University of South Australia

Domestic Energy Use by Australians with Multiple Sclerosis including Medically Required Cooling

Final Report

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Executive Summary

Heat intolerance is a major medical problem affecting people with multiple sclerosis. When their core body temperatures increase even as little as 0.2–0.5°C people with MS experience significantly increased symptoms which greatly reduces their capacity to participate in social, household and work activities, as well as increasing their need for pharmaceuticals and medical services. For people with MS, using air conditioners, with all associated purchase and operating costs, are a medical necessity. Approximately 90% of the 21,000 people with MS in Australia are sensitive to heat, and run their air conditioners more frequently and for longer periods than most Australians.

This work was carried out in partnership between the University of South Australia and MS Australia to develop a more accurate understanding of electricity consumption patterns in MS households, particularly in relation to their need to keep cool to avoid increasing their MS symptoms.

This research built on the 2008-2009 *Keeping Cool Survey: Air Conditioner Use by Australians with MS*. Although that survey included responses from 2,385 households of people with MS, it was only able to document their perceived air conditioner use. This research goes several steps further and actually examines energy bills in 38 households of people with MS.

The main findings from this study regarding households that include people with MS are:

- Participant households used, on average, about 16.8% more electricity in summer and 10.5% more electricity in winter than the state or post code average. This increased to 32.2% more in summer when the 24% of homes with solar PV were removed.
- Looking more closely at non-solar homes, summer electricity use showed that those using more than the state or post code average, which was 60% of the sample, used about 80% more electricity while the rest used about 18% less. The latter were predominantly found to have introduced energy savings initiatives and were careful about energy use.
- In addition, 52.6% of non-solar homes had annual energy costs (electricity plus gas) of $2000 - $5950, putting them in the medium to high cost range. The remainder had an average bill of $1540/y.
- 44% of homes that provided electricity bills received a concession (11/25) and 58% (11/19) of non-solar homes. The value of the concession varied widely between states, being 5 – 15% of the total energy bill in NSW and SA and 18 – 21% in Victoria. The highest concessions were received in Victoria and the lowest in SA. The concession range was from $181/y - $974/y.
- Of the 36 homes that answered the air conditioning survey, almost half (47%) were split refrigerative systems with the majority in Victoria. Ducted refrigerative systems (22.2%) were the next most common with the majority in SA.

  Homes with ducted refrigerative air conditioners were associated with the highest energy use and electricity bills and those with window/wall air conditioners with the lowest bills. However, the latter were most likely to be smaller and the air conditioning confined to single rooms. Ducted evaporative air conditioners used the

least electricity but as they are frequently associated with gas heating the annual energy bills for homes with this form of cooling were virtually the same as those that use split system air conditioners for both heating and cooling.

A number of significant recommendations arise from this research:

- The value and feasibility of developing a single national medical energy concession to assist those with a medical need to keep cool and/or warm should be examined by an appropriate national body (such as the COAG Energy Council).

  National uniformity would improve clarity and ease of access for consumers with a need for medical energy concession. It would also simplify administration for energy retailers and governments. Importantly, it would also create significant incentives for governments to strengthen and better target energy efficiency improvements to medical-energy-concession-eligible households, and thereby ultimately reducing costs for all stakeholders.

- In relation to a single national medical energy concession, the current Victorian medical energy concession utilizing a percentage of the energy bill rather than a daily rate appears to be the most progressive and fair approach. This approach does not discriminate against those living with larger families or those on lower incomes who might be living in poor quality housing with outdated appliances and unable to put more measures in place to improve their home's thermal efficiency.

  The results of this research also make it clear that a proportional percentage based concession system linked to additional assistance for concession-eligible households to install solar energy systems (and other efficiency measures) would also benefit concession-eligible home owners through reduced costs, and also more than pay for itself through lower concession costs for government over time.

- If there is no agreement by the appropriate national body (such as the COAG Energy Council) on the best model for implementing a national medical energy concession, then additional research should be undertaken to determine the best way to achieve this.

  In regards to future research, using electricity bills is not the most accurate or ideal method to determine medically required energy use, for heating, cooling or other needs. Given the findings of this research, a more costly and comprehensive study is justified to more accurately determine actual energy use for heating, cooling and other medically required energy use at home. Many other conditions besides MS result in medically required energy use, such as Parkinson's disease and spinal cord injury.

  With more detailed results of actual cooling/heating energy use in these households, via smart meter or data logging equipment, the most effective and fair means of providing medical energy concessions could be undertaken. It would also provide a stronger platform to further examine the links between different concession structures and savings/costs to governments in relation to energy efficiency support programs.

  Also in relation to future research, it was found that gas bills can provide reasonable accuracy for estimating average annual gas heating use since people usually have a

maximum of 3 gas appliances – though the number of gas heated spas is increasing, and the impact of this will need to be considered.

- State/territory government energy efficiency schemes should include programs and initiatives that specifically target households with high energy needs as a consequence of medical need. Given these are often very high energy use households relative to 'average' households, and are also often on lower than average incomes, there are significant economic, social and environmental gains to be made.

  Many of the homes of people with MS used energy efficiency initiatives and were aware of what might help them to reduce costs. Also, the previous Keeping Cool Survey found that overall MS households had taken more measures to improve thermal efficiency than the average Australian household.

  However, given the much higher than average energy use and costs in most of these homes, there is a need for improved access to energy efficiency advice, and specific programs targeted at people who require cooling/heating as a consequence of medical need may be particularly valuable to this group (or alternatively, targets set within existing programs that specifically target households with significant medically-related energy requirements).

  A mix of energy efficient initiatives and use of solar would significantly reduce energy use and bills in homes of people with medical energy needs. These new initiatives should include a research/evaluation component to further examine the most effective means of achieving this.

  These state/territory initiatives should also provide targeted information to these households regarding: available concessions, efficiency, retail market information and solar options. During the study it was found that existing web based information on concessions and the best value electricity and gas retailer to choose were not always easy to follow for households. Ensuring that existing information sources include a subset or specific information that addresses the particular needs of households with medically-related high energy use requirements, including indicative costings and savings, would likely provide significant assistance to help these households to make considered choices. This should include assistance with energy efficiency and solar initiatives for households with high energy use as a consequence of medical need.

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1 Introduction

People with MS identify high temperatures as one of the top three factors adversely affecting their symptoms (Simmons et al. 2004), and this in turn is known to have a significant impact on their quality of life and economic situation (De Judicibus & McCabe 2007). Hot weather can become a significant problem for people with MS if they are unable to stay cool, with as little as 0.2–0.5°C increase in core body temperature resulting in increased MS symptoms (Guthrie & Nelson 1995).

Previous Australian research has found that 90% of people with MS are heat intolerant, and all but the 10% who do not have or cannot afford an air conditioner, rely on air conditioners extensively on hot days and nights as a medical necessity (Summers, Simmons & Verikios 2012). In 2011 there were approximately 21,000 people with MS in Australia (Covance & Menzies Research Institute Tasmania 2011). MS is a chronic, progressive and incurable disease that attacks the central nervous system (brain and spinal cord). Most people with MS are of working age and three-quarters are women (Covance & Menzies Research Institute Tasmania 2011).

People with MS face significant disease-related expenses that must generally be met from lower than average incomes as a consequence of their MS (Covance & Menzies Research Institute Tasmania 2011). Additionally, the rapidly rising costs of electricity they require to keep cool, along with the growing number of hot days and nights due to climate change (BOM & CSIRO 2007) create an increasingly difficult financial burden for many people with MS.

Given this situation, a clearer understanding of energy use in households of people with MS is vital. This report presents the results and analysis of energy use in 38 households in four capital cities. This project builds directly on the *Keeping Cool Survey* conducted in 2008-09 which provided a strong overview of the impact of heat intolerance on air conditioner use by people with MS. This new research adds depth and detail regarding total energy use in these households with a particular focus on keeping cool, and utilises actual energy billing data as the central parameter for analysis.

2 Background

2.1 MS and Heat Intolerance

Recognition of heat intolerance and MS first surfaced in the late 19th century. A review by Guthrie and Nelson in 1995 describes the development of the scientific and medical understanding of the heat intolerance in people with MS since Uhthoff's work in 1890 to 1995. Guthrie and Nelson found that overall the international literature indicates that MS symptoms increase in about 80% of people with MS when they get too warm. Recent Australian research found that about 90% of people with MS were adversely affected by the heat (Summers, Simmons & Verikios 2012), and the higher proportion in Australia might be explained by the generally higher temperatures in Australia compared with Europe and the northern parts of North America where most previous research on this issue has been undertaken.

As summarized by Summers and Simmons (2012):

> Heat is generally associated with an increase in MS symptoms such as blurred vision, extreme fatigue, muscle weakness, pain, tremors, memory problems, loss of balance, bladder and bowel problems, numbness and tingling, decreases in cognitive function, and in severe instances partial or complete paralysis (Guthrie & Nelson 1995; Simmons et al 2001; Lerdal et al 2007). Also, while it is rare, there are reports of deaths from heat in people with MS. Guthrie (1951, cited in Guthrie and Nelson 1995) reported two deaths from heat therapy (electro pyrexia) used in attempts to improve MS symptoms. Two more recent reports include a death at home in a bath tub attributed to heat and MS (Kohlmeier, Di Maio & Kagan-Hallet 2000), and a death from sunbathing and MS (Henke, Cohle & Cottingham 2000). Paradoxically, while exposure to the cold is generally helpful and reduces MS symptoms (NASA/MS Cooling Study Group 2003; Petrilli et al 2004; Meyer-Heim 2007), some people with MS (5–30%) have a worsening of symptoms in the cold (Simmons et al 2001; Visscher et al 1983).

2.2 Economic Impact of MS on Households

Many people with MS struggle financially. In 2010 the average annual disease-related costs to people with MS and their families in Australia was $10,554 ($3,697 out-of-pocket and $6,857 for informal care). There were also significant indirect costs, such as lost income, which averaged over $23,000 annually. These findings by Covance and Menzies Research Institute Tasmania (2011) also observed that direct and indirect costs increase with severity of MS.

While most people with MS are employed when first diagnosed, and 87% are of working age, 80% of these are not employed 10 years after diagnosis (Access Economics 2005). Consequently, 52% of Australians with MS have annual incomes below $26,000 (Australian MS Longitudinal Study, unpublished data).

The end result is that ultimately most people with MS end up on fixed incomes, often provided through part and full government pension benefits. This combination of low incomes and the high economic costs of MS mean that concessions such as energy rebates are often a critical financial factor in their daily lives, and in their ability to keep cool during hot weather.

2.3 Climate

Air conditioner use to keep cool is a direct response to day-to-day weather by people with MS in Australia (Verikios, Summers & Simmons 2013). With an increasing number of hot days and nights, and more frequent and more severe heat-waves, the use of electricity increases for people with MS in their efforts to keep cool, pushing up costs to a group already under considerable economic pressure.

Climate change is leading to an increased frequency and severity of heat waves (Saman et al 2013). Spells of several consecutive days of unusually high temperatures have led to increased morbidity and mortality rates for the more vulnerable in the community. The problem is compounded by the escalating energy costs and increasing peak electrical demand as people become more reliant on air conditioning. Domestic air conditioning is the primary determinant of peak power demand which has been a major driver of higher electricity costs.

The increasing frequency and severity of heat waves (Alexander et al. 2007) have increased the morbidity and mortality rates for the more vulnerable in the community who cannot afford air conditioning. An increase of peak demand for a few days necessitates more costly higher capacity electrical infrastructure, driving up household electricity prices. As an example, in South Australia (SA), 50% of the electrical infrastructure is needed for only 5% of the time, resulting in SA having the highest electricity prices in the National Electricity Market (ESAA 2012). As a result, climate change can cause an upward spiraling effect of increasing electricity prices and increasing mortality rates over time.

Table 2.3.1 gives the average number of days per year above 35°C at selected sites for present (1971-2000) climate and best estimate values for 2030 and 2070, with ranges of uncertainty in brackets (Climate Change in Australia 2007 BOM CSIRO).

Table 2.3.1: Average number of days per year above 35°C at selected sites for present climate and best estimate values for 2030 and 2070 (Climate Change in Australia 2007 BOM CSIRO).

	Present average (1971-2000)	2030 average (mid emissions)	2070 average (low emissions)	2070 average (high emissions)
Sydney	3.5	4.4 (4.1-5.1)	5.3 (4.5-6.6)	8.2 (6-12)
Melbourne	9.1	11.4 (11-13)	14 (12-17)	20 (15-26)
Adelaide	17	23 (21-26)	26 (24-31)	36 (29-47)
Brisbane	1.0	2.0 (1.5-2.5)	3.0 (2.1-4.6)	7.6 (4-21)
Hobart	1.4	1.7 (1.6-1.8)	1.8 (1.7-2.0)	2.4 (2.0-3.4)
Perth	28	35 (33-39)	41 (36-46)	54 (44-67)
Darwin	11	44 (28-69)	89 (49-153)	230 (140-308)

2.4 Average Energy Use in Australia

In order to determine whether people with multiple sclerosis use, and therefore spend, more than the average on energy (particularly in summer and even winter), it is necessary to know what the average household energy consumption levels are in Australia. The usual way to get annual state averages is to divide state electricity (or gas) sales by the number of customers/households. This is a relatively blunt method, and more nuanced approaches were examined for this research.

In 2011 the Australian Energy Regulator (AER) commissioned ACIL Tasman to develop benchmarks for a new web site 'Energy Made Easy'. Implementation of the web site, www.energymadeeasy.gov.au occurred in 2012 with the main goals being;

- to help residential customers understand and compare electricity usage against other similar households living in their area and to learn about energy related topics such as energy efficiency, contracts, bills, rights and obligations, such as concessions and the energy market, and
- to enable informed decisions about actions to reduce energy consumption, and to motivate energy savings action.

There are many factors that influence energy use in the home such as occupancy, i.e. number of people living in the home, size of home (area), type of home (one or two storey), structure of building and floor plan area, income, appliance mix, tenancy (whether own home or renting) and often most importantly behavior. However, household occupancy is one of the easiest of the parameters to understand and determine and is the one with most influential impact on energy usage in the home and so is most generally used in energy comparison studies. Oliphant (2003) and ABS Statistical Consultancy South Australia (2007) are two of many studies that have determined the major part occupancy plays in residential household energy use.

ACIL Tasman (2011) have developed benchmarks from a 5000 home sample across Australia and based on household occupancy. Not wishing to skew results they excluded homes in their study with a swimming pool. Data used in the analysis came from electricity bills and a survey and resulted in Table 2.4.1 which, at this stage, is the only known current electricity consumption data by state and household size in Australia.

Table 2.4.1: Jurisdictional benchmarks – based on household size only, no swimming pool

Household size (people)	1	2	3	4	5	6	Var
		Electricity consumption (kWh)					
Queensland	4,030	5,331	6,633	7,934	9,236	10,538	34%
New South Wales	4,422	5,548	6,673	7,799	8,924	10,050	27%
Australian Capital Territory	5,939	7,219	8,500	9,780	11,061	12,341	15%
Victoria	4,028	4,835	5,642	6,449	7,256	8,064	14%
Tasmania	6,862	8,733	10,604	12,475	14,347	16,218	28%
South Australia	4,398	5,306	6,213	7,121	8,028	8,936	18%
Western Australia	4,107	5,140	6,173	7,206	8,239	9,272	32%
Northern Territory	6,266	7,806	9,345	10,885	12,425	13,965	29%

Note: VAR is explained variance
Data source: ACIL Tasman

Average seasonal electricity use was then calculated in kWh/day for spring, summer, autumn and winter for use on the Energy Made Easy web site. No similar study has been undertaken for natural gas use.

Since each state often covers a number of climate zones Energy Ministers were asked to nominate a number of geographic areas or zones in their state or territory that consumption data should be assigned to. As a result some states and territories have many zones; New South Wales (18), Queensland (12) and South Australia (10) but others just have one - Victoria, Tasmania and the Australian Capital Territory. Western Australia and the Northern Territory were not required to nominate any zones. ACIL Tasman developed benchmarks for Western Australia and the Northern Territory as one zone each.

The postcode entered into the average electricity usage calculator on Energy Made Easy identifies the localised zone. Therefore in the body of the report when calculations are made comparing electricity use greater or less than the state average in summer and winter it is really for **the climate zone identified by the person's post code** and not for the state as a whole, unless it is a single zone state or territory.

Figure 2.4.1 shows how seasonally electricity use varies by jurisdiction as defined by ACIL Tasman (2011).

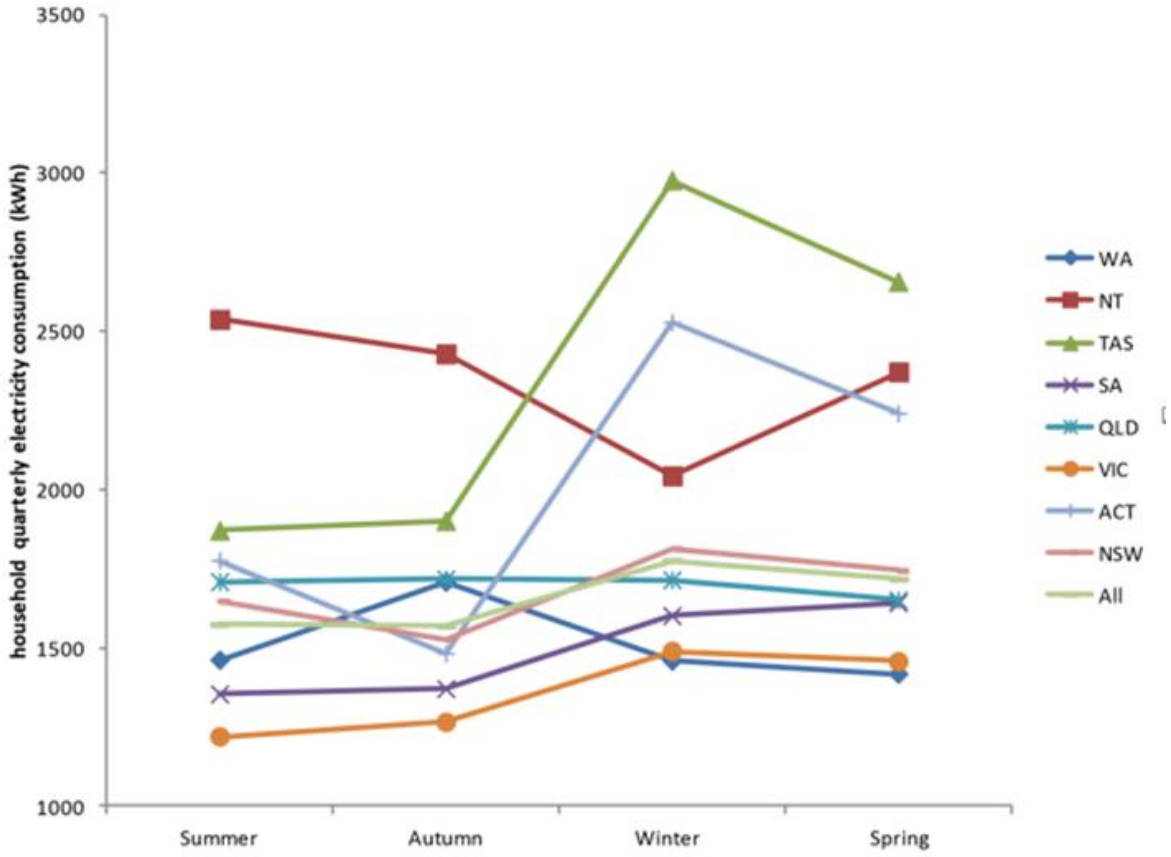


Figure 2.4.1: Average electricity use by jurisdiction and season (ACIL Tasman 2011)

Graphs show that except for NT, WA and Qld – where the latter's electricity use is almost constant over the year – winter electricity use is higher than summer. The reason for this is that the graphs and the Energy Made Easy web site are based on quarterly electricity bills. The beginning and end of summer predominantly have mild weather and this masks the high use consumption in the middle of the quarter that often people have and which dominate electricity utilities' peak loads.

A summary for the 4 states involved in the study is shown in Table 2.4.2 for a 2 person home near the capital cities (obtained from www.energymadeeasy.gov.au). It also demonstrates the extent to which electricity use in winter is greater than that in summer – except in Brisbane. This difference becomes even greater when gas heating is included.

