Energy consumption forecasts 2011-12 to 2016-17

Energy consumption forecasts for Aurora Energy covering six customer classes

Prepared for Aurora Energy

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ACIL Tasman

Economics Policy Strategy

ACIL Tasman Pty Ltd

ABN 68 102 652 148
Internet www.aciltasman.com.au

Melbourne (Head Office)
Level 4, 114 William Street
Melbourne VIC 3000

Telephone (+61 3) 9604 4400
Facsimile (+61 3) 9604 4455
Email melbourne@aciltasman.com.au

Canberra
Level 1, 33 Ainslie Place
Canberra City ACT 2600
GPO Box 1322
Canberra ACT 2601

Telephone (+61 2) 6103 8200
Facsimile (+61 2) 6103 8233
Email canberra@aciltasman.com.au

Sydney
PO Box 1554
Double Bay NSW 1360

Telephone (+61 2) 9389 7842
Facsimile (+61 2) 8080 8142
Email sydney@aciltasman.com.au

Brisbane
Level 15, 127 Creek Street
Brisbane QLD 4000
GPO Box 32
Brisbane QLD 4001

Telephone (+61 7) 3009 8700
Facsimile (+61 7) 3009 8799
Email brisbane@aciltasman.com.au

Perth
Centa Building C2, 118 Railway Street
West Perth WA 6005

Telephone (+61 8) 9449 9600
Facsimile (+61 8) 9322 3955
Email perth@aciltasman.com.au

For information on this report

Please contact:

Peter Crittall
Telephone (07) 3009 8718
Email p.crittall@aciltasman.com.au

Jim Diamantopoulos
Telephone (03) 9604 4418
Email j.diamantopoulos@aciltasman.com.au

Contents

List of figures

List of tables

Executive summary

This report has been produced in response to a request from Aurora Energy in its capacity as a distribution network service provider (DNSP) to produce independent energy forecasts for six customer classes for their next regulatory period from 2012-13 to 2016-17. The forecast period also includes the 2011-12 financial year.

The six classes for which forecasts are produced are:

- Residential
- Small business (LV)
- Large business (LV)
- Large commercial (HV)
- Irrigation
- Unmetered supply

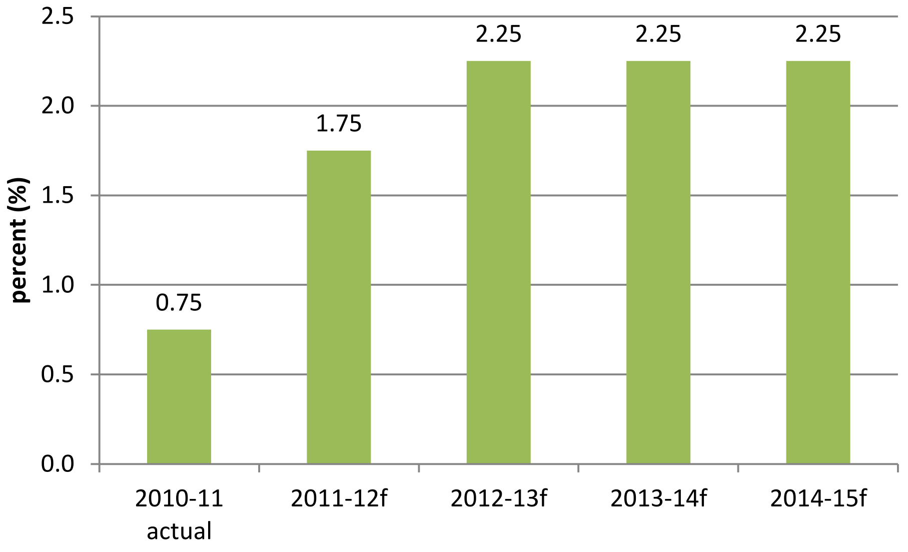
The approach taken is to estimate multiple regression models for each customer class against a set of drivers which differ for each class and which are validated using standard statistical tools such as goodness of fit, correlation (R^2) and statistical significance (T-test).

The key drivers for residential energy consumption are population growth and weather variation. For the Small and Large business (LV) customers, the key driver of energy consumption is economic growth (GSP). Irrigation energy consumption is driven predominantly by variation in annual rainfall. Unmetered supply is driven by growth in Tasmanian GSP.

In the case of the Large commercial (HV) customers, we note that this category contains only a very small number of very large energy customers. In this case, a regression based approach is not appropriate as the forecasts would be highly sensitive to changes in company specific factors. The best approach to forecasting energy consumption for very large customers is to survey them regularly to determine their energy requirements. This is the approach taken by Aurora Energy and ACIL Tasman has chosen to adopt Aurora's forecasts for these customers.

Key inputs into the forecasting process are projections for Tasmanian economic and population growth rates. For the purposes of our economic forecasts, we utilise the GSP growth forecasts published in the 2011-12 Budget document of the Tasmanian Government, Budget Paper Number 1. These are shown in Figure ES 1 below.

Figure ES 1 **Tasmanian GSP growth projections, Department of Treasury and Finance**

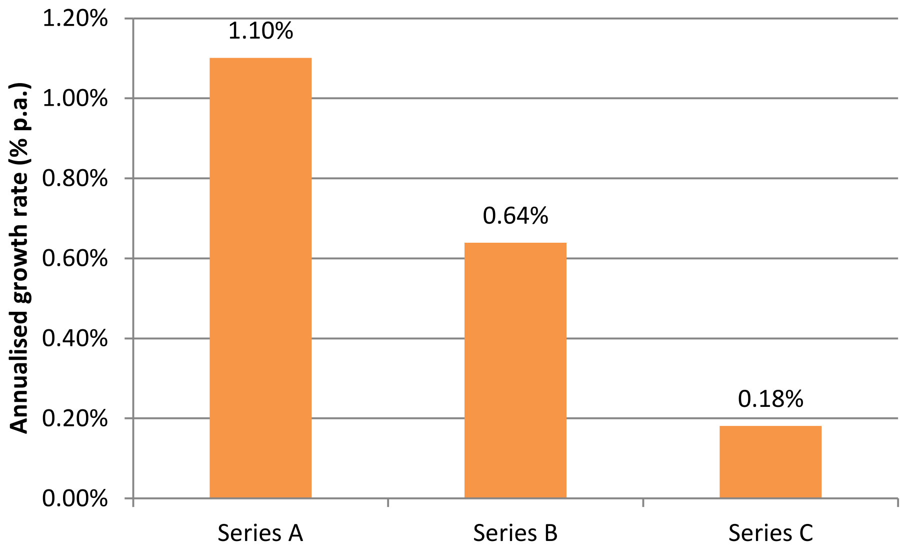


Data source: Budget Paper Number 1, The Budget 2011-12

Tasmanian GSP is forecast to grow at 1.75% in 2011-12 before accelerating to 2.25% p.a. in 2012-13, 2013-14 and 2014-15. This is below historical rates of economic growth as Tasmanian GSP growth has averaged 2.65% per annum over the past decade, even with the impact of the global financial crisis.

Our population forecasts are the series B population projections produced by the Australian Bureau of Statistics. Series B projects a rate of population growth for Tasmania of 0.64% per annum between 2010-11and 2016-17 (see Figure ES 2 below). This growth rate is considerably less than the actual rate of 0.86% per annum for the five years to June 2010.

Figure ES 2 **Projected Tasmanian population growth per annum, 2010-11 to 2016-17, Series A, B and C**



Data source: ABS, 3222.0 Population Projections, Australia

The base forecasts (MWh) produced by the calibrated models presented in section 5 of this report are shown in Table ES 1 below.

Table ES 1 **Base case forecasts by customer class, 2011-12 to 2016-17**

Year	Residential	Small business (LV)	Large business (LV)	Large commercial (HV)	Irrigation	Unmetered supply (UMS)	Total
2002-03	1,923,058	762,759	462,205	876,188	99,236	35,624	4,159,070
2003-04	2,092,323	798,807	491,816	813,747	98,675	36,140	4,331,508
2004-05	2,072,904	807,258	487,978	869,489	101,896	36,701	4,376,226
2005-06	2,108,331	818,652	503,796	869,224	76,368	36,916	4,413,287
2006-07	2,148,339	842,398	517,576	830,618	129,424	36,563	4,504,918
2007-08	2,108,660	853,688	540,997	825,063	117,803	37,622	4,483,833
2008-09	2,162,722	905,345	568,190	822,450	108,734	37,484	4,604,924
2009-10	2,077,409	935,795	537,707	818,724	107,553	36,928	4,514,116
2010-11	2,085,648	904,369	521,608	811,596	57,046	36,912	4,417,179
Forecast							
2011-12	2,024,501	895,662	543,520	739,677	78,593	37,389	4,319,342
2012-13	2,072,777	944,344	573,066	739,677	99,637	37,679	4,467,180
2013-14	2,079,888	965,592	585,960	739,677	99,637	37,880	4,508,633
2014-15	2,086,788	987,318	599,144	739,677	99,637	38,085	4,550,649
2015-16	2,093,465	1,009,532	612,624	739,677	99,637	38,295	4,593,232
2016-17	2,099,838	1,032,247	626,408	739,677	99,637	38,510	4,636,317

Data source: ACIL Tasman

Over the forecast period of six years, the total increase in energy consumption of 219 GWh (0.8% per annum) is largely due to increases Small Business LV (128 GWh) and Large Business LV (105 GWh) customer classes.

It is important to note that the methodology to generate the 2011-12 forecast has been amended to incorporate the fact that at the time of preparation, we had already observed energy sales for the first five months of the 2011-12 financial year. We have therefore made a weighted adjustment to the forecast derived from the calibrated models to account for the five months of data that we have already observed. Across the whole of the Aurora distribution network, sales have declined by 3.8% over the first five months of 2011-12 compared to the corresponding period in the previous year.

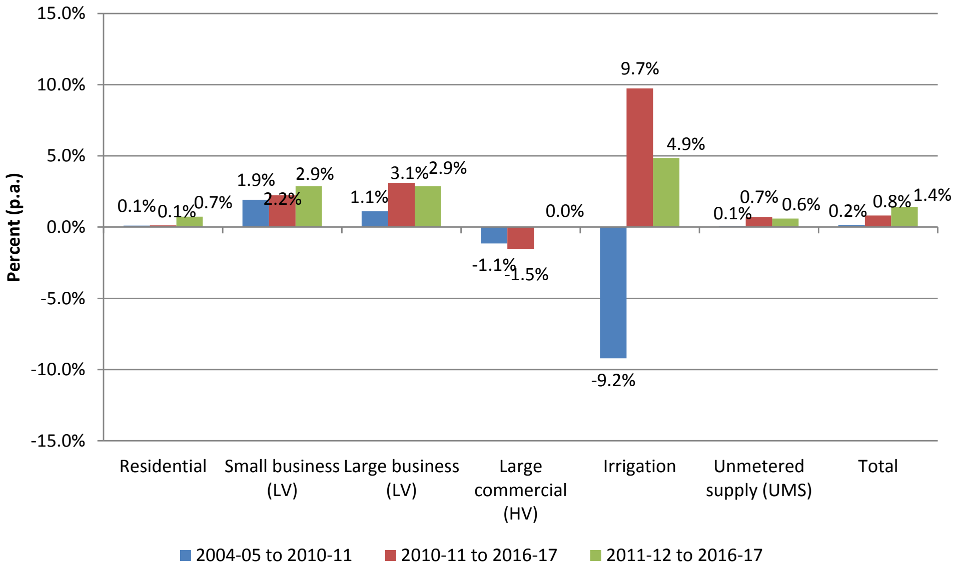
This is most probably due to the warmer than average weather conditions that we have experienced over the first five months of the 2011-12 financial year compared to the conditions experienced in 2010-11. Weather conditions in 2011-12 are closely tracking those observed in 2009-10, a year that was considerably milder/warmer than average.

From 2010-11 to 2016-17, total energy consumption within the Aurora distribution network is forecast to grow at a rate of 0.8% per annum, compared to a historical growth rate of 0.2%[1] between 2004-05 and 2010-11.

Figure ES 3 below compares the historical versus forecast growth rates graphically.

[1] Note that this calculation is based on non-weather corrected historical data which could be subject to bias.

Figure ES 3 **Annualised growth rate by sector, historical versus forecast**



Data source: ACIL Tasman

1 Introduction

This report has been produced in response to a request from Aurora Energy to produce energy forecasts for six customer classes for their next regulatory period from 2012-13 to 2016-17. The forecast period also includes the 2011-12 financial year. Further, this report outlines a methodology for the estimation of system level energy forecasts for Aurora Energy. It is important to note that this document concerns itself with Aurora as a distribution network service provider (DNSP). Wherever reference is made to Aurora Energy in this document, and unless otherwise stated, we are referring to Aurora Energy Pty Ltd in its capacity as a DNSP, not the Aurora Energy retail business.

Aurora Energy revenues are to a large extent based on per unit energy usage charges. These revenues are regulated within an overall cap, with per unit tariffs set by customer class such that the overall forecast revenues fit within the cap. Hence the energy forecast is a fundamental element in determining the per unit pricing for each customer class. In the event that the energy forecast lacks accuracy, the actual revenues could be significantly different to the forecast revenues with potentially corporate wide implications for the business.

This report outlines a regression based methodology which takes into account the key underlying drivers that are influencing system energy sales in the Aurora network. The report presents a step by step description of the approach taken and the presents a set of forecasts for each of six customer classes.

While a regression based methodology is used to establish a baseline energy forecast, it cannot be used to forecast the impact of new policies for which there is no history (e.g. the introduction of the Federal Government's carbon tax on July 1 2012). Further modifications for specific policy impacts should be undertaken exogenously from the regression.

The report is organised as follows:

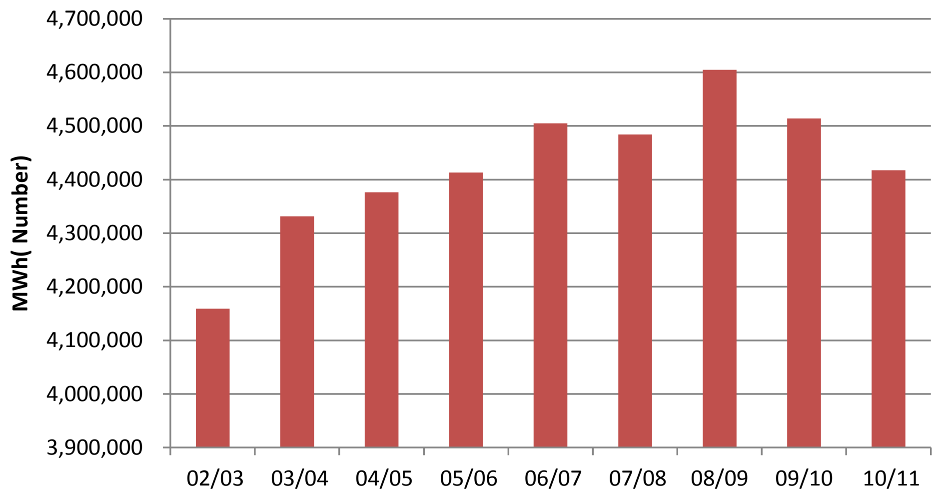
- Chapter 2 describes Aurora Energy's energy sales and customer numbers by class.
- Chapter 3 describes the key drivers of system energy sales
- Chapter 4 covers model specification
- Chapter 5 presents a set of calibrated models and assesses these models based on goodness of fit and statistical significance
- Chapter 6 develops a set of forecasts based on the calibrated models

- Chapter 7 discusses how policy changes can be incorporated into the forecasting methodology and then adjusts the forecasts in Chapter 6 for the impact on energy consumption from the proposed introduction of the carbon tax.

2 Energy consumption by sector

Figure 1 shows the historical energy consumption across the entire Aurora Energy distribution network from 2002-03 to 2010-11. The series is characterised by steady growth up to the 2008-09 financial year before a decline in 2009-10 and 2010-11 in response to slower economic growth and milder weather. In 2010-11, energy consumption across the Aurora network was 4.42 million MWh.

Figure 1 **Aurora Energy total energy consumption, 2002-03 to 2010-11**



Data source: Aurora Energy

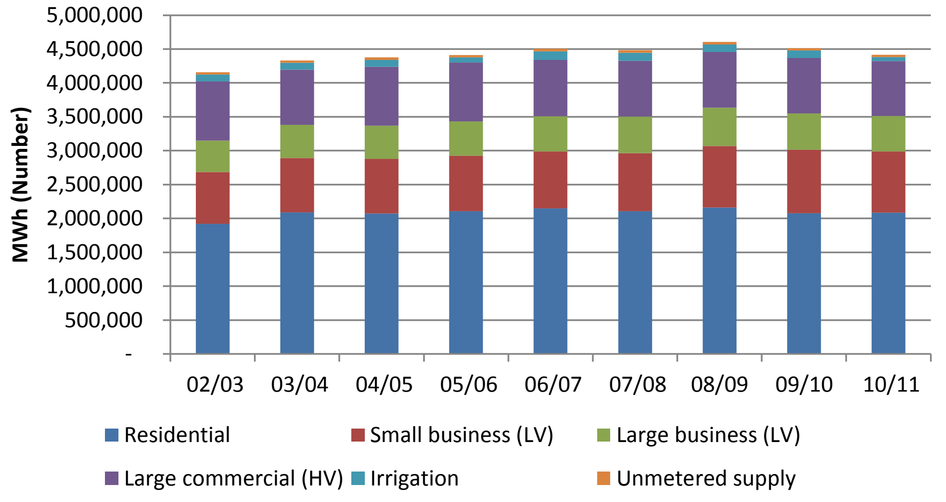
Figure 2 further splits Aurora's distribution energy sales into six distinct customer classes, namely:

- Residential
- Small business (LV)
- Large business (LV)
- Large commercial (HV)
- Irrigation
- Unmetered supply

The largest customer class by energy use is residential, which accounted for 47% of all energy consumption in 2010-11. This is followed by Small business (LV) and Large commercial (HV) classes which comprised 20% and 18% respectively of total sales in 2010-11.

