AUSTRALIA

Keeping Cool Survey:

Air Conditioner Use by Australians with MS

Public Policy Related Results & Recommendations

Dr Michael Summers & Dr Rex Simmons **2009**

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The views expressed in this document do not necessarily reflect the views of the Consumer Advocacy Panel (or its parent organisation – the Australian Energy Market Commission), or the Consumer Utilities Advocacy Centre, MSRA or the Public Interest Advocacy Centre.

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Executive Summary

Heat intolerance is a major medical problem affecting people with multiple sclerosis. As little as 0.2–0.5°C increase in core body temperature significantly increases MS symptoms, and significantly reduces the capacity of people with MS to participate in social, household and work activities, as well as increasing their need for pharmaceuticals and medical services. Consequently the use of air conditioners, with all associated purchase and operating costs, is usually a necessity for people with MS.

The Keeping Cool Survey found that 90% of the 20,000 people with MS in Australia are sensitive to heat, and run their air conditioners more frequently and for longer periods than most Australians. Nationally, people with MS averaged 1616 hours of air conditioner use annually.

In Victoria the annual average was 1544 hours of air conditioner use. This compares with another Victorian survey of all households which found that average use over the warmer months was 107 hours. This suggests that people with MS might run their air conditioners 15 times as much as the average Australian household.

Economic modelling estimated that average costs for people with MS across Australia from September to April for running their air conditioners were between $488 and $650 (based on $0.15 and $0.20 per kWh respectively). Not surprisingly costs are higher in the hotter areas ($753–1004 in QLD) and lower in cooler areas ($297–396 in ACT). For 2007 the estimated average cost of cooling for all Australian households was $49–66. This indicates that on average people with MS are estimated to spend almost 10 times more on keeping cool than the average Australian household.

To help minimise these costs and the related carbon emissions, people with MS make minor home modifications to improve the thermal efficiency of their homes more often than the average Australian household. For example, approximately 10% more people with MS have roof and wall insulation in their homes than average Australian households, and are more likely to have external window coverings.

However, notwithstanding these measures to keep their costs down, the high costs of keeping cool, combined with (a) rising electricity prices, (b) the increasing economic pressures on households generally, and (c) the increasing number of hot days and nights due to climate change, mean it is increasingly difficult for people with MS on low incomes to keep cool on hot days and nights. In 2007, 52% of Australians with MS had annual incomes below $26,000.

From a societal perspective this raises a number of public policy issues and challenges:

- ensuring that community service obligations to people who are heat intolerant are met in a way that is effective and equitable;
- maximising the efficiency of cooling for these households to minimise both the economic and environmental costs; and
- minimising the impact of catastrophic events such as power-blackouts on this group.

These public policy issues and challenges must be resolved in ways that will continue to be effective and equitable in a rapidly changing policy environment which includes:

- the development of national electricity markets;
- the implementation of smart meters, and time-of-use peak pricing tariff structures;
- rapidly increasing electricity costs now and into the foreseeable future; and
- more hot days and nights nationally, increasing the need for medical cooling and the associated increasing costs for households.

Public policy responses to heat intolerance will be most effective and equitable if they are aimed broadly at the wide range of people who are heat intolerant, such as those serviced through the existing VIC and WA concession programs. Additionally, across all of the recommendations outlined below, developing and implementing effective responses to the need for people with MS and other heat intolerant people to keep cool involves actions by individuals; families; health, community and professional organisations that work with them; energy retailers and suppliers; and governments at all levels. For all three recommendations, leadership and support from state and territory governments in particular will be essential to ensuring that people with heat intolerant conditions are not further disadvantaged by their condition, and are able to lead full lives.

The high levels of electricity use by this group along with their low incomes make them especially vulnerable to any increases in electricity costs (whether through smart metering and/or general increased costs). Community service obligation schemes must be engineered to make sure they can afford to run their air conditioners enough to keep cool on hot days and nights. The three recommendations below cover this and additional critical issues for people with MS and other heat intolerant conditions.