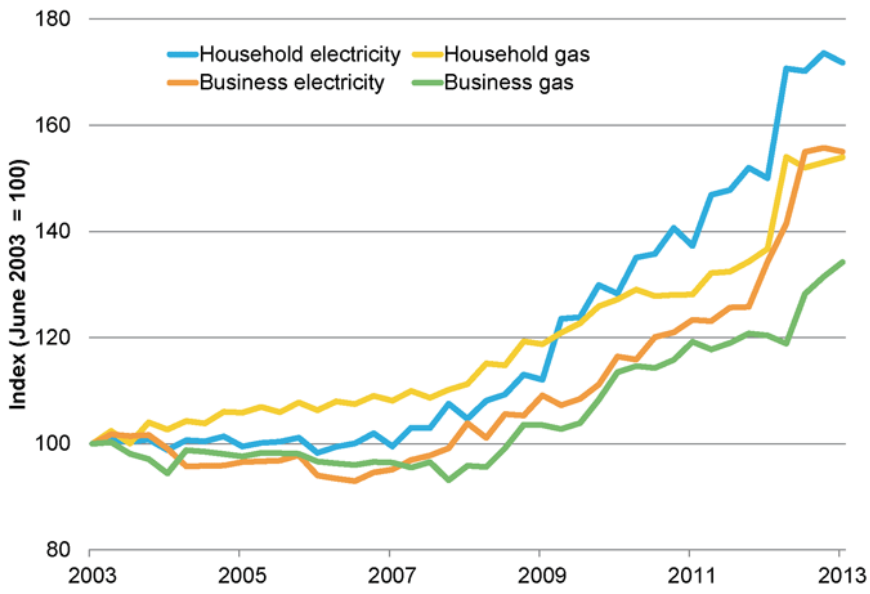
Table 2.4.2: Average seasonal electricity use by postcode for a 2 person household

City and Postcode	Summer (kWh/day)	Autumn (kWh/day)	Winter (kWh/day)	Spring (kWh/day)	Winter> Summer (%)
Sydney,2010	13.6	13.1	16.1	15.4	18.4%
Melbourne,3010	11.6	11.9	14.8	14.3	27.6%
Brisbane,4010	14.1	14.1	14.0	13.9	-0.7%
Adelaide,5010	12.4	12.5	15.2	15.5	22.6%

Notwithstanding average higher electricity use in winter, it was found that people with MS that were involved in the study, and did not have solar PV, used on average 32.2 % more electricity than that indicated for their state or post code area, resulting in electricity use being virtually the same, and even greater than that in winter (see Section 4.2). This project has also identified many homes where owners have made significant efforts to introduce energy efficiency measures in order to keep electricity usage down during the heat of summer. On the other hand some home owners were found to be not as energy aware. From the range of energy responses received recommendations are made to help people with MS make cost effective energy choices in future.

2.5 Energy Costs

Electricity and gas prices for households and business have increased sharply in recent years (see Figure 2.5.1) and indications are that prices will continue to increase (Parliamentary Library 2014 and Australian Energy Regulator 2013).



Source: Australian Bureau of Statistics.

Figure 2.5.1: Real electricity and gas price increases, 2003 to 2013

In real terms—that is, taking into account the general increase in prices across all goods and services—prices for households increased on average by 72% for electricity and 54% for gas in the 10 years to June 2013.

The increase in real prices after June 2012 of around 14% for household electricity and 13% for household gas is associated with the implementation of a carbon price from July 2013.

The pattern of price increases over the 10 years to June 2013 has differed across states and territories. The rate of increase for electricity has been 30% in Perth, 41% in Adelaide, 73% in Brisbane and 107% in Sydney. For those cities connected to natural gas networks,

household gas price increases over the 10 years to June 2013 have ranged from 40% in Sydney to 78% in Perth.

In recent years, much of the increase in prices has been due to investment in distribution and transmission networks as a result of previous under investment in maintaining them or in increasing their capacity. Also important has been the impact of policies to address environmental issues.

In the case of electricity, the rate of price increase is expected to moderate in the next few years. Overall, household electricity prices are expected to increase at an average of 3% over the next year, with outcomes varying across the country from a high of 16% in the Northern Territory to a 1% fall in prices in South Australia.

In the case of gas, prices for households and businesses are expected to increase significantly in eastern Australia, as the development of new gas export terminals leads to a tightening of supply. Rises as high as 17.6 % have been quoted (ABC News, 2014)

Though the Energy Made Easy web site does not indicate average electricity costs by postcode it does provide a comparison of electricity prices for different Electricity Retailers in each postcode area. Retailer prices vary significantly and Appendix 1 sourced from the Australian Energy Regulator (2013) shows in greater detail how electricity and gas prices have changed over the years and also indicates how important the choice of Retailer can be in containing costs. For example the Australian Energy Regulator (AER) found that the annual bill spread in August 2013 (measured within a particular distribution network) varied among jurisdictions:

- For electricity, Retailer prices varied by $200 in Queensland and by around $1000 in Victoria. The price spread for most networks was larger in August 2013 than in August 2012.
- For gas, it was around $200 for most networks.

The spread for all networks rose between August 2012 and August 2013.

2.6 Air Conditioner Use in Australia

There are a variety of estimates available regarding the use of air conditioning in Australia, and the amount of energy required. The most comprehensive national estimates and projections for energy use in relation to household cooling and air conditioner use are in *Energy Use in the Australian Residential Sector 1986–2020* (Dept of the Environment, Water, Heritage and the Arts 2008). In this report electricity for space cooling nationally is estimated at 4% of average household energy use (p. 25).

An estimate prepared for the Australian Greenhouse Office, indicates that air conditioners account for between 40 and 50 percent of residential demand on system peak summer days and 30 to 40 percent of commercial demand (Wilkenfeld, 2004). The two loads are currently of similar magnitude, but the household air conditioner load is growing more rapidly. Other factors contributing to growing air conditioner use are increasing average dwelling sizes, and the probability that global warming will increase the frequency of very hot days in summer. South Australians report using their air conditioners an average of 11.5 days per month during summer at present, so there is significant scope for increasing frequency of use.

Saman et al (2012) report that on average, space heating and cooling represents 41% of the energy demand of the 8.5 million Australian homes with heating and cooling of buildings directly responsible for 11% of Australia's national greenhouse gas emissions despite the temperate climate of major Australian cities.

Whaley et al (2013) has summarised the energy breakdown for appliances in homes located in a sustainable housing development, Lochiel Park. All homes constructed here required numerous sustainable household characteristics such as maximising the efficiency of, and peak load relating to:

- the building envelope for passively maintaining thermal comfort
- major appliances such as water heaters, Heating, Ventilation, Air-Conditioning (HVAC) and refrigeration appliances
- other significant household appliances such as dishwashers, clothes dryers and washing machines
- water fixtures such as low-flow showerheads and faucets; lighting fixtures such as high efficiency fluorescent and light-emitting diode (LED) lighting.

At Lochiel Park, stringent requirements for building passive thermal performance were put in place, which mandated that at least a 7.5 energy star rating was required, when modelling the building envelope, using the AccuRate software package. Large scale use of double glazing has formed a significant part of this passive design in most homes, along with uncharacteristically high levels of wall and ceiling insulation. For a 12 month monitoring period from June 2011 to May 2012, heating and cooling was measured to be about 26% of the total household energy consumed.

2.7 Concessions

The Energy Made Easy web site is useful for determining energy concessions available in each state (see https://www.energymadeeasy.gov.au/consumer-rights-and-support/rebates-and-concessions). This site provides a link to the relevant state/territory concession provider.

Energy concessions vary quite significantly between the various states and territories (see Table 2.7.1) and are received only by eligible concession card holders. The terminology of describing the concessions and the availability of each is also not consistent between states/territories. The main concessions are:

- Annual Pensioner Energy Concession: - household rebate off electricity bills all year round
- Additional Winter Gas Concession – household rebate off gas bills 1st May to 31st October
- Additional Medical Energy Concession – household rebate off electricity bill for those with specific medical conditions such as MS, Parkinson's disease, spinal cord injury etc.

Most concessions are capped to a maximum yearly value, and are calculated from a set daily rate. Only in Victoria are concessions calculated as a percentage of the bill, and are calculated on the remaining account balance once any retailer discounts and/or solar credits have been applied. Concessions are 17.5% of account balance all year round, plus eligible pensioners receive an additional 17.5% Medical Cooling electricity concession for the 6 warmer months

(November – April). Victoria also has a gas winter heating concession of 17.5% (May – October). Most states/territories also have a Life Support Concession to cover some additional costs such as for oxygen concentrators and other essential medical equipment used in the home.

Table 2.7.1: Energy Concessions in Australia (Energy Made Easy 2014)

Concessions 2013/14	Pensioner Electricity	Pensioner Gas	Medical Energy	Total	Comments
Queensland	$282.54	$65.58	$282.54	$630.66	GST inclusive
NSW	$250		$235	$470.00	2014 GST exclusive
ACT	$322.10 (max) (Includes gas) Additional $84.05 available to minimise cost of living and water costs Combined value $406.15 (2013/14)			$374.82 max	Combined Utility rate is 52.428 c/day in summer (Nov – May) and 192.798 c/day winter (June – Oct) Life Support is 0.3258 c/day ($121.37 max)
Victoria	17.50%	17.50% (May – Oct)	17.50% Medical Cooling (Nov – April)	35.0%	The two 17.5% of Bills are additive. (Gas winter only, Medical is summer cooling)
Tasmania	$458.84 (Max)		Medical Cooling $137	$595.84	Electricity Concession 125.71c/day, 2014 Medical Cooling 37.653 c/day
South Australia	$165		Medical Heating &Cooling $165	$330.00	GST Exclusive
Western Australia	$208		$567*	$775.00	Electricity goes off bill, Medical goes into bank account GST inclusive
NT**					

*Thermoregulatory Dysfunction Energy Subsidy Scheme
http://www.finance.wa.gov.au/cms/uploadedFiles/_State_Revenue/Other_Schemes/Thermoregulatory_Dysfunction_Information_Sheet.pdf?n=691
** NT data not found – refer to -
http://www.health.nt.gov.au/Aged_and_Disability/Subsidies/NT_Pensioner_and_Carer_Concession_Scheme_NTPCCS/index.aspx

The range of concessional payments across Australia is quite large with the lowest concessions being in SA, and the ACT only slightly better. Concessions are considered within the analysis conducted for this research.

3 Methodology

3.1 Introduction

The objective of this project was to determine air conditioner use within the broader context of household energy consumption by Australians with MS. It builds on the *Keeping Cool Survey: Air Conditioner Use by Australians with MS* (Summers & Simmons 2012), which found that 90% of people with MS in Australia were heat intolerant, and operated their air conditioners more frequently and for longer periods than most Australians out of medical necessity. The report also noted that high levels of electricity use by this group along with their low income made them especially vulnerable to increases in electricity costs.

Since that time not only have electricity costs increased significantly but gas prices have also increased (see Section 2.5). As gas penetration is quite substantial in some states – particularly Victoria, where about 81% of Victorian households and 92% in Melbourne are connected to mains gas – both gas and electricity billing data was collected. This was important given that some people with MS also report sensitivity to the cold and are therefore likely to require more heating than average in the winter. Also, overall the economic burden of energy use in MS households is of interest given that the rising energy costs must be met from often quite limited incomes already stretched due to other MS disease-related costs.

In this project, energy audits were conducted by David Whiting Solutions in 38 households of people with MS across Australia. Accompanying these audits was an air conditioning survey very similar to that conducted in the earlier study of Summers et al. (2012). Appendix 2 has a copy of the audit procedure and the air conditioning survey which was completed by 36 of the 38 households. In addition, data loggers were installed in 9 homes for monitoring temperature to determine thermal temperature levels and the patterns of use for cooling systems. The data from these households was compared to other 'average efficiency' and state of the art 'high efficiency' households which were previously monitored by the University of South Australia (UniSA) (Saman et al 2013).

The location and number of the participating homes was; Adelaide (16), Brisbane (5), Sydney (2) and Melbourne (15). These cities have been selected based on the fact that these climates have the largest number of people with MS.

The initial recruitment target was 50 homes across the four capital cities named above. The original intention was to recruit participants from the Australian MS Longitudinal Study which has over 3000 participants, and has a very rich data-set as it has been running since 2000 which could then be accessed and included in the subsequent analyses. However, recruitment efforts through the AMSLS attracted less than 20 participants to this study. Subsequently recruitment of participants expanded to include promotion on social media websites frequented by Australians with MS, and direct recruitment through networks and snowballing from existing participants. The initial ethics approval for this project was granted by UniSA on 25/10/2012 (Application ID: 0000030804), and amended on 11/2/2013 to include the new participant recruitment processes. The timeline for the project was also extended to enable additional recruitment, and to accommodate the delays experienced in getting billing data from some energy retailers.

An energy audit was conducted in 38 homes and included a short survey questionnaire completed by 36 homes that detailed major energy consuming appliances, such as those for

heating and cooling, as well as registering any energy efficiency measures put in place such as insulation, and the impact of hot weather on the person with MS. The questionnaire was used to determine the type, size and efficiency of existing air conditioning system, pattern of use of air conditioning, and energy consumption associated with any other major energy consuming equipment (see Appendix 2 for a copy of the questionnaire).

Of the 38 homes audited, 9 were selected to have monitoring equipment installed (3 in Adelaide, 4 in Melbourne and 2 in Sydney), so that the temperature in the bedroom and/or the living area of the home of the person with MS could be monitored. This enabled the temperature levels and the pattern of air conditioning use in these homes to be determined.

In addition to the surveys, electricity and gas bills were sought from the 38 households. The householder was asked to sign a release form to enable the electricity and gas bills to be obtained. The household energy bills along with the information from the energy audits were analysed to determine summer electricity use. Due to the significance of air conditioning on summer bills a comparison was made between the home owners' usage in summer with that of the state average or post code region – whichever was available - on the Energy Made Easy web site. If the energy usage is greater than the average it is a reasonable assumption that costs will be higher than the average.

A summary of the samples used in this research is summarized in Table 3.1.1.

Table 3.1.1: Summary of samples used

	Total Number of Households with Audits	**Temperature Data Loggers**	**Electricity Bill Data**	**Gas Bill Data**
Adelaide	16	3	11	6
Brisbane	5	2	3	1
Melbourne	15	4	9	7
Sydney	2		2	1
TOTAL	38	9	25	15

Various options that can reduce energy consumption were explored using this information and some of the most cost effective recommendations made. The data was also analysed to determine the most suitable energy efficient cooling systems.

3.2 Data collected from Energy Bills

The 38 households involved in the project were asked to provide a signed release form to enable collection of electricity and gas bills for a period of 2 - 3 years, if available. Of these, 25 homes provided useable billing data – a few had less than a year of data that did not include summer, others provided just gas and no electricity bills. Although this represents just 66% of homes, some homes provided over 20 electricity and 20 gas bills, which is good for seeing trends. Some data came electronically and some by post.

Eleven retailers were represented and all presented their bills differently. Data collated over the billing periods (90 days for electricity and 60 or 90 days for gas, depending on the retailer) included:

- energy use
- energy cost
- concession credits
- whether the home had solar or not
- postcodes
- comparison data from the Energy Made Easy web site.

Retailers who provided bills were: AGL, Alinta Energy, Australian Power and Gas, Energy Australia, Lumo, Momentum/Hydro Tas, Origin, Power Direct, RED, Sanctuary Energy and Simply Energy. When data from the energy bills was collated the pensioner all year round electricity concession, the gas winter heating and medical electricity cooling concessions paid by retailers were all noted (see Appendix 3). The analysis was aided by incorporating the number of household members – taken from the survey. Seasonal daily energy use was plotted on a graph as this was a good visual aid to see whether winter or summer consumption was greater. This seasonal data was then plotted together with the postcode and state average data taken from the Energy Made Easy web site. Below is a selection of representations of Energy Made Easy comparison data on Retailer electricity bills.

Origin Energy

How you Compare

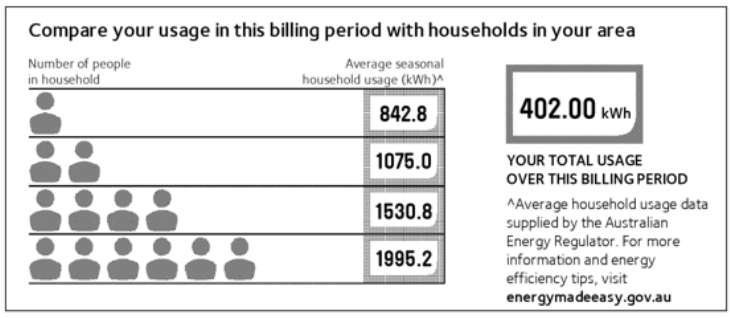
The table to the right allows you to compare your average daily electricity consumption with other households in your region. For more information on electricity usage and energy efficiency visit **www.energymadeeasy.gov.au**

Household size	1 Person	2 People	3 People	4 People
Summer	9.8kWh	12.4kWh	14.9kWh	17.5kWh
Winter	12.8kWh	15.2kWh	17.7kWh	20.1kWh

AGL

Compare your usage.

Compare your usage in this billing period with households in your area



Sanctuary Energy

Your daily usage (kWh)	Same time last year
17.37	0.00

Average cost per day (incl GST): $4.45

Average daily use (kWh)
Peak: 15.39
Off Peak: 1.98

Average daily consumption in your area

Number of Occupants	1	2	3	×4	×5	×6
kWh	10.45	13.07	15.70	18.32	20.95	23.57

You can use the table above to compare your average daily electricity usage figures with other households in your area. More information on electricity usage, these calculations and energy efficiency is available at www.energymadeeasy.gov.au

To streamline the logistics of collecting the data for similar research in the future, the following are recommended:

1. phoning the energy retailer while visiting the households and getting the householder to provide verbal consent for the data for pre and post quarters to be collected and sent to the researchers
2. trying to ascertain more completely a way for householders to remember their previous energy retailers. Many of the houses visited had changed retailer over the previous three years and a reasonable number of them could not remember who the retailer was which made it more difficult to gather the historical data that inevitably created gaps in the data that was available to be analysed.

3.3 Using Energy Bills

Electricity and gas bills are generally the most inexpensive and readily available way to measure household energy consumption, which is why they were used for this research. They are not however a simple and straightforward way of determining exactly what the energy was used for. Consequently, there are some significant limitations to this method, and these are described below.

The strengths of using energy bills include the following:

(a) data is available over longer periods of time
(b) often more affordable than using direct monitoring
(c) data readily available for all households
(d) they are generally very accurate
(e) they are a source of not only energy data but, costs, tariffs, concessions and emissions
(f) in some cases provide a year of quarterly historical bar graph energy use data.

The best way to get an accurate picture of energy use for cooling (and heating) is to install data logging equipment to monitor the energy directly at end-use. Monitoring equipment is usually located in the electricity or gas meter box and data collected at 15 minute or 30 minute intervals. Total household energy use is generally collected as well. Logging equipment is left in place, ideally over a one year period, and the percentage of total home energy use for heating and cooling can then be accurately determined. However, though this is the ideal procedure it is expensive and time consuming.

The next best option for data collection is to use homes with ‘interval’ or ‘smart’ meters that provide the retailer with ½ hourly electricity usage data. Unfortunately at a national level most homes are not yet equipped with these meters, although they are being rolled out gradually in many locations.

4 Results

This chapter of the report presents the results from the survey questionnaire, energy audits, billing data and temperature loggers. It also goes one step further and presents these results holistically in a set of 6 household case studies.

4.1 Air conditioning Survey Summary

The energy audit carried out during this project included a detailed air conditioning survey. The complete results are given in Appendix 3 and the average results are given below in Table 4.1.1. The survey included some questions from the original MS Longitudinal Study, as well as some additional questions. The number of contributors to the survey was 36, as 2 of the 38 participant homes had recently changed residency.

