, CIE concluded that the price of electricity should not be included in its models of gas demand (CIE, 2012). Given the ambiguous nature of the results and the low absolute cross-elasticity values observed in the CIE analysis, as well as the lack of other relevant evidence, we consider that Envestra's reliance on own-price elasticity estimates alone is not unreasonable.

Core has adjusted the Envestra Victoria demand forecasts to take into account the anticipated effects of the 6-star building standard for new homes in Victoria. This is a new policy, the effects of which could not be expected to be reflected in the historical data on gas demand. Drawing on a Regulatory Impact Statement (RIS) prepared by the Centre for International Economics (CIE) for the Council of Australian Governments, Core has estimated that the average impact of the 6-star energy efficiency requirement across all new residential connections on the Envestra Victoria network will be a reduction in demand of approximately 5.8 GJ/a per connection. We consider this assumption to be reasonable.

We have reviewed the forecasts themselves, to consider whether the application of the methodologies and assumptions used by Core has produced forecast results for the Envestra Victoria network that are reasonable in light of historical patterns of demand as well as current and anticipated influences on retail gas demand in the distribution area.

Based on a comparison with historical trends and statistical confidence intervals around those trends, together with consideration of recent policy and market developments, we find that the forecasts of customer numbers, average demand per customer and total demand by customer class are not unreasonable, with the proviso that the forecasts should be modified by adopting the current AEMO EDD standard of 1309 EDD for 2012, declining at 7.8 EDD per year, as the basis for weather normalising the historical data.

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## A Curriculums Vitae

Following are brief curriculums vitae for the consulting team involved in the preparation of this report

### **Paul Balfe**

Paul Balfe is an Executive Director of ACIL Tasman and has overall responsibility for ACIL Tasman's gas business. Paul has more than 30 years experience in the energy and resources sectors. Previously he held a number of senior executive positions in the Queensland Department of Minerals and Energy. He has a Masters in Business Administration and a degree in Science.

Paul is responsible for the development and commercialisation of ACIL Tasman's *GasMark* model and its application to strategic and policy analysis throughout Australia, New Zealand and in South East Asia. He provides a range of analytical and advisory services to companies, government agencies and industry associations, particularly in the gas, electricity and resources sector. He has expertise in gas, electricity, resources, mining, economic impact analysis and in the analysis of core risk management, safety and health.

He has advised government and corporate sector clients on matters relating to the coal, oil and gas industries, coal seam gas, oil shale, mining safety and health, environmental management and alternative and renewable energies. With qualifications in geology and business administration, his experience ranges across both technical and commercial aspects of project evaluation and development.

Paul has worked extensively on gas industry matters, particularly gas policy reform issues; gas market analysis; gas pipeline developments, acquisitions and disposals; and gas project commercial analysis. He has worked extensively in the Queensland coal seam gas industry as an adviser to both government and corporate sector clients on regulatory, technical, economic and commercial aspects of CSG development.

### **Joel Etchells**

Joel Etchells is a Consultant in ACIL Tasman's Brisbane office. Prior to joining ACIL Tasman Joel was employed by the Federal Treasury as a member of the International and Model Development Unit, within the Macroeconomic Modelling Division. In this role he was required to produce and analyse economic modelling results, including results from a variety of models. Joel used CGE models to forecast the impact of alternative climate change mitigation policies on the Australian economy and its major trading partners.

This involved examining the broad macroeconomic impacts of proposed policies, through to sector specific analysis within a CGE framework.

Since joining ACIL Tasman, Joel has used CGE modelling techniques to analyse the economic impact of variety of infrastructure/capital investments and economic policies; ranging from large natural resource development projects, through to an analysis of the impact of geospatial information for the Tasmanian economy. This work involved formulating and subsequently simulating economic shocks associated with a particular scenario as well as the qualitative analysis of the model output. He has also worked on gas access regulation in Victoria.

Joel has an Honours degree in economics from the University of Queensland and is currently completing a Bachelor of Applied Mathematics at the Queensland University of Technology. His honours year encompassed 12 months of postgraduate coursework and research with a major in econometrics, equipping him with the requisite skills to undertake a wide range of economic analysis.