In the same year, Large business (LV) made up 12% of total consumption. The two smallest contributors to total energy consumed were Irrigation and Unmetered supply, each contributing 1% to total energy sales.

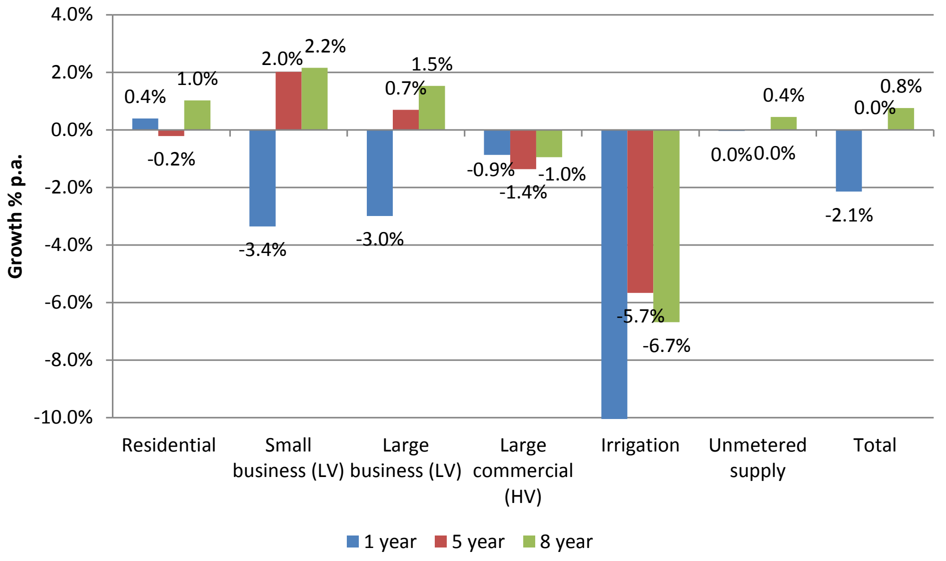
Figure 2 **Energy consumption by class, 2002-03 to 2010-11**



Data source: Aurora Energy

Figure 3 shows the rate of historical growth in energy consumption to 2010-11 for each of the customer classes over one, five and eight year time frames.

Figure 3 **Growth in energy consumption by sector, to 2010-11**



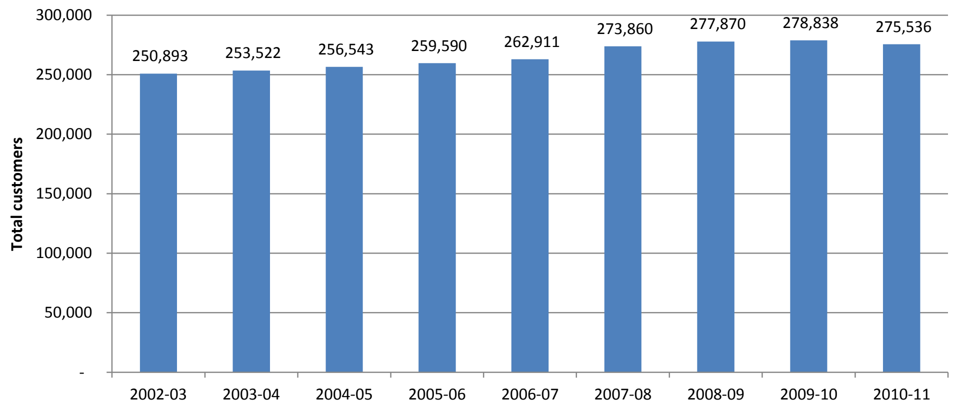
Data source: Aurora Energy

In 2010-11, all of the customer classes, apart from the Residential customers, experienced a decline in energy consumption. Over a longer period of eight years, all customer classes grew except for the large Commercial customers and Irrigation customers, which have exhibited an annual rate of decrease of -1.0% and -6.7% respectively. The fastest growing customer class over the last eight years has been the Small business customer class, which has grown at a rate of 2.2% per annum. Over the same period, residential energy consumption has grown at a rate of 1.0% per annum.

2.1 Customer numbers

Customer[2] numbers in the Aurora Energy distribution network have grown steadily over time (see Figure 4). In 2010-11 they reached 275,536, an increase of 24,643 from 250,893 in 2002-03. The average annual growth in customer numbers over this period was 1.2% per annum.

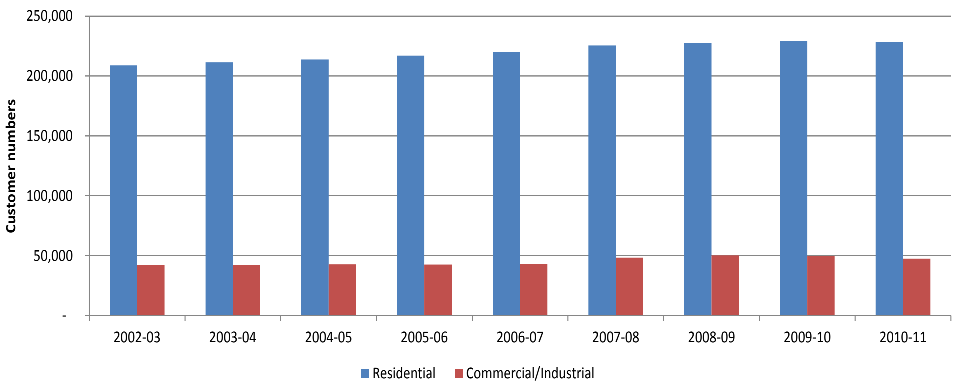
Figure 4 **Total customer numbers, Aurora Energy, 2002-03 to 2009-10**



Data source: Aurora Energy

The vast majority of customers (82.7% of total customers in 2010-11) in the Aurora distribution network are residential customers (see Figure 5).

Figure 5 **Customer numbers by sector, Aurora Energy, 2002-03 to 2010-11**



Data source: Aurora Energy

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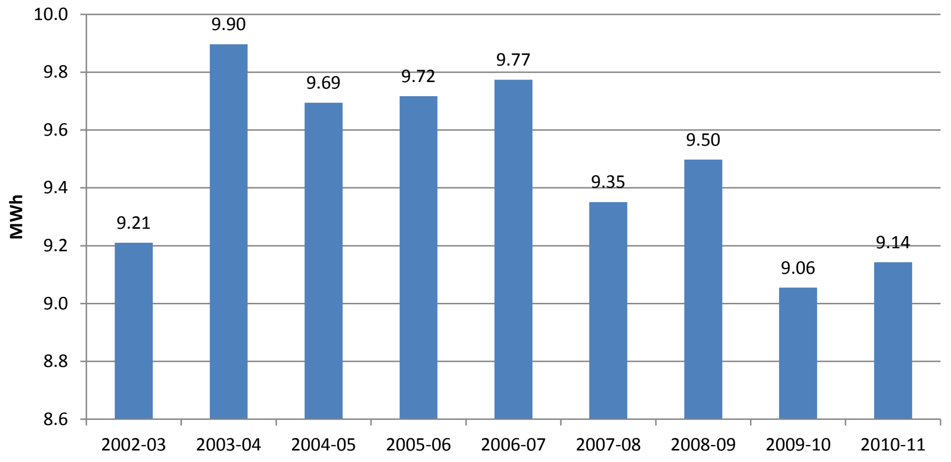
2 By 'customer' we mean NMI connections.

2.2 Residential energy use per customer

Average energy use per residential customer connection is shown in Figure 6. We do not present per customer energy use for the other customer classes as we are unable to obtain an accurate split over time for these classes.

For residential customers, average energy use per customer has decreased since 2006-07. In fact, the result for 2010-11 (9.1 MWh) is lower than for 2002/03 (9.2 MWh).

Figure 6 **Residential energy use per customer, MWh, 2002-03 to 2010-11**



Data source: Aurora Energy

Key drivers of this decline are likely to include softer economic growth following the global financial crisis in 2008 as well as milder weather conditions, particularly in 2009-10. Another likely driver of per customer energy use is the increase in electricity prices that has occurred over the last few years. The drivers of energy use are discussed in greater detail in the next section of this report.

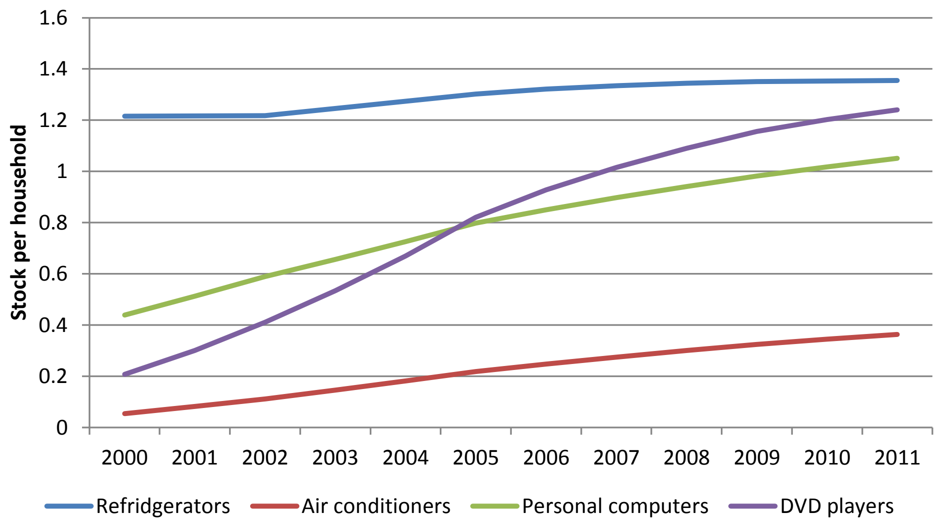
3 Economic and demographic drivers

3.1 Economic growth

Increasing energy use is driven by higher disposable incomes and subsequent demand for new electronic appliances and equipment, as well as increasing commercial and industrial activity.

The numbers of electronic appliances per household have been increasing steadily over time in Tasmania. Data obtained from the report 'Energy use in the Australian residential sector 1986-2020' published by the Department of the Environment, Water, Heritage and the Arts, shows that over the eleven years between 2000 and 2011 there has been a steady increase in selected electrical appliances and gadgets (see Figure 7 and Figure 8 below).

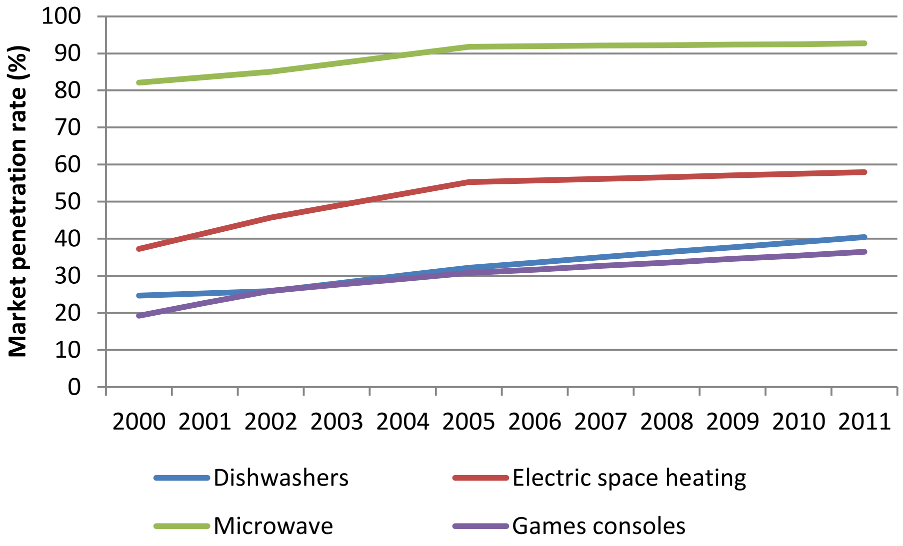
Figure 7 **Number of appliances per household, Tasmania, 2000 to 2011**



Data source: Energy use in the Australian residential sector 1986-2020, Department of the Environment, Water, Heritage and the Arts

While the increase in electrical appliances can be expected to have a positive impact on energy consumption, the overall impact is uncertain. For example, many new appliances are considerably more energy efficient than those they replace, potentially leading to lower energy consumption per household.

Figure 8 **Market penetration of selected electrical appliances, Tasmania, 2000 to 2011**

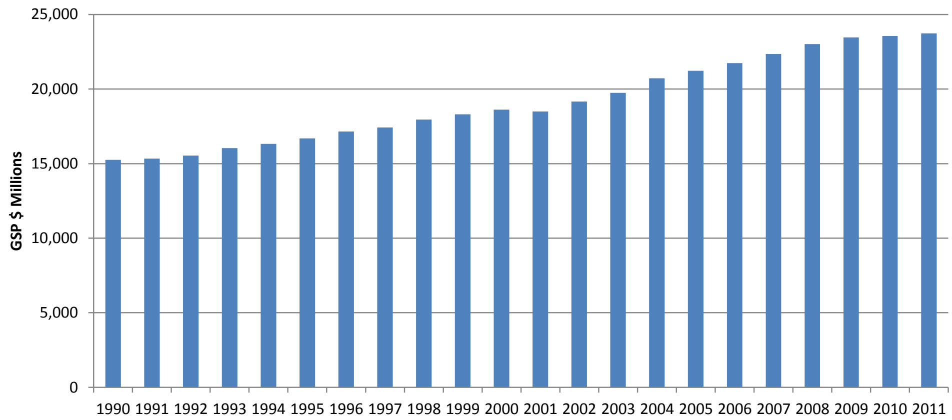


Data source: Energy use in the Australian residential sector 1986-2020, Department of the Environment, Water, Heritage and the Arts

Economic growth is a major driver of rising incomes and hence growth in energy sales. In addition, it reflects the extent to which economic output is increasing, of which electricity is a key input, particularly for energy intensive manufacturing industries.

Figure 9 shows the historical time series of Tasmanian Gross State Product from 1990 through to 2011.

Figure 9 **Tasmanian Gross State Product (GSP), 1990 to 2011, $m (Real)**



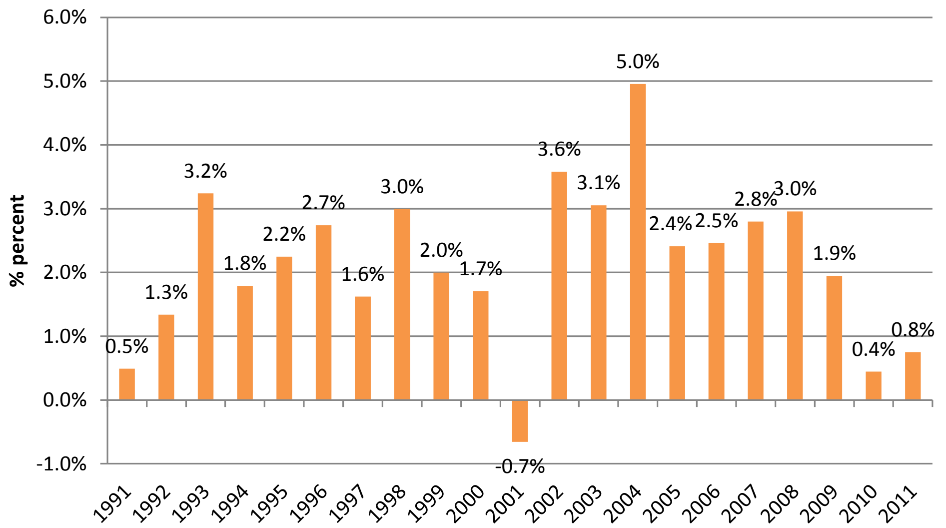
Data source: ABS, 5220.0 Australian National Accounts: State Accounts

Tasmanian economic growth has been positive in all but two years since 1990-91. In 1990-91 Tasmanian GSP shrunk by 2.1%. In 2000-01 GSP declined again by 1.5% (see Figure 10).

In 2009-10, while Tasmanian economic growth slowed considerably, it remained positive with a growth rate of 0.4%.

Between 2001-02 and 2008-09, Tasmanian GSP growth was generally robust, with growth exceeding 3% in five of those years and above 2% in all years between 2001-02 and 2008-09.

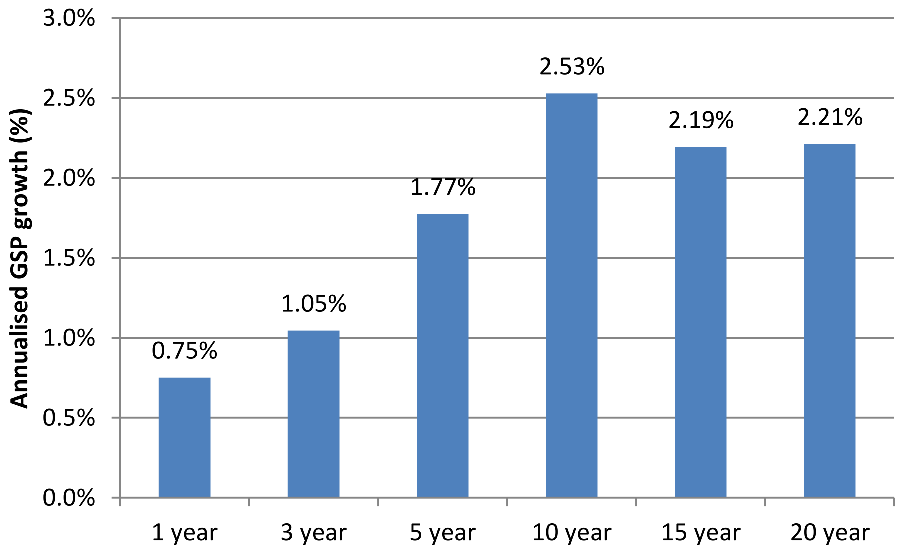
Figure 10 **Annual Tasmanian real GSP growth, 1991 to 2011**



Data source: ABS, 5220.0 Australian National Accounts: State Accounts

Over the last 20 years, Tasmanian GSP growth has averaged 2.2% per annum, while over very short time horizons growth has been weak, averaging an annual rate of growth of around 1.1% and 1.8% over the last three and five years to 2011-12 (see Figure 11).