Recommendation 1**: Current public policy responses such as electricity rebates are a useful and effective means of assisting people with heat intolerance. Experiences in both VIC and WA indicate that rebates are effective for people who are heat intolerant and relatively low cost for government. Rebates must be set at meaningful levels and be regularly adjusted to take into account residential electricity price increases. Rebates need to be developed and implemented in all states and territories, as they currently exist only in VIC and WA.**

Recommendation 2**: New programs should be developed, and existing programs should be better targeted at people who need to keep cool for medical reasons to maximise the efficiency of cooling for these households, and to minimise both the economic and environmental costs. This involves three interrelated strategies: (a) replacement of older inefficient air conditioners; (b) minor home retrofitting such as ceiling insulation and external window coverings; (c) advice to the general public; people with heat intolerant conditions and their families; and professionals who work with them on steps they can take to minimise energy consumption and keep cool.**

Recommendation 3**: It is essential that heat wave and electricity blackout responses by state and local governments, and energy retailers and suppliers are developed for all locations before next summer, and that the needs of people with MS and other heat intolerant conditions are included routinely and effectively in these responses.**

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1 Introduction

Heat intolerance is a significant medical problem affecting people with MS. As little as 0.2–0.5°C increase in core body temperature creates an increase in MS symptoms for people with MS (Guthrie & Nelson 1995). 'Heat worsens and cooling improves negative symptoms of multiple sclerosis, sometimes dramatically so' (Baker 2001: p. 1779).

As a consequence of their heat intolerance, people with MS in Australia use air conditioners extensively on hot days and nights as a medical necessity – not as a luxury.

There are approximately 20,000 people with MS in Australia (extrapolation from prevalence data by Access Economics 2005). 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 (Access Economics 2005).

For people with MS the costs of running their air conditioners are an additional disease-related expense that must be met on top of other out-of-pocket disease-related expenses. All of these expenses must be met from lower than Australian average incomes that people with MS earn. These out-of-pocket costs, combined with (a) rapidly rising electricity costs, (b) increasing economic pressures on households generally, and (c) the increasing number of hot days and nights due to climate change, mean that it is more and more difficult for people with MS on low incomes to keep cool on hot days and nights.

Given that people with MS must run their air conditioners to minimise their symptoms during hot weather, environmental costs regarding carbon emissions are also important and relate particularly to air conditioner efficiency, the thermal efficiency of the space being cooled and how air conditioners are used.

Notwithstanding the importance of keeping cool for people with MS, no previous research could be found in the literature that has explored and described the use of air conditioners by people with MS across Australia, nor in other countries. This is why the Keeping Cool Survey was conducted.

Prior to developing the survey, informal discussions with people with MS generated a range of remarks in relation to what happens to them when they get too hot, such as:

> 'Once I get hot, I hit the wall and all I can do is go to bed, often for 18 hours at a time because I am so exhausted I can't even think or do anything else.'
>
> 'Last time it was hot my vision was blurred and I could hardly see anything. I just had to sit at home in my one room with an air conditioner and try and get cool. It took a few days for the tiredness and my eyes to improve.'
>
> 'It's really hard to look after my three kids when it's hot, I can't keep up.'

The Keeping Cool Survey was sent to 3,150 people with MS in September 2008. By February 2009 we had received 2,385 responses, for a response rate of 76%.

See Appendix 1 for a copy of the survey. Key issues covered included:

- What happens when a person with MS gets too hot
- Use of air conditioning to keep cool
- Outside air temperature when air conditioner is turned on
- Type of air conditioner

- Age of air conditioner
- Hours of use
- Minor home modifications related to keeping cool

The survey was relatively quick and efficient to undertake as it was done within the framework of the Australian Multiple Sclerosis Longitudinal Study (AMSLS) which has been running since 2000, and has enrolled a large cohort of Australians with MS for interdisciplinary research relevant to improving their situation (see http://www.msaustralia.org.au/msra/research/ms-life-study.php). The Keeping Cool Survey was sent to all consenting participants of the AMSLS, which eliminated the need for special recruitment and maximised response rates.

The AMSLS project is approved by the ACT Health Human Research Ethics Committee, an independent National Health and Medical Research Council-constituted human research ethics committee. The Keeping Cool survey was sent out under the general AMSLS project approval.

There was an overlap of 1,578 respondents (66%) to both the Keeping Cool Survey and the Economic Surveys (conducted in 2003 and 2007 as part of the AMSLS). This enabled us to undertake additional analysis regarding air conditioning use by people with MS who are likely to be eligible for a concession or rebate for their electricity bills.