Table 4.1.1: Summary of results from air conditioner survey

	Average	Yes	No	No Answer
How hot is it outside when you usually turn your air conditioner on?	**29 C**			
How old is your air conditioner?	**7.3 yrs**			
Summer thermostat	**23.1 C**			
Winter thermostat	**22.5 C**			
How many hrs would air con be used on HOT summer day when temp > 30C	**10.4 hrs**			
Hrs air con on an AVERAGE hot summer day when temperature 25 to 30 C?	**3.4 hrs**			
In addition to an air conditioner, do you have any other home modifications that help you keep cool? Please note any that apply				
External window blinds, awnings, or other coverings		**63.9%**		**36.1%**
Internal window blinds, awnings, or other coverings		**63.9%**		**36.1%**
Roof Insulation		**63.9%**		**36.1%**
Roof Vents		**11.1%**		**88.9%**
Wall Insulation				**100.0%**
As a person with MS, what happens to you when you get too hot? (Tick all that apply):				
Nothing I cope just fine				**100.0%**
I lack energy and require more rest		**94.4%**		**5.6%**
Apart from fatigue, my other symptoms of MS become worse		**72.2%**		**27.8%**
I am unable to participate in normal social activities (time with family or friends)		**75.0%**		**25.0%**
I am unable to do my normal household duties (eg cleaning, cooking, etc.)		**69.4%**	**2.8%**	**27.8%**
I am unable to work effectively		**63.9%**		**36.1%**
I am unable to look after myself in the usual manner		**27.8%**	***2.8 %****	**69.4%**
I need more medication to cope		**8.3%**	**8.3%**	**83.3%**
I have felt sufficiently unwell to require a doctor or other health professional		**8.3%**	**2.8%**	**88.9%**
I have been hospitalised because of heat		**13.9%**	**2.8%**	**83.3%**
siezures		**2.8%**	**2.8%**	**94.4%**
physical collapse		**33.3%**		**66.6%**
loss of motor function		**52.8%**		**47.2%**
			**** sometimes***	

In relation to wall insulation, the fact that 100% of homeowners said there was 'none' could indicate that some may not have known whether there was any or not but answered in the negative anyway.

As expected it can be seen that a majority of participants in this research with MS do in fact experience a number of adverse symptoms during hot weather. Many of the questions used in this survey mirror questions that were asked in the previous *Keeping Cool Survey* (Summers & Simmons 2012), and some comparisons are useful for considering the group participating in this survey relative to the previous extensive national survey of 2,384 respondents. The

average temperatures at which people turn on their air conditioners to get cool were essentially identical in both surveys: 29°C in this survey compared to 29.2°C previously. Efforts to improve thermal efficiency are slightly higher for this group than in the previous survey, for instance external window coverings at 63.9% compared to 40% previously. Comparison of the results in relation to what happens to the person with MS when they get too hot, respondents in this current survey generally identified higher incidences of problems occurring. For instance, 94.4% reported reduced energy and needing more rest, compared to 82% previously, and 75% reported being unable to participate in their usual social activities compared to about 46% previously. A much larger proportion reported having been hospitalized because of heat – 13.9% compared to about 3% previously. Data from the earlier Keeping Cool Survey is a valid and robust description of the national MS population given the quality of the sampling frame used and that well over 10% of the total estimated number of people with MS in Australia were surveyed. Not surprisingly, given the smaller sample here there is some variation from national averages and it would appear that in comparison nationally, this survey sample is impacted somewhat more by heat than the national average would indicate.

4.2 Electricity and Gas Bills

The data from the air conditioning survey was combined with data from energy bills, and the following information extracted for use in analysis;

- Household occupancy
- Gas and/or electricity use per season
- Gas and/or electricity costs per season
- Whether home has solar PV or a solar water heater
- Concessions - if available
- Air conditioner type plus any other air conditioner information from the survey
- Energy efficiency initiatives noted

Additionally, using the Energy Made Easy web site a comparison was made of summer and winter household electricity use with the state or post code average – whichever was applicable.

Tables of results are in Appendix 3 and divided into three parts:

- All available data
- Homes that do not have solar
- Homes with solar (photovoltaics and/or solar hot water)

A summary of results are presented below in Table 4.2.1.

Table 4.2.1: Summary of air conditioner and billing data surveys

Air conditioning and Billing Data	Average All Homes	Ave All Homes with Billing Data	Ave of Homes with No Solar	Ave of Homes With Solar
How hot is it outside when you usually turn your air conditioner on?	29.0 C	29.0 C	29.2 C	28.3 C
How old is your air conditioner?	7.3 yrs	7.7 yrs	8.3 yrs	5.9 yrs
Summer thermostat	23.1 C	23.1 C	23.2 C	23.0 C
Winter thermostat	22.5 C	22.9 C	22.7 C	19.5 C
How many hrs would A/C be used on HOT summer day when temp > 30C	10.4 hrs	10.7 hrs	11.2 hrs	9.3 hrs
Hrs A/C on an AVERAGE hot summer day when temperature 25 to 30 C?	3.4 hrs	3.5 hrs	4.1 hrs	1.5 hrs
Number of Persons in Home		2.5	2.5	2.5
Annual Energy Bill (Electricity + Gas) $/y		$2,068	$2,350	$1,174
Summer Electricity Use > or < State Ave (%)		16.8%	32.2%	-32.0%
Winter Electricity Use > or < State Ave (%)		10.5%	13.0%	2.8%

The results showed that participant households used, on average, about 16.8% more electricity in summer and 10.5% more electricity in winter than the state or post code average. This increased to 32.2% more in summer when the 24% of homes with solar PV are removed. Not only do solar PV systems have maximum impact on peak loads in summer but the Energy Made Easy web site data was developed using historical data taken at a time when the percentage penetration of solar PV would have been less than 5%, so impact of solar on the resulting average electricity use would have been small. In 2014 the penetration of PV on SA households is now 24% - the highest penetration in Australia.

Table 4.2.1 shows that the homes that had solar installed tended to have newer air conditioners, set their thermostats lower than average in winter but not in summer and used their air conditioners less in both summer and winter. Their average energy bills ($1174/y) were approximately 50% less than the non-solar households, and they used about 32.0% less electricity than the state averages in summer.

Table 4.2.2 shows the household summer electricity use greater than or less than the state averages for non-solar homes, along with energy cost from energy bills and number of persons in the home. The non-solar homes tended to have higher annual energy bills compared with the overall average, $2350/y compared to $2068/y. When the data of the non-solar group was analysed more closely it was found that;

- about 60% of homes used more electricity than average in summer, and on average they used ~80% more.
- the remainder of homes that used less, ~18% less than the state averages were predominantly found to have introduced energy savings initiatives and were careful about energy use. None had ducted refrigerative air conditioners – 12.5% had window/wall, 25% evaporative and 67.5% split system air conditioners.

Table 4.2.2: Summer and winter electricity use compared to state averages for non-solar homes

	Summer Electricity Use > or < State Ave (%)	Persons	Winter Electricity Use > or < State Average (%)	(Electricity + Gas) Bill ($/y)	State
	251.6%	4	172.3%	$5,950	VIC
	248.0%	2	200.0%	$4,100	VIC
	108.7%	4	89.4%	$4,100	QLD
	94.5%	2	24.1%	$2,677	SA
	72.0%	3	-1.2%	$3,338	SA
	29.7%	1	40.1%	$1,360	QLD
	19.7%	2	-8.8%	$2,000	SA
	18.5%	2	15.8%	$2,250	VIC
	18.0%	2	8.1%	$3,000	VIC
	14.0%	4	58.8%	$3,347	NSW
	4.1%	2	-31.1%	$2,140	SA
Average of homes with a positive difference	*80%*	*2.5*	*52%*	*$3,115*	
	-9.2%	1	-40.3%	$750	VIC
	-15.5%	4	-21.4%	$605	QLD
	-21.0%	4	-8.7%	$3,180	VIC
	-23.2%	4	-32.6%	$1,400	VIC
	-42.2%	1	-29.2%	$910	SA
	-48.2%	2	-56.1%	$1,350	VIC
	-50.9%	2	-55.4%	$1,085	SA
	-56.0%	2	-77.0%	$1,105	SA
Average of homes with a negative difference	*-18%*	*2.5*	*-30%*	*$1,564*	
AVE of TOTAL	**32.2%**	**2.5**	**13.0%**	**$2,350**	

A number of graphs were plotted using available data to see whether any correlations could be found between occupancy, costs, usage hours on hot days etc. Little correlation was found, however, a selection of the graphs is shown below and in Section 4.4 to illustrate common usage patterns and other details.

Figure 4.2.1 shows the annual energy bill taking into account number of persons in the home. The households with solar have been included in this figure, which clearly shows that the solar homes have cheaper bills. Figure 4.2.2 shows the summer electricity use greater than each state's average taking into account number of persons in the home. The high outlying points on both graphs are from two homes with underfloor heating which is expensive to operate.

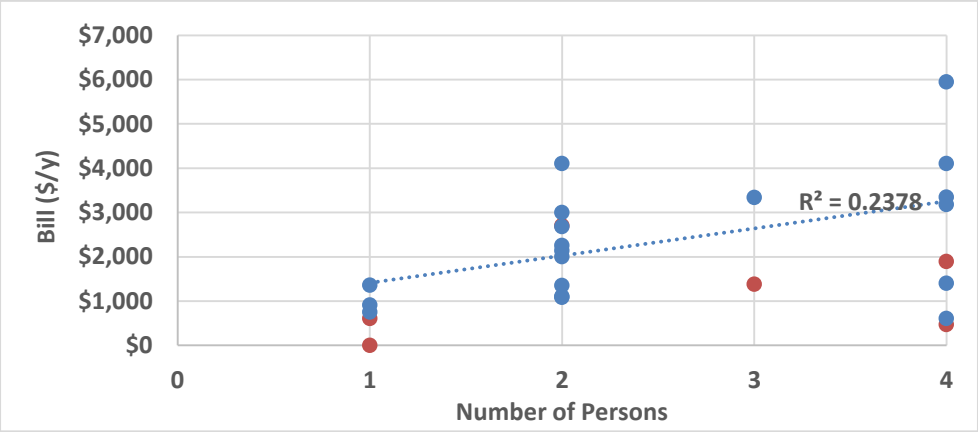


Figure 4.2.1: Annual energy bill taking into account number of persons in the home. (Red Points are Solar Homes)

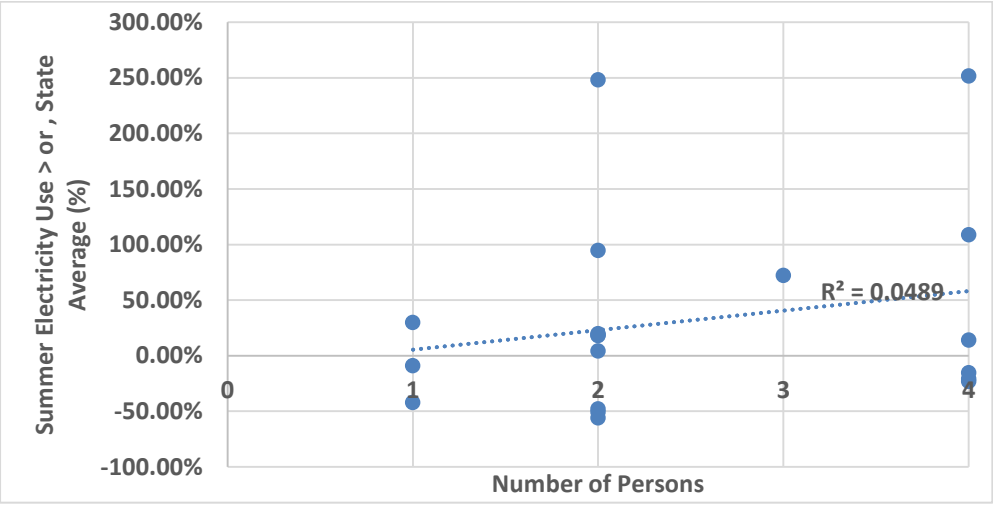


Figure 4.2.2: Summer electricity use greater than or less than the state average (%) taking into account number of persons in the home

Two reasonably strong data correlations found in the analyses were as follows:

- Annual energy bill relative to electricity use greater or less than the relevant state averages (Figure 4.2.3)
- Summer relative to winter energy use being greater or less than the relevant state averages (Figure 4.2.4).

Figure 4.2.3 indicates that as summer electricity use greater than the state averages increases, so do the energy bills and that the converse is true also. Figure 4.2.4 shows that if the summer use is greater than the state average, then in the main so also is winter electricity use.

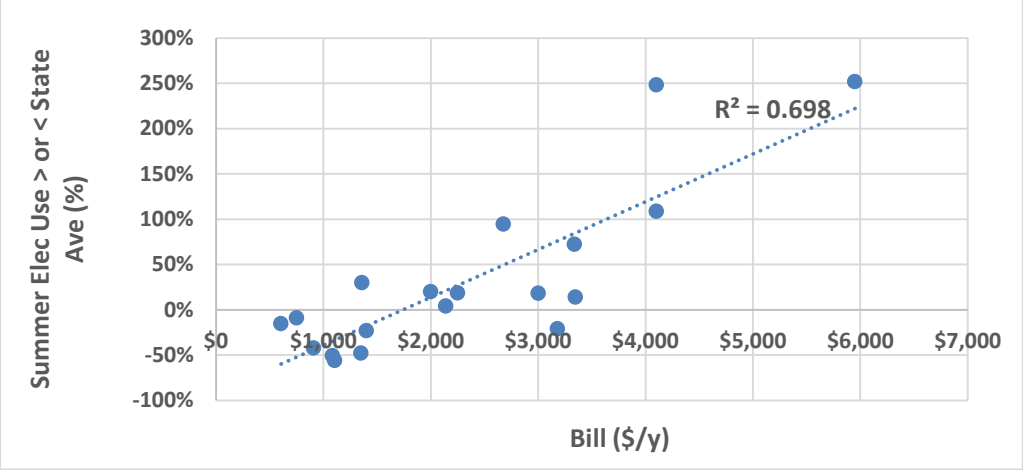


Figure 4.2.3: Relation between annual bill and summer electricity use

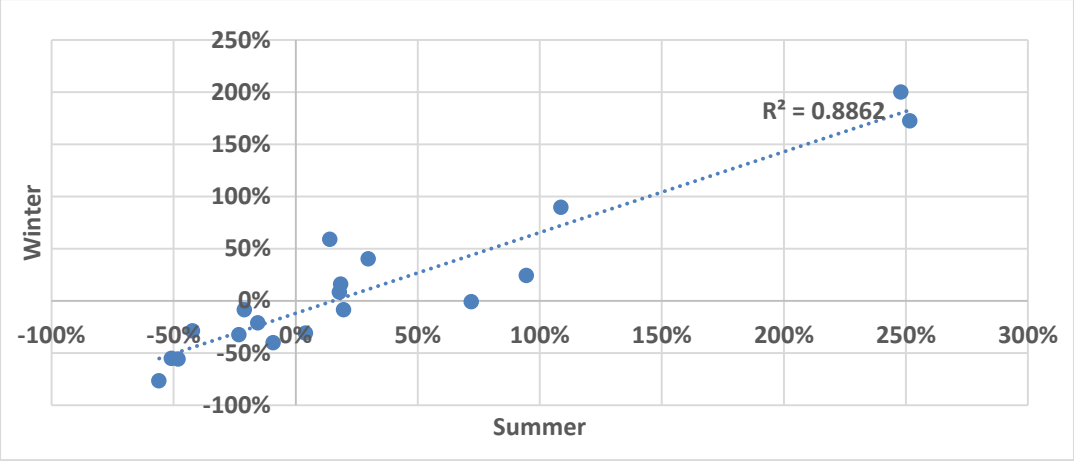


Figure 4.2.4: Relation between summer and winter electricity use > or < state or post code average

4.3 Impact of Air conditioner Type

There were 36 homes involved in the air conditioning survey. The distribution of air conditioner types between States is shown below in Table 4.3.1. Most participants in the survey were in SA and Victoria.

Table 4.3.1: Distribution of air conditioner type between States

Air Conditioner Type	SA	Vic	Qld	NSW	Total
Evaporative (Ducted)	11.1%	5.6%			16.7%
Refrigerative (Ducted)	13.9%	5.6%	2.8%		22.2%
Split Refrig (No Duct)	13.9%	25.0%	5.6%	2.8%	47.2%
Window/Wall (No Duct)	5.6%	5.6%	2.8%		13.9%
Total (%)	**44.4%**	**41.7%**	**11.1%**	**2.8%**	**100.0%**

It can be seen that the most prominently represented air conditioners - almost half at 47% - were split refrigerative systems with the majority in Victoria. Ducted refrigerative systems (22.2%) were the next most common with the majority in SA.

The analysis presented in Table 4.3.2 was undertaken in order to determine whether any particular air conditioner type was used for longer periods of time once the temperature was greater than 30° C and at what temperature on a hot day they were switched on. The results indicate that in the sample of homes both of the ducted air conditioner types – evaporative and refrigerative – were on average used for longer periods of time. However, Queenslanders used their air conditioners longer than in the other states except for the small window/wall systems of which there was only one in the Queensland sample, so no conclusion can be drawn from it.

If just SA and Victoria are compared then Table 4.3.2 indicates that for every air conditioner type, Victorians used their systems longer by an average of almost 4 hours than the people in SA. Also people with MS in SA turned their air conditioner on at higher temperatures than those in Victoria by an average of 2.1 C (30.1 C compared with 28.0 C). This follows the trend noted in the Keeping Cool Survey that people with MS in cooler climates turn on their air conditioners at lower temperatures compared to people with MS in warmer climates.

Table 4.3.2: Number of hours air conditioners used when temperature was greater than 30 C and temperatures when air conditioners are switched on, by air conditioner type

	A/C Hrs >30C	Temp A/C on Deg C	A/C Hrs >30C	Temp A/C on Deg C	A/C Hrs >30C	Temp A/C on Deg C	A/C Hrs >30C	Temp A/C on Deg C	A/C Hrs >30C	Temp A/C on Deg C
Air Conditioner Type	SA		Vic		Qld		NSW		Average	
Evaporative (Ducted)	9.0	31.0	17.0	30.0					**11.7**	**30.7**
Refrigerative (Ducted)	9.0	29.8	13.5	26.0	20.0	32.0			**11.5**	**29.1**
Split Refrig (No Duct)	9.6	28.0	10.0	27.3	16.0	30.0	13.0	30.0	**10.2**	**28.2**
Window/Wall (No Duct)	7.5	31.5	10.0	28.5	6.0	27.0			**8.2**	**29.4**
Average	**8.8**	**30.1**	**12.6**	**28.0**	**14.0**	**29.7**			**10.4**	**29.3**

From the analysis of electricity bills in the 19 homes with no solar Table 4.3.3 was developed to see whether there was any noticeable difference in average electricity use and annual energy (gas plus electricity) costs in homes with different air conditioner types.

Table 4.3.3: Energy use by air conditioner type in non-solar homes

Type of Air Conditioner	Summer Electricity Use > or < State Ave (%)	(Electricity + Gas) Bill ($/y)
Evaporative, Ducted	-3%	$2,134
Window/wall	2%	$1,428
Split, not ducted	29.1%	$2,224
Refrigerative , Ducted	125%	$3,329

For this sample it is quite noticeable that homes with ducted refrigerative air conditioners use more electricity and have higher annual energy bills. Homes with window/wall air conditioners are likely to be smaller and the air conditioning confined to single rooms – therefore the lower electricity use and running costs. This is also consistent with the lower hours of use seen in the previous Table 4.3.2. Ducted evaporative air conditioners used the least electricity as they have lower input power and are more efficient than ducted refrigerative systems in areas of low humidity. They are frequently associated with gas heating, particularly in SA, and the annual energy bills are virtually the same as those in homes that use split system air conditioners for both heating and cooling. Part of the reason for similar costs is the need to pay two supply charges (gas and electricity) and the lower efficiency of gas space heaters (0.75 – 0.85) compared with that of split system reverse cycle air conditioners for heating (2.5 – 4), i.e. splits are about 4 times more efficient.

4.4 Electricity Bills and Summer Energy Use between States

In relation to electricity bills and energy use, the concessions people were receiving were included as part of the analysis. Just under half of the people with MS whose bills were collected (11 of the 25) received a concessional payment. Of these, five received both the all year round pensioner concession and medical cooling concession, four from Victoria and one from NSW.

SA introduced its medical heating and cooling concession on 1st January 2012 and there was no evidence of SA participants receiving this on their bills – either they were not eligible or the information on its availability was not known or their retailer had not delivered it yet. The sample sizes in NSW and Qld are too small to make any comments on their concessions. However, Case Study 6 describes how electricity tariffs and concessions have changed in NSW between 2009 and 2013.

A calculation was made of concessions as a percentage of what the bill would have been without a concession, i.e. (Concession)/(Concession +Total energy Bill) and this is shown in the Table 4.4.1. Additional information is provided in Case Study 6.

Table 4.4.1: Concessions as a proportion of energy bills

State	Households with Concessions	Proportion of Bill (%)
NSW	1	4.9
SA	5	5 - 14
VIC	5	18 -21

Table 4.4.2 compares electricity bills and summer energy use between states, after the state concessions have been applied. It shows that Victoria has much higher energy bills and electricity use than SA. However, the Victorian results are dominated by two very large bills – both from homes with under floor heating which are notorious for high energy use. If they were not included then Victorian bills would be on a par with the rest, indicating the problem of averages with small sample sizes. Nevertheless inclusion of the high bills provides a valuable reminder of how appliance choice can impact significantly on bills.