Figure 11 **Annualised Tasmanian economic growth over multiple periods**



Data source: ABS, 5220.0 Australian National Accounts: State Accounts

3.1.1 Tasmanian economic outlook

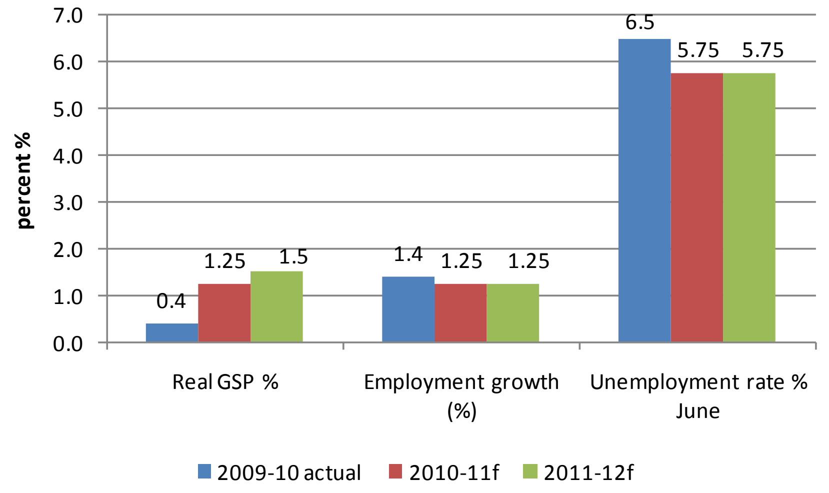
The outlook for the Tasmanian economy is relatively weak. As a State that is not generally participating in the resources led boom which is benefitting resources rich states such as Queensland and Western Australia, Tasmanian economic activity is being detrimentally affected by the strong Australian dollar (relative to the US$).

The higher Australian dollar is likely to impact on Tasmanian economic activity by:

- hurting agricultural exports and import competition
- hurting domestic tourism, with the high dollar making overseas travel more attractive and limiting overseas arrivals
- hurting the manufacturing sector
- hurting international education exports

Recent analysis conducted by the Commonwealth Bank of Australia (CBA), predicted that employment growth in Tasmania will average just 1.25% in 2010-11 and 2011-12, with an associated unemployment rate of 5.75% over the same period (see Figure 12).

Figure 12 **Tasmanian economic projections made by CBA, 2010-11 and 2011-12**

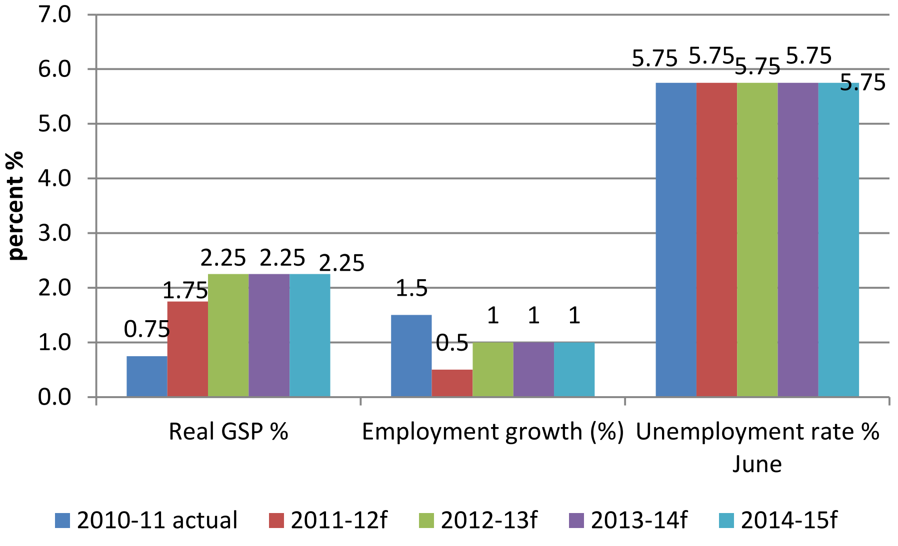


Data source: CBA, Tasmanian economic outlook- March 2011

The CBA also forecast GSP growth to remain significantly below the long run growth rate of 2.2%. The CBA forecast a rate of growth of 1.25% in 2010-11 followed by 1.5% in 2011-12.

Figure 13 presents a range of economic projections from the Tasmanian Government's 2011-12 Budget.

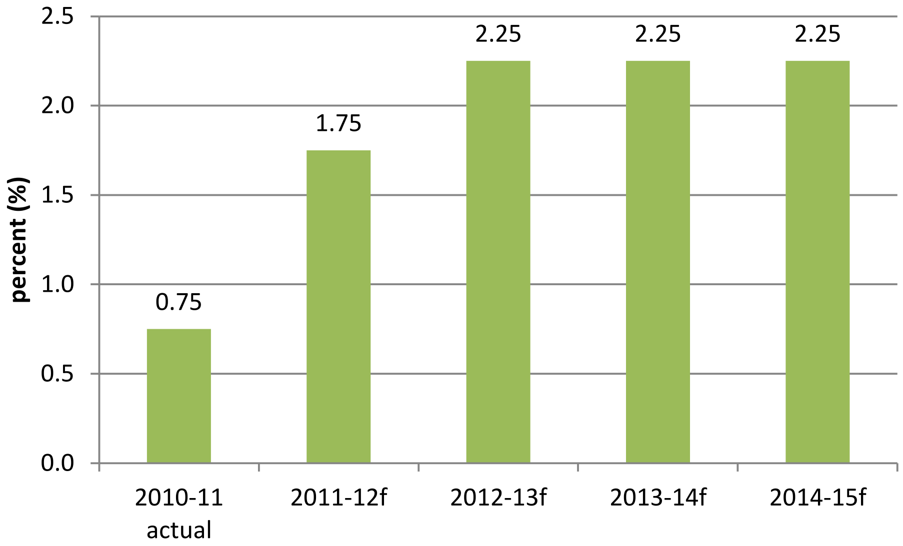
Figure 13 **Tasmanian economic projections, Tasmanian budget 2011-12**



Data source: Government of Tasmania

In its 2011-12 Budget, the Tasmanian Government projected a more optimistic rate of growth of 1.75% in 2011-12, increasing to 2.25% from 2012-13 to 2014-15 (see Figure 14).

Figure 14 **Tasmanian GSP growth projections, 2011-12 Tasmanian Government Budget**



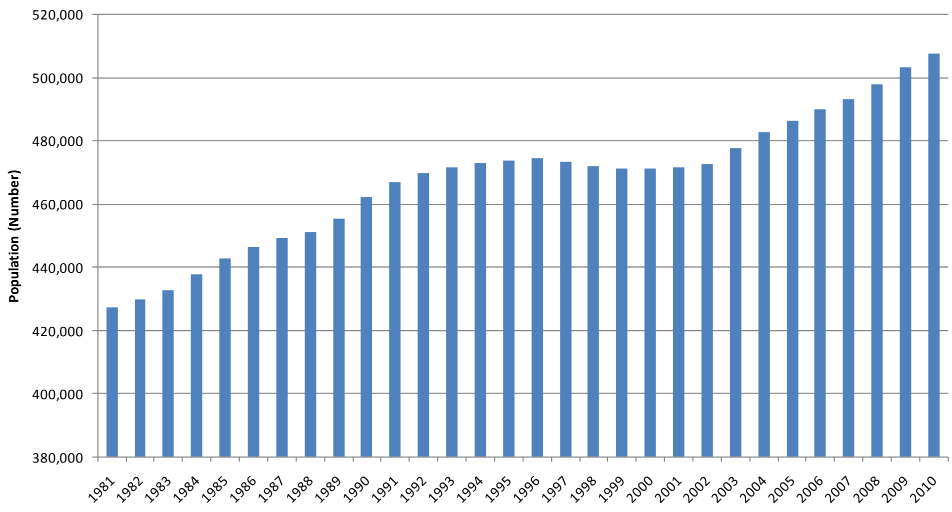
Data source: Budget Paper Number 1, The Budget 2011-12

3.2 Population growth

Energy sales growth shows a steady upward trend. This rising trend has been driven by the growth in connections, offsetting reduced energy consumption per connection. Increasing residential customer numbers are driven by household formation arising from population growth – both natural and migration driven.

Population growth in Tasmania has gone through periods of both relatively strong growth and also periods of stagnation or decline (see Figure 15). In the years between 2000 and 2010, the estimated resident population of the State grew by 0.74% per annum, reaching 507,603 by the June quarter of 2010.

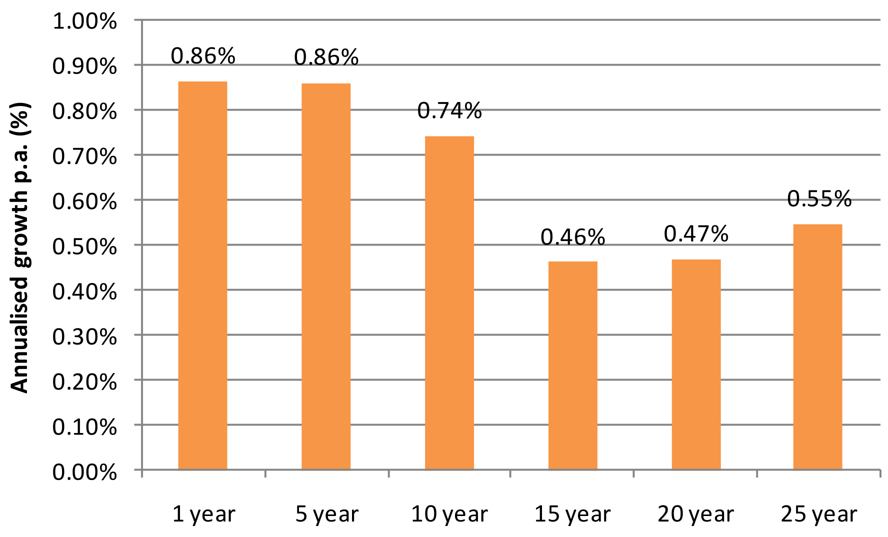
Figure 15 **Estimated resident population, Tasmania, June 1981 to June 2010**



Data source: 3101.0 Australian Demographic Statistics

Over a one and five year time horizon, Tasmania's population growth has averaged 0.9% per annum (see Figure 16). Longer term growth rates are significantly lower. This is largely due to the fact that Tasmania experienced a period of population decline starting from June 1996 and ending in June 2000, which has reduced the long run rate of population growth to 0.47% per annum over the past 20 years.

Figure 16 **Annualised growth in Tasmania's population over several time periods, % p.a.**



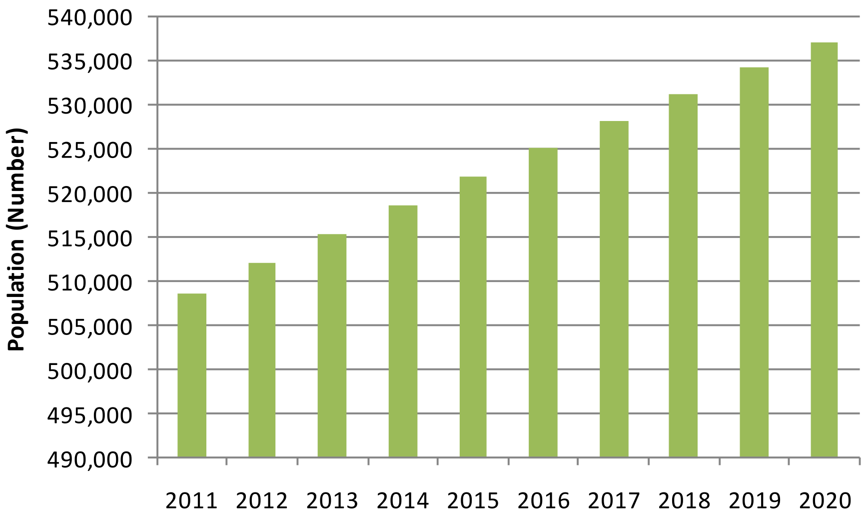
Data source: ABS, 3101.0 Australian Demographic Statistics

A key input into generating energy consumption forecasts for Aurora Energy is the projected population for the State. The Australian Bureau of Statistics

(ABS) produces three distinct population projections for Tasmania, known as Series A, B and C. Series A and C are the optimistic and pessimistic scenarios respectively. Series B is the mid-point, which is the scenario that ACIL Tasman adopts for the purposes of producing its energy consumption forecasts.

Under the Series B population scenario, the ABS projects Tasmania's population to reach 537,188 by June 2020 – an average growth rate of 0.6% per annum (see Figure 17). This ten year forecast is slightly lower than the actual result of 0.7% per annum for the ten years to 2009-10.

Figure 17 **Projected Tasmanian population, June 2011 to June 2020**

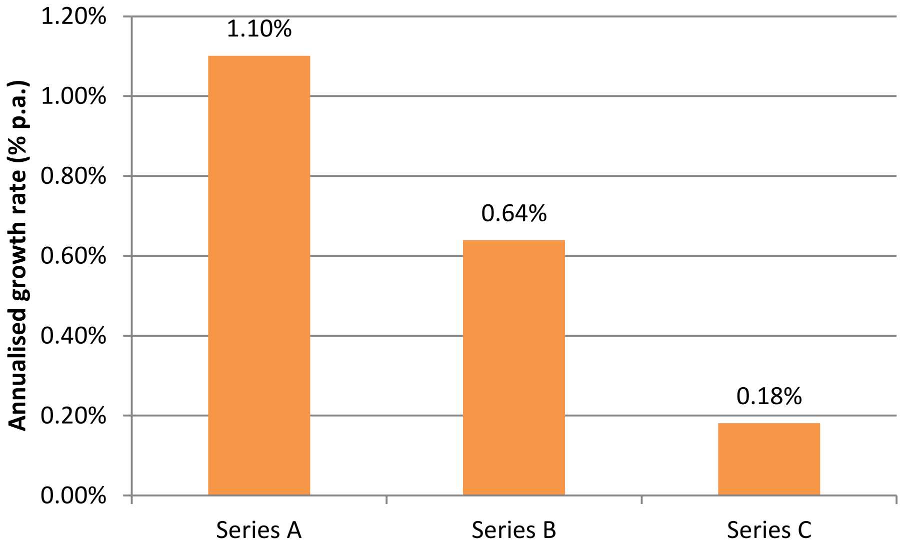


Data source: ABS, 3222.0 Population Projections, Australia, Series B

According to the Series A projections sourced from the ABS publication, "3220.0 Population Projections Australia", Tasmania's population is expected to increase by 1.1% p.a. between 2010-11 and 2016-17. Under the less optimistic Series B scenario, population growth is expected to be 0.64% p.a. over the next 6 years (see Figure 18).

The rate of household formation is likely to follow population growth closely, given the relatively stable number 2.4 persons per household for Tasmania in 2006 from data obtained from the ABS Census.

Figure 18 **Projected Tasmanian population growth per annum, 2010-11 to 2016-17, Series A, B and C**



Data source: ABS, 3222.0 Population Projections, Australia, Series B

3.3 Weather variables

3.3.1 Air temperature

Variations in average weather conditions over the course of a year may drive movements in energy consumption. While a single extreme day is sufficient to result in a season peak maximum demand, that day will make only a small contribution to total annual energy sales. A measure of the overall hotness or mildness of a season is likely to be a better indicator of how temperature is affecting energy consumption. We assess the impact of average weather conditions with the concept of heating degree days (HDD) and cooling degree days (CDD).

HDD is a measure designed to reflect the amount of energy required to heat a home or business, while the CDD is designed to reflect how much energy is required to cool a home or business.

The number of HDD in a given year is simply the sum of the difference between some measure of ambient room temperature which we define as 18 degrees Celsius and the average daily temperature on each day. Any given day makes a contribution to the total number of heating degree days only if the average temperature on that day is below 18 degrees. For example, if the average temperature today is 10 degrees Celsius, then the number of heating degree days contributed to the annual total from that day is 8 (ie. 18-8).

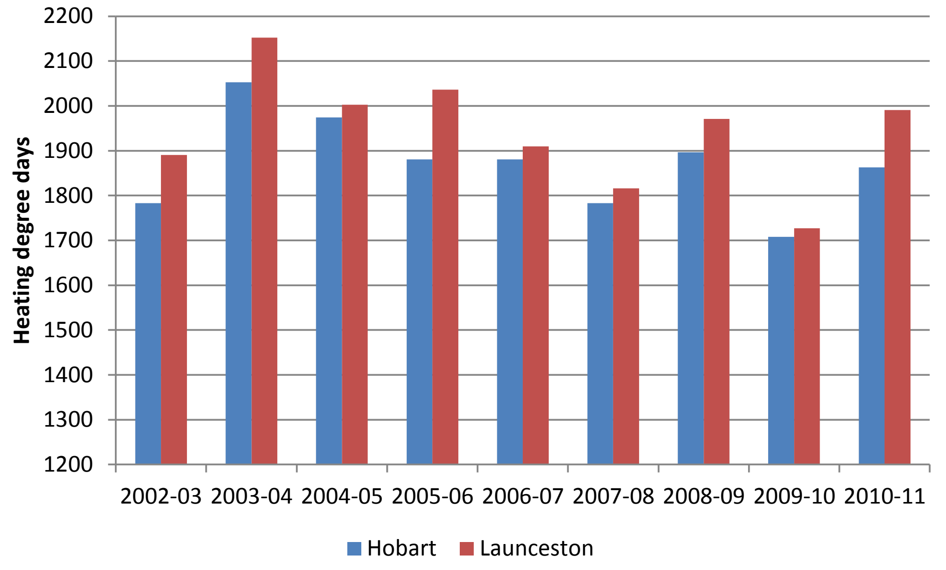
If the average temperature exceeds 18 on a given day then that day contributes zero to the total number of heating degree days for the year. The higher the number of HDD for a given year, the colder that year is.