The remainder of the report is presented in three sections: Background, Results, and Conclusions and Recommendations.

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2 Background

MS and Heat Intolerance – the Literature

Heat intolerance has been known to be a significant issue for people with MS since the late 19th century. Guthrie and Nelson's (1995) critical review of the influence of temperature changes on MS traces the scientific and medical understanding of the issue from Uhthoff's work in 1890 to more recent work. Two key points emerge from their review: (a) internationally MS symptoms increase in about 80% of people with MS when they get too warm, and (b) the exact physiological cause cannot be fully explained through the usual hypothesis that heat blocks the nerve conduction of already damaged (demyelinated) axons of nerve cells.

Knowledge of the impact of heat on people with MS resulted in the use of hot bath tests from the 1960s to 1980s to help diagnose MS. This was discontinued because it was not an accurate enough diagnostic test (better tests became available) and 'because it sometimes resulted in permanent neurological deficits in MS patients' (Guthrie & Nelson 1995: p. 1).

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).

Heat intolerance has significant economic and quality of life impacts in the day-to-day lives of people with MS and their families (De Judicibus & McCabe 2007). Also, managing heat-related problems is a key component in ensuring that people with MS are able to retain employment (Johnson & Fraser 2005).

These findings are reinforced by an internet epidemiological survey of 2,500 responders with MS which found that exposure to high temperatures was one of the three most commonly cited adverse factors in relation to their MS symptoms (stress and insufficient sleep were the other two). Also, hot baths and infections, both of which increase body temperature, tied as the fourth most cited adverse factors (Simmons et al 2001).

It is generally believed that symptoms usually return to their baseline status when the body temperature returns to normal. However, largely as a result of reports regarding the hot bath test, Guthrie and Nelson (1995) and others (see for example Edlich 2004) note that on rare occasions the increase in symptoms is not reversible. Additionally, Visscher et al (1983: 56) 'speculate…that the more frequent exposure to heat in the Los Angeles area patients may accelerate the pathologic process resulting in the earlier onset and possibly more rapid course [of MS] observed in Los Angeles area patients' when compared to those in the cooler climate of King-Pierce counties in Washington state.

In a meta-analysis of six reports on seasonal variations in MS onsets and exacerbations a statistically significant difference was found with the highest frequencies in spring and the lowest in winter (Ya-Ping et al 2000). In their study of seasonal variations in Japan, Ogawa et al (2003) found that there were more frequent exacerbations in the warmest months, and the coldest. This was attributed to the probable impact of increased viral infections in cold months and warmer weather in spring and summer.

In contrast, Tataru et al (2006) unexpectedly found no increase in MS relapses during the 2003 heat wave in France. They did note however that one of several possible explanations for this was that people with MS are well aware of the problems heat causes them, and that they take appropriate precautions during hot weather.

While it is clear that heat exacerbates MS symptoms, results from epidemiological studies of patterns in exacerbations in relation to seasonal climate variations are confounded by other sources of exacerbations (such as viral infections), and the modifying behaviours of people with MS who routinely take precautions to minimise their exposure to heat on hot days and nights whenever possible.

Economic Impact of MS

There are significant costs associated with having MS. Access Economics (2005) found that the average annual costs in 2005 to people with MS and their families in Australia was $10,500 ($3,893 out-of-pocket and $6,593 for informal care). These costs have increased substantially in the last four years, making the additional cost of running an air conditioner particularly difficult for most people with MS.

These very significant economic costs are borne by people with MS and their families across the financial spectrum. However, like other people in the community with chronic illnesses, overall people with MS have lower income levels than the general community. Although 87% of people with MS are of working age, and most people with MS are employed when first diagnosed, 80% are not employed 10 years after diagnosis (Access Economics 2005). One result of this is that 52% of Australians with MS have annual incomes below $26,000 (Australian MS Longitudinal Study, unpublished data).

Consequently, although many people with MS are employed, ultimately most end up on fixed incomes provided through part and full pensions. This combination of low incomes and the high economic costs of MS means that concessions such as energy rebates are often a critical financial factor in their daily lives.

Climate

Air conditioner use by people with MS in Australia is a direct response to day-to-day weather. As the number of hot days and nights increases, 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.