Table 4.4.2: Electricity bill comparisons for non-solar homes (concession inclusive) by state

State	(Electricity + Gas) Bill ($/y)	Summer Electricity Use > or < State Ave (%)
NSW	$3,347	14%
Queensland	$4,100	108.70%
	$1,360	29.70%
	$605	-15.50%
AVERAGE	**$2,022**	**41.0%**
South Australia	$2,677	94.5%
	$3,338	72%
	$2,000	19.70%
	$2,140	4.10%
	$910	-42.20%
	$1,085	-50.90%
	$1,105	-56%
AVERAGE	**$1,894**	**5.9%**
Victoria	$5,950	251.60%
	$4,100	248.00%
	$2,250	18.50%
	$3,000	18.00%
	$750	-9.20%
	$3,180	-21.00%
	$1,400	-23.20%
	$1,350	-48.15%
AVERAGE	**$2,748**	**54.3%**

The average energy bill for all homes in Table 4.4.2 is $2350 and average electricity use greater than the State (or postcode) average is 32.2%.

Regarding Concessions, 44 % of homes that provided electricity bills received a concession (11/25) and 58% (11/19) of non-solar homes.

To see the impact of concessions on all homes, by state and including both solar and non-solar homes, Table 4.4.3 was compiled.

Queensland was the only state where none of the participants received a concession. Concessions in both NSW and SA are fixed amounts regardless of energy use – see Table 2.7.1.

In NSW the solar home listed that received a concession had an additional concession for Life Support.

In SA the fixed annual concession is $165 + GST = $182. This amount has recently doubled for those eligible for a medical heating and cooling concession, however, it has not yet shown up as a credit in the energy bills made available to the project.

Table 4.4.3: Bill comparisons for solar and non-solar homes (showing concessions) by state

State	(Electricity + Gas) Bill ($/y)	Concession (Total) $/y	Bill + Concession ($/y)	Concession % (Bill+Concession)
VIC	$3,180		$3,180	
	$3,000	$656	$3,656	17.9%
	$5,950		$5,950	
	$1,350		$1,350	
	$2,250	$506	$2,756	18.4%
	$750	$250	$1,000	25.0%
	$1,400	$362	$1,762	20.5%
	$4,100	$974	$5,074	19.2%
Solar	$2,700		$2,700	
Average Vic	$2,742	$550	$3,048	20.2%
SA	$2,000	$181	$2,181	8.3%
	$3,338	$184	$3,522	5.2%
	$2,140	$135	$2,275	5.9%
	$2,677	$181	$2,858	6.3%
	$1,085		$1,085	
	$1,105	$182	$1,287	14.1%
	$910		$910	
Solar	$1,380	$181	$1,561	11.6%
Solar	$1,890		$1,890	
Solar*	$0		$0	
Solar	$470		$470	
Average SA	$1,545	$174	$1,640	8.6%
QLD	$1,360		$1,360	
	$4,100		$4,100	
	$605		$605	
Average Qld	$655		$655	
NSW	$3,347	$233	$3,580	6.5%
Solar	$605	$300	$905	33.1%
Average NSW	$1,976	$267	$2,243	19.8%
AVERAGE ALL	$2,068	$319	$2,246	14.8%

*Home used to receive a concession – however, as bill was in credit for $5000 the concession was removed. (All bills are GST inclusive)

In Victoria, the pensioner concessions is a fixed 17.5% of the bill all year round with the possibility, of an extra 17.5% natural gas winter heating contribution (May to October) and, depending on eligibility, an extra Medical Summer Cooling concession of 17.5% on summer electricity bills (November – April). The Victorian concessions are calculated on the remaining account balance once any retailer discounts and/or solar credits have been applied.

Table 4.4.3 does not indicate that any person in Victoria receives the full 35 % discount, however, there are a number of factors that influence the percent of bill concession in Victoria. For example

- gas and electricity could be delivered by different retailers with different discount programs,
- the gas heating rebate is for 6 months only as is the medical cooling concession and some may not get either or both

Therefore the total concession in Table 4.4.3, which includes both electricity and gas concessions, will rarely show 17.5% or 35 % of the total bill.

An example of a very favorable quarterly September to December 2012 concessional electricity bill in Victoria is shown below to demonstrate the various components that can make up a bill. Most bills are much simpler than and not as generous as this.

Charges (ex GST)

Energy Charge	$130.46
Supply Service Charge	$95.82
Total	$226.28

Credits (ex GST)

Annual Reward	$25
Medical Cooling Concession	$24.04
Annual Electricity Concession Less Carbon Price Threshold	$31.93
2% Energy Reward	$4.53
Off Peak Concession	$9.92
Total	$95.42

Bill = $130.86 + GST = $143.95

In this case the Medical Cooling plus Pensioner Electricity Concession less carbon price threshold is 42.8 % of the bill.

Suppose the only credits were the concessions, then the percent of bill would drop to 24.7 %.

Except where solar customers still get concessions, the Victorian fixed percentage of bill concessions are more favorable and equitable than the fixed concession amount and should be recommended for other States to follow.

Table 4.4.4 shows bills and concessions for concession homes with no solar. For comparison the bills and concessions for solar homes are given as well – noting that only half the solar homes received a concession. Nevertheless even comparing bills of non-solar homes with concessions added with solar homes where they are not – ie $2358 compared with $1277, solar home bills are about half. Since solar incentive tariffs no longer exist a new and larger study should be undertaken to determine current bill reduction benefits of new entrant solar households.

Table 4.4.4: Bills and concessions for non-solar homes with a concession including a comparison with all solar homes

State	(Electricity + Gas) Bill ($/y)	Concession (Total) $/y	Bill + Concession ($/y)	Concession % (Bill+Concession)
Victoria	$2,300	$550	$2,850	20.2%
SA	$2,252	$173	$2,425	8.0%
NSW	$3,347	$233	$3,580	6.5%
Non Solar Ave	**$2,358**	**$351**	**$2,710**	**13.5%**
Solar ave	**$1,174**	**$103**	**$1,277**	**48.2%**

4.5 Data from Temperature Loggers

From the sample of 38 homes, 9 were selected to have monitoring equipment installed (3 in Adelaide, 4 in Melbourne and 2 in Sydney), so that the temperature in the bedroom and/or the living area of the home of the person with MS could be monitored. This enabled the temperature levels and the pattern of air conditioning use in these homes to be determined.

Table 4.5.1 shows average temperature data for the two households with people with MS (PwMS) and nine other households without PwMS in Adelaide. The data for the households without PwMS was taken from Lochiel Park, an energy efficient housing development. The data was taken from 9:30am to 8:30pm, from December 2012 to February 2013. Table 4.5.1 shows that the average temperature in the homes with PwMS was 1.5°C lower than the homes without PwMS. Furthermore, the temperature in the households without PwMS was on average at 27°C or greater for 150 hours (i.e. 52%) more than the households with PwMS.

Table 4.5.1: SA indoor temperature summary (average from December 2012 to February 2013, from 9:30am to 8:30PM)

SA households without PwMS		
House No.	**average indoor temperature**	**hours indoor temperature = 27°C or more**
1	27.8	566
2	27.2	578
3	26.2	358
4	27.2	526
5	27.1	507
6	26.4	408
7	26.3	358
8	25.9	260
9	26.5	393
Average	26.7	439
SA households with PwMS		
1	24.5	192
2	25.8	385
Average	25.2	289

A comparison was also made for 2 homes with PwMS to 7 homes without PwMS for Sydney. Table 4.5.2 shows average temperature data for the two households with PwMS and seven other households without PwMS. Since Sydney has a milder weather, only days with a maximum temperature above 35°C were analysed. The data is taken from 9:30am to 8:30pm. Table 4.5.2 shows that the average temperature in the homes with PwMS was 0.8°C lower than the homes without PwMS.

Table 4.5.2: Indoor temperature in Sydney households with and without PwMS on hot days with maximum temperature over 35°C (Average from 9:30am to 8:30pm).

Day	Max outdoor temperature	Indoor temp of homes with PwMS	Indoor temp of homes without PwMS
23/12/2012	36.6	26.1	27.1
24/12/2012	37.6	26.5	27.2
5/01/2013	37	25.7	26.6
8/01/2013	41.1	25.8	27.4
8/02/2013	35.4	25.4	26.1
9/02/2013	35.7	26.7	26.5
Average		26.0	26.8

4.6 Case studies

The *Keeping Cool Survey* (Summers & Simmons 2012) provided a broad view of the impact of heat intolerance on the electricity bills of people with MS as a consequence of their need to keep cool during hot weather. The present research provides some important depth to this picture, and this case study section takes this depth a bit further. These case studies are a useful analytical tool to illustrate the details of several households and demonstrate the interaction of multiple factors. Importantly, these case studies also help go beyond the averages and emphasize that these are households of individuals whose lives and living situations vary considerably. They draw on the results of the audit study summarized in Appendix 4

Six case studies are described. Studies 1 – 5 were chosen to demonstrate how heating, cooling and other appliance choice plus energy efficiency initiatives and Solar PV impact on energy use and costs. In particular Case Studies 1 and 2 were chosen because both homes were situated in the same postcode area, both had 2 people living in the homes and both had room temperature monitoring to determine whether homes of people with MS tend to maintain them at lower temperatures than the general public in summer thereby causing higher electricity bills.

Case Study 6 demonstrates electricity price rises between 2009 and 2013 and compares them with the concession changes over the same period.

The project did not take into account the severity or stage of a participant's medical condition or the family's behavioural use of energy – both of which could have significant impact on energy use.

Note: In all Case Studies the graphs plotted are in kWh/day for both gas and electricity. Normal convention is to use MJ/day for gas but for ease of comparison kWh/day has been

used for both (1 kWh = 3.6 MJ). Also post code, zone and State average electricity use plotted for comparison were taken from the Energy Made Easy web site - http://www.energymadeeasy.gov.au/ .

Case Study 1: South Australia - Postcode 5107(a)

This is the first of the 2 homes both in the same post code area, therefore both experiencing the same weather conditions, and both with an occupancy of 2 people.

- ***Number of persons in the home****:* 2
- ***Major Gas Appliances***: Instantaneous gas hot water and gas cooking
- ***Major Electrical Appliances***: Ducted reverse cycle air conditioner, clothes dryer, 4 fridges and freezers.
- ***Site Electricity Use****:* Between 2011 and 2014 the average daily electricity use exceeded the State average by 94.5% in summer and by 24.1% in winter.
- ***Impact of High Temperature on people with MS***: Lack of energy and more rest required.

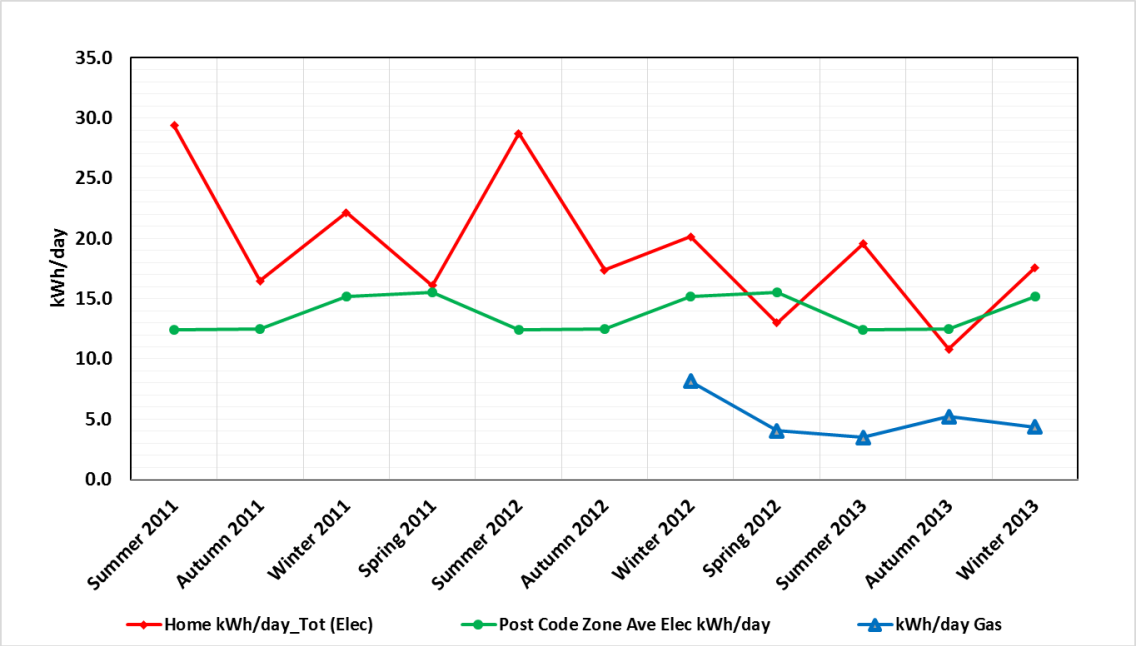


Figure 4.6.1: Case Study 1 - showing household seasonal electricity and gas usage (kWh/day) compared with electricity postcode average.

The plot of electricity and gas usage in kWh/day indicates that there were some changes made after the high electricity use in the summer of 2012. Unfortunately it is not known what these changes were but they resulted in an annual electricity reduction from 7546 kWh/y in 2011/12 to 5559 kWh/y in 2012/13 – a decrease of 26%. Perhaps the summer quarterly electricity bill of $1008 (not including concession, $963 with concession) was the incentive for reducing electricity use. Or an inefficient electrical appliance was replaced by a more efficient one, or 1 or more of their 4 fridges and freezers were not in use – the latter two are the most likely causes due to the decrease in base load.

The annual electricity cost dropped 15% as a result of changes, from $2781 in 2011/12 to $2413 in 2012/13 – not as great as 26%, due to tariff increases.

Gas use for water heating and cooking was quite modest and raised the total annual bill - gas plus electricity by $445 to $2859 in 2012/13. The concession payment of $181/y was 6.3% of bill.

Note: Energy use for 2012/13 was 5559 kWh/y (electricity) plus 1552 kWh/y (5587 MJ/y) gas giving a total of 7111 kWh/y. When compared with historical analysis from a UniSA study (Oliphant, 2003) that used billing data compiled by the ABS on electricity and gas use in SA homes, it was found that electricity use over the whole year was greater than the state average by about 11.0% (in good agreement with the Energy Made Easy result of 9.6%) and gas consumption was about 70% less.

The energy efficiency initiatives that have been introduced to date are shown below and look reasonably comprehensive. However, the air conditioner survey indicates that their ducted reverse cycle system is now 11 years old and could be due for some servicing and checking of the condition of ducts. Though it is not known why four refrigerators and freezers are needed, rationalizing these could reduce costs.

Home energy efficiency initiatives,

- roller shutters for all windows and thick curtains,
- ceiling insulation - topped up in 1997,
- veranda to rear of house for shade,
- zoning - can close off lounge room from rest of house to aid with heating and cooling,
- ceiling fans in bedroom and lounge.

Case Study 2: South Australia - Postcode 5107(b)
Second of the two homes in the same post code area.

- ***Number of persons in the home****:* 2
- ***Major Gas Appliances***: hot water and main heating
- ***Major Electrical Appliances***: Ducted evaporative air conditioner, 1 fridge and freezer, 2.4 kW portable electric heater
- ***Site Electricity Use****:* Between 2011 and 2014 the average daily electricity use for this home was always consistently a great deal less than the state average by 56% in summer and by 77% in winter. Electricity use in summer was greater than in winter, but this is probably because winter heating is with gas.
- ***Impact of High Temperature on people with MS***: Aggravated symptoms of MS are present when the weather gets too hot, plus lack of energy, unable to participate in normal social activities, do normal household duties and more medication is needed.

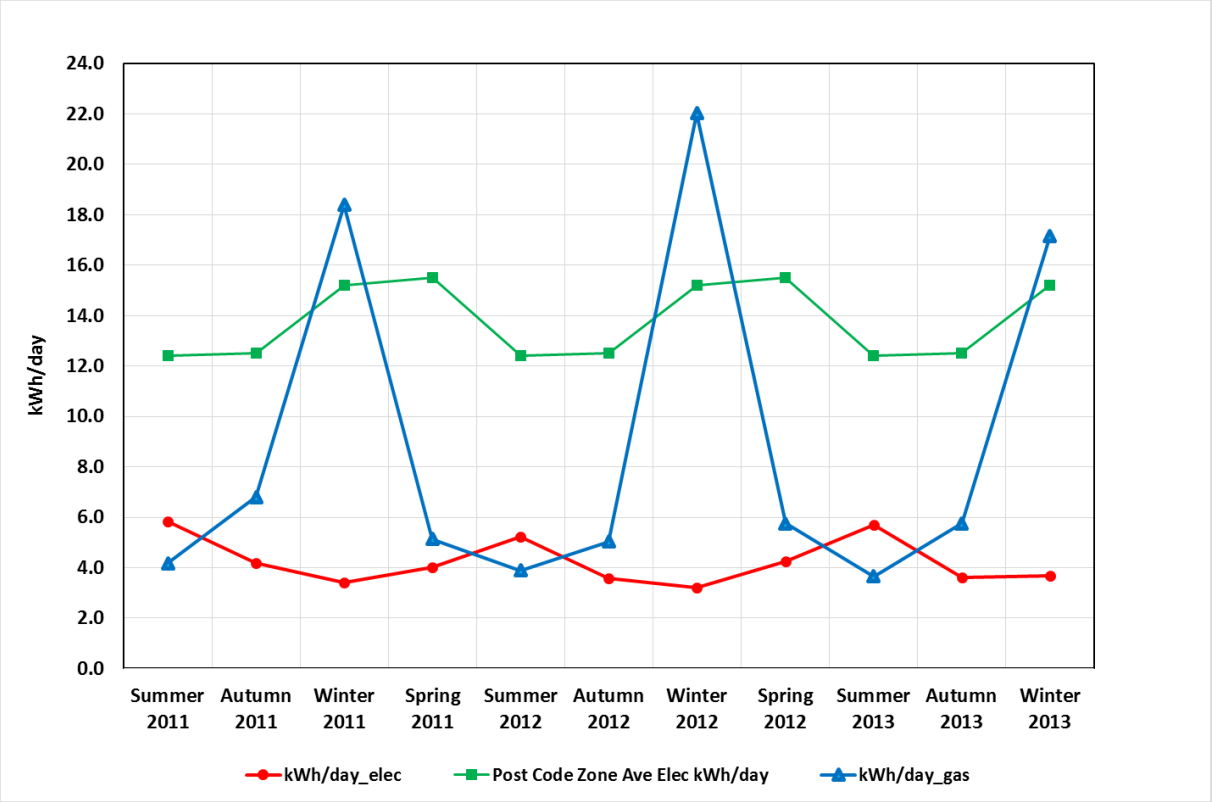


Figure 4.6.2: Case Study 2 - showing household seasonal electricity and gas usage (kWh/day) compared with electricity postcode average.

Though this home and the one in Case 1 are both located in the same postcode region and both have an occupancy of 2 and receive energy concessions, their energy use and bills are significantly different with the Case 2 home using about 40 % less energy and having a bill about 50 % less. Possible causes are:

- the Case 2 home has a ducted evaporative rather than a ducted reverse cycle air conditioner
- more has been done to reduce heat gain in Case 2 – see below in energy efficiency initiatives and people appear to be energy conscious.
- from the energy audit the number of electrical appliances in the Case 2 home appears to be less – eg one rather than four refrigerators and freezers and no dryer.

The plot of electricity and gas usage in kWh/day indicates fairly consistent and low electricity and gas use over the period 2011 – 2013. The annual electricity use was 1569 kWh/y in 2012/13 and gas use 2903 kWh/y (10452 MJ/y), i.e. total annual energy use of 4472 kWh/y. The electricity bill was also modest at $717 without the concession and $535 with it. The annual gas bill was $570 resulting in a total bill of $1287/y. The concession payment of $182/y was 14.1% of the bill. Though gas use looks high it only appears this way because electricity use is so low. In reality, from the UniSA study (Oliphant 2003), gas consumption is about 40% less than average for a 2 person home in SA with gas water heating and main space heating.

Home energy efficiency initiatives

- Three front windows (lounge and x 2 bedrooms) have reflective film to reduce heat gain,
- pedestal fan used where possible,
- 2 'whirly birds' to vent heat from roof space,
- roller shutters to bedroom windows,
- canvas awnings and Holland blinds with pelmets to most other windows,
- veranda to rear of house provides shade.