In the case of cooling degree days the concept is the same, but the formula takes the sum of degrees that exceed some benchmark (in our case 18 degrees Celsius) for each day. It is therefore an indication of how hot a given year is, with a higher number of CDD reflecting a hotter season.

In the case of Tasmania, energy consumption is predominantly driven by colder weather which leads to higher energy consumption related to space and hot water heating. Unlike other Australian states, summer peak demand is also predominantly driven by colder rather than hot days. For this reason, the more likely driver of energy consumption is heating degree days rather than cooling degree days.

Figure 19 shows the total number of heating degree days, as measured at Hobart and Launceston between 2002-03 and 2010-11. The average number of heating degree days since 2002-03 at Hobart is 1,869 per year. The most recent year, 2010-11 is around average, while the 2009-10 year was significantly milder/warmer than normal. Interestingly, this corresponds to a marked slowdown in energy sales, particularly in the domestic sector.

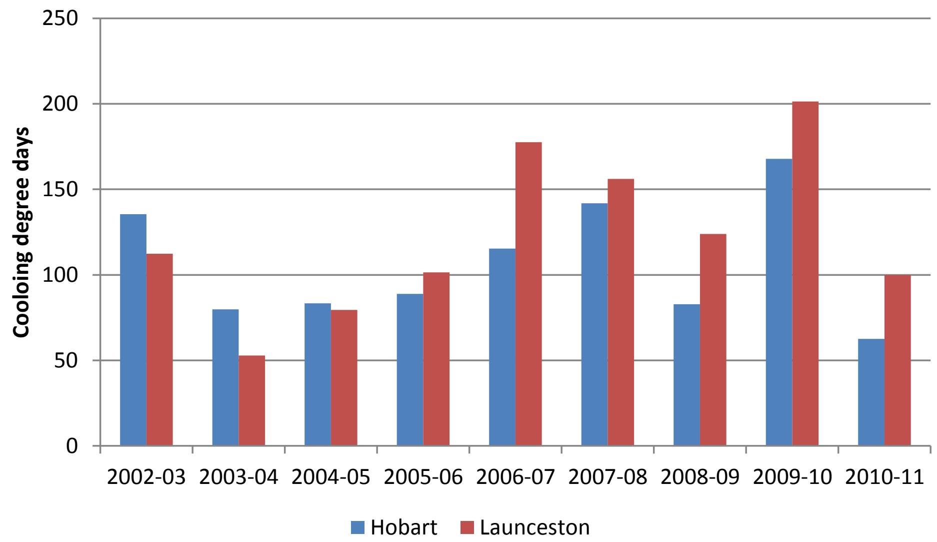
Figure 19 **Number of heating degree days (HDD), Hobart and Launceston weather stations, 2002-03 to 2010-11**



Data source: Bureau of Meteorology and ACIL Tasman

Figure 20 shows the number of cooling degree days from the Hobart and Launceston weather gauges. Over this period, the average number of cooling degree days at Hobart has been 106.

Figure 20 **Number of CDD, Hobart and Launceston weather stations, 2002-03 to 2010-11**



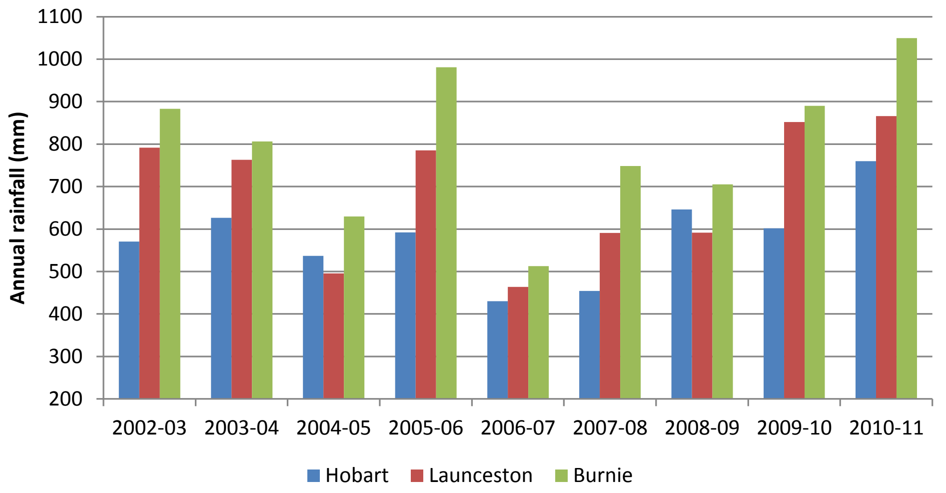
Data source: Bureau of Meteorology and ACIL Tasman

3.3.2 Rainfall

Annual rainfall is expected to be a significant determinant of energy consumption for the irrigation customer class. Periods of below average rainfall are expected to correspond to an increased need to irrigate crops resulting in higher energy consumption. Conversely, in periods of above average rainfall, the need to irrigate crops is reduced and hence energy consumption associated with pumping to supply irrigation is also reduced.

Figure 21 shows annual rainfall (mm) for the period between 2002-03 and 2010-11 at the Hobart, Launceston and Burnie weather stations. Average rainfall at Burnie averaged 801 mm over the period. Rainfall in 2006-07 was significantly below this level, reflecting the drought affecting southern Australia. This was reversed in 2009-10 and 2010-11 when rainfall was significantly above average. The energy consumption of irrigators (predominantly located in northern Tasmania) should reflect these deviations in annual rainfall. This hypothesis is tested empirically in section 5 of this report.

Figure 21 **Annual rainfall, Hobart, Launceston and Burnie weather stations, 2002-03 to 2010-11**



Data source: Bureau of Meteorology and ACIL Tasman

3.4 Electricity prices

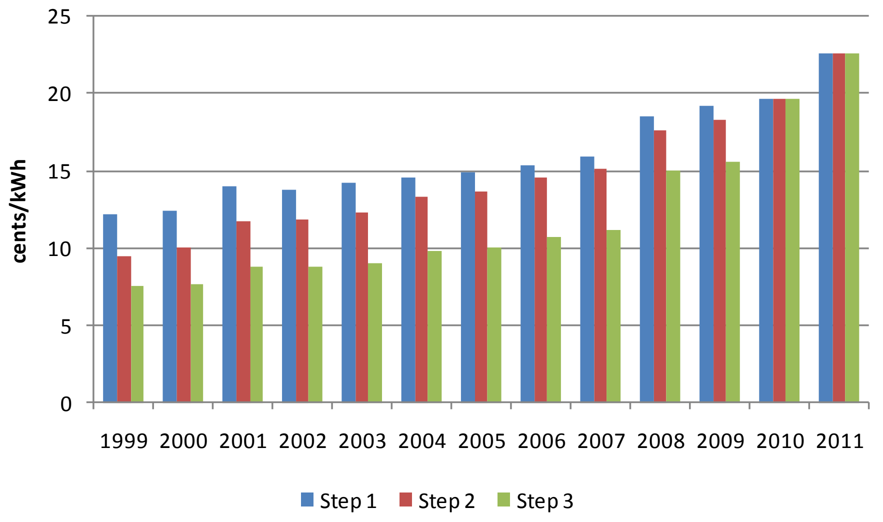
Another potential driver of energy consumption is the retail price of electricity as there is a negative relationship between price and consumption. Energy consumers are likely to exhibit some sensitivity to rising energy costs, particularly in 2008-09, 2009-10 and 2010-11 as retail prices increased by substantially more than the preceding years where retail prices exhibited more modest rates of growth.

The figures that follow show a time series for retail tariffs for the residential, business, commercial/industrial and irrigation sectors. The price series cover the period from 1999 through to 2011.

Tariffs were relatively stable up to 2007 across all tariff classes, before commencing a more rapid ascent. It is therefore reasonable to expect that the strong price rises of recent years have had a dampening effect on energy consumption across the main customer classes.

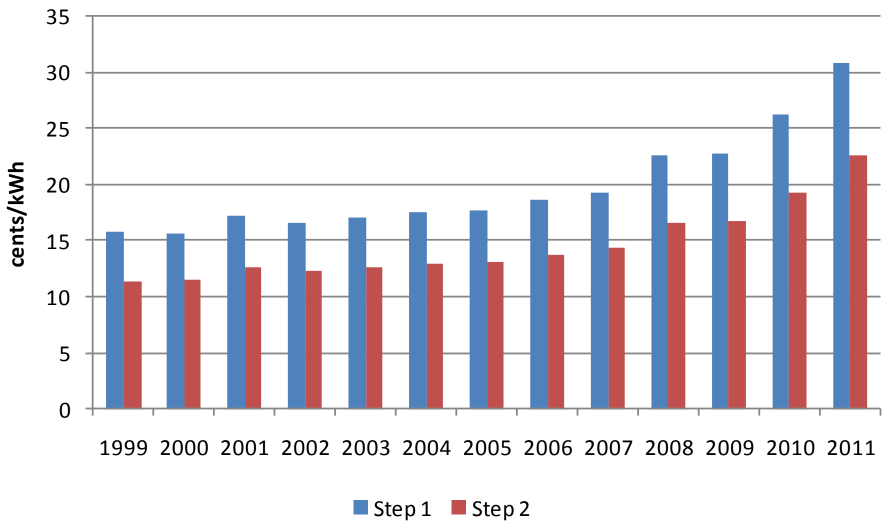
The degree of responsiveness of energy consumption to changes in price is known as the price elasticity of demand. The degree of responsiveness is thought to differ considerably across customer classes, with residential customers thought to be generally less responsive to price changes compared to commercial and industrial users. This is because energy costs comprise a significantly larger proportion of the total expenditures of large energy users, so that significant price increases might be expected to lead to adaptive behaviour designed to reduce energy consumption and hence costs.

Figure 22 **Residential retail tariffs, cents per kWh, 1999 to 2011**



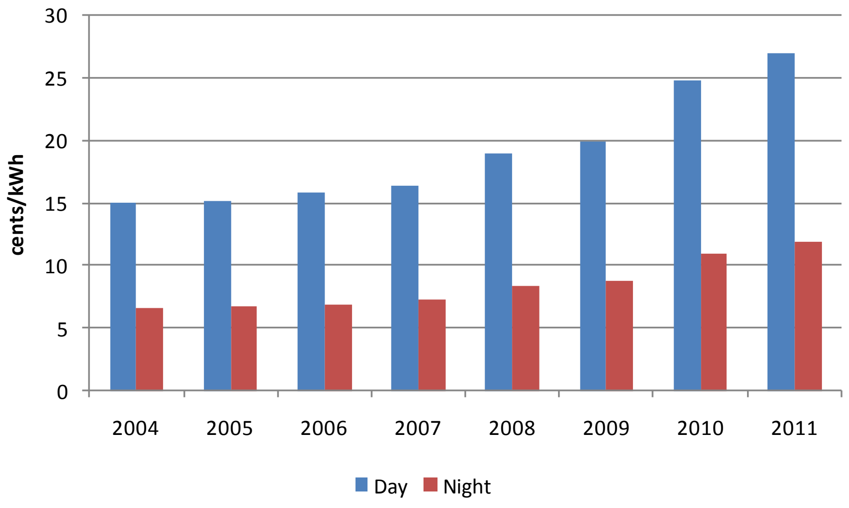
Data source: Aurora Energy

Figure 23 **General business retail tariffs, cents per kWh, 1999 to 2011**



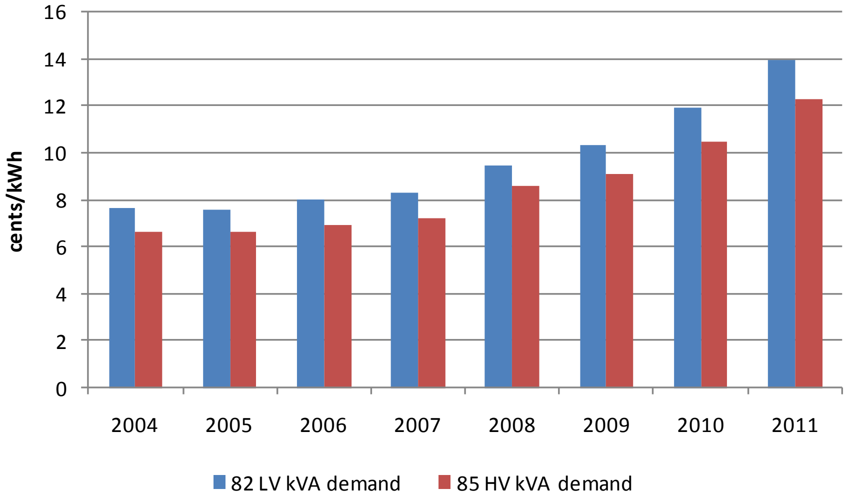
Data source: Aurora Energy

Figure 24 **Irrigation retail tariffs, cents per kWh, 2004 to 2011**



Data source: Aurora Energy

Figure 25 **LV and HV kVA commercial/industrial retail tariffs, cents per kWh, 2004 to 2011**



Data source: Aurora Energy

4 Model specification

4.1 Formulating the models

The methodology generally proposed by ACIL Tasman to forecast system energy consumption is a multiple regression approach.

Separate forecasts are produced for each customer type and then added together to derive a system level energy forecast. The rationale for this approach is that the drivers of energy growth between customer segments are expected to differ as follows:

- The residential sector is likely to be closely correlated with population growth and household formation.
- Growth in energy sales to the commercial/industrial sectors is more likely to be driven by overall economic growth.

For this reason, a forecasting methodology that models the separate customer types independently is likely to produce a superior set of forecasts than one which models the entire system in a single model.

Residential, Small business (LV) and Large business (LV) energy consumption have been modelled separately. Separate models for Unmetered supply and Irrigation related energy consumption were also developed.

For the residential sector, an accurate time series of customer numbers is available. Therefore, energy sales forecasts are derived from two distinct components:

1. Customer number growth
2. Energy use per customer.

Together these two separate components are multiplied together to provide the forecast energy consumption for the residential sector.

In the case of Small business (LV), Large business (LV), Irrigation and Unmetered supply, it was not possible to accurately disaggregate the customer numbers from a single time series. Therefore, for these sectors the overall energy consumption is modelled, rather than splitting out the customer numbers and energy use per customer.

In the case of the Large commercial (HV) customer segment, energy consumption is made up of the energy usage of a small number of very large industrial customers. In this instance, an econometric methodology is unsuitable due to the large contribution to total energy that is made by these individual businesses. This means that company specific factors will have a material impact on energy consumption. For example, if one of these large customers were to close down, then this would have a material impact on total energy usage and disrupt the smoothness of the time series.

Forecasts of very large customers energy usage are best made 'bottom up', by surveying each of the very large customers to ascertain their future energy requirements. This is the approach taken by Aurora Energy which ACIL Tasman considers to be superior to any top-down statistical approach. ACIL Tasman has therefore adopted Aurora's Large commercial (HV) forecasts as its base line forecast of Large commercial (HV) energy consumption.

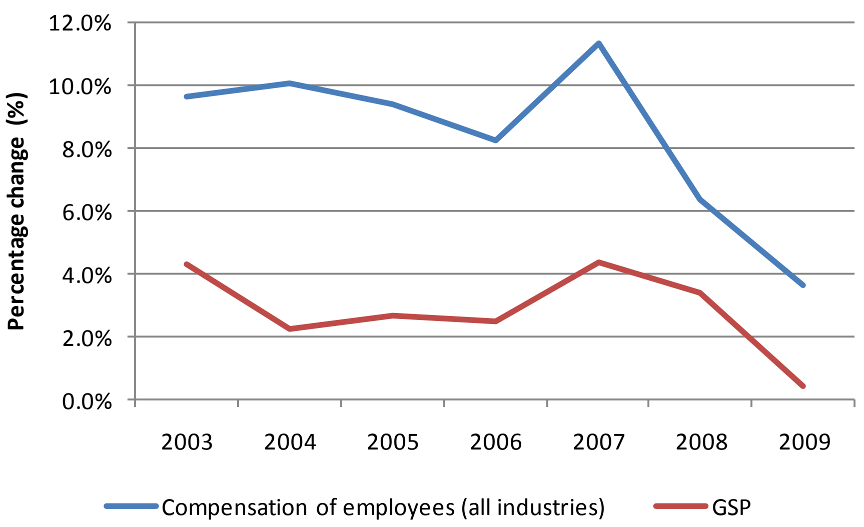
4.1.1 Residential models

The model used for forecasting the number of residential customers is as follows:

$$Residential\ customers = \alpha + \beta_1 \times Population + \varepsilon$$

The model of energy use per residential household is assumed to be driven by rising household incomes over time, for which Tasmanian GSP is a good proxy. As can be seen in Figure 26, movements in employee compensation across Tasmania have moved broadly in line with GSP over time.

Figure 26 **Tasmanian compensation of employees and GSP, 2003 to 2009**



Data source: 5220.0 Australian National Accounts: State Accounts

The potential impact of cold weather is measured by the HDD. Also, the potential impact of rising prices is captured by the real marginal price of electricity.

$$\text{Energy per household}=\alpha+\beta_1\times\text{GSP}+\beta_2\times\text{HDD}+\beta_3\times\text{Real price}+\varepsilon$$

Total residential energy sales are therefore calculated as:

$$\text{Total energy}=\text{Energy per household}\times\text{No: of customers}$$

The α and β's in the specified models correspond to coefficients which measure the sensitivity of the dependent variable (number of customers and energy use) to changes in the explanatory variables (Population, GSP, HDD and Price). For example, in the energy per household equation shown above, the coefficient β_2 shows the sensitivity of energy use per household to an increase (or decrease) in the number of HDD. The coefficients are estimated by minimising the sum of squared errors (ε) between the predicted values from the model and the observed historical values over the sample period.