### **Jeremy Tustin**

Jeremy Tustin is a senior consultant in ACIL Tasman's Melbourne office. He has a degree in Economics from the University of Adelaide. His background is in economic regulation, in particular in the energy and water sectors, and competition and consumer protection.

Jeremy's energy background includes significant experience in greenhouse and renewable policy. He represented South Australia on the National Emissions Trading Taskforce, which was the joint taskforce of Australian States and Territories that was first to propose a cap and trade emissions trading system for Australia. In this area, Jeremy and his team developed and interpreted models of the impact an emissions trading scheme would have on South Australia and in developing a mechanism for offsets. Jeremy was also closely involved with the development of South Australia's solar feed-in law.

In relation to energy efficiency, Jeremy developed a reporting methodology for the South Australian Government's target to improve the energy efficiency of its buildings. He also coordinated interdepartmental activity in relation to that target, developed strategies to achieve it and prepared public reports on progress.

In his role with the Department of Treasury and Finance (SA), Jeremy advised the Treasurer on water policy, both rural and urban. He worked with the Office for Water Security to prepare Water for Good, South Australia's water security plan. In particular, Jeremy worked on the early stages of the design of

the future economic regulatory regime for the South Australian urban water sector. This included the decision to assign the regulator's role to the Commission. He also worked on a cost benefit analysis of a number of possible means of meeting South Australia's urban water demand.

Jeremy recently conducted (with others) the following projects:

- A review of the electricity sales, customer numbers and maximum demand forecasts submitted by the five Victorian electricity distribution businesses to the AER for the upcoming regulatory period (2011 to 2016).
- A review of the demand forecasts submitted to the Essential Services Commission of South Australia by SA Water
- A review of certain principles underpinning the Essential Services Commission of South Australia's upcoming determination of the standing contract price for gas in South Australia

### Dr Leo Yanes

Leo Yanes is a Senior Consultant in ACIL Tasman's Brisbane Office. Dr Yanes has a strong background in quantitative economics, with an emphasis on econometrics, planning, valuation (discounted cash flows, cost-benefit analysis), quantitative risk analysis (Monte Carlo simulation, real options), and general equilibrium analysis.

Dr Yanes' modelling expertise encompasses supply chain modelling (including consolidated valuation using discounted cash flows, tax modelling and quantitative risk analysis), partial and general equilibrium models, input-output analysis and cost-benefit analysis.

Dr Yanes' regulatory and policy experience includes the following economic impact studies:

- Oil & gas sector expansion in Venezuela (PDVSA, Venezuela, 1994-1997)
- Santos GLNG project (Santos/Petronas/Total/KoGas, QLD, 2008)
- Australia-Pacific LNG project (Origin/ConocoPhillips, QLD, 2009)
- Impact to 2070 of the educational aspects of the National Reform Agenda, encompassing early childhood, schools and tertiary (Department of Education, Employment and Workplace Relations, ACT, 2010)

Dr Yanes has several years of econometrics training, most of it received at the London School of Economics (U.K.), where he completed the M.Sc. and Ph.D. in economics. His econometrics expertise includes non-parametric methods (Data Envelopment Analysis or D.E.A.), time series, cross-section and panel data studies, using classical econometrics. His experience in this field includes:

- Forecasting private mining exploration expenditure and mining production for NSW to 2025. These forecasts were based on time series and dynamic



panel data econometrics, and required forecasting the Reserve Bank of Australia's Commodity Price Index (for the NSW Geological Survey, 2010)

- A time series (co-integration) analysis of oil sector linkages in Venezuela, spanning 1950-1995 (for PDVSA, the National oil company of Venezuela, 1995)
- Forecasts for the Eastern Australia gas market to 2100. These forecasts were based on market growth projections (for Santos, 2009)

Dr Yanes' commercial/business planning experience includes project appraisal using discounted cash flow and long and short-run forecasting. He has built cash flow models for various oil & gas projects at Santos and PDVSA (the Venezuelan national oil company). Among these, Dr Yanes contributed to the construction of an integrated supply chain model for the Santos GLNG project, which encompasses all aspects of the production process, from a module forecasting gas and water flows through to LNG delivery.