It is apparent that significant thought has gone into keeping heat out in summer and in during winter. The evaporative air conditioner is 13 years old and if there has not been regular servicing this could further reduce electricity usage.

Case Study 3: Victoria - Postcode 3113

This home demonstrates how very high bills can be achieved with under floor heating. Also there is a query whether the correct concession is being paid.

- ***Number of persons in the home:*** 2
- ***Major Gas Appliances:*** storage hot water and main heating was gas hydronic under floor heating – note that under floor hydronic heating is always very energy intensive - expensive to run but very nice to have.
- ***Major Electrical Appliances:*** 2 split system air conditioners,
- ***Site Electricity Use:*** In 2011/12 there was a change of electricity retailer after which there was a slight decrease in electricity use. However, in general this home has very high energy consumption for both electricity and gas. Gas usage is plotted separately to that of electricity as the billing periods did not quite coincide. Average daily electricity use for this home was always consistently significantly greater than the state average and in 2012/13 exceeded average by about 248% in summer and by 200% in winter.
- ***Impact of High Temperature on people with MS***: Aggravated symptoms of MS are present when the weather gets too hot including fatigue, unable to participate in normal social activities, do normal household duties or work effectively and hospitalisation has been needed because of the heat. So it is very important for this person to maintain good cooling levels specific to needs in the home.

The original Electricity Retailer, Lumo, produced good summaries of energy use (copied below in Figure 4.6.3). It shows the very high consumption and costs for this home in 2010/11.

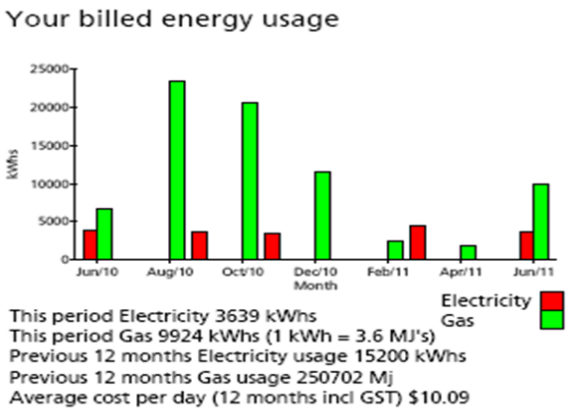


Figure 4.6.3: Lumo joint electricity and gas bill graph of a year of energy use.

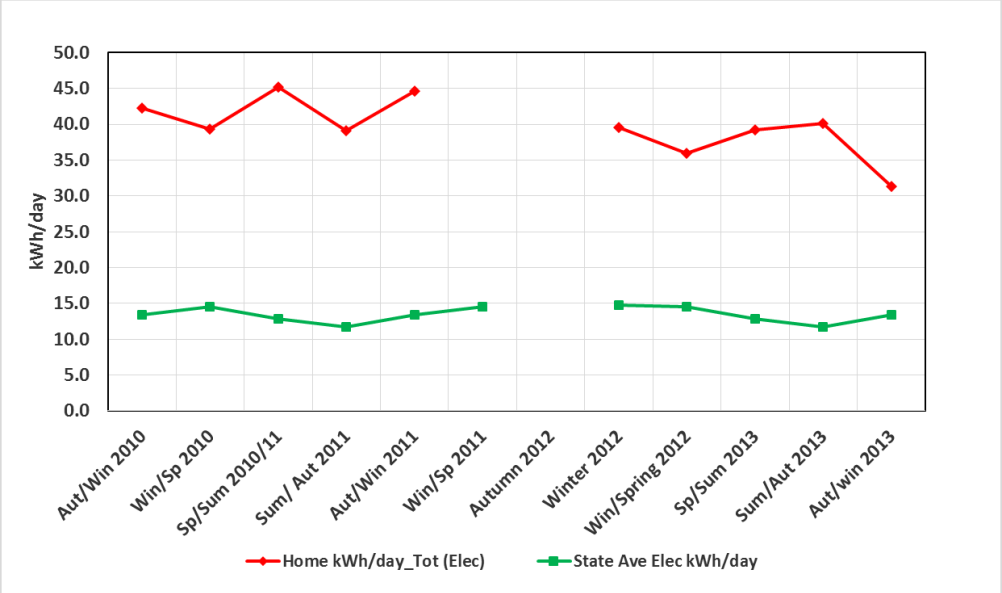


Figure 4.6.4: Case Study 3 - showing household seasonal electricity use (kWh/day) compared with State electricity average (change in Retailer in 2011/12).

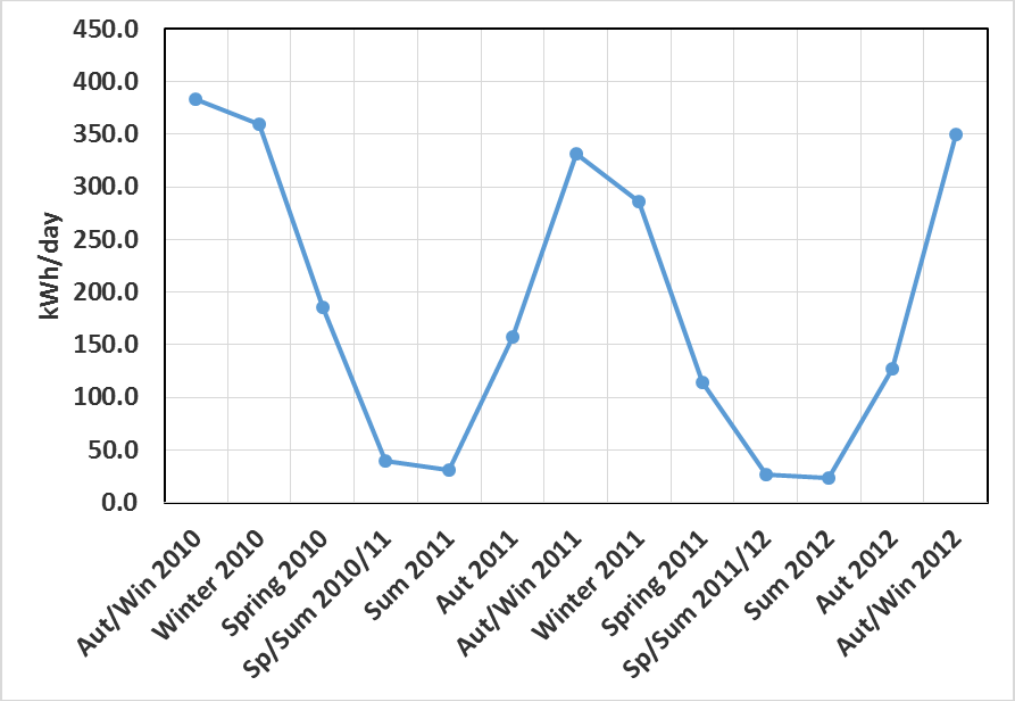


Figure 4.6.5: Case Study 3 - showing household seasonal gas usage (this and previous graph were separated as bill reading dates did not match).

Due to data gaps in the electricity and gas bills, the exact energy use and costs can't be made over equivalent periods but it is assumed that the changes between the years for gas during 2011 to 2013 is not great.

In 2012/13, the annual electricity use was 13,427 kWh and gas for 2011/12 was 55,368 kWh (199,326 MJ) an approximate total of 68,800 kWh/y or 188 kWh/day. Though the audit only mentions in the list of electrical appliances 2 split system air conditioners the variation in electricity use in summer and winter above the base is not great but the base load is very high, about 35 kWh per day indicating some high use appliances on a daily basis. If this could be reduced easily it would provide significant savings.

Bills – electricity: $3096 before $737 concession and gas: $1954 before $236 concession. The total bill before Winter Heating and Medical Cooling Concessions are applied is $5050, which becomes $4076 after the $974 concession credit giving an equivalent power cost of $11.17/day. This is very high for a pensioner household.

The concession was 19.3% of the bill. This is higher than 17.5% as there is a 12% discount for prompt payment. The householder has the same retailer for both electricity and gas; However, the concession on the bill is worded strangely and there could be an under payment. The winter gas concession of 17.5 % is paid but in summer there is just a 17.5 % 'Medical Cooling' concession and for the rest of the year what is called an 'Annual Concession' of 17.5% (there is never a 35% electricity concession). As this household has very high energy bills any extra savings would be beneficial.

Below are the energy efficiency initiatives introduced:

- crystal bond tinting on sun room windows,
- large veranda shades living areas,
- vertical blinds to most windows,
- ceiling well insulated,.

In general vertical blinds will not provide much insulation and window tinting reduces heat gain in winter. The main problem of course is the underfloor heating – which is most likely very desirable for this home. Solar would reduce the cost somewhat, with a 4 kW PV installation possibly reducing mains electricity use by about 50% but would depend on the usage pattern. An expert advisor is needed for this home and then financial help with implementation of recommendations. The air conditioner is quite new – about 3 years old.

Case Study 4 - Queensland - Postcode 4011

This is an example of a home with multiple air conditioners and a swimming pool. Electricity costs are high. Gas is available on site but is rarely used and gas bill comprises 90% service charge and 10% gas use.

- ***Number of persons in the home****:* 4
- ***Major Gas Appliances***: Gas stove cook top
- ***Major Electrical Appliances***: About 5 small split system air conditioners for bedrooms and a larger split in the lounge. Dishwasher, dryer, pool pump and 2 fridge/freezers plus off peak storage hot water.
- ***Site Electricity Use****:* Between 2011 and 2014 the average daily electricity use exceeded the State average by 94.5% in summer and by 24.1% in winter. Note that for this postcode in Queensland there is generally not much seasonal variation in electricity use.
- ***Impact of High Temperature on people with MS***: Aggravated symptoms of MS are present when the weather gets too hot, plus lack of energy, unable to participate in normal social activities and do normal household duties.

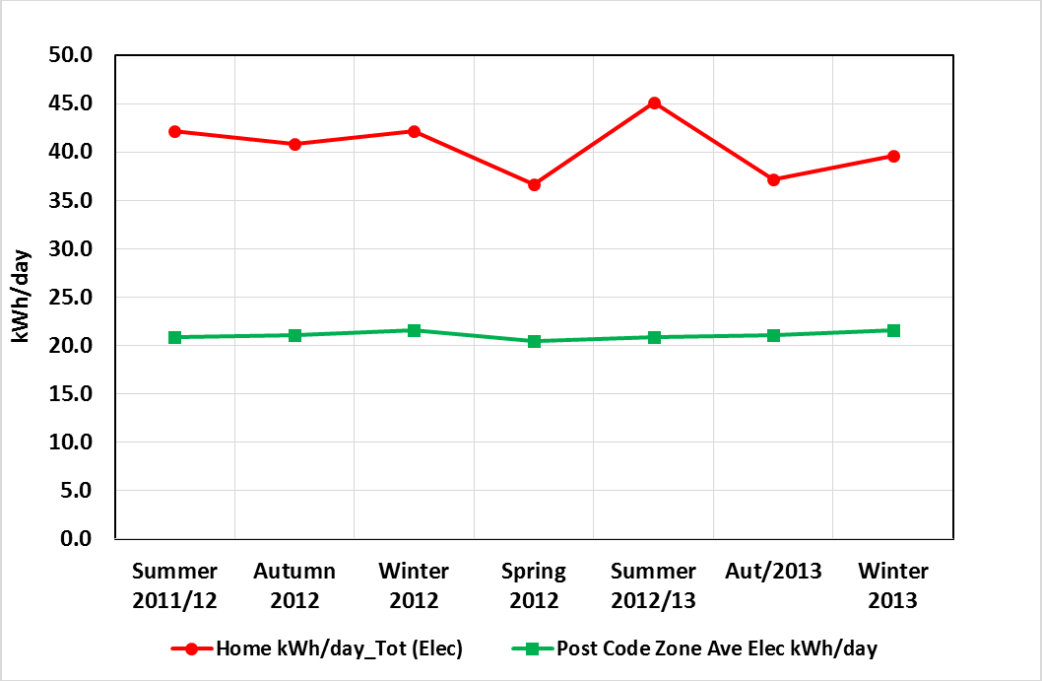


Figure 4.6.6: Case Study 4 - showing household seasonal electricity usage (kWh/day) compared with electricity postcode average.

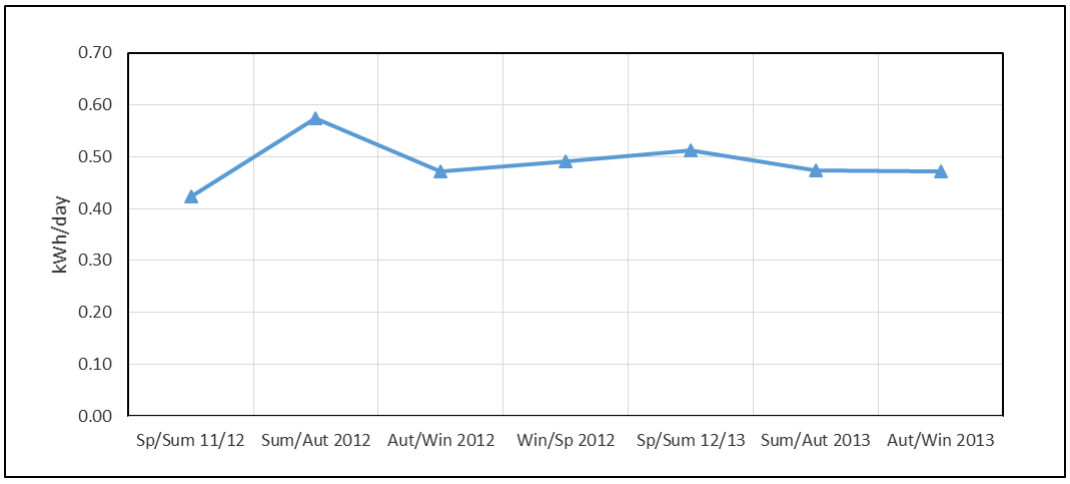


Figure 4.6.7: Case Study 4 - showing household seasonal gas usage averaging round 0.5 kWh/day or 1.8 MJ/day indicating that the gas appliance is very rarely used, if used at all.

This home has 5 individual air conditioners plus a pool pump, dishwasher and dryer. Electricity base load use has dropped from about 40 kWh/day in 2011/12 to 35 kWh/day in 2012/13. Prior to the drop there was not much seasonal variation. However, afterwards the variation in summer is much larger though the peak is about the same. About 18% of

electricity use is off peak water heating. Daily electricity use in summer is 115.7% greater than the State average and it is 83.4% greater than average in winter.

Gas use is very small, only 178 kWh/y (639 MJ/y). The total energy use, gas plus electricity, is 14,441 kWh/y.

The gas bill in 2012/13 was $400 of which 90% was supply charge and 10% energy charge. The small quarterly usage seems to imply gas is used very little for cooking. It could be worthwhile just getting gas disconnected and saving the $400. The annual electricity bill is $3699 plus the $400 for gas gives an annual energy bill of $4099 in 2012/13. There are no energy concessions for this home.

Home energy efficiency initiatives:

- ceiling fans installed,
- rear veranda and external blinds and awnings provide shade to most windows,
- Holland blinds in bedrooms,
- foil insulation in walls when renovated in 2003,
- re-roofed in 2012 and insulation replaced.

There is probably potential for more energy saving initiatives in this home. Consideration could be given as to whether the pool pump can go on the off peak tariff. If affordable for the home owner – solar works well in Brisbane.

The main air conditioner is only 3 years old so it is probably still in good condition. Filters should be cleaned if this has not already been done.

Case Study 5: South Australia - Postcode 5009

Example of a home with solar

- ***Number of persons in the home****:* 4
- ***Major Gas Appliances***: Cooking only
- ***Major Electrical Appliances***: Ducted reverse cycle air conditioner, 3 kW solar PV
- ***Site Electricity Use****:* Between 2011 and 2013 the average daily electricity use was 38% less than the State average in summer and 41% less in winter.
- ***Impact of High Temperature on person with MS***: Lack of energy and more rest is required.

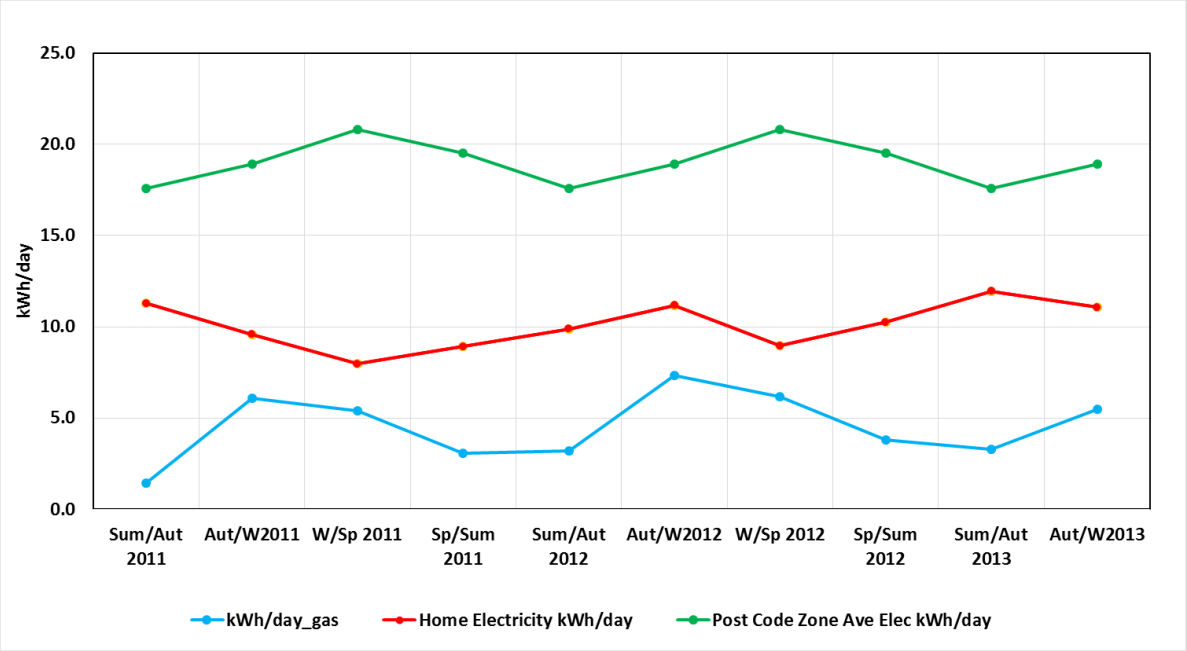


Figure 4.6.8: Case Study 5 - showing household seasonal electricity and gas usage (kWh/day) compared with electricity postcode average. House has solar

The 3 kW solar PV system was installed on the home at a time when there was a feed in tariff available of 52 c/kWh for electricity fed back to the grid. The owners will receive this payment for 25 years. Consequently the electricity bill is low and for 2012/13 was just $52.90.

The gas bill was $414.80 giving a total energy bill for 2012/13 of $468, which is very modest for a 4 person household. However, there is no longer a 52 c/kWh feed in tariff available for new solar customers in SA. For new entrants, solar systems should be sized to just offset electricity use in the home with minimal electricity sent back to the grid as this currently only receives 7.6 c/kWh whereas electricity used in the home is worth 30 – 35 c/kWh in SA. The annual electricity use was 3851 kWh/y and gas 1684 kWh/y (6062 MJ/y), a total of 9913 kWh/y.

Home energy efficiency initiatives:

- insulation in external walls,
- internal roller blinds,
- veranda shades part of living area

Though the total energy use in this home is about 30% less than the average gas/electric 4 person home in SA, energy efficiency initiatives have the potential to be increased and therefore bills further reduced. The age of the ducted reverse cycle air conditioner was 3 years. In this home higher electricity costs are in winter so care in zoning the home in the colder months could be a way to reduce ducted air conditioner costs.

Case Study 6: NSW – postcode 2074

Case Study 6 concentrates on an analysis of concession and tariff changes from 2009 to 2013.

