

Domestic Energy Use by Australians with Multiple Sclerosis



Frank Bruno
Associate Professor
University of South Australia
Australia
Frank.Bruno@UniSA.Edu.Au

Associate Professor Monica Oliphant, University of South Australia, Australia.
Dr Michael Summers, LaTrobe University, Australia.

Abstract

Heat intolerance is a major medical problem affecting people with multiple sclerosis (MS). When their core body temperatures increase 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 is a medical necessity.

This work was carried out in partnership between the University of South Australia and MS Australia to develop an 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 involved surveys and examining energy bills in 38 households of people with MS. Participant households used, on average, about 16.8% more electricity in summer and 10.5% more electricity in winter than the average for the area. This increased to 32.2% more in summer when the 24% of homes with solar PV were removed.

Examining non-solar homes more closely, summer electricity use showed those using more than the average (60% of sample) used about 80% more electricity while the rest used 18% less. The latter were predominantly found to have introduced energy savings initiatives and were careful about energy use.

The research provided evidence that people with MS require more air conditioning to keep cool as a result of their medical condition. The work provides vital material for future policy in relation to supporting vulnerable and often low income households with high energy use due to medical need.

Keywords - multiple sclerosis, air conditioning, cooling, domestic energy use



Bruno, F. DOI: <http://dx.doi.org/10.4225/50/5810757f2d31e>

HealthyHousing2016: Proceedings of the 7th International Conference on Energy and Environment of Residential Buildings, November 2016, edited by Miller, W., Susilawati, C. and Manley, K. Brisbane: Queensland University of Technology, Australia. DOI: <http://dx.doi.org/10.4225/50/58107c8eb9c71>

1. Introduction

People with MS identify high temperatures as one of the top three factors adversely affecting them (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 et al, 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 paper presents the results and analysis of energy use in 38 households in four capital cities in Australia. This work builds directly on the Keeping Cool Survey (Summers & Simmons, 2012) 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.

It is also important to note that heat (and/or cold) intolerance are also common to many other people with a wide range of conditions including Parkinson's disease, motor neuron disease, lymphoedema, amputees, spinal cord and brain injury, post-polio syndrome and fibromyalgia. Consequently the medical need and costs of keeping cool are not unique to people with MS, and this research is also likely to be indicative of issues facing many people who are heat and/or cold intolerant.

2. Methodology

The objective of this research 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. That work 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. As gas penetration is quite substantial in some states of Australia – 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 research, energy audits were conducted 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). The air conditioning survey 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, 2012 & 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. An energy audit was conducted in the 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.

In addition to the surveys, electricity and gas bills were sought from the 38 households. 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 (Energy Made Easy, 2014). 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 1.

Table 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

2.1 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 was very useful for identifying trends.

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 and comparison data from the Energy Made Easy web site. 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. The analysis was aided by incorporating the number of household members – taken from the survey. This seasonal energy use data was then plotted together with the postcode and state average data taken from the Energy Made Easy web site.

2.2 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 way of determining exactly what the energy was used for. Consequently, there are some significant limitations to this method. The strengths of using energy bills include:

- (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 most homes in Australia are not yet equipped with these meters, although they are being rolled out gradually in many locations.

3. Results and Discussion

This section presents the results from the survey questionnaire, energy audits, billing data and temperature loggers.

3.1 Air conditioning Survey Summary

The energy audit carried out during this project included a detailed air conditioning survey. The average results are given in Table 2. The number of contributors to the survey was 36. 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.

Table 2: 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%
seizures		2.8%	2.8%	94.4%
physical collapse		33.3%		66.6%
loss of motor function		52.8%		47.2%

* sometimes

3.2 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
- Whether energy concessions were in place
- 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.

A summary of results are presented in Table 3. The Table of results is divided into three parts:

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

Table 3: 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 South Australian households was 24% - the highest penetration in Australia.

Table 3 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 shows the household summer electricity and gas use greater than or less than the state averages for non-solar homes for summer and winter, along with energy cost from energy bills. The average number of people in each household (for both above and below average energy use) was 2.5. 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: Summary of summer and winter electricity use compared to state averages for non-solar homes

	Summer electricity use	Winter electricity use	Total Cost (electricity + gas bills)
Average of homes > state average	80%	52%	\$3,115
Average of homes < state average	-18%	-30%	\$1,564
TOTAL relative to state average	32.2%	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 to illustrate common usage patterns and other details.

Figure 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 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.

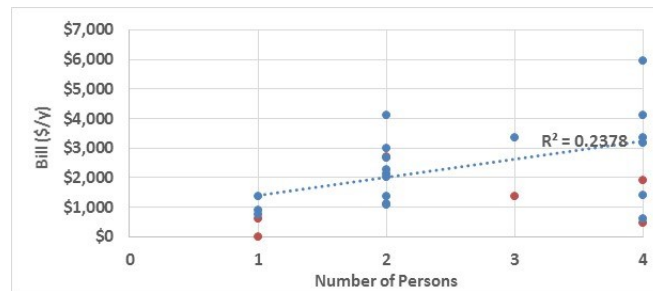


Figure 1: Annual energy bill taking into account number of persons in the home. (Red Points are Solar Homes)

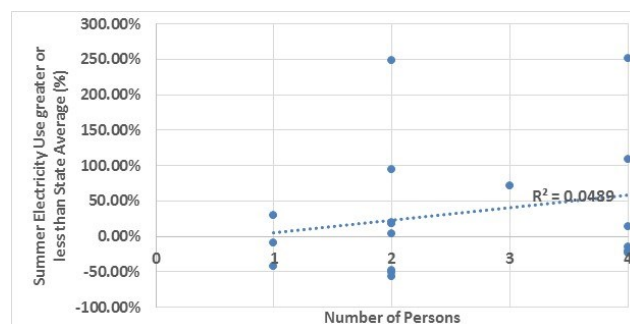


Figure 2: Summer electricity use greater than or less than the state average (%) taking into account number of persons in the home

Two reasonably strong data correlations found in the analyses that were not particularly surprising: as both summer and winter energy use increases, so do the costs for those households. And the converse is equally true.

3.3 Data from Temperature Loggers

From the sample of 38 homes of people with MS (PwMS), 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.

Data logger material was also available for households in Adelaide and Sydney. In Adelaide comparison data was available from December 2012 to February 2013, and averages from 9:30am to 8:30pm were used. The average temperature in the 2 homes with PwMS was 1.5°C cooler than the 9 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. The data for the households without PwMS was taken from Lochiel Park, an energy efficient housing development (Saman et al, 2012 & 2013).

A comparison was also made for 2 homes with PwMS to 7 homes without PwMS for Sydney. Table 5 shows average temperature data for the 2 households with PwMS and 7 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 5 shows that the average temperature in the homes with PwMS was 0.8°C lower than the homes without PwMS.

Table 5: Indoor temperature in Sydney households with and without PwMS on days over 35°C

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. Conclusion and Policy Recommendations

This study 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 Australian 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. A detailed examination of the findings can be found in the project report (Bruno et al, 2014).

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.
- 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 include:

- Existing and new energy efficiency schemes regarding existing and future housing stock should ensure that specific targeting of these high energy use/low income households are targeted as part of their overall strategy.
- Examining the potential of developing a single national medical energy concession, ideally based on a percentage of the overall energy bill to ensure equity, reduce administrative costs and provide incentives for concession funders to promote energy conservation measures (including solar PV installations) for these households.
- Future research should include a more detailed study of energy use in MS households, as well as is in other households such as those with Parkinson's disease, spinal cord injury, etc that are known to have a medical need to keep warm and/or cool.

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