4.1.2 Small business (LV) and Large business (LV)

The model used for forecasting Small business (LV)and Large business (LV) consumption is as follows:

$$\text{Energy}=\alpha+\beta_1\times\text{GSP}+\beta_2\times\text{HDD}+\beta_3\times\text{Real price}+\varepsilon$$

The model for energy use for Small business and Large business LV customers will be correlated with economic activity. Also, price and weather variation could play a role in influencing total energy use.

4.1.3 Irrigation model

Total irrigation energy sales are modelled as a linear function of a constant, GSP and annual rainfall.

$$\text{Energy}=\alpha+\beta_1\times\text{GSP}+\beta_2\times\text{Annual Rainfall}+\varepsilon$$

4.1.4 Unmetered supply model

Total Unmetered supply energy sales are modelled as a linear function of a constant and GSP.

$$\text{Energy}=\alpha+\beta_1\times\text{GSP}+\varepsilon$$

While the model specifications shown above are guided by our theoretical understanding of the likely driving forces behind energy consumption for each of the customer classes, the actual functional form for each of the models is determined only after assessing the contribution to the overall explanatory power and the statistical significance of each of the drivers. In other words, an empirical approach is adopted, guided by the theoretical drivers influencing energy consumption.

5 Model calibration and results

5.1 Calibrated models

In this section we calibrate or estimate a number of models which capture some or all of the relationships we have discussed in previous sections of this report. The exclusion or inclusion of an explanatory will depend on its contribution to the overall explanatory power of each regression. This is assessed using metrics such as the R^2 of the regression and the statistical significance of individual coefficients. Statistical significance is assessed at both the 1% and 5% significance level.

The main model specifications estimated are:

- Model 1: Residential customer numbers
- Model 2: Residential average energy use per customer
- Model 3: Small business LV energy consumption
- Model 4: Large business LV energy consumption
- Model 5: Irrigation energy consumption
- Model 6: Unmetered supply energy consumption

The regression models are calibrated using a limited sample size of annual observations from 2002-03 to 2010-11. One drawback with such a small sample of nine observations is that we have less confidence in the estimated coefficients than we would otherwise have with a larger sample size (ideally in excess of 20 to 30 observations).

5.2 Model results

5.2.1 Residential

Number of residential customers

The growth in the number of residential customers in the Aurora network is modelled as a function of the total Tasmanian population.

The estimated coefficients are shown in Table 1. For every additional 1,000 people living in Tasmania, the number of Aurora residential customers increase by 403. This is broadly consistent with data obtained from the ABS census which shows that in Tasmania in 2006 there were 2.4 persons per household.

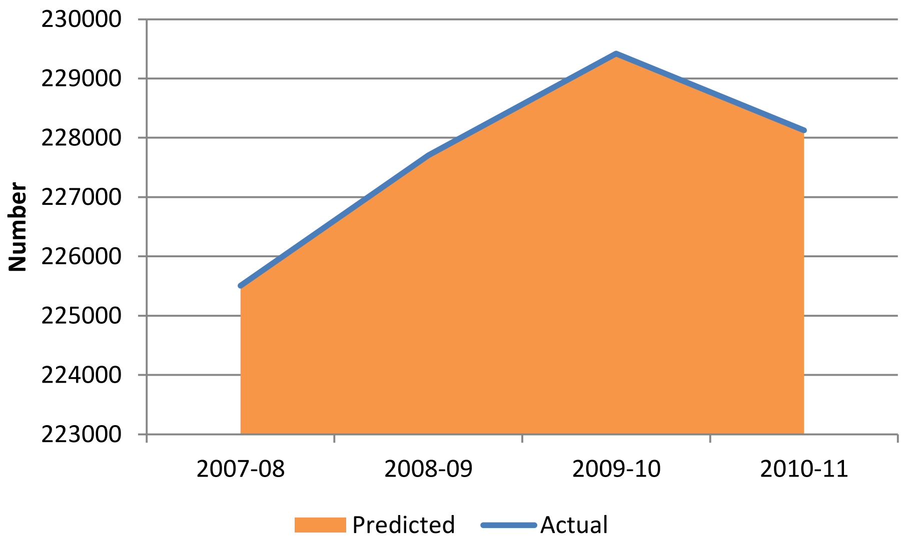
Table 1 **Model 1: Residential customer numbers**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	24734.58	2452.556	10.08523	0.0629
Population	0.403237	0.004876	82.69554	0.0077
2010-11 dummy	-1716.404	47.72268	-35.96621	0.0177
R-squared	0.999858	Mean dependent var	227689.8	

Data source: ACIL Tasman

Figure 27 below plots the actual historical residential customer numbers against the predicted values.

Figure 27 **Residential customer numbers, Predicted versus Actual**



Data source: ACIL Tasman model

Residential consumption per customer

The results from the model of residential average energy use per customer are shown in Table 2.

Table 2 **Model 2: Residential energy use per customer**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	5.029065	0.885508	5.679302	0.0013
Heating degree days (HDD)	0.002404	0.000473	5.084346	0.0023
2010-11 dummy	-0.3651	0.147547	-2.474464	0.0482
R-squared	0.844371	Mean dependent var	9.481913	

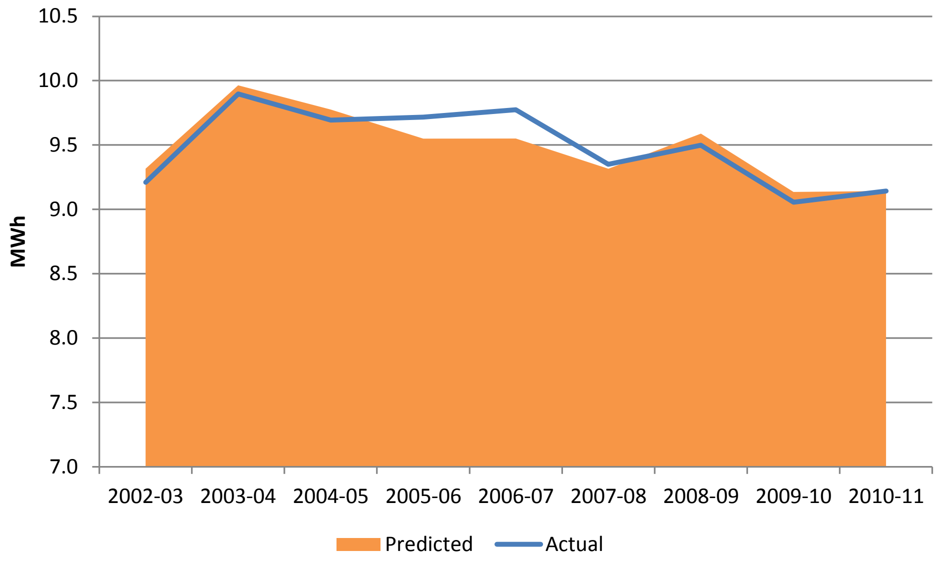
Data source: ACIL Tasman

The coefficients from the model can be interpreted as follows:

- Each additional 100 HDD in a given year increases energy use per customer by 0.240 MWh

Figure 28 below shows the predicted values from the model against the actual historical residential energy use per customer.

Figure 28 **Average residential use per customer (MWh pa), predicted versus actual**



Data source: ACIL Tasman model

5.2.2 Small business (LV)

Small business (LV) energy consumption is modelled as a function of GSP. The real marginal price and weather (number of heating degree days) were not found to be statistically significant at the 5% level and so were excluded from the specification.

Table 3 **Model 3: Small business (LV) energy consumption**

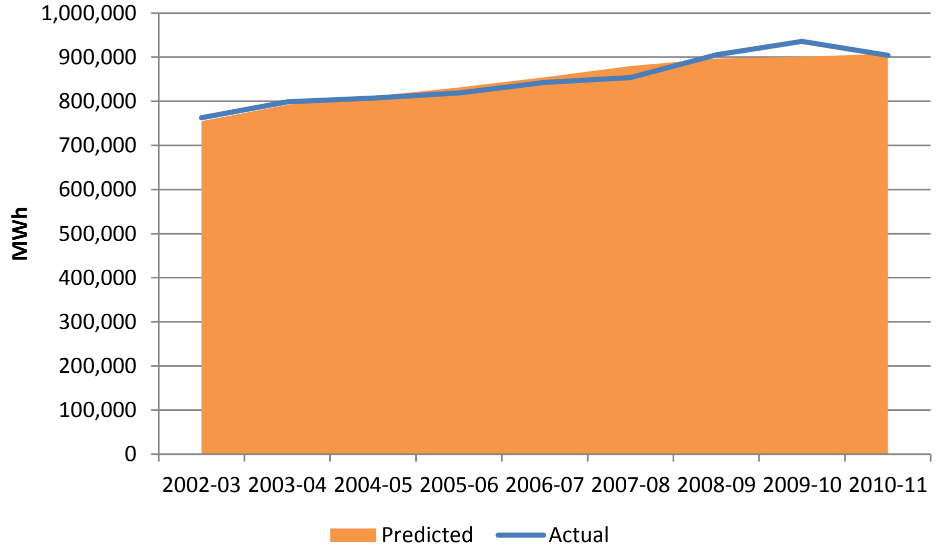
Variable	Coefficient	Std. Error	t-Statistic	Prob.
GSP	38.23741	0.260469	146.8021	0
R-squared	0.90888	Mean dependent var	847674.4	

Data source: ACIL Tasman

For each additional $100 million increase in GSP, Small business (LV) energy consumption increases by an average of 3,824 MWh.

Predicted values from the model are plotted against actual historical Small business (LV) energy consumption in Figure 29.

Figure 29 **Small business (LV) energy consumption (MWh pa), predicted versus actual**



Data source: ACIL Tasman model

5.2.3 Large business (LV)

The estimated coefficients for the Large business (LV) total energy consumption model are shown in Table 4 below.

Table 4 **Model 4: Large business (LV) energy consumption**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GSP	23.20398	0.219753	105.591	0
R-squared	0.792114	Mean dependent var	514652.5	

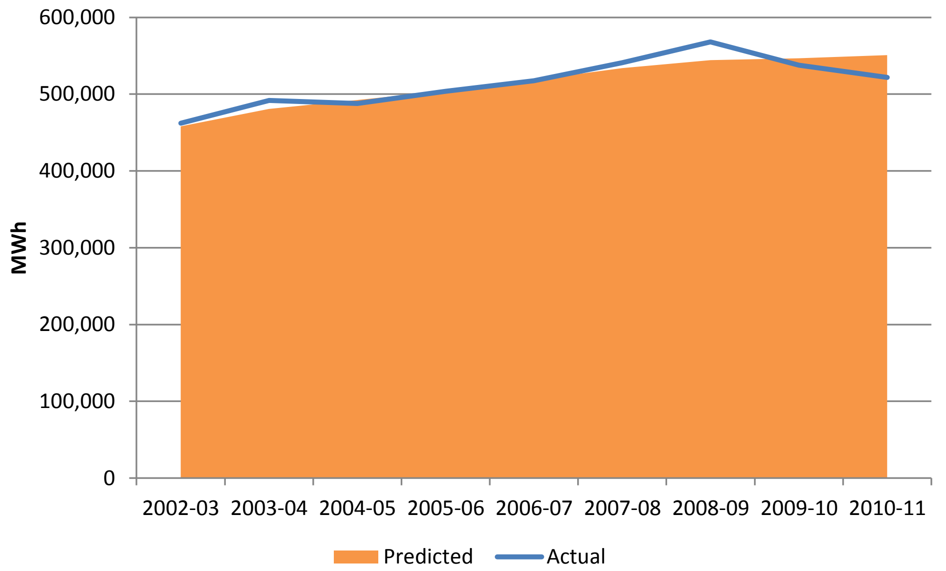
Data source: ACIL Tasman

Large business (LV) energy is modelled as a function of GSP. Electricity prices and weather effects were not found to be a statistically significant driver of Large business (LV) energy consumption at the 5% significance level.

Each $100 million increase in Tasmanian GSP results in an average increase in Large business (LV) energy consumption of 2,320 MWh.

The predicted values from the model plotted against actual historical values are shown in Figure 30.

Figure 30 **Large business (LV) energy consumption (MWh pa), predicted versus actual**



Data source: ACIL Tasman model

5.2.4 Irrigation

The estimated coefficients of the irrigation energy consumption model are shown in Table 5. Irrigation is found to vary negatively with annual rainfall at the Burnie weather gauge.

Table 5 **Model 5: Irrigation energy consumption**

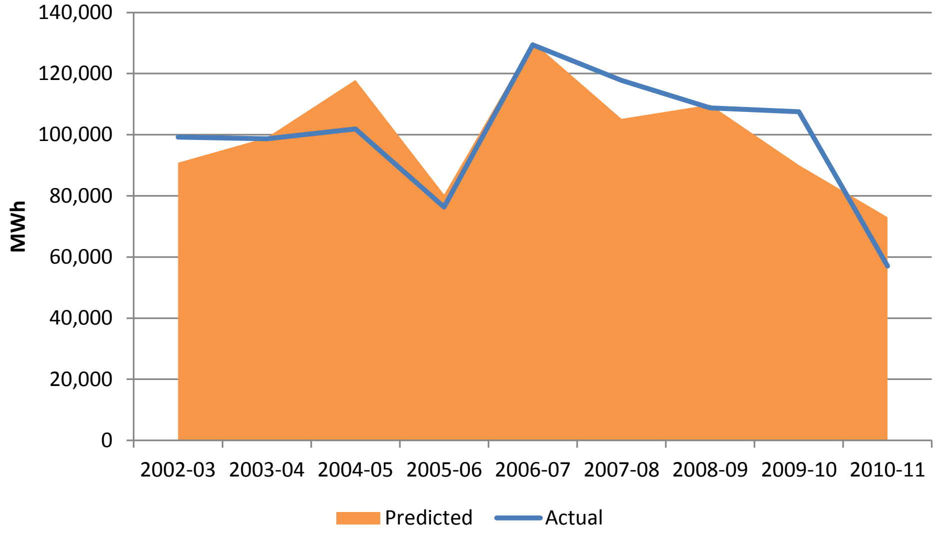
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	185182.6	20872.59	8.872047	0
Annual rainfall	-106.85	25.55995	-4.18037	0.0041
R-squared	0.714	Mean dependent var	99637.26	

Data source: ACIL Tasman

For each 1 mm increase in annual rainfall (at Burnie), energy consumption by Tasmanian irrigators was found to decline on average by 107 MWh.

Figure 31 shows the predicted values from the model against actual historical observations.

Figure 31 **Irrigation energy consumption (MWh pa), predicted versus actual**



Data source: ACIL Tasman model

5.2.5 Unmetered supply (UMS)

Unmetered supply energy use is modelled as a function of GSP. For each increase in Tasmanian GSP of $100 million, UMS energy consumption increases by 36 MWh (see Table 6).

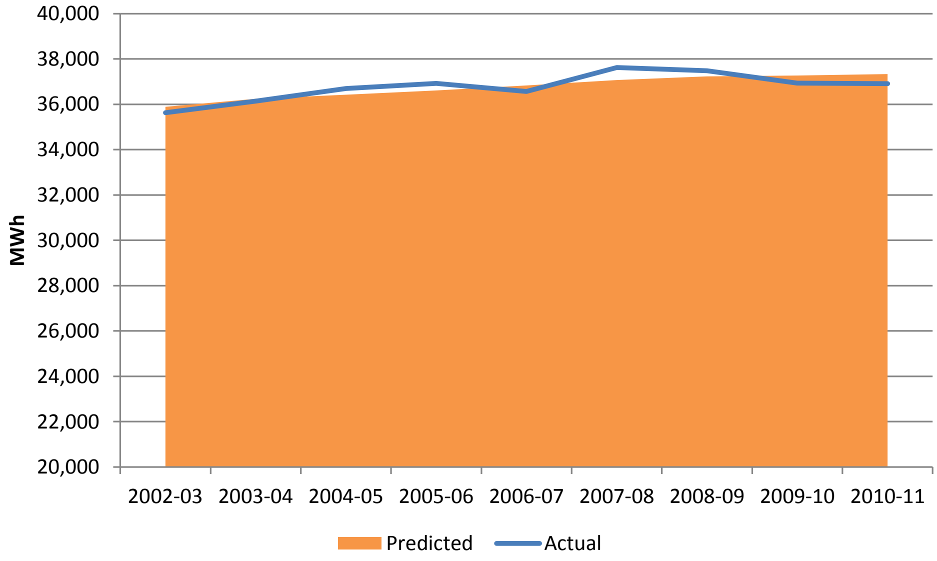
Table 6 **Model 6: Unmetered supply energy consumption**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	28752.31	2090.239	13.75552	0
GSP	0.36145	0.094113	3.84059	0.0064
R-squared	0.678163	Mean dependent var	36765.69	

Data source: ACIL Tasman

Figure 32 shows the predicted values from the model against actual historical UMS consumption.

Figure 32 **UMS energy consumption (MWh pa), predicted versus actual**



Data source: ACIL Tasman model

5.3 Methods of model validation

ACIL Tasman has adopted two methods to model validation, namely assessing:

- the goodness of fit of the regression
- the statistical significance of the explanatory variables

5.3.1 Theoretical basis

The choice of model parameters is based on theoretical considerations of key drivers to explain the measured variation in energy consumption. As a consequence, some sense of the likely size and direction of model coefficients is possible.

5.3.2 Goodness of fit

The most commonly used measure of the goodness of fit of the regression model to the observed data is R^2. In the model validation process, the R^2 is considered as part of a suite of tools available. Emphasis is placed on the overall fit of the models as well as on the statistical significance of individual explanatory variables.

5.3.3 Statistical Significance

A statistically significant result is one which is unlikely to have occurred by chance. Each estimated coefficient in the regression models has an associated t-statistic or p value. If the estimated p value is less than 0.01 then that coefficient is statistically significant at the 1% significance level. A p-value that is less than 0.05 is significant at the 5% level of significance. The lower the observed p value on a coefficient the greater the probability that a meaningful relationship exists between the dependent variable and the explanatory variable concerned.

In this empirical analysis we exclude all potential explanatory variables that are insignificant at the 5% level of significance.