- ***Number of persons in the home****:* 1
- ***Major Gas Appliances***: No gas
- ***Major Electrical Appliances***: 1.3 kW split system air conditioner, 1.8 kW fan heater, solar PV
- ***Site Electricity Use****:* The average daily electricity use was 21.0% less than the State average in summer and 19.4% greater in winter.
- ***Impact of High Temperature on person with MS***: Lack of energy, unable to do normal household duties and work effectively

This case study looks at how electricity prices and concessions have changed in recent years. It is for a person with MS in NSW who is a long-time customer of Sanctuary Energy and uses electricity only. In 2009 the customer had a single tariff meter with an electricity tariff of 15.6 c/kWh and Service Charge of $0.39/day (all prices quoted in this example are exclusive of GST). In late 2010 a solar system was purchased and a good feed in tariff of 60 c/kWh received for electricity fed back to the grid. At the same time a smart meter was installed and a 3 part tariff was introduced – peak, shoulder and off peak. In addition the householder received a NSW Energy Rebate and a NSW Life Support Concession.

Table 4.6.1 below shows how tariffs and concessions changed between 2009 and 2013. The average electricity tariff, based on consumption in each tariff block, increased 12.2% between 2009 and 2011 and the service charge 23.1%. However, between 2011 and 2013 the tariffs increased by 53.2%, service charge by 65.1% but the energy rebate only increased by 28.4% and the very modest Life Support Concession of 16 c/day did not increase at all.

Table 4.6.1: Tariff and concession changes 2009 - 2013

	Year	Peak (c/kWh)	Shoulder (c/kWh)	Off Peak (c/kWh)	Average ($/kWh)	Service Charge ($/day)	NSW Energy Rebate ($/day)	NSW Life Support ($/day)
	2009				0.156	0.39		
	2011	0.366	0.136	0.08	0.175	0.48	$0.4800	$0.16
	2013	0.477	0.1986	0.119	0.268	0.7925	$0.6164	$0.16
%Change	2009 - 2011				12.2%	23.1%		
	2011 - 2013				53.2%	65.1%	28.4%	0.0%

If the concessions were based on a percentage of the bill, as in Victoria, then a much more equitable result would be achieved.

The two graphs below show how, in Case Study 6, solar has reduced electricity use and costs since 2011even though prices have virtually doubled. Winter 2013 is an exception and it is unknown what caused the increase in usage.

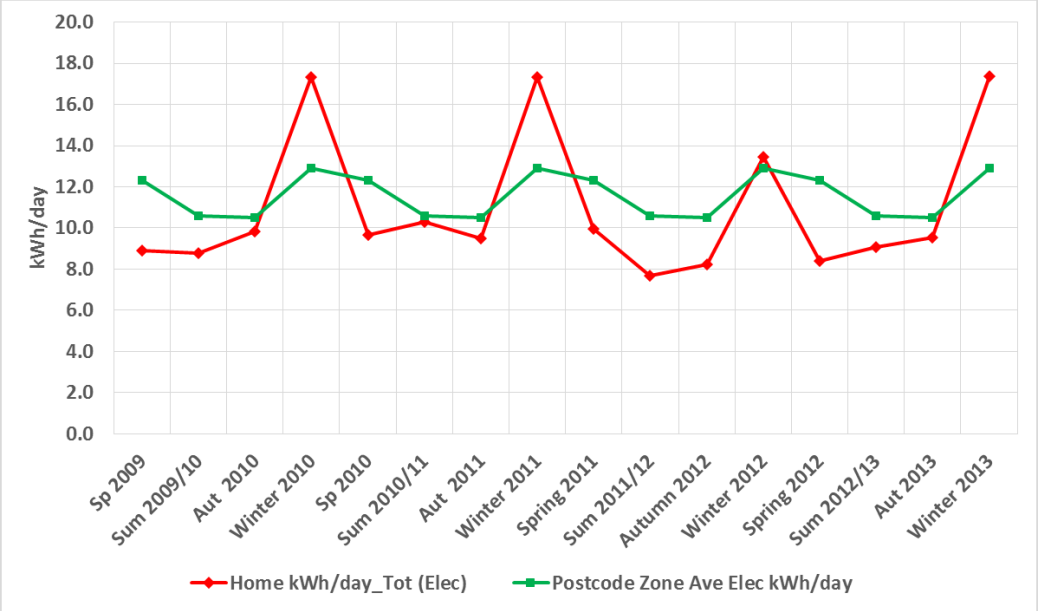


Figure 4.6.9: Case Study 6 - showing household seasonal electricity usage (kWh/day) compared with electricity postcode average (Solar Home).

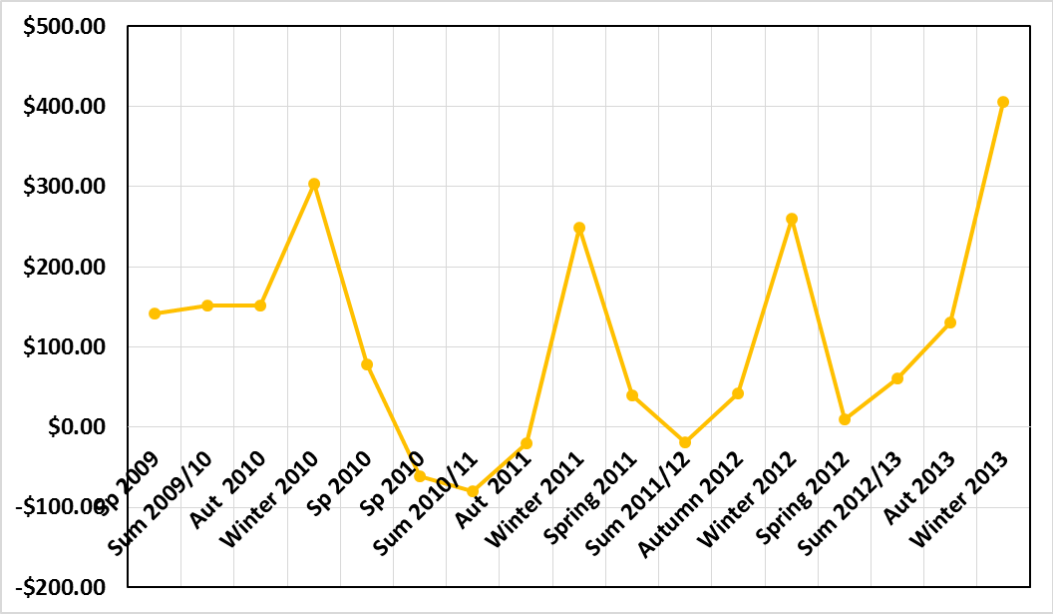


Figure 4.6.10: **Case Study 6 –Electricity Bill ($) of home with solar – Solar installed Winter/Spring 2010. The impact on the winter bill is small, but large in summer. Possible household changes after autumn 2013.**

A summary of the Case Studies is tabulated in Table 4.5.2 and below are some of the key findings.

Summary of Case Studies

Energy, Energy Efficiency and Solar
Case Studies 1 – 5 show how great an impact appliance choice, efficiency initiatives and behaviour can have on energy use and therefore energy costs.

Main Heating and Cooling appliances for each case study were:
Case Study 1: Ducted Refrigerative A/C,
Case Study 2: Ducted Evaporative A/C and electric fan heater,
Case Study 3: Refrigerative Split A/C and under floor gas heating,
Case Study 4: Multiple refrigerative split A/Cs,
Case Study 5: Ducted Refrigerative A/C (plus Solar PV).

Energy use and costs are tabulated in two groups in Tables 4.6.2 (a) and 4.6.2 (b) below;
1. Case Studies 1- 3 which are homes with an occupancy of 2 and
2. Case Studies 4 -5 that have homes with occupancy of 4.

Tables 4.6.2 (a) and (b): Annual electricity and gas use in kWh/y plus associated bills and concessions for Case Studies 1 to 5.

(a) 2 Person Households

Case Study 2 persons	Electricity kWh/y	Gas kWh/y	Total kWh/y	Total Annual Bill ($/y)	Concession ($/y)
1 (SA)	5,559	1,552	7,111	$2,858	-$181
2 (SA)	1,569	2,903	4,472	$1,287	-$182
3 (Vic)	13,427	55,368	68,795	$5,050	-$974

(b) 4 Person Households

Case Study 4 persons	Electricity kWh/y	Gas kWh/y	Total kWh/y	Total Annual Bill ($/y)	Concession ($/y)
4 (Qld)	14,263	178	14,441	$4.099	$0
5 (SA) Solar	3,851	1,684	5,535	$906	$0

The solar home in Case Study 5 has a good feed in tariff that impacts well on bill. This is no longer available for new PV homes however. The energy use figures are still relevant for comparison and show significant energy savings. Case Study 2 (SA) has the best range of energy efficiency initiatives, and Case Study 5's installed solar helps offset ducted air conditioner costs. Table 4.6.3 is a summary of appliance mix and energy efficiency measures for the homes considered in the case studies.

Table 4.6.3: Case Study Summary

	Appliances		Modifications to house or appliances for heat and cool	Energy Use 2012/13, kWh/y			Annual Bill and Concession 2012/13				
Case Studies	**Gas**	**Electricity**		Electricity	**Gas**	**Total**	Electricity	**Gas**	**Total**	**Concession**	Concession % of Bill
1	Instantaneous Gas HW	ducted reverse cycle a/c	Roller shutters installed to all windows. Thick curtains, ceiling insulation topped up in 1997, verandah to rear of house for shade, has door to close off lounge room from rest of house to aid with heating and cooling, has ceiling fan installed	5559	1552	7111	$2,413	$445	$2,858	-$181	6.3%
Number of Persons: 2	cooking	clothes dryer			(5587 MJ/y)						
Postcode: SA 5107 (1)		x 4 fridges and freezers		Electricity use > or < State Ave							
				Summer	94.50%						
				Winter	24.10%						
2	hot water	main cooling is ducted evap a/c	Three front windows (lounge and x 2 bedrooms) have reflective film to reduce heat gain, pedestal fan used where possible, x 2 whirly birds to vent heat from roof space, roller shutters to bedroom windows, canvas awnings and Holland blinds with pelmets to most other windows, verandah to rear of house provides shade	1569	2903	4472	$717	$570	$1,287	-$182	14.1%
Number of Persons: 2	Main heating: 40 MJ/h	pedestal fans in bedroom									
Postcode: SA 5107 (1)		2400 watt heater									
		1 x fridge		Electricity use > or < State Ave							
		1 x freezer		Summer	-56.00%						
				Winter	-77.00%						
3	Storage gas HW	under floor hydronic heating	Crystal bond tinting on sun room windows, large veranda shades living areas, vertical blinds to most windows, ceiling well insulated,	13427	55368	68795	$3,096	$1,954	$5,050	-$974	19.3%
Number of Persons: 2	Main heating: 40 MJ/h	2 kw split system a/c in sitting room									
Postcode: Vic 3113		1.6 kW split system a/c in bedroom		Electricity use > or < State Ave							
				Summer	248.00%						
				Winter	200.00%						
4	Gas stove cook top	elec oven	Ceiling fans installed, rear verandah and external blinds and awnings provide shade to most windows, Holland blinds in bedrooms, foil insulation in walls when renovated in 2003, reroofed in 2012 and insulation replaced	14263	178	14441	$3,699	$400	$4,099	$0	0.0%
Number of Persons: 4		2.6 kW split system in upstairs lounge r									
Postcode: Qld 4011		0.7 kW split system in master bedroom									
		ceiling fans in bedrooms									
		dish washer		Electricity use > or < State Ave							
		0.7 kW split system in x 3 bedrooms		Summer	115.70%						
		2.1 kW split system in down stairs loun		Winter	83.40%						
		750 watt pool pump									
		2 x fridge freezers									
		clothes dryer									
5	All cooking + HW?	ducted reverse cycle a/c	3 kW PV. Insulallation in external walls, internal roller blinds, verandah shades part of living area	3851	1684	5535	$53	$415	$468	$0	0.0%
Number of Persons: 4											
Postcode: SA 5009				Electricity use > or < State Ave							
				Summer	-38.00%						
				Winter	-41.00%						
6		Refigerative Split a/c	Roman blinds in bedroom, pelmets to most windows, whirlybird installed in roof space, mostly uses pedestal fan rather than split system a/c, new ceiling insulation topped up 5 years ago Solar PV	4022	0	4022	$906	$0	$906	-$300	33.1%
Number of Persons 1	No Gas	Electric fan Heater									
Postcode: NSW 2074		Solar		Electricity use > or < State Ave							
				Summer	-14.30%						
				Winter	34.60%						

Concessions

Concessions in SA are a fixed amount regardless of the amount of the bill and are $165/y (GST exclusive). In January 2012 this doubled for people with specific medical conditions, including MS. No such doubling was seen on bills included in this survey from SA.

The Victorian concessions are calculated on the remaining account balance once any retailer discounts and/or solar credits have been applied. In Victoria pensioner concessions are 17.5% of the account balance, and eligible pensioners receive an additional 17.5% Medical Cooling electricity concession for the six warmer months, November - April and a gas winter heating concession of 17.5% (May – October).

Concessions ranged from $182 (GST inclusive) in SA to $974 in Victoria. It is noted that if the Case Study 3 home with the Concession of $974 was in SA then the maximum credit this homeowner would have received would have been $330 +GST = $363 leaving them with an annual bill to pay of $4711, $600 more than in Victoria.

Note: Appendix 1 shows that for Victorian homeowners using 6500 kWh/y of electricity, the choice of Retailer can cause a bill variation of $1000/y. Since Government Concessions are paid as a percentage of the bill it is in the Government's interest that concession recipients have the least cost Retailer that is known to provide good service. For the same reason solar and energy efficiency initiatives will benefit both the homeowner and Government.
In the States where the concession is a fixed amount regardless of energy usage, getting the right Retailer for both electricity and gas, plus installing solar and energy efficiency initiatives are of course still very beneficial to the concession holder but have little impact on Government costs. Further work is needed to determine how a unified approach to concessions and providing access to energy reducing initiatives can benefit all.

Health Impacts

The air conditioning survey conducted during the study clearly identified that symptoms of people with MS were adversely affected by hot weather conditions. In an attempt to provide the medically necessary cooling and minimise energy costs many homes introduced a range of energy saving initiatives. Though occasionally the choice of major appliances dominated energy use and negated efficiency impacts, in some instances costs were contained to manageable levels. The study will enable information to be provided to people with MS on how to contain costs while maintaining comfort.

5 Conclusions and Recommendations

This project examined energy use and costs, with a particular focus on medically-required cooling on hot days and nights in 38 homes of people with MS compared to average residential energy use patterns. The states targeted were Queensland, New South Wales, Victoria and South Australia and the people with MS were asked to participate in a survey, energy audit and electricity plus gas bill analysis. Gas was included as in Victoria and SA gas forms quite a high proportion of energy use in many homes and during the energy audit it was found that some people found cold as well as hot weather particularly problematic as a consequence of their MS.

Of the 38 homes, 25 provided useable billing data. A few had less than a year of data that did not include summer, others provided just gas and no electricity bills and some changed retailer and did not know who their previous retailer was. Although 25 represents just 66% of homes, some homes provided over 20 electricity and 20 gas bills, which is good for observing trends.

Main findings

The main findings from this study regarding households that include people with MS are:

- Participant households used, on average, about 16.8% more electricity in summer and 10.5% more electricity in winter than the state or post code average. This increased to 32.2% more in summer when the 24% of homes with solar PV were removed.
- Looking more closely at non-solar homes, summer electricity use showed that those using more than the state or post code average, 60% of sample, used about 80% more while the rest used about 18% less. The latter were predominantly found to have introduced energy savings initiatives and were careful about energy use.
- In addition, 52.6% of non-solar homes had annual energy costs (electricity plus gas) of $2000 - $5950, putting them in the medium to high cost range. The remainder had an average bill of $1540/y.
- Homes with either solar PV or a solar hot water tended to have newer air conditioners, set their thermostats lower than average in winter but not in summer and used their air conditioners less in both summer and winter. Their average energy bills ($1174/y) were approximately 50% less than the non-solar households, and they used about 32.0% less electricity than the state averages in summer.
- Frequently gas bills are of the same order and sometimes higher than electricity bills. In one home in Queensland with just gas cooking, 90% of the $400 annual gas bill was the service charge.
- 44% of homes that provided electricity bills received a concession (11/25) and 58% (11/19) of non-solar homes. The value of the concession varied widely between states, being 5 – 15% of the total energy bill in NSW and SA and 18 – 21% in Victoria. The highest concessions were received in Victoria and the lowest in SA. The concession range was from $181/y - $974/y. Recently (June 2014) the SA Government increased energy concessions by $50/y.

- Of the 36 homes that answered the air conditioning survey, almost half (47%) were split refrigerative systems with the majority in Victoria. Ducted refrigerative systems (22.2%) were the next most common with the majority in SA.

  Homes with ducted refrigerative air conditioners were associated with the highest energy use and electricity bills and those with window/wall air conditioners with the lowest bills. However, the latter were most likely to be smaller and the air conditioning confined to single rooms. Ducted evaporative air conditioners used the least electricity but as they are frequently associated with gas heating the annual energy bills for homes with this form of cooling were virtually the same as those that use split system air conditioners for both heating and cooling.

Recommendations

A number of significant recommendations arise from this research:

- The value and feasibility of developing a single national medical energy concession to assist those with a medical need to keep cool and/or warm should be examined by an appropriate national body (such as the COAG Energy Council).

  National uniformity would improve clarity and ease of access for consumers with a need for medical energy concession. It would also simplify administration for energy retailers and governments. Importantly, it would also create significant incentives for governments to strengthen and better target energy efficiency/thermal efficiency improvements to medical-energy-concession-eligible households, and thereby ultimately reducing costs for all stakeholders.

- In relation to a single national medical energy concession, the current Victorian medical energy concession utilizing a percentage of the energy bill rather than a daily rate appears to be the most progressive and fair approach. This approach does not discriminate against those living with larger families or those on lower incomes who might be living in poor quality housing with outdated appliances and unable to put more measures in place to improve their home's thermal efficiency.

  The results of this research also make it clear that a proportional percentage based concession system linked to additional assistance for concession-eligible households to install solar energy systems (and other efficiency measures) would also benefit concession-eligible home owners through reduced costs, and also more than pay for itself through lower concession costs for government over time.

- If there is no agreement by the appropriate national body (such as the COAG Energy Council) on the best model for implementing a national medical energy concession, then additional research should be undertaken to determine the best way to achieve this.

  In regards to future research, using electricity bills is not the most accurate or ideal method to determine medically required energy use, for heating, cooling or other needs. Given the findings of this research, a more costly and comprehensive study is justified to more accurately determine actual energy use for heating, cooling and other

medically required energy use at home. Many other conditions besides MS result in medically required energy use, such as Parkinson's disease and spinal cord injury.

With more detailed results of actual cooling/heating energy use in these households, via smart meter or data logging equipment, the most effective and fair means of providing medical energy concessions could be undertaken. It would also provide a stronger platform to further examine the links between different concession structures and savings/costs to governments in relation to energy efficiency support programs.

Also in relation to future research, it was found that gas bills can provide reasonable accuracy for estimating average annual gas heating use since people usually have a maximum of 3 gas appliances – though the number of gas heated spas is increasing, and the impact of this will need to be considered.

- State/territory government energy efficiency schemes should include programs and initiatives that specifically target households with high energy needs as a consequence of medical need. Given these are often very high energy use households relative to 'average' households, and are also often on lower than average incomes, there are significant economic, social and environmental gains to be made.

  Many of the homes of people with MS used energy efficiency initiatives and were aware of what might help them to reduce costs. Also, the previous Keeping Cool Survey found that overall MS households had taken more measures to improve thermal efficiency than the average Australian household.

  However, given the much higher than average energy use and costs in most of these homes, there is a need for improved access to energy efficiency advice, and specific programs targeted at people who require cooling/heating as a consequence of medical need may be particularly valuable to this group (or alternatively, targets set within existing programs that specifically target households with significant medically-related energy requirements).

  A mix of energy efficient initiatives and use of solar would significantly reduce energy use and bills in homes of people with medical energy needs. These new initiatives should include a research/evaluation component to further examine the most effective means of achieving this.

  These state/territory initiatives should also provide targeted information to these households regarding: available concessions, efficiency, retail market information and solar options. During the study it was found that existing web based information on concessions and the best value electricity and gas retailer to choose were not always easy to follow for households. Ensuring that existing information sources include a subset or specific information that addresses the particular needs of households with medically-related high energy use requirements, including indicative costings and savings, would likely provide significant assistance to help these households to make considered choices. This should include assistance with energy efficiency and solar initiatives for households with high energy use as a consequence of medical need.

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Appendices

Appendix 1 – Retail Price Changes

Reference: AER State of the Energy Market 2013
http://www.aer.gov.au/sites/default/files/Complete%20report%20A4.pdf

This Australian Energy Regulator (AER) report provides a very useful overview of the current status of the National Energy Market in the Eastern region of Australia.