One of the difficulties of examining climatic impacts on the use of air conditioners by people with MS is the wide variability of the weather across Australia. Additionally, air temperature data has significant limitations because moderate to high levels of humidity, coupled with hot days and nights, make it more difficult for people to keep cool.

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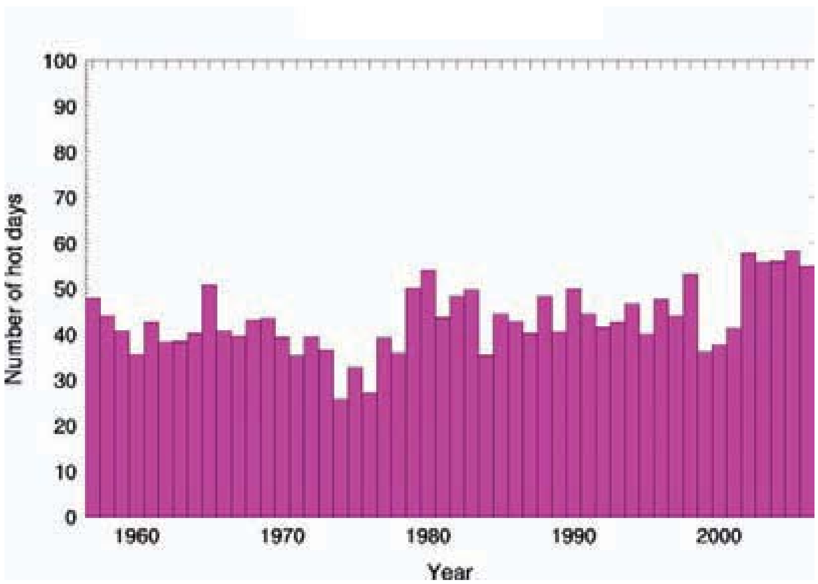
Summary climate data is presented below to give an overview of some of the key issues. The first two graphs (Figures 1 and 2) present national averages for the annual number of hot days (35°C and over) and hot nights (20°C and over) for the last 50 years. These demonstrate a clear trend towards more hot days and nights.

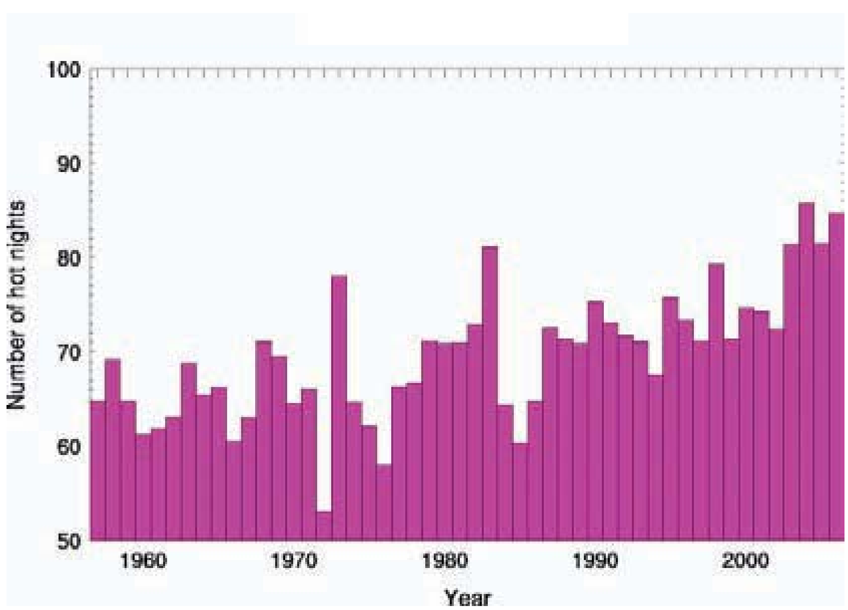
Significantly, 35°C is a very high temperature for most people with MS. The survey results found that on average people with MS turn on their air conditioner when the outside temperature reaches 29°C, with many turning it on well before then. (see Results).