6 Developing the base forecasts

6.1 Forecast inputs

In order to produce forecasts from the calibrated models of the previous section it is necessary to produce forecasts of the driving or explanatory variables.

Population forecasts

The forecast population input is the Series B population projection produced by the ABS in the publication '3222.0 Population Projections, Australia'.

GSP forecasts

In order to project the value of Tasmanian GSP, we apply the GSP forecasts adopted by the Tasmanian Government in its 2011-12 Budget. These are shown above in Figure 14. We assume an annual growth rate of 2.25% in the years after 2014-15. Over the long run (ie. past 20 years) Tasmanian GSP growth has averaged 2.2% p.a.

Weather forecasts

The key weather input into the forecasting models is the number of HDD. These are projected using a long term time trend from 1990 to 2011. The results of this time trend regression are shown in Table 7. They show that the number of heating degree days decline by an average of 8.6 every year. This is consistent with a slight warming trend over time.

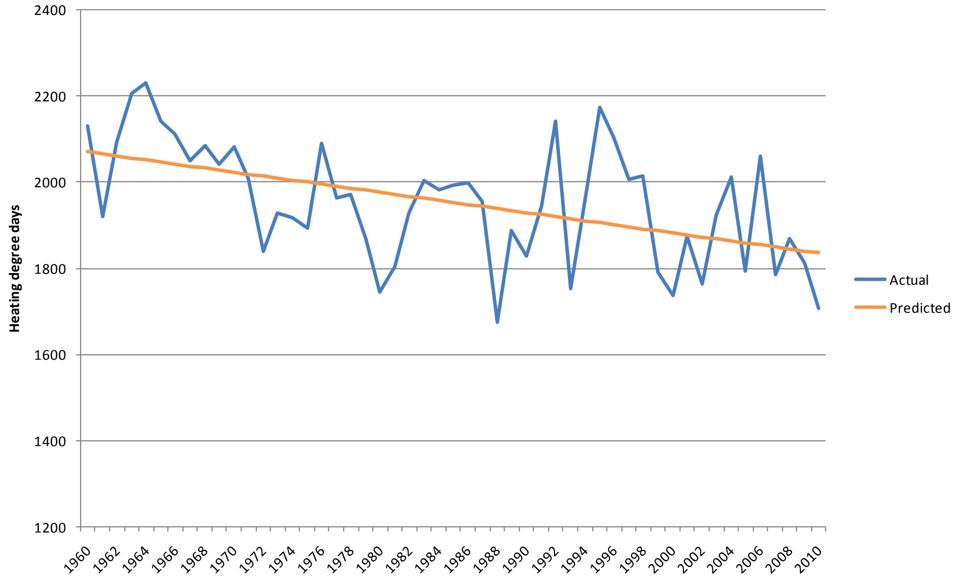
Table 7 **Trend in long run HDD, Hobart weather station**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	2260.726	199.5136	11.33119	0
TIME	-8.623052	4.813966	-1.791257	0.0892
R-squared	0.144476	Mean dependent var	1907.181	
Adjusted R-squared	0.099448	S.D. dependent var	140.7648	

Data source:

Figure 33 shows the declining trend in the number of heating degree days since 1960.

Figure 33 **HDD long run time trend, actual versus predicted – Hobart weather station**

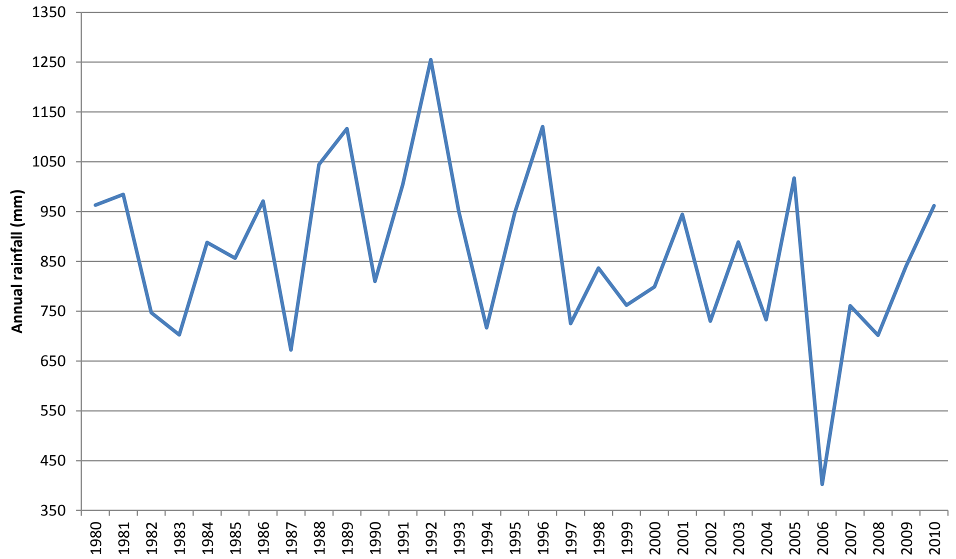


Data source: Bureau of Meteorology and ACIL Tasman

Rainfall

Annual rainfall serves as an input into the irrigation energy consumption model. It is therefore necessary to enter a given level of rainfall in each year of the forecast period into the model. Figure 34 shows the annual rainfall from 1980 to 2010 at the Burnie weather station. The figure shows that annual rainfall has oscillated around a stationary average. There is no strong time trend apparent over the long term. For the purposes of forecasting, we therefore assume an annual rate of rainfall of 801mm which corresponds to the average level of rainfall over the sample period.

Figure 34 **Long run annual rainfall (mm) at Burnie weather station**



Data source: Bureau of Meteorology

Table 8 shows the explanatory variables which serve as the basis for producing the base forecasts.

Table 8 **Explanatory variable inputs into base forecasting models**

Year	GSP $ millions	Heating degree days (HDD)	Rainfall (mm)	Population
2002-03	19741	1783	882.8	477646
2003-04	20719	2053	806.1	482770
2004-05	21218	1974	629.6	486327
2005-06	21740	1880	980.6	489951
2006-07	22348	1881	512.9	493204
2007-08	23009	1783	748.6	497922
2008-09	23457	1897	705.4	503292
2009-10	23561	1708	890.0	507643
2010-11	23738	1863	1049.5	508658
		Forecast		
2011-12	24153	1708.1	890.0	512043
2012-13	24697	1795.1	800.6	515380
2013-14	25253	1786.5	800.6	518673
2014-15	25821	1777.8	800.6	521923
2015-16	26402	1769.2	800.6	525126
2016-17	26996	1760.6	800.6	528259

Data source: ACIL Tasman

6.2 Base forecasts

The base forecasts produced by the calibrated models presented in section 5 of this report are shown in Table 9 below.

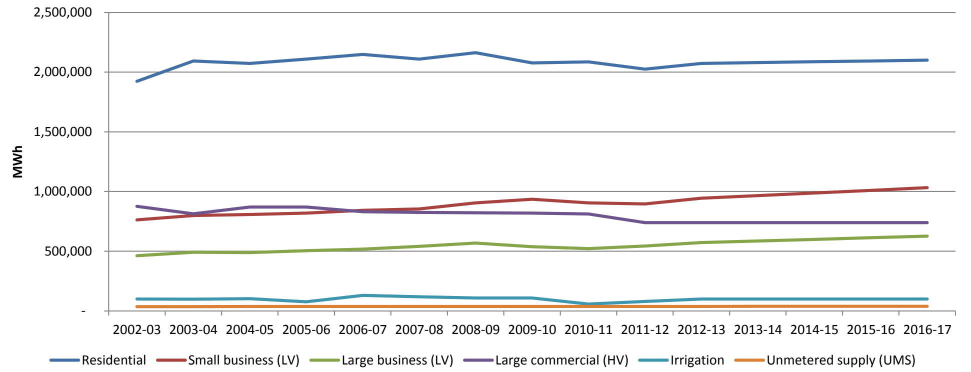
Table 9 **Base case forecasts by customer class, 2011-12 to 2016-17**

Year	Residential	Small business (LV)	Large business (LV)	Large commercial (HV)	Irrigation	Unmetered supply (UMS)	Total
2002-03	1,923,058	762,759	462,205	876,188	99,236	35,624	4,159,070
2003-04	2,092,323	798,807	491,816	813,747	98,675	36,140	4,331,508
2004-05	2,072,904	807,258	487,978	869,489	101,896	36,701	4,376,226
2005-06	2,108,331	818,652	503,796	869,224	76,368	36,916	4,413,287
2006-07	2,148,339	842,398	517,576	830,618	129,424	36,563	4,504,918
2007-08	2,108,660	853,688	540,997	825,063	117,803	37,622	4,483,833
2008-09	2,162,722	905,345	568,190	822,450	108,734	37,484	4,604,924
2009-10	2,077,409	935,795	537,707	818,724	107,553	36,928	4,514,116
2010-11	2,085,648	904,369	521,608	811,596	57,046	36,912	4,417,179
Forecast							
2011-12	2,024,501	895,662	543,520	739,677	78,593	37,389	4,319,342
2012-13	2,072,777	944,344	573,066	739,677	99,637	37,679	4,467,180
2013-14	2,079,888	965,592	585,960	739,677	99,637	37,880	4,508,633
2014-15	2,086,788	987,318	599,144	739,677	99,637	38,085	4,550,649
2015-16	2,093,465	1,009,532	612,624	739,677	99,637	38,295	4,593,232
2016-17	2,099,838	1,032,247	626,408	739,677	99,637	38,510	4,636,317

Data source: ACIL Tasman

The forecasts are also shown graphically in Figure 35.

Figure 35 **Base case model forecasts to 2016-17 by customer class, MWh**



Data source: ACIL Tasman model

Over the forecast period of six years, the total increase in energy consumption of 219 GWh (0.8% per annum) is largely due to increases in Small business LV (128 GWh) and Large business LV (105 GWh) customer classes.

It is important to note that the methodology to generate the 2011-12 forecast has been amended to incorporate the fact that at the time of preparation, we had already observed energy sales for the first five months of the 2011-12 financial year. We have therefore made a weighted adjustment to the forecast derived from the calibrated models to account for the five months of data that we have already observed. As can be seen from Table 10, the five months from July to November 2011 have seen a considerable decline in energy sales compared to the same period in the previous year. Across the whole of Aurora Energy, sales have declined by 3.8% over the first five months of 2011-12 compared to the corresponding period in the previous year.

Table 10 **Year to date decline between July and November 2010 and 2011, MWh**

Customer category	July to November 2010	July to November 2011	Percentage difference
Residential	1,128,783	1,101,100	-2.5%
Small LV	420,004	407,677	-2.9%
Large LV	223,283	216,959	-2.8%
Comm. HV	359,889	327,991	-8.9%
Irrigation	12,606	8,415	-33.2%
UMS	15,460	15,605	0.9%
TOTAL (inc UMS)	**2,160,026**	**2,077,748**	**-3.8%**

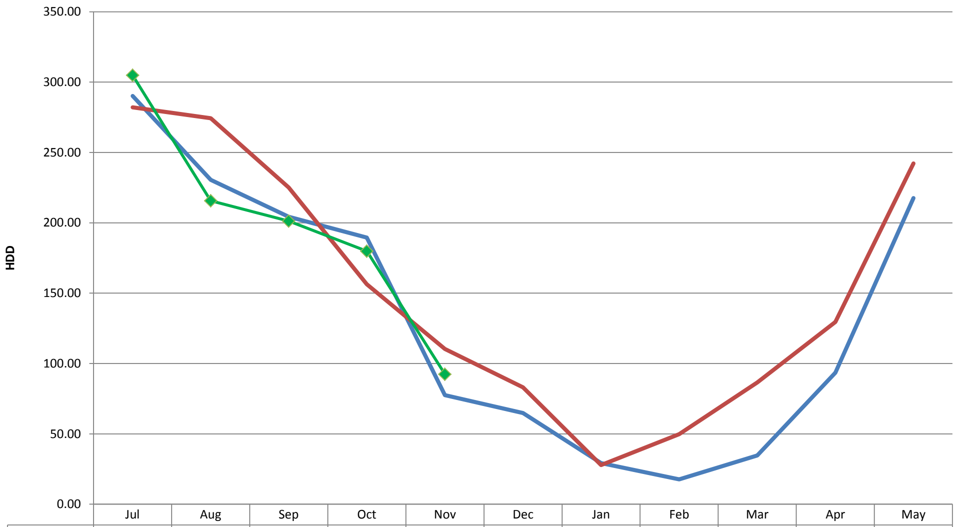
Data source: ACIL Tasman

This is most probably due to the warmer than average weather conditions that we have experienced over the first five months of the 2011-12 financial year compared to the conditions experienced in 2010-11. This can be seen in Figure 36 below.

The figure shows that weather conditions in 2011-12 are closely tracking those observed in 2009-10, a year that was considerably milder/warmer than average. For the purpose of calculating the component of the 2011-12 forecast derived from the calibrated model, we assume that weather conditions for the rest of 2011-12 will continue to resemble those of 2009-10.

The models then assume that the weather patterns return to long run historical behaviour from 2012-13 onwards. This means that a large component of the 3.4% increase in base energy consumption forecast to take place between 2011-12 and 2012-13 is driven by weather correction across the residential and irrigation sectors (the other sectors are not weather sensitive).

Figure 36 **Tasmanian heating degree days (HDD) by month, 2009-10, 2010-11 and 2011-12**



	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
2009/10	290.19	230.49	204.32	189.53	77.46	64.80	29.15	17.64	34.6875	93.4875	217.5125
2010/11	282.09	274.34	225.06	156.36	110.28	83.06	27.83	49.79	86.5375	129.55	242.1875
2011/12	304.86	215.64	201.19	179.81	92.34						

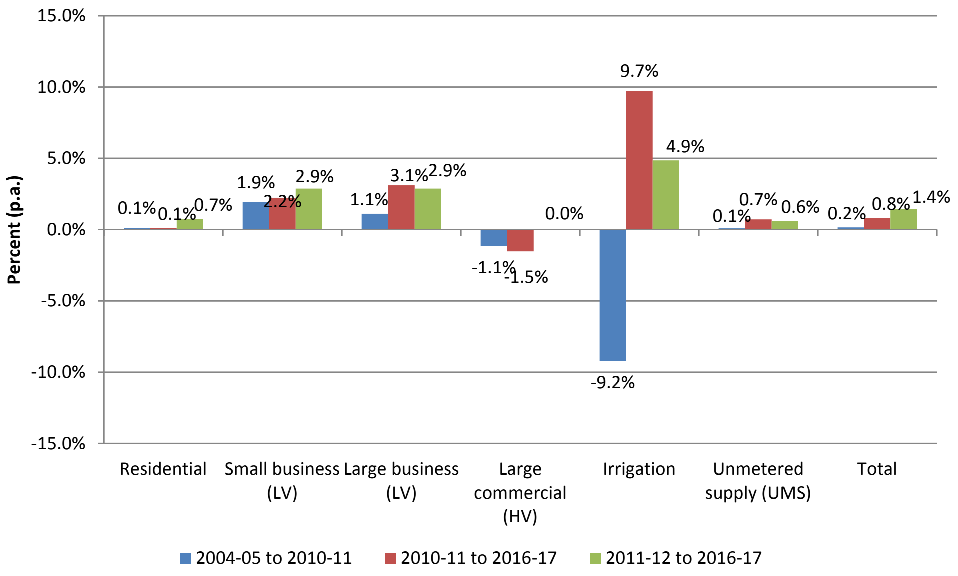
Data source: Aurora Energy

From 2010-11 to 2016-17, total energy consumption within the Aurora distribution network is forecast to grow at a rate of 0.8% per annum, compared to a historical growth rate of 0.2%[3] between 2004-05 and 2010-11.

Figure 37 compares the historical versus forecast growth rates graphically.

[3] Note that this calculation is based on non-weather corrected historical data which could be subject to bias.

Figure 37 **Annualised growth rate by sector, historical versus forecast**



Data source: ACIL Tasman

7 Assessing policy impacts

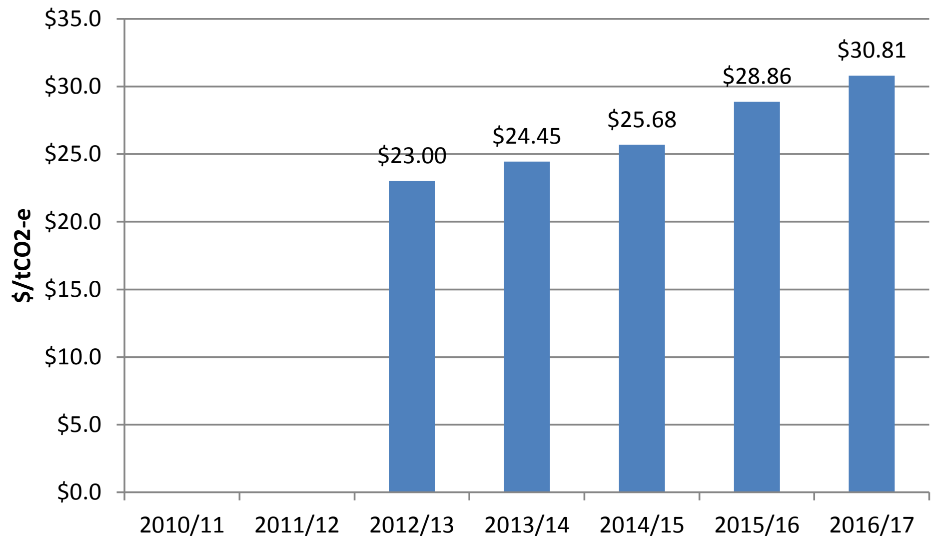
7.1 Estimating the effect of a carbon price on energy consumption

The most important policy change that is expected to impact on energy consumption within the Aurora network is the introduction of a carbon tax from 1 July 2012.

ACIL Tasman model the impact of a carbon scenario, with a starting price of \$23 per tonne CO_2, gradually increasing to \$31 per tonne by the end of the next regulatory period in 2016-17 (see Figure 38).