In the context of this project, Section 5 of the AER report on the Retail Market shows, for the various distribution networks of the NEM,

- percentage of electricity and gas price increases over the past 5 years
- average annual cost of electricity and gas as at August 2013 for a customer that uses 6500 kWh/y of electricity and 24 GJ/y of gas (Note: 1 MWh = 3.6 GJ).

Table A1.1: Movements in regulated and standing offer prices—electricity and gas

			AVERAGE PRICE INCREASE (PER CENT)					ESTIMATED ANNUAL
JURISDICTION	REGULATOR	DISTRIBUTION NETWORK	2009–10	2010–11	2011–12	2012–13	2013–14	COST ($)
ELECTRICITY								
Queensland	QCA	Energex and Ergon Energy	15.5	13.3	6.6	10.6	20.4	2113
New South Wales	IPART	AusGrid	21.7	10.0	17.9	20.6	3.9	2106
		Endeavour Energy	21.1	7.0	15.5	11.8	1.6	2044
		Essential Energy	17.9	13.0	18.1	19.7	–0.6	2725
Victoria	Unregulated	Citipower	5.7	14.6	3.7	19.9	6.4	2006
		Powercor	5.2	15.4	7.7	23.1	5.8	2389
		SP AusNet	6.0	11.3	23.6	19.7	12.4	2386
		Jemena	7.7	17.7	10.5	23.2	6.1	2339
		United Energy	7.0	11.4	9.7	25.2	4.8	2167
South Australia	Unregulated	ETSA Utilities	3.1	18.3	17.4	12.7	2.8	2510
Tasmania	OTTER	Aurora Energy	6.2	15.3	11.0	10.6	1.8	2205
ACT	ICRC	ActewAGL	6.4	2.3	6.5	17.7	3.5	1577
GAS								
New South Wales	IPART	Jemena	4.4	5.2	4.0	14.8	9.6	922
South Australia	Unregulated	Envestra	5.3	3.1	13.8	17.7	11.6	1072

Notes:

Estimated annual cost is based on a customer using 6500 kilowatt hours of electricity per year and 24 gigajoules of gas per year on a single-rate tariff at August 2013.

The Victorian price movements (and estimated annual costs) are for the calendar year ending in that period—for example, the 2013–14 Victorian data are for the calendar year 2013. Victorian price movements (and those for South Australia in 2013–14) are based on unregulated standing offer prices of the local area retailer for each distribution network. The data for South Australia in 2013–14 relates to movements in the standing offer in the six months to December 2013.

The price increase for Tasmania in 2013–14 relates to the period 1 July 2013 to 31 December 2013. A further price adjustment will occur on 1 January 2014.

Sources: Determinations, factsheets and media releases by IPART (New South Wales), the QCA (Queensland), ESCOSA (South Australia), OTTER (Tasmania) and the ICRC (ACT); Victorian Government gazette.

The highest prices are in Regional NSW (Essential Energy network) and in South Australia, and the lowest prices in the ACT. There is about $1000/y difference between these high and low cost regions for the same amount of annual electricity used.

Electricity and Gas Retailers offer contracts for a range of products with different price structures and the following two figures below provide estimates for August 2012 and August

2013 price offerings for residential customers in the regions represented. Again prices are for 6500 kWh/y of electricity and 24 GJ/y of gas.

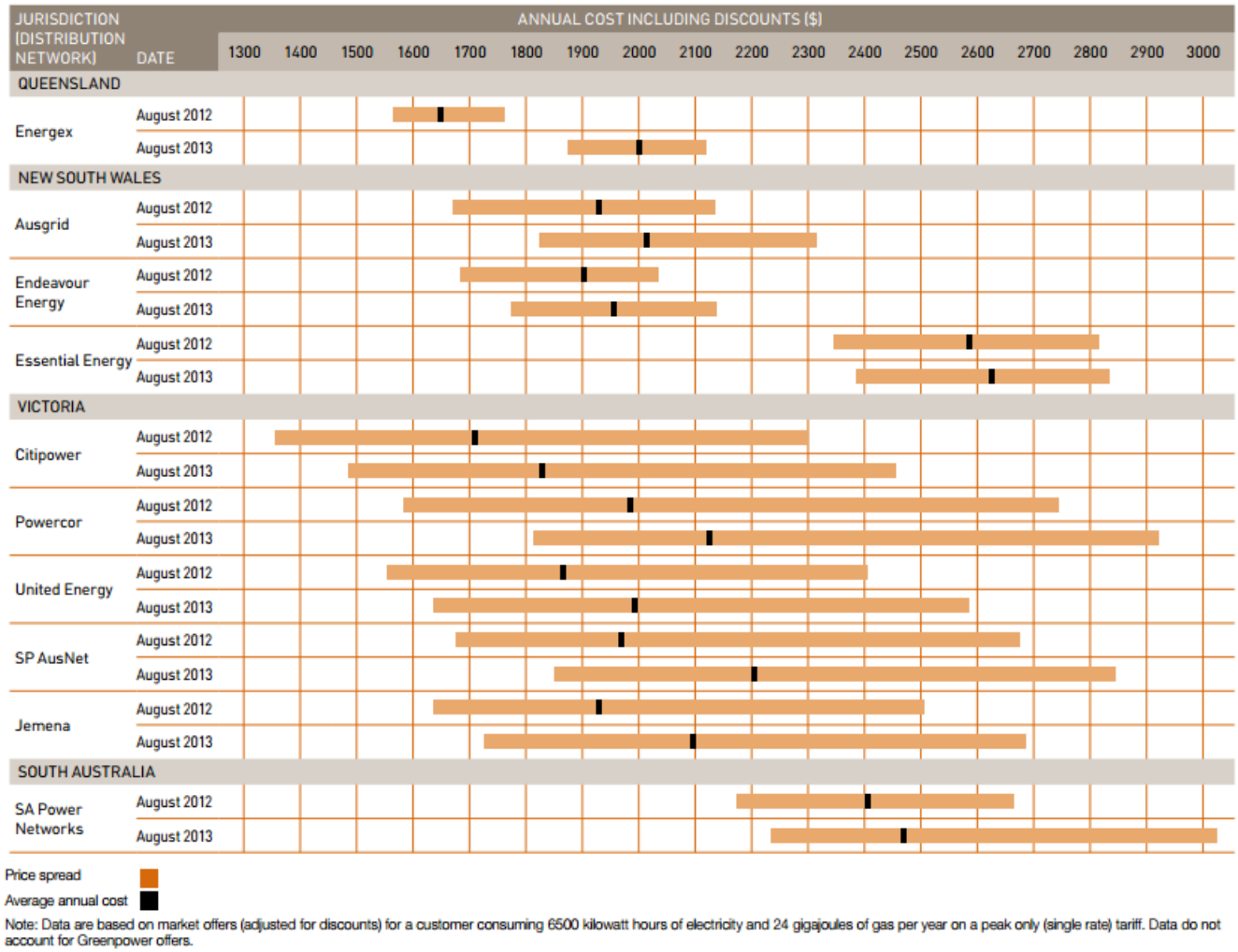

Figure A1.1: Price diversity in retail product offers—August 2012 and August 2013: Electricity

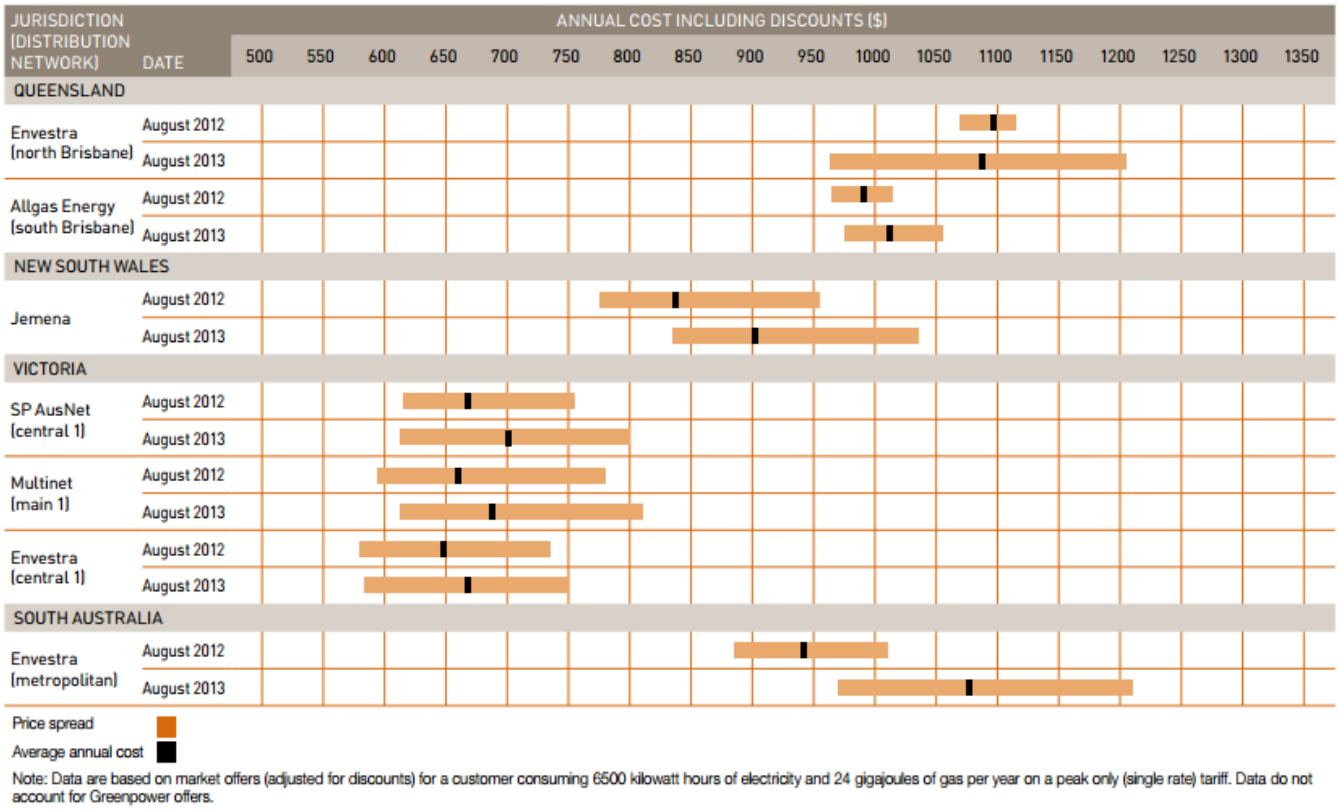

Figure A1.2: Price diversity in retail product offers—August 2012 and August 2013: Gas

The data indicate varying degrees of price diversity. Victoria exhibited the greatest price diversity, with the annual cost under the cheapest contract 35−40 per cent lower than under the most expensive contract**.**

The annual bill spread in August 2013 (measured within a particular distribution network) varied among jurisdictions:

- In electricity, it ranged from $200 in Queensland to around $1000 in Victoria. The spread for most networks was larger in August 2013 than in August 2012.
- In gas, it was around $200 for most networks. The spread for all networks rose between August 2012 and August 2013.

Though information is available on the Energy Made Easy and State Regulator websites on electricity retailer charges they are not easy to compare and the MS Society or ACOSS should help pensioners and concession holders with their choice of Retailer.

Appendix 2 – Questionnaire

The questionnaire is in 4 parts:
1. Selecting participants
2. Billing Information and 2A - Billing Authorisation Letter
3. Appliance and demographic information - Audit
4. Original AC Survey (for consistency) but with modifications

Part 1 – Selecting MS Participants: (Want 3 years of billing information to analyse so need people who have been at the same location for at least 3 years.)

			Comments
1. How long have you lived in your current home?	**Years**		
	0 to 1	[ ]	If less than 2 then terminate interview
	1 to 2	[ ]	
	2 to 3	[ ]	
	over 3	[ ]	
2. Has the number of people usually living in the home increased or decreased from what it is now over the last 2 to 3 years. (Take into account increases or decreases that ocurred for more than a month at a time)?			If yes then terminate interview
	YES	[ ]	
	NO	[ ]	
3. Over the last 2 or 3 years have you had long periods of absence from the home - say a month or more, for medical reasons or holidays etc?			If yes then terminate interview
	YES	[ ]	
	NO	[ ]	

4.Would you be prepared to sign a release form to your electricity and gas provider to enable researchers to ask for copies of your energy bills over the last 3 years? Confidentiality will be assured.	YES NO	[ ] [ ]	If no then terminate interview
5. Would you allow 3 Temperature sensors to be installed in your home to enable an estimate of comfort conditions to be determined?	YES NO	[ ] [ ]	2 homes in each State need to say YES to this question
6. Do you you have broadband Internet?	YES NO	[ ] [ ]	This question is relevant only to Sydney participants in Heat Wave project

Once this Section is completed and participants selected then proceed to the next stage

Part 2 - Billing Information

1. Do you have both electricity and gas appliances in your home?	YES	[ ]
	NO	[ ]
2. If YES what gas appliances do you have	Hot water	[ ]
	Cooking	[ ]
	Main Heating	[ ]
	Spa	[ ]
	Other - please say	[ ]
3. Who is your - **Electricity Retailer** **Gas Retailer (if applicable)**		
4. Have you been with your retailer for up to 3 years	YES	[ ]
	NO	[ ]
5. If NO please give previous Retailer's name and approximately when changeover occured		
6. Do you have difficulty in finding the money to pay power bills?	YES	[ ]
	NO	[ ]
7. Do you receive an Energy Concession to reduce your bills	YES	[ ]
	NO	[ ]
8. Do you receive an additional Medical Concession to reduce your bills	YES	[ ]
	NO	[ ]

Part 2A: Collecting Energy Bills for Both Gas and Electricity

University of South Australia Electricity and Gas Authorisation Form

Multiple Sclerosis Survey

(To)
The General Manager
(Insert Gas and/or Electricity Retailer - Name and address below)
Address:

Dear Sir/Madam,

I hereby authorise release to Dr Frank Bruno, of the Barbara Hardy Institute University of South Australia, records of electricity (gas) consumption, held by you for the address shown below and covering an approximate 3 year period, November 2009 to May 2012.
(We would like to include 3 summers.)

The information will be used only for statistical purposes in connection with a survey of Multiple Sclerosis sufferers as part of the project "Patterns of Electricity Use for Medically Required Cooling by Australians with Multiple Sclerosis"
Any information supplied to the University of South Australia is confidential and will not be disclosed to any other person or agency.
In addition when presenting results they will be grouped according to State and all participants will be anonymous.

Signature:……. Date:…….

Name of Account Holder (please print)……..

Address of dwelling……

Part 3: Appliance and demographic information – AUDIT

AUDIT

Note: When presenting results they will be grouped according to state and all participants will be anonymous.

Participant Details

Name: **Address:**	
Retailer: Gas Electricity **Account Number:** Gas Electricity Date of Audit: Auditor: Auditor phone No.:	
Structural Characteristics of Dwelling	
Household Type Home age No of Bedrooms Home size m2 Roof materials Wall materials Draught proofed Zoned Y/N Fans Y/N Orientation (NESW) No of bathrooms Insulation Floor materials Excess standby use Duct condition Shading Storeys Open Plan Y/N HWS lagged Y/N No of Occupants	

Appliance	Star Rating*	Age*	Brand/Capacity	Location	Gas/Electric	Potential Running Cost
Fridge/Freezer						
Chest Freezer						
Washing Machine:						
Heater (Main)						
Heater (Supplementary):						
1						
2						
3						
Air conditioner (See extra questions as well)						
Water Heater						
Electric						
Gas						
Microwave oven						
Electric or gas oven						
Electric or gas hot plates						
Entertainment:						
TV						
video						
stereo						
Computer						
Printer						
Dishwasher						
Dryer						
Spa:						
Electric						
Gas						
water bed						
pool pump						
rain water pump						
Other:						

Air conditioning survey

I <u>do not</u> use an air conditioner at home because…

I do not have a problem with hot weather	[ ]
I do have a problem with hot weather but cannot afford to buy an air conditioner	[ ]
I have an air conditioner and need to use it, but can not afford the electricity	[ ]
I have an air conditioner and need to use it, but it is broken	[ ]
I do not like the noise	[ ]

If you have answered this question please go directly to question 9

How hot is it outside when you usually turn your air conditioner on?

20 - 24 ^{o}C	[ ]
25 - 29 ^{o} C	[ ]
30 - 34 ^{o} C	[ ]
35 - 39 ^{o} C	[ ]

What type of air conditioner do you have and how many do you have of each?
Could you also tell me which is the main system and which, if any, is a support system?

	1	2	3	4+	Main	Support
Evaporative						
Portable						
Fixed (single room)						
Ducted (multi room)						
Reverse Cycle						
Window/wall						
Split system						
Refrigerative						
Cooling Only						
Window/wall						
Split system						
Ducted (multi room)						

How old is your air conditioner?

0 - 3 years	
4 - 9 years	[ ]
10 or more years	[ ]
Don't Know	[ ]
	[ ]

Does your air conditioner have a thermostat if so what temperature do you set it for:

Summer	[-- ^{o} C]
Winter	[-- ^{o} C]

Which rooms do you usually try to keep cool with your air conditioner (s)?

Bedroom	
Lounge/Sitting	[ ]
Kitchen	[ ]
Other room(s)	[ ]
	[ ]

How many hours would your air conditioner be used on a HOT summer day when the temperature is greater than 30 o C?

Less than 4 hours	[ ]
4 to 8 hours	[ ]
9 to 12 hours	[ ]
13 to 16 hours	[ ]
17 to 24 hours	[ ]
On all the time	[ ]
Not sure, on thermostat	[ ]
Other (specify)	[ ]

How many hours would your air conditioner be used on an AVERAGE hot summer day when the temperature is in the range of, say, 25 to 30 o C?

Less than 4 hours	[ ]
4 to 8 hours	[ ]
9 to 12 hours	[ ]
13 to 16 hours	[ ]

17 to 24 hours	[ ]
On all the time	[ ]
Not sure, on thermostat	[ ]
Other (specify)	[ ]

In addition to an air conditioner, and if you answered Q1, do you have any other home modifications that help you keep cool? Please note any that apply and when it was done.