Figure 1: Average number of hot days in Australia over 30 years



Source: http://www.bom.gov.au/cgi-bin/silo/reg/cli_chg/extreme_timeseries.cgi

Figure 2: Average number of hot nights in Australia over 30 years



Source: http://www.bom.gov.au/cgi-bin/silo/reg/cli_chg/extreme_timeseries.cgi

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Table 1 presents the apparent temperature (AT) data averaged over 30 years (from 1976–2005) for states/territories and capital cities. AT is an adjustment to the ambient air temperature based on the level of humidity. The adjustments made to air temperature to take into account the impact of humidity use absolute humidity with a dewpoint of 14°C as the reference point (with slight adjustments depending on the temperature). If the humidity is higher than the reference point then the AT is higher than the air temperature, and if the humidity is lower than the reference point, then the AT is lower than the air temperature.

Table 1: Average annual maximum apparent temperature for states/territories and capital cities

	State/territory apparent temperature (Celsius)	Capital city apparent temperature (Celsius)
NT	31.2°	35.0°
QLD	30.2°	27.0°
WA	28.0°	24.1°
SA	25.0°	21.4°
NSW	23.1°	22.9°
VIC	19.5°	19.7°
ACT	16.4°	18.9°
TAS	15.8°	16.5°

Source: data was compiled for MS Australia by the Bureau of Meteorology in 2008, 30 year averages from 1976-2005.

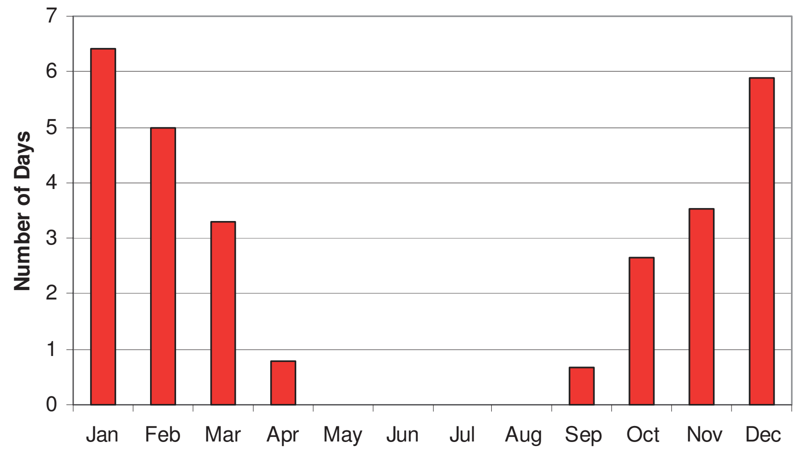
Table 1 is ordered from highest to lowest AT, and capital cities are included as state/territory averages may misrepresent impacts on populations. That is, as populations are not equally distributed throughout each state/territory, data for capital cities may be a better representation of actual impacts on the population. See Appendix B for a gradient map of AT across Australia.

As useful as the above graphs and table are to get an overview of climate data, such broad-brush figures obscure the wide variations across seasons and across locations. It is also difficult to translate these broader figures into what this means in relation to hot days and hot nights that would adversely affect someone with MS.

As NSW represents an approximate mid-point for AT across the states/territories and capital cities, additional figures from Sydney and NSW are presented below to give an indication of these variations across locations and over time.

On average there are 28 days each year that are 30°C or higher in the Sydney area (see Figures 3). There is also considerable variation across Sydney area locations. For example, Observation Hill averages only 15 days at 30°C and over annually, in contrast to Bankstown which has 42.

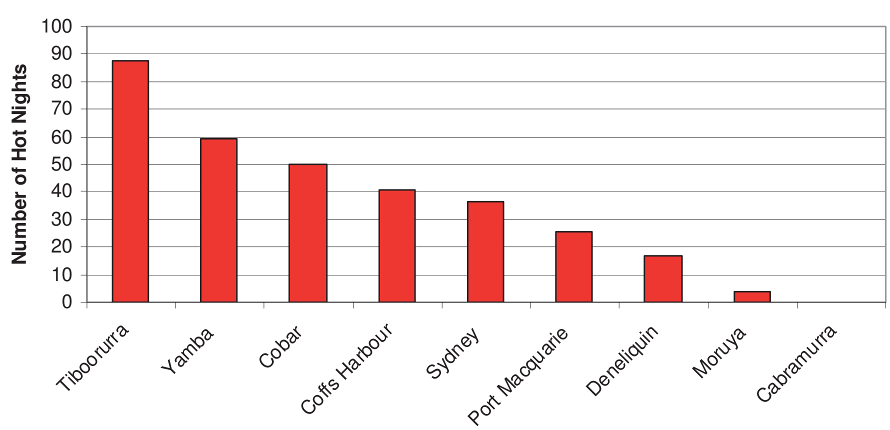
Figure 3: Average number of days 30°C and over for Sydney area by month



Source: Australian Bureau of Meteorology: http://www.bom.gov.au/climate/averages/; based on averaged data across 5 Sydney area sites: Observations Hill, Bankstown, Parramatta, Airport, and Riverview Observatory.