ACIL Tasman's approach involves estimating the impact on retail electricity prices by sector of the carbon tax versus a base case of no tax. We then apply suitable price elasticities of demand for each sector to obtain an estimate of the impact on energy consumption by sector.

Figure 38 **Proposed path of carbon tax commencing from 3rd quarter 2012**



Data source: ACIL Tasman model

7.2 Methodology

To estimate the effect of a carbon price on energy consumption, ACIL Tasman estimated retail electricity prices for households, small, medium and larger commercial businesses, and for irrigation users, and used *PowerMark* modelling results to estimate how higher wholesale energy prices would affect Tasmanian retail prices.

The retail price series was estimated from the following cost components:

- Wholesale energy costs (including carbon and hedging costs)
- Network costs (distribution and transmission)
- Compliance costs for the Large-scale Renewable Energy Target (LRET) and the Small-scale Renewable Energy Scheme (SRES)
- Retail operating costs and market fees (also known as 'cost to serve' customers)
- Retail margins.

Due to the predominant use of long-run marginal cost (LRMC) modelling in setting the wholesale energy component of retail tariffs for small customers, ACIL Tasman estimated the LRMC of a hypothetical new-entrant combined-cycle gas turbine, with and without carbon, for each year of the projection. This wholesale energy component, adjusted for losses, was adopted for both residential and small business customers.

For larger customers, wholesale energy costs are likely to reflect wholesale market prices with an uplift to reflect the usage patterns and hedging costs associated with serving particular customer classes. Larger energy users (e.g. high voltage connected customers) are likely to have high load factors and so pay energy costs closer to the average wholesale market price. By contrast, medium size users are likely to have usage weighted towards higher price daytime periods, and so pay a premium to the average wholesale market price. Uplift factors adopted were:

- For medium businesses, 135% for peak energy usage and 110% for off-peak energy usage
- For high voltage connected customers, 115% for peak energy usage and 110% for off-peak energy usage.

ACIL Tasman's analysis of wholesale energy prices indicated a clear trend in Tasmania towards greater uplift from a carbon price in off-peak times than in peak times.[4] Whilst the 'pass-through' of carbon prices into wholesale prices in peak times is typically between 0.4 and 0.6 times the assumed carbon price

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[4] Peak times were defined using the National Electricity Market definition of 7am to 11pm on weekdays. Off-peak times were all other times.

(with declines beyond the period of this analysis), the level of off-peak pass-through commenced around 0.9 before declining to around 0.65 times the assumed carbon price. This is likely explained by the greater influence of the more emissions-intensive Victorian electricity supply in setting Tasmanian market prices in off-peak periods (e.g. overnight), and the greater influence of Hydro Tasmania's renewable generation during peak times.

In turn, this means that a carbon price has a greater impact on wholesale energy costs for users that consumer a greater proportion of their energy during off-peak times.

Current network costs were estimated based on Aurora's 2010-11 published network tariffs and the relative usage of each network tariff using data provided by Aurora. This allowed fixed charges to be apportioned on a cents/kWh basis within the broad consumer categories analysed.

Distribution tariffs were grown in proportion to Aurora's internal forecast of distribution tariff growth, while transmission tariffs were grown in accordance with the real cost growth factors specified in the Transend regulatory determination to 2013-14, and then held constant in real terms beyond.

LRET and SRES costs were based on ACIL Tasman's *RECMark* model and internal estimates of small-scale renewable take-up. These estimates captured the impact of partial exemptions for emissions-intensive trade-exposed industries to increase the per unit of cost of these schemes for non-exempt consumers (e.g. households and most businesses).

Retail operating costs were estimated to remain constant at $13/MWh (real 2010-11$) for small customers, based on the Office of the Tasmanian Economic Regulator's (OTTER's) October 2010 report on maximum retail tariffs. Based on the same source, NEM market fees were assumed to hold constant at $1/MWh in real 2010-11 dollars. Finally, a retail margin of 3.8% was assumed for small customers, again in line with the recent OTTER retail determination. For large customers, retail operating costs of $5/MWh (real 2010-11$) and a retail margin of 2% was assumed.

7.2.1 Responsiveness of energy consumption to price changes

The responsiveness of each customer class to higher electricity prices will depend on their own price elasticity of demand. The price elasticity of demand is defined as the percentage change in energy sales resulting from a 1% change in the price of electricity. Most studies of the price elasticity of demand for energy have found energy demand to be price inelastic, implying a price elasticity with a value less than 1.

The study most relevant to the Australian context was conducted by NIEIR in June 2007[5]. The long run own price elasticities by sector recommended by this NIEIR report are shown in the following table. These are the price elasticities adopted in this study to determine the adjustment in consumption as a result of the carbon tax.

Table 11 **Assumed price elasticities by sector**

Sector	Elasticity
Residential	-0.25
Commercial	-0.35
Industrial	-0.38

Data source: NIEIR

These elasticities can be interpreted as follows:

- A 1% increase in the residential retail tariff results in a 0.25% reduction in the residential sector's demand for energy
- A 1% increase in the commercial retail tariff results in a 0.35% reduction in the commercial sector's demand for energy
- A 1% increase in the industrial retail tariff results in a 0.38% reduction in the industrial sector's demand for energy.

As expected, the commercial and industrial sectors are more responsive to price changes in electricity due to the energy intensity of these sectors relative to the domestic sector, in which energy costs have traditionally comprised only a very small proportion of the total household budget.

Higher electricity prices would be expected to reduce demand in a number of ways including:

- encouraging changes in behaviour on the part of energy users that result in increased conservation
- encouraging a shift towards newer more energy efficient technologies and processes, particularly in the case of energy intensive industrial users.

NIEIRs residential sector elasticity was applied to Aurora's residential customers. NIEIRs industrial sector elasticity was applied to Aurora's Large commercial (HV) customers and its estimate of the commercial sectors price elasticity to the Small Business (LV), Large business (LV) and Irrigation segments. In the case of Unmetered supply we assume that there is no demand response at all as a result of the introduction of a carbon price.

[5] The own price elasticity of demand for electricity in NEM regions, A report for the National Electricity Market Management Company, Prepared by the National Institute of Economic and Industry Research, June 2007

7.3 Results

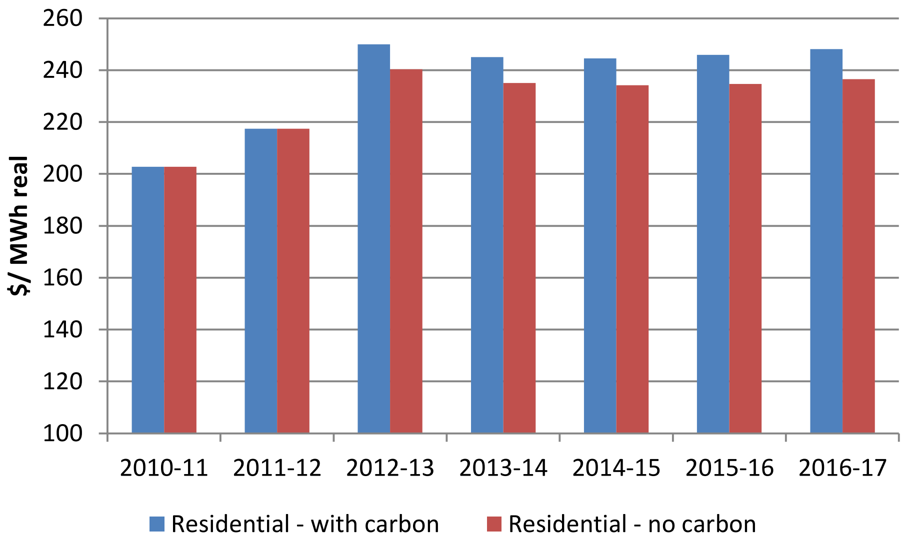
ACIL Tasman's results suggest that larger customers face a greater proportional increase in retail tariffs due to a carbon price. This is largely due to two factors:

- Larger energy users tend to consumer more electricity in off-peak times, when carbon cost pass-through is higher
- Larger energy users have lower electricity bills in the absence of a carbon price (largely due to lower network costs) and so face a greater increase in proportional terms.

While household and small business customers face an estimated retail price increase in the order of 4-5%, businesses connected at a medium voltage face impacts of around 11%. In turn, high voltage customers are estimated to face cost increases starting around 18%.

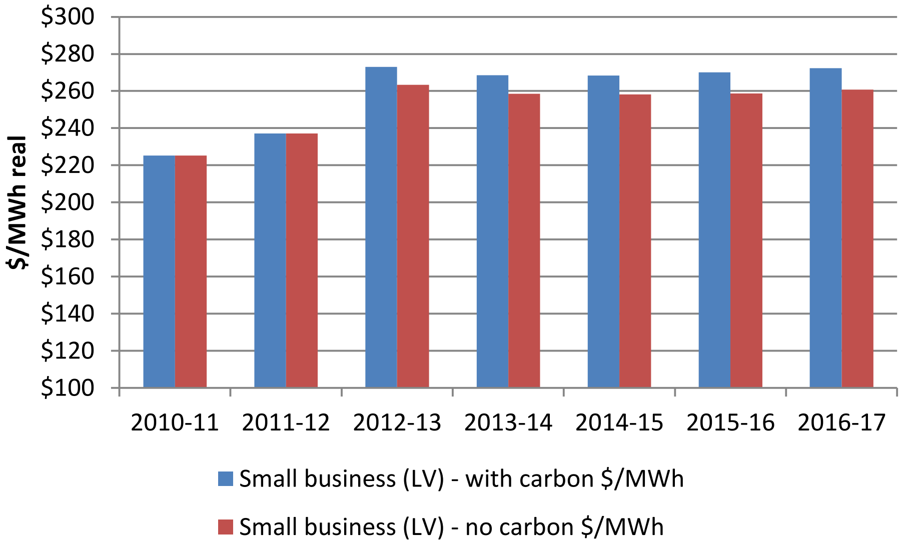
The following figures show the projected retail price impact for each customer class.

Figure 39 **Residential real retail prices, with and without carbon tax, $/MWh**



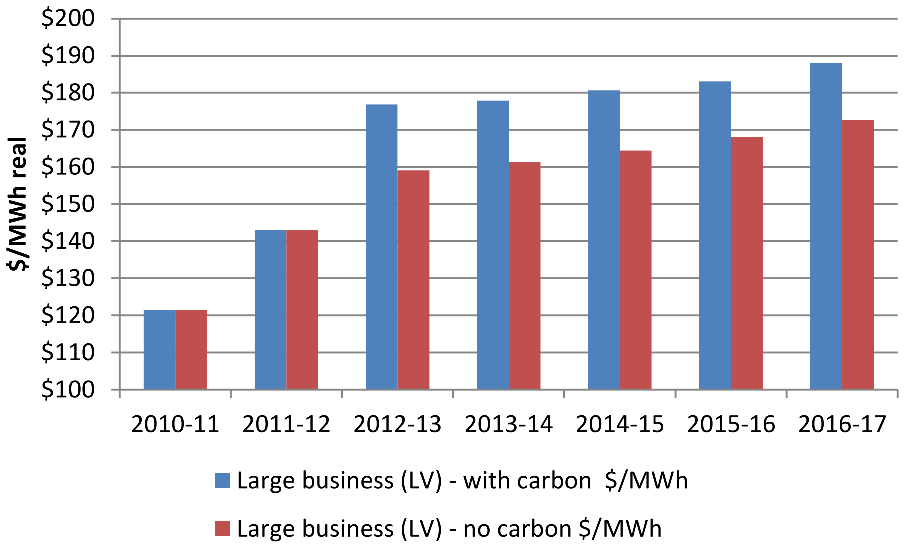
Data source: ACIL Tasman

Figure 40 **Small business (LV) real retail prices, with and without carbon tax, $/MWh**



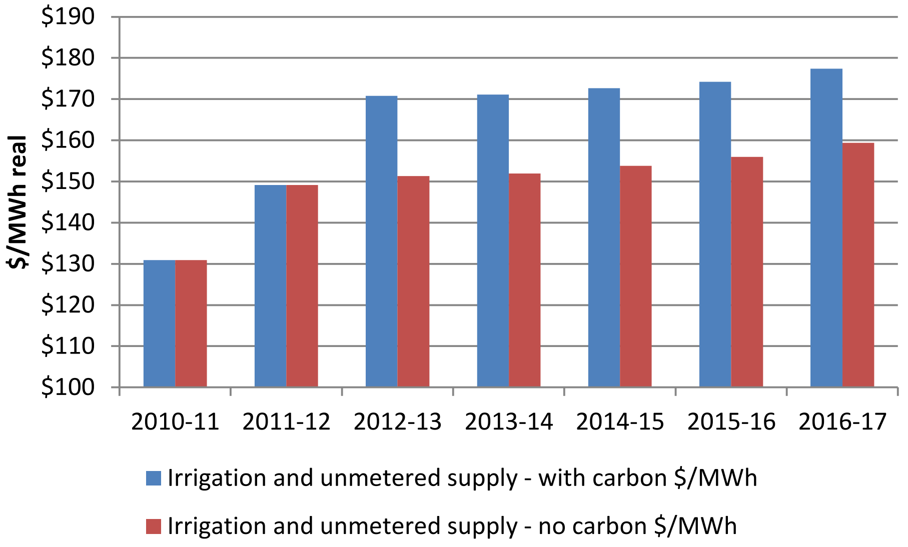
Data source: ACIL Tasman

Figure 41 **Large business (LV) real retail prices, with and without carbon tax, $/MWh**



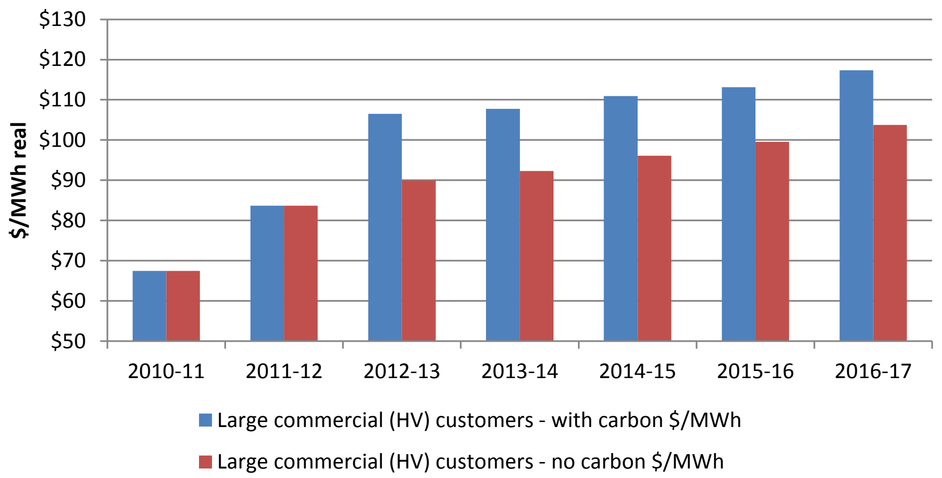
Data source: ACIL Tasman

Figure 42 **Irrigation and UMS real retail prices, with and without carbon tax, $/MWh**



Data source: ACIL Tasman

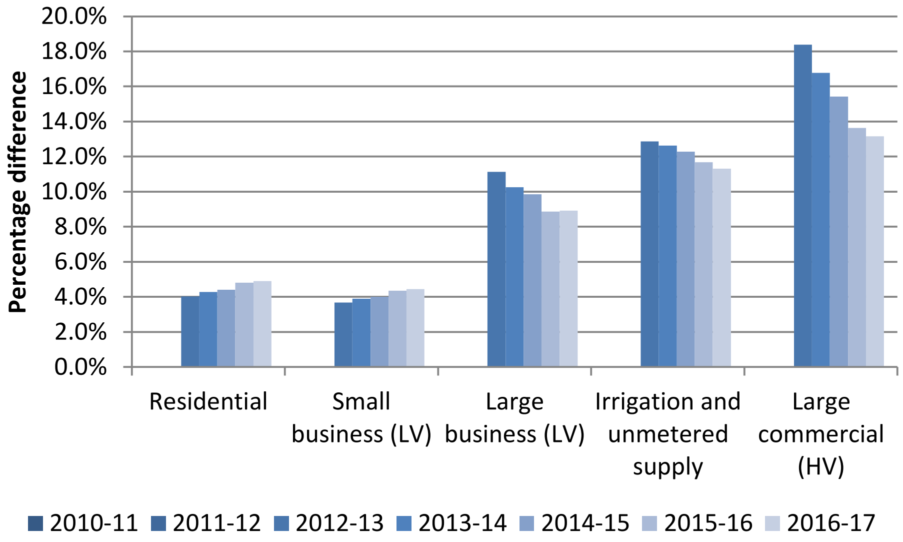
Figure 43 **Large commercial (HV) real retail prices, with and without carbon tax, $/MWh**



Data source: ACIL Tasman

Figure 44 shows the retail price impact of the introduction of a carbon tax by sector in percentage terms over the period to 2016-17. This figure clearly shows that the largest price impact occurs in the Large commercial (HV) segment. In contrast, the smallest proportional price impacts occur in the residential and Small business (LV) customer classes.

Figure 44 **Percentage retail price impact of carbon tax by customer class, %**



Data source: ACIL Tasman

7.3.1 Adjusted energy forecasts

The adjusted base case forecasts incorporating the carbon tax impact are shown in Table 12.