As a lecturer at the School of Economics, University of Queensland (2002-2008), Dr Yanes taught and carried out research in industrial economics (monopoly, oligopoly & antitrust), mathematical economics, game theory, international trade, economic growth and firm structure. His research concentrated on analysing the impact of oligopolies on economic growth and international trade (in dynamic general equilibrium).

## B Terms of Reference

The AER is seeking independent advice through written reports on the demand forecasts contained in the access arrangement proposals submitted by the Victorian transmission and distribution businesses to assist it in its decision about whether to approve the access arrangement proposals.

The consultant will be required to provide advice on whether the demand forecasts for each business have been arrived at on a reasonable basis and represent the best forecast for demand in the circumstances.

The review will require the consultant to undertake the following:

- (i) a desktop review of demand forecasts and any relevant materials contained in the access arrangement proposals submitted by service providers
- (ii) formulate a series of detailed questions on areas where it is considered that further information or clarification is required from the service providers to substantiate the demand forecasts
- (iii) analyse all material provided and prepare separate reports for each service provider containing a list of issues identified from the review, and recommendations on whether the demand forecasts for each service provider have been arrived at on a reasonable basis and represent the best forecast for demand in the circumstances.
- (iv) provide alternative forecasts of demand for the service providers if the consultant finds that the proposed demand forecasts have not been arrived on a reasonable basis and do not represent the best forecast for demand in the circumstances.

If requested by the AER the consultant will also:

- (v) provide further advice on the revised access arrangement proposals from service providers scheduled to be submitted after the release of the AER's draft decisions.

The AER's decisions are subject to merits review by the Australian Competition Tribunal and judicial review by the Federal Court. The consultant's analysis and reports must be produced to a standard that is commensurate with scrutiny at that level. The consultant must describe in its written report the qualitative and/or quantitative methodologies applied in any calculation or formulae, the input values used or assumed, the rationale for any substituted values used or assumptions made and the conclusions reached in sufficient detail to support the AER in meeting its obligations under the relevant clauses of Part 9 of the NGR.



**ACIL Tasman**

Economics Policy Strategy

## **Review of Demand Forecasts for Envestra Victoria**

In addition to the draft and final reports, the consultant must provide supporting spreadsheets and analysis to ensure the AER can meet the requirements set out in Rules 59 and 62 of the NGR for the making and publication of decisions.

The consultant will be required to liaise with service providers and AER staff during the course of the access arrangement review. These consultations may include e-mail and telephone communications with AER staff and service providers.

## C Establishment of Confidence Intervals around historical trend lines

The following explanation of the construction of confidence intervals is based on information provided in the manual for the Statistica software package.

The confidence intervals for specific statistics (for example, means or regression lines) provide a range of values around the statistic where the "true" (population) statistic can be expected to be located (with a given level of certainty).

The confidence intervals for the mean give us a range of values around the mean where we expect the "true" (population) mean is located (with a given level of certainty). Confidence intervals can be calculated for any p-level; for example, if the mean in a sample is 23, and the lower and upper limits of the  $p=.05$  confidence interval are 19 and 27 respectively, then we can conclude that there is a 95 per cent probability that the population mean is greater than 19 and lower than 27. If the p-level is reduced to a smaller value, then the interval would become wider thereby increasing the "certainty" of the estimate, and vice versa. The width of the confidence interval depends on the sample size and on the variation of data values. The calculation of confidence intervals is based on the assumption that the variable is normally distributed in the population. This estimate may not be valid if this assumption is not met, unless the sample size is large, say  $n = 100$  or more.

Confidence Intervals (CI's) have the form:

$$Est \pm t_{1-\frac{\alpha}{2},(n-2)} SE_{est}$$

For the CI around the y-estimate in the linear regression equation, the CI is given by:

$$CI = Est_y \pm t_{1-\frac{\alpha}{2},(n-2)} SE_{est}$$

Where  $t_{1-\frac{\alpha}{2},(n-2)}$  is the inverse of the Student's t-distribution for confidence level  $\alpha$  given that  $n$  is the number of data points (so that  $n-2$  is the number of degrees of freedom in the distribution)

and

$$SE_{est} = SE_y \times \sqrt{\frac{1}{n} + \frac{(x_i - \bar{x})^2}{\sum(x_i - \bar{x})^2}}$$