Similarly there are wide variations across NSW locations generally. Figure 4 summarises differences in hot nights (20°C or greater) between 1962 and 2006. There are more than twice as many hot nights in the north-east of NSW than in Sydney, and fewer still in the mountains.

Figure 4: Average number of hot nights across NSW (1962–2006)



Source: Australian Bureau of Meteorology supplied the data sets from which this data was extracted. Hot nights have a minimum temperature of 20°C or higher.

Air Conditioner Use in Australia

There have been several Australian reports in recent years regarding air conditioners, climate and/or energy use, such as work by de Dear and Hart (2002) based on NSW data and Roy Morgan Research (2005) on a Victorian survey. One of the most important works is a national survey by the Australian Bureau of Statistics in 2005: *Environmental Issues: People's Views and Practices*.

The ABS report includes a significant section on Australian air conditioner ownership and use patterns, as well as other relevant material on household construction as it relates to thermal efficiency and energy use generally. Results from the ABS survey are used in parts of the results section of this report as a national benchmark against which results from the Keeping Cool Survey are compared.

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). Data from this report is used in the results section to compare costs for MS households to households across Australia.

In 2007 the Victorian Utility Consumption Household Survey was conducted (Roy Morgan Research 2008) involving a stratified random sample of 2,061 households. This survey repeated similar surveys done in 2001 and 1996. The number of people in the sample that were eligible for the then MS Summer Concession was too small (n = 5) for any separate analysis of their usage patterns to be valid, but results related to air conditioner ownership and use are reported as Victorian household benchmarks in the results section.

Policy Context and Responses Regarding the Need for Medical Cooling

The major issues shaping public policy developments in relation to residential electricity include the development of national electricity markets, the implementation of smart meters, rapidly increasing electricity costs and related environmental measures to reduce demand and carbon emissions.

Nationally electricity prices have risen 31% above the consumer price index since 1990 (and over 80% for Melbourne in that same time, Dufty 2009), and this trend is accelerating. For example the Independent Pricing and Regulatory Tribunal in NSW has proposed price increases for the next year of between 18.5% and 21.5% (IPART 2009). Major drivers of these increasing costs are: rising fuel costs; increasing infrastructure and maintenance costs; increased demand; new construction costs; and carbon taxes.

Smart meters are gradually being introduced in many parts of Australia. Smart meters being strongly promoted as means of increasing efficiency, reducing energy use and greenhouse gas emissions, and improving the capacity of consumers to self-manage their electricity use through better information. Costs of installing smart meters will be passed on to consumers, and consideration should be given to exempting low income households from this additional expense.

Smart meters enable:

- consumption to be measured and charged in small time increments such as half-hours;
- differential pricing during peak (and low) consumption times (time-of-use pricing);
- back-to-base remote monitoring and control (e.g. electricity can be switched on/off remotely by a retailer); and
- possibility of add-ons such as in-home monitoring of electricity consumption.

Differential pricing (time-of-use pricing) is of particular concern as peak hours (the highest cost period for electricity under time-of-use tariff structures) are often during working hours when many people with MS are at home and needing to use their air conditioners. Peak pricing periods are also especially sensitive to peak demand times that often relate directly to the hottest times of the day in warm weather. This pricing regime will particularly disadvantage people with a medical need to keep cool who are not at work, and who will have to pay maximum prices out of low fixed incomes. The Ministerial Council on Energy (2008b) has committed to a review regarding impacts on consumer protection and safety regulation to be completed by May 2009, and this 'may consider consumer pricing...treatment of vulnerable consumers' and other relevant issues.