External window blinds, awnings, or other coverings	[ ]
Internal window blinds, awnings, or other coverings	[ ]
Roof Insulation	[ ]
Roof Vents	[ ]
Wall Insulation	[ ]
Other (please specify)	

As a person with MS, what happens to you when you get too hot? (Tick all that apply):

Nothing I cope just fine	[ ]
I lack energy and require more rest	[ ]
Apart from fatigue, my other symptoms of MS become worse	[ ]
I am unable to participate in normal social activities (time with family or friends)	[ ]
I am unable to do my normal household duties (eg cleaning, cooking, etc.)	[ ]
I am unable to work effectively	[ ]
I am unable to look after myself in the usual manner	[ ]
I need more medication to cope	[ ]
I have felt sufficiently unwell to require a doctor or other health professional	[ ]
I have been hospitalised because of heat	[ ]
siezures	[ ]
physical collapse	[ ]
loss of motor function	[ ]
Other (please specify)	

Appendix 3 – Air Conditioner and Billing Data Results

All 36 homes involved in the air conditioner survey

	How many hours would air con be used on HOT summer day when temp > 30C	How hot is it outside when you usually turn your air conditioner on?	What type of air conditioner do you have ?	How old is your air conditioner?	Summer thermostat (Deg C)	Winter Thermostat (Deg C)	Which rooms do you usually try to keep cool with your air conditioner (s)?	Ave Hrs	Number Persons in Home	State	Postcode	Summer > or< State Ave %	Winter > or< State Ave %	Bill Electricity + Gas ($/y)*	Billing data Available
1	20	30	split,noduct	3	21	23	both	0	4	VIC	3135	-21.00%	-8.70%	$3,180	
2	20	32	ref,ducted	1	23	24	both	6	1	QLD	4051	29.70%	40.10%	$1,360	
3	18	30	evap	10	25	25	both	2	4	VIC	3136				No data
4	16	30	evap	7	24	19	both	0	2	VIC	3095	18.00%	8.10%	$3,000	
5	16	30	split,noduct	3	24	22	both	10	4	QLD	4011	108.70%	89.40%	$4,100	
6	15	22	ref,ducted	12	22	21	both	8	4	VIC	3111	251.60%	172.30%	$5,950	
7	15	23	split,noduct	0.5	22	21	living	2	3	SA	5502	-6.10%	7.90%	$1,380	solar
8	15	26	split,noduct	4	24	20	both	0	2	VIC	3088				No data
9	15	27	split,noduct	9	24	20	both	2	2	VIC	3130	-48.15%	-56.10%	$1,350	
10	15	29	ref,ducted	12	19	23	living	6	3	SA	5118				No data
11	13	30	split,noduct	14	23	23	both	2	1	NSW	2074	-21.00%	19.40%	$605	solar
12	12	30	ref,ducted	5	26	26	both	0	2	VIC	3134	-12.00%	42.00%	$2,700	solar
13	10	27	ref,wind/wall	20	25	25	living	2	2	VIC	3135	18.50%	15.80%	$2,250	
14	10	27	split,noduct	6	22	24	living	10	1	VIC	3137	-9.20%	-40.30%	$750	
15	10	27	ref,ducted	12	25	19	both	6	3	SA	5118				
16	10	27	split,noduct	10	22	25	living	6	2	SA	5373	19.70%	-8.80%	$2,000	
17	10	27	evap	9	25		both	8	3	SA	5118	72%	-1.20%	$3,338	
18	10	28	evap	12	15		both	6	2	SA	5118	4.10%	-31.10%	$2,140	
19	10	30	split,noduct	4	22	22	living	6	2	SA	5355				No data
20	10	30	ref,wind/wall	6	25		living	6	2	VIC	3135				No data
21	10	30	ref,ducted	11	24	22	both	6	2	SA	5107	94.5%	24.1%	$2,677	
22	10	35	evap	10	26		both	0	2	SA	5086	-50.90%	-55.40%	$1,085	
23	9	31	ref,wind/wall	2	21		living	1	4	SA	5163				
24	8	25	split,noduct	2	21	24	living	5	4	SA	5170	-21.60%	66.10%	$1,890	solar
25	8	33	ref,ducted	13	21	24	both	0	2	SA	5001				No data
26	6	25	split,noduct	7	24	22	living	6	2	VIC	3122				No data
27	6	26	split,noduct	3	26	18	both	2	2	VIC	3155				No data
28	6	27	split,noduct	3	20	24	both		1	VIC	3131				No data
29	6	27	ref,wind/wall	10			bed	4	4	QLD	4500	-15.50%	-21.40%	$605	
30	6	28	split,noduct	4	24		both	2	4	VIC	3132	-23.20%	-32.60%	$1,400	
31	6	30	split,noduct	3	23	22	both	0	2	VIC	3113	248.00%	200%	$4,100	
32	6	32	ref,wind/wall	11	23		living	0	1	SA	5016	-93.10%	-77.60%	$0	solar
33	6	**34**	evap	13	25		both	4	2	SA	5107	-56.00%	77.00%	$1,105	
34	6	34	split,noduct	2	24		living	0	1	QLD	4007				No data
35	5	35	split,noduct	6	25	25	living	0	1	SA	5109	-42.20%	-29.20%	$910	
36	2	30	ref,ducted	3	23	23	living	0	4	SA	5009	-37.90%	-40.90%	$470	solar
Average	10.4	29.0		7.3	23.1	22.5		3.4	2.4			16.96%	14.95%	$2,014	

***Bills are concession inclusive**

Air conditioner and Concession data in homes with and without solar – Total 25 homes with electricity billing data

Without Solar

	A/C Hrs used on HOT summer day when temp > 30C	Outside Temp for A/C turn on	Type of A/C & How Many	A/C Age (yrs)	Summer thermostat	Winter thermostat	Rms kept Cool	A/C Hrs used on AVE hot summer day: Temp 25 to 30oC?	Persons	State	P/C	Summer Electricity Use > or < State Ave (%)	Winter Electricity Use > or < State Average (%)	(Electricity + Gas) Bill ($/y)	Concession (Total) $/y	Bill + Concession ($/y)
1	20	30	split,noduct	3	21	23	both	0	4	VIC	3135	-21.00%	-8.70%	$3,180		$3,180
2	20	32	ref,ducted	1	23	24	both	6	1	QLD	4051	29.70%	40.10%	$1,360		$1,360
3	16	30	evap	7	24	19	both	0	2	VIC	3095	18.00%	8.10%	$3,000	$656	$3,656
4	16	30	split,noduct	3	24	22	both	10	4	QLD	4011	108.70%	89.40%	$4,100		$4,100
5	15	22	ref,ducted	12	22	21	both	8	4	VIC	3111	251.60%	172.30%	$5,950		$5,950
6	15	27	split,noduct	9	24	20	both	2	2	VIC	3130	-48.15%	-56.10%	$1,350		$1,350
7	10	27	ref,wind/wall	20	25	25	living	2	2	VIC	3135	18.50%	15.80%	$2,250	$506	$2,756
8	10	27	split,noduct	6	22	24	living	10	1	VIC	3137	-9.20%	-40.30%	$750	$250	$1,000
9	10	27	split,noduct	10	22	25	living	6	2	SA	5373	19.70%	-8.80%	$2,000	$181	$2,181
10	10	27	evap	9	25		both	8	3	SA	5118	72%	-1.20%	$3,338	$184	$3,522
11	10	28	evap	12	15		both	6	2	SA	5118	4.10%	-31.10%	$2,140	$135	$2,275
12	10	30	ref,ducted	11	24	22	both	6	2	SA	5107	94.5%	24.1%	$2,677	$181	$2,858
13	10	35	evap	10	26		both	0	2	SA	5086	-50.90%	-55.40%	$1,085		$1,085
14	6	27	ref,wind/wall	10			bed	4	4	QLD	4500	-15.50%	-21.40%	$605		$605
15	6	28	split,noduct	4	24		both	2	4	VIC	3132	-23.20%	-32.60%	$1,400	$362	$1,762
16	6	30	split,noduct	3	23	22	both	0	2	VIC	3113	248.00%	200%	$4,100	$974	$5,074
17	6	**34**	evap	13	25		both	4	2	SA	5107	-56%	-77%	$1,105	$182	$1,287
18	5	35	split,noduct	6	25	25	living	0	1	SA	5109	-42.20%	-29.20%	$910		$910
19									4	NSW	2154	14%	58.80%	$3,347	$233	$3,580
Average	**11.2**	**29.2**		**8.3**	**23.2**	**22.7**		**4.1**	**2.5**			**32.2%**	**13.0%**	**$2,350**	**$349**	**$2,552**

With Solar																	
	A/C Hrs used on HOT summer day when temp > 30C	Outside Temp for A/C turn on	Type of A/C & How Many	A/C Age (yrs)	Summer thermostat	Winter thermostat	Rms kept Cool	A/C Hrs used on AVE hot summer day: Temp 25 to 30C?	Persons	State	P/C	Summer Electricity Use > or < State Ave (%)	Winter Electricity Use > or < State Average (%)	(Electricity + Gas) Bill ($/y)	Concession (Total) $/y	Bill + Concession ($/y)
1	15	23	split,noduct	0.5	22	21	living	2	3	SA	5502	-6.10%	7.90%	$1,380	$181	$1,561
2	13	30	split,noduct	14	23	23	both	2	1	NSW	2074	-21.00%	19.40%	$605	$300	$905
3	12	30	ref,ducted	5	26	26	both	0	2	VIC	3134	-12.00%	42.00%	$2,700		$2,700
4	8	25	split,noduct	2	21	24	living	5	4	SA	5170	-21.60%	66.10%	$1,890		$1,890
5	6	32	ref,wind/wall	11	23		living	0	1	SA*	5016	-93.10%	-77.60%	$0	$134	$134
6	2	30	ref,ducted	3	23	23	living	0	4	SA	5009	-37.90%	-40.90%	$470		$470
Average	9.3	28.3		5.9	23	19.5		1.5	2.5			-32.0%	2.8%	$1,174	$103	$1,277

* Home no longer receives a concession as has a $5000 credit from solar

Appendix 4 – Audit Summaries

	State	post code	occupants	Gas	Elec	Appliances		Modifications to house or appliances for heat & cool
						Gas	Electricity	
1	SA	5107	2	yes	yes	instant hws cooking	ducted refrigerated a/c clothes dryer x 4 fridge and freezers	has installed roller shutters to all windows and has thick curtains, ceiling insulation topped up in 1997, verandah to rear of house for shade, has door to close off lounge room from rest of house to aid with heating and cooling, has ceiling fan
2	NSW	2074	1	no	yes	none	1.3 kw split system a/c 1800 W fan heater 80 Litre peak HWS	Roman blinds in bedroom, pelmets to most windows, whirlybird installed in roof space, mostly uses pedestal fan rather than split system a/c, new ceiling insulation topped up 5 years ago
3	VIC	3134	2	yes	yes	instant hws stove top main heating- 40 mJ/hr	elec oven clothes dryer main a/c is a 4 kw ducted r/c a/c secondary a/c is a 1.6 kw split in bedroom	thick curtains, double glazed windows, wide opening windows for cross ventilation, zoned air conditioner, many trees for shade, split system a/c in master bedroom, motor car recently replaced with one with a better air conditioner
4	VIC	3131	1	yes	yes	hot water stove top and oven	main a/c is a 1.6 kw split system a/c in lou pedestal fan in bedroom 2000 Watt oil filled elec heater	outside canvas awnings, thick inside curtains with pelmets, small split system a/c in lounge room, pedestal fan in bedroom, roof insulation checked by Fed Govt Home Insulation Scheme and acceptable, trees shade front of unit, another unit provides shade
5	SA	5118	6	bottled gas		gas cooking instant hws	main a/c is 4.6 kw ducted RCAC washing machine clothes dryer 2 x fridge freezers 1 x small freezer	has installed 2 kw solar panels to reduce electricity costs, Holland blinds or other thick curtains (some with pelmets) to most windows, verandah and pergola shades one side of house, whirly birds to vent roof space, insulation in external and internal walls
6	SA	5016	1	yes	yes	instant hws cooking main heating - 40 mJ/hr	main a/c is a 2 hp RCAC pedestal fans	6.8 kW solar a/c is only used in heat waves and zoned off from rest of house, uses cooler rooms of the house for day to day living, uses pedestal fans where possible, many aluminium and canvas awnings to provide shade to windows, sisalation to underside of roof and ba
7	SA	5107	2	yes	yes	hot water main heating - 40 MJ/h	main cooling is ducted evap a/c pedestal fans in bedroom 2400 watt heater 1 x fridge 1 x freezer	three front windows (lounge and x 2 bedrooms) have reflective film to reduce heat gain, pedestal fan used where possible, x 2 whirly birds to vent heat from roof space, roller shutters to bedroom windows, canvas awnings and Holland blinds with pelmets to most other windows, verandah to rear of house provides shade
8	VIC	3137	1	yes	yes	main heating -40MJ/h	gravity fed hws main cooling is 1.6 kw split in lounge elec cooking secondary hting is 2kW fan heater	uses electric blanket in winter when sitting in lounge room instead of split system or heater, checks next day's temperature and adjusts appliance use and her activities accordingly, whirly birds to vend roof space, had insulation checked in 2009 with fed Govt Home Insulation Scheme, had roof painted from orange to light grey in 2011 to reduce heat transfer, as no a/c in bedroom uses ice bricks in a tub at end of bed near a pedestal fan, all windows have thick, double backed curtains, lounge room , kitchen and two bedroom windows also have external blinds
9	NSW	2154	4	yes	yes	instant hws cooking main heating - 40MJ/h	main cooling is 4 kw ducted r/c	
10	SA	5170	4	yes	yes	cooking only	solar hws with elec boost main cooling is ducted evap a/c 2 kw splitAC in lounge room 1.6 kw portable refrig a/c	solar hot water with electric boost, portable refrig a/c used for personalised cooling rather than whole of house cooling,
11	SA	5086	2	yes	yes	instant hot water cooking main heating - 40MJ/h	ducted evap a/c ceiling fans	solid verandah to rear provides shade to living area, ceiling fans installed,
12	SA	5118	2	yes	yes	hot water cooking main heating - 40MJ/h	spa used for cooling in summer -pump to run water jets but not for water ht. Ducted evap a/c ceiling fans pedestal fans	uses ceiling fans and pedestal fans where possible, uses spa in summer for cooling, verandah provides good shade to living areas at rear, 3 kw solar system to be installed by Nov 2013, thick curtains
13	SA	5001	2	yes	yes	instant hws, stove top	2.4 kw ducted reverse cycle a/c elec cooking	would like to install solar but difficult due to strata issues in the block of units, another unit upstairs provides shade and insulation, shade cloth to front lounge room window, Roman blinds to front window, 30 cm ceiling space insulated

	State	post code	occupants	Gas	Elec	Appliances		Modifications to house or appliances for heat & cool
						Gas	Electricity	
14	SA	5373	2	bottled gas	yes	hopes to have solar system instal	2 kw split system a/c in living rm pedestal fans	solar system to be installed by end of 2013, internal and external walls have insulation, pergola and shade cloth awnings to west facing windows, uses combustion wood heater in winter and can source free wood,
15	SA	5163	4	yes	yes	instant hws all cooking main heating - 40MJ/h	ceiling fans refrigerative only 2 kw a/c	veranda to west side of house for shade, trees to south side of house,
16	SA	5009	4	yes	yes	all cooking	ducted reverse cycle a/c	3 kw solar system installed installation in external walls, internal roller blinds, verandah shades part of living area
17	SA	5502	3	no	yes	none	2 kw split system in lounge room ceiling and pedestal fans 2 kw oil filled elec heater	3 kw solar system installed, wide rear verandah, roof insulation
18	SA	5355	2	bottled gas	yes	portable 40 MJ/h gas heater instantaneous hws	2 kw split system a/c in lounge 2 x fridge and freezer clothes dryer 80 litre peak hws 2 hp pool pump	roller shutters to some east and west facing windows, batts to ceiling insulation and foil insulation in external walls, carport and verandah shades front of house, swimming pool provides some respite in summer
19	SA	5241	1	no	yes	none	2 kw split system in lounge room 1.6 kw oil filled electric heater	moved to Adelaide Hills to keep cooler in summer but cold weather causes a problem to health in winter, blow in batts installed in 2009 with fed Govt Home Insulation Scheme, roller shutters installed on all windows to reduce heat gain, thick curtains to all windows, rear verandah for shade
20	VIC	3135	2	yes	yes	gas cook top ducted gas heating 40 mJ/hr (prin 40 mJ/hr space heater (secondary heating) 90 Litre gas hws	2 x fridge freezers 2 hp refrig only a/c in lounge elec oven dishwasher	installed ceiling fans to bedroom, new batts installed in ceiling in 2009 with Fed Govt Home Insulation Scheme, canvas awnings to front windows, front bedroom awning always pulled down, wooden slats to windows but no thick curtains, carport shades side of
21	VIC	3135	1	yes	yes	instant hws gas stove top 40 mJ/hr gas space heater	elec oven 1180 Watt refrig a/c in lounge room 2400 Watt electric heater	no man hole in ceiling so could not check insulation - he suspects very poor quality insulation,
22	VIC	3111	4	yes	yes	135 litre gas storage hws stove top main heating under floor gas heating	elec oven 4 kw ducted refrigerative a/c 2.5 kw split system in lounge room clothes dryer dish washer	roller shutters to windows, very effective roof insulation (recently checked), shade cloth blinds to west facing windows, day and night blinds to most windows to provide shade, skylights are double glazed
23	VIC	3088	2	Yes	yes	Ducted gas hting for1st floor 40 mJ/hr gas space heater in grou 135 litre gas storage hws	x 2 fridge and freezer 900 Watt ducted evap a/c for first floor clothes dryer dish washer 3.5 kw split for ground floor	ceiling insulation is inadequate and is planned to be replaced shortly, rear verandah replaced to provide better shade to ground floor living areas, heavy Holland blinds to most windows, ground floor is naturally cooler in summer than first floor
24	VIC	3130	2	yes	yes	storage gas hws all cooking 40 mJ/hr Space heating	2 kw split a/c in lounge(primary) 2 x 1.2 kw portable refrig a/cs (secondary in bed room)	external blinds to most windows, thick curtains to most windows
25	VIC	3095	2	yes	yes	instant gas hws stove top 40 m/hr gas space heater	elec oven 900 Watt ducted evap a/c dish washer clothes dryer	wooden Venetian blinds and curtains to most windows, blow in batts installed in walls of bathroom and laundry during recent renovations, is investigating solar to reduce energy costs
26	VIC	3122	2	yes	yes	170 litre storage gas hws gas stove top 40 mJ/hr gas space heater	elec oven 2.1 kw split a/c in family room 1500 Watt radiator 2 kw r/c split system dish washer clothes dryer 750 watt pool filter pump 640 Watt solar pool water heater	internal blinds and curtains, external awning facing east in kitchen, sisalation to underside of roof tiles

						Appliances		Modifications to house or appliances for heat & cool
	State	post code	occupants	Gas	Elec	Gas	Electricity	
27	VIC	3132	4	yes	yes	storage gas hws gas stove top 40 mJ/hr gas space heater	elec oven clothes dryer very old dish washer 2 x 1500 Watt oil filled elec heaters 70 watt portable evap a/c 2 x 1500 Watt split system a/c (bedroom and lounge) only purchased since MS diagnosis	awnings to west windows, reflective film on windows, extra ceiling insulation added in 2009 with Fed Govt Home Insulation Scheme, insul batts installed under floor boards in bedrooms , whirly birds to vent roof space.
28	VIC	3155	2	yes	yes	storage gas hws gas stove top 40 mJ/hr gas space heater	elec oven 900 watts ducted evap a/c 1.2 kW split system in bed room 1 kW portable refrig a/c	awnings to most windows, whirly birds to vent roof space, upstairs extension has blow in ceiling insulation
29	VIC	3135	4	yes	yes	storage gas hws gas stove top 50 mJ/hr ducted gas heating	elec cooking 2.4 kW split system a/c in lounge 0.75 kW split system in bed room dish washer	canvas awnings to most windows, thick curtains, ceiling fans installed, no ceiling insulation when first moved into house in 2003 (first winter in house very cold - next winter with ceiling insulation noticed an appreciable improvement in heat retention
30	VIC	3113	2	yes	yes	storage gas hws 40 mJ gas heater	under floor hydronic heating 2 kw split a/c in sitting rm 1.6 kW split a/c in bedroom	crystal bond tinting on sun room windows, large veranda shades living areas, vertical blinds to most windows, ceiling well insulated,
31	VIC	3136	4	yes	yes	gas stove top gas ducted under floor heating	315 Lt off peak hws elec oven dish washer clothes dryer 900 watt ducted evap a/c	installed solar panels 4 years ago, canvas awnings and heavy backed curtains to most windows,
			has solar panels					
32	SA	5118	3	yes	yes	gas hot water gas stove top	elec oven 900 Watt ducted evap a/c 1.2 kW split a/c in lined granny flat	owns own home and would like solar but can not afford it, ducted evap a/c is regularly maintained and serviced (new pads recently), ceiling fans, some windows tinted, shade cloth awnings and glory vine and front and rear verandah provide shade, whirly bird
33	SA	5118	3	yes	yes	gas hws gas cooking	3.5 kW ducted reverse cycle a/c	wall insulation installed to one west facing bedroom, roller shutters to east facing (lounge room and master bedroom) windows, thick curtains to most windows, large rear verandah
34	QLD	4500	4	no	yes	all elec house	2 hp r/c wall mounted a/c off peak elec hws	bi-fold doors installed between kitchen and living area to improve efficiency of natural venting when weather permits, internal blinds to most windows, deck to front of house shades ground floor rooms
35	QLD	4007	1	n o	yes	all elec house	2 kw split system in lounge room elec cooking	ceiling fans installed in bed rooms, internal roller blinds, whirly birds
36	QLD	4011	4	yes	yes	gas stove top	elec oven 2.6 kW split in upstairs lounge 0.7 kW split in master bedroom ceiling fans in bedrooms dish washer 0.7 kW split in x 3 bedrooms 2.1 kW split in down stairs lounge 750 watt pool pump 2 x fridge freezers clothes dryer	ceiling fans installed, rear verandah and external blinds and awnings provide shade to m most windows, Holland blinds in bedrooms, foil insulation in walls when renovated in 2003, reroofed in 2012 and insulation replaced
37	QLD	4051	1	bottled gas	yes	bottled gas for instant hws	clothes dryer 3.3 kW ducted r/c a/c ceiling fans in kitchen	double brick walls, ceiling fans, has thick curtains to windows, ceiling recently re-insulated with batts
38	QLD	4122	1	no	yes	all elec house	2.5 kW split system a/c in lounge ceiling fans dish washer clothes dryer 80 Litre peak elec hws 0.7 kW split system in bed room	tinted windows on verandah, sliding door to verandah to promote better air flow and cross ventilation