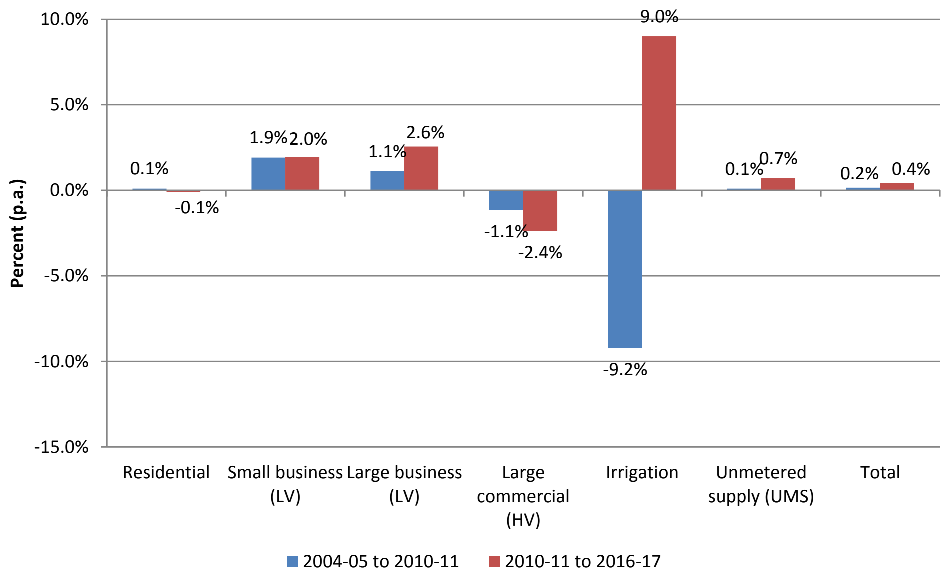
Table 12 **Energy consumption forecasts (MWh) by customer class with carbon tax impact, 2011-12 to 2016-17**

Year	Residential	Small business (LV)	Large business (LV)	Large commercial (HV)	Irrigation	Unmetered supply (UMS)	Total
2002-03	1,923,058	762,759	462,205	876,188	99,236	35,624	4,159,070
2003-04	2,092,323	798,807	491,816	813,747	98,675	36,140	4,331,508
2004-05	2,072,904	807,258	487,978	869,489	101,896	36,701	4,376,226
2005-06	2,108,331	818,652	503,796	869,224	76,368	36,916	4,413,287
2006-07	2,148,339	842,398	517,576	830,618	129,424	36,563	4,504,918
2007-08	2,108,660	853,688	540,997	825,063	117,803	37,622	4,483,833
2008-09	2,162,722	905,345	568,190	822,450	108,734	37,484	4,604,924
2009-10	2,077,409	935,795	537,707	818,724	107,553	36,928	4,514,116
2010-11	2,085,648	904,369	521,608	811,596	57,046	36,912	4,417,179
Forecasts with estimated carbon impact							
2011-12	2,024,501	895,662	543,517	739,677	78,598	37,389	4,319,343
2012-13	2,051,942	932,219	550,761	687,983	95,153	37,679	4,355,737
2013-14	2,057,644	952,452	564,929	692,507	95,237	37,880	4,400,649
2014-15	2,063,820	973,513	578,491	696,331	95,354	38,085	4,445,593
2015-16	2,068,339	994,149	593,626	701,366	95,566	38,295	4,491,342
2016-17	2,074,103	1,016,182	606,851	702,712	95,695	38,510	4,534,054

Data source: ACIL Tasman

Total energy usage for the Aurora network is forecast to reach 4.5 million MWh (102 GWh less than for the no carbon tax case). This is equivalent to a growth rate of 0.4% per annum between 2010-11 and 2016-17. This is compared to a growth rate of 0.2% p.a. in between 2004-05 and 2010-11 (see Figure 45).

Figure 45 **Annualised rate of growth by sector with carbon tax, historical versus forecast**



Data source: ACIL Tasman

Table 13 shows the percentage impact of the carbon tax on energy use by sector. It is not surprising that the largest impacts on consumption occur in the Large business (LV) and Large commercial (HV) sectors. This is because these sectors incur the largest retail price increases, as well having higher assumed price elasticities of demand compared to other sectors.

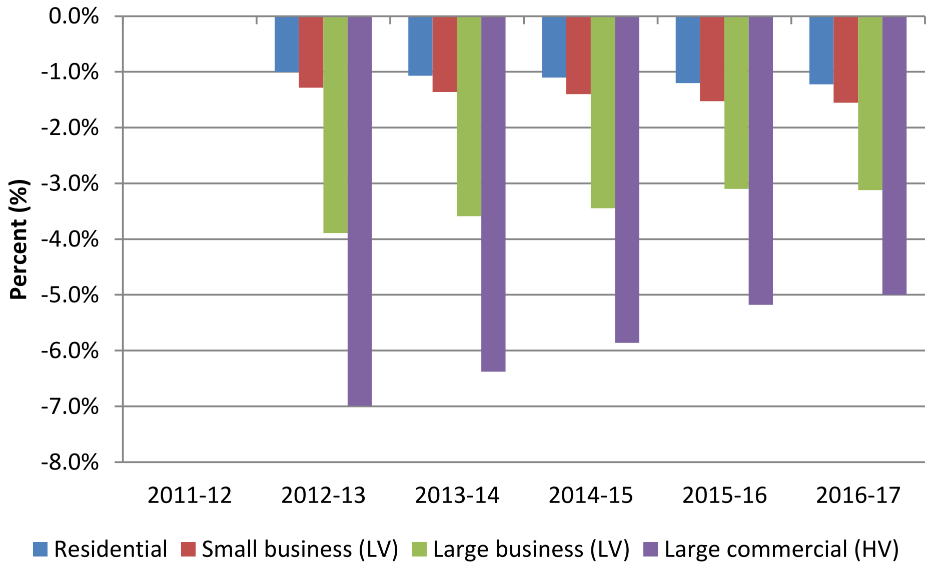
Table 13 **Percentage decline in energy use as a result of the carbon tax relative to the base case, 2011-12 to 2016-17**

Year	Residential	Small business (LV)	Large business (LV)	Large commercial (HV)	Irrigation	Unmetered supply (UMS)
2011-12	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2012-13	-1.0%	-1.3%	-3.9%	-7.0%	-4.5%	0.0%
2013-14	-1.1%	-1.4%	-3.6%	-6.4%	-4.4%	0.0%
2014-15	-1.1%	-1.4%	-3.4%	-5.9%	-4.3%	0.0%
2015-16	-1.2%	-1.5%	-3.1%	-5.2%	-4.1%	0.0%
2016-17	-1.2%	-1.6%	-3.1%	-5.0%	-4.0%	0.0%

Data source: ACIL Tasman

Results in Table 13 are also presented graphically in Figure 46 below.

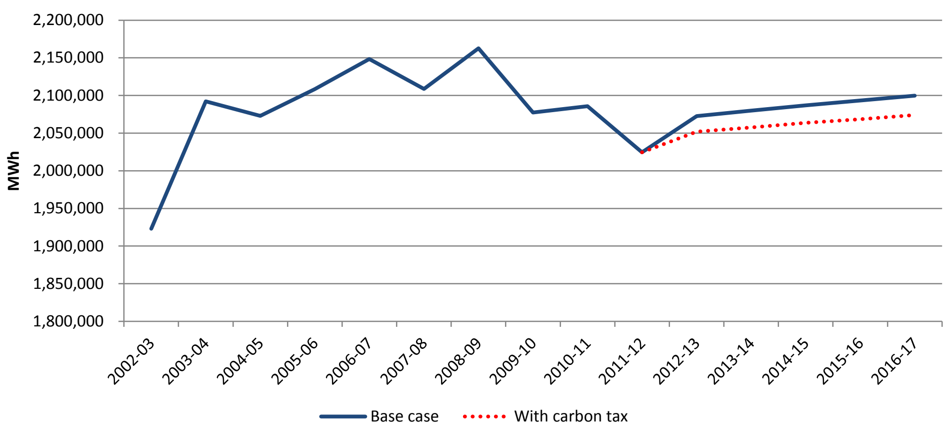
Figure 46 **Percentage decline in energy use by sector due to the carbon tax, 2011-12 to 2016-17**



Data source: ACIL Tasman

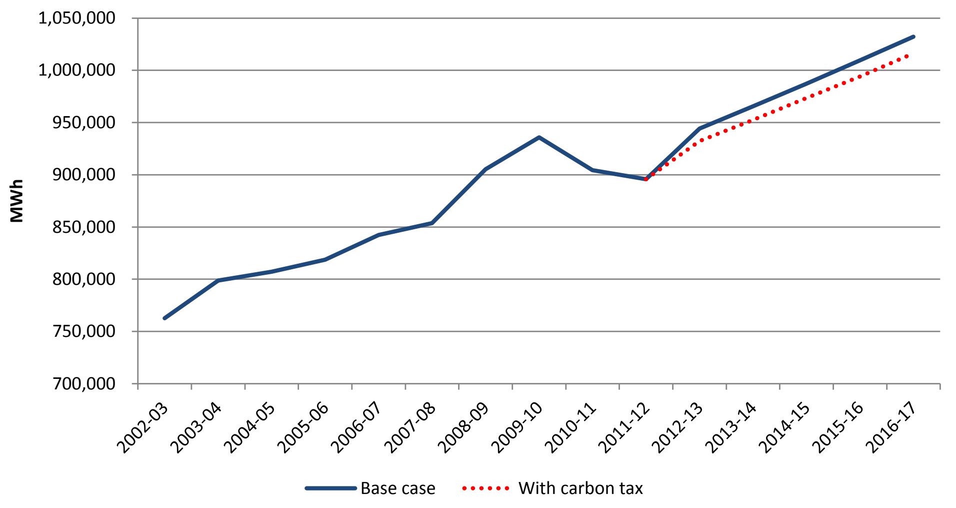
The following five figures plot both the adjusted and base energy forecasts against historical energy use for each of the sectors affected by the introduction of the carbon tax. This provides a good visual representation of the impact of the introduction of the carbon tax on energy consumption against the alternative of no carbon tax.

Figure 47 **Residential energy forecasts, with and without carbon tax, MWh**



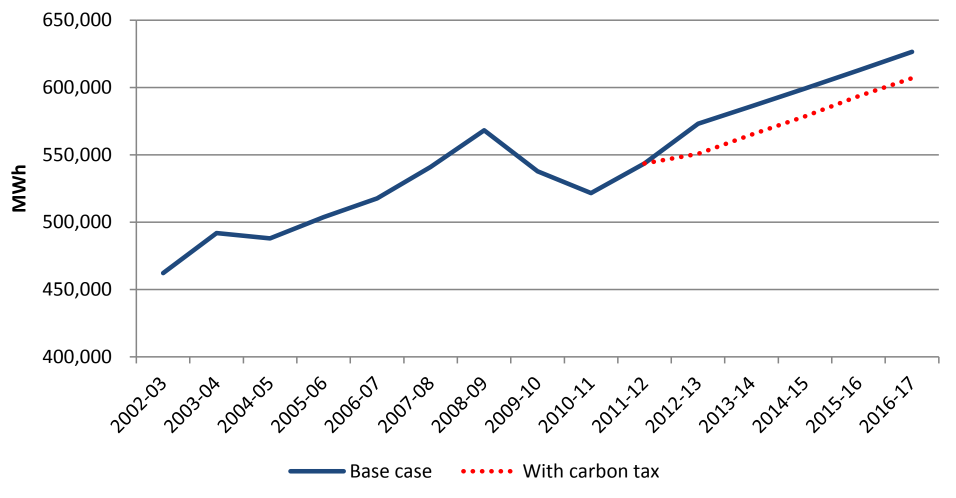
Data source: ACIL Tasman

Figure 48 **Small business (LV) energy forecasts, with and without carbon tax, MWh**



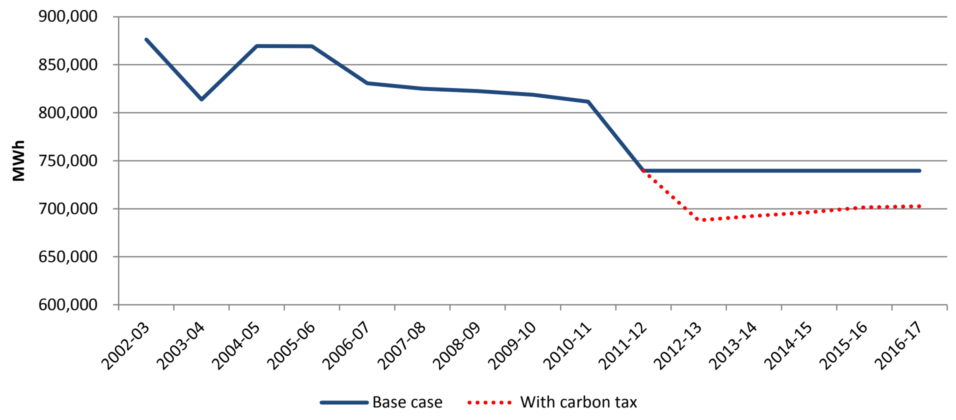
Data source: ACIL Tasman

Figure 49 **Large business (LV) energy forecasts, with and without carbon tax, MWh**



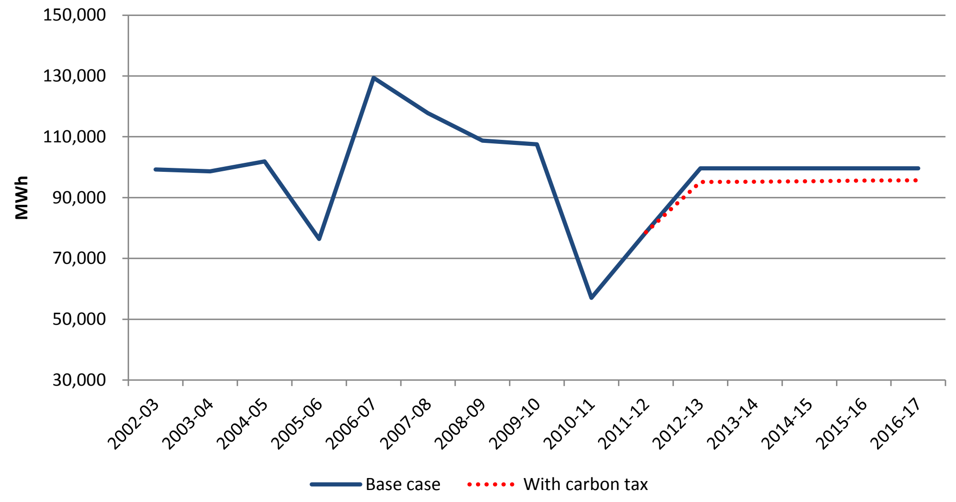
Data source: ACIL Tasman

Figure 50 **Large commercial (HV) energy forecasts, with and without carbon tax, MWh**



Data source: ACIL Tasman

Figure 51 **Irrigation energy forecasts, with and without carbon tax, MWh**



Data source: ACIL Tasman

7.4 Time of use tariffs

In this section we assess and explore the potential impact of the extension of time of use (TOU) distribution tariffs to some of Aurora's residential, business, irrigation and industrial customers.

The introduction of time of use distribution tariffs raises questions about the potential behavioural changes arising from their introduction. While it is likely that some switching from peak towards shoulder and off-peak periods to take advantage of lower per unit energy prices during these periods will occur, the impact on overall energy use is likely to be less certain. This forecasting exercise only covers overall energy consumption, not shifts between peak, shoulder and off-peak periods.

While time of use distribution tariffs (TOU) might be expected to have some impact on patterns of energy use, ACIL Tasman does not consider that there will be a significant impact on total energy use as a result of these tariffs.

There are three key reasons for this:

Firstly, distribution charges only account for about 40% of the total retail tariff. As a result, the incentives provided by time of use tariffs will be diluted somewhat at the retail level.

Secondly, in the case of Aurora only a small proportion of the total energy load in the next regulatory period is expected to come under a TOU tariff structure.

Finally, demand for energy is known to be price inelastic with estimates of own price elasticity that are considerably less than 1.

These three factors together suggest that total energy consumption within the Aurora distribution network is unlikely to change significantly as a result of moving customers to TOU tariff structures.

Residential (TOU)

In 2009-10, Aurora's total residential energy consumption was 2,077 GWh, with only 80 MWh on the applicable TOU tariff (N13R). This is expected to increase to 4,527 MWh in 2011-12 and is expected to remain at this level throughout the next regulatory period. This amounts to less than 0.25% of total residential load and is therefore unlikely to have a material effect on total residential consumption.

Irrigation (TOU)

As of 1 July 2012, Aurora Energy will move its irrigation customers away from the existing tariff N08 to TOU tariff N08A. The purpose of this tariff is to provide incentives for irrigators to move from peak to off-peak usage and is not expected to impact on total energy usage. ACIL Tasman notes that the peak period time of use tariff is equal to the day charge of the non-TOU irrigation tariff. There is therefore no penalty to irrigators from continuing to irrigate at peak times under the TOU tariff. Off-peak prices are considerably lower however, providing incentives to change behaviour.

Given that the peak period tariffs under N08A and N08 are the same, total energy consumption is unlikely to change although we expect to see a degree of shifting towards shoulder and off peak periods.

Small business LV (TOU)

The only customer segment that has a significant element of TOU energy consumption is the small business category. In 2009-10, 72,272 MWh out of a total of 935,795 MWh in the small LV category were on the N13B TOU tariff. This amounted to 7.7% of total small business energy consumption. As part of a drive to shift its small business customers to the N13B tariff, Aurora estimates this to have increased to 232,680 MWh in 2010-11, which accounts for around 25% of total energy use in this customer category.

It is ACIL Tasman's understanding that the transfer of small business customers from the standard tariff to the TOU distribution tariff is voluntary, with only those businesses who have the flexibility to shift energy use from peak to shoulder and off peak times, or those that operate during shoulder and off-peak times such as bakeries and businesses that operate mostly on weekends, opting for a time of use tariff. Businesses that cannot adjust their energy usage patterns would not move to the higher TOU tariff. For this reason, ACIL Tasman believes that while there will be a significant shift in the pattern of energy use in the Small business (LV) customer category, overall level of energy use for this sector is expected to remain largely unchanged.

Large commercial (HV) (TOU)

Aurora's Large commercial (HV) customers are predominantly already on contracts that involve a time of use element in their tariff structures. For these customers, there is no significant shift in distribution tariff structures in the next regulatory period compared to the previous one. ACIL Tasman therefore does not expect to see any significant behavioural changes as a result of time of use tariffs during the forecast period.