In one of the major reports related to the cost/benefits of smart metering it was noted that 'the relatively low benefits associated with demand response (compared to business efficiencies) from a smart meter rollout means that providing for vulnerable customers to be excluded from TOU [time-of-use] and CPP [critical peak pricing] tariffs (where they wish to be) would not materially impact the overall cost benefit results' (NERA 2008a: p. xxiii, see note 30).

Studies of residential household electricity consumption patterns demonstrate that overall demand drops when smart meters are used to implement time-of-use tariff structures that charge substantially higher prices during peak demand periods (NERA Economic Consulting 2008a). While such structures may be a good thing for many households and for the environment, people with MS (and other heat intolerant conditions) are likely to find that this creates a serious financial burden that they are unable to meet, especially as their air conditioner use and cost is approximately ten times higher than that of average Australian households (see Results).

The Ministerial Council on Energy (2008a: p. 3), in its response to the Council of Australian Governments' request for a national review of community service obligations and advice on best practice, observed that:

> Energy is an essential service that plays an important role in maintaining Australians' living standards. As such it is important that consumers should have access to a supply of energy. In order to facilitate the provision of energy to vulnerable customers, Governments can create a range of CSOs [community service obligations] to assist those in need.
>
> The MCE considers that energy CSOs are services that Governments require energy businesses to provide to sections of the community to fulfil Government social policy objectives. Typical energy CSOs include rebates for pensioners and concessions for people on life support but do not include income support or other payments made directly by Government to consumers.
>
> Governments can ensure the delivery of energy CSOs by a range of mechanisms. Some of the most common mechanisms are subsidies to retailers for providing non-commercial services and concessions on bills for classes of consumers to assist them to pay energy bills.
>
> State and Territory governments are responsible for delivering energy CSOs.

To date two state/territory governments have responded to the need to provide assistance to people with MS (and other heat intolerant conditions): WA and VIC.

The WA government implemented a Thermoregulatory Dysfunction Subsidy Scheme in January 2007. The projected annual budget is $500,000 to provide 1,500 people with $335 annually for assistance with heating and cooling costs as a result of a medical condition, and paid in monthly instalments.

The subsidy is administered by the Office of State Revenue which also administers the Life Support Equipment Energy Subsidy. To be eligible the person suffering thermoregulatory dysfunction must be:

- certified by their treating physician as suffering clinical thermoregulatory dysfunction, as a result of their condition, that is of such severity that without artificial control of their immediate physical environment they would suffer serious adverse consequences and further medical complications.
- in possession of a valid means-tested concession card issued by either Centrelink or the Department of Veterans' Affairs, being either a: Pensioner Concession Card; Health Care Card; or Health Care Interim Voucher.

The VIC Medical Cooling Concession (previously known as the MS Summer Concession) was implemented approximately 10 years ago, and has provided a discount of 17.5% on summer (Dec, Jan and Feb) electricity bills for those eligible. In July 2008, the concession was expanded to 6 months of coverage (Nov–April), and the annual budget commitment was increased from $102,500 in 2007–08 to $2.4M over 5 years ($625,000 annual average).

To be eligible applicants for the VIC concession, as with the WA scheme, must be assessed by a medical practitioner as having a significant heat intolerance problem. They must also hold a Pensioner Concession Card, Health Care Card or Veterans' Affairs Gold Card.

In 2007–08 the VIC concession assisted 4,313 households. It is estimated that approximately 1,500–1,800 of these were people with MS. Other conditions receiving the concession include:

Cerebral Palsy	Chronic Fatigue
Fibromyalgia	Lymph oedema
Motor Neurone Disease	Muscular Dystrophy
Parkinson's Disease	Poliomyelitis and Post Polio Syndrome
Quadriplegia	Scleroderma
Systemic Lupus Erythematosus	

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3 Results

Survey Method

The Keeping Cool Survey was sent to 3,150 people with MS in September 2008. By February 2009 we had received 2,385 responses, for a response rate of 76%. See Appendix A for a copy of the survey.

There was an overlap of 1,578 respondents (66%) across the Keeping Cool Survey and the two Economic Surveys (conducted in 2003 and 2007 as part of the AMSLS). This enabled us to undertake additional analysis regarding air conditioning use by people with MS who are likely to be eligible for a concession or rebate in relation to their electricity use for keeping cool.

For the 1,578 participants for whom economic data was available, additional analysis was done comparing responses on the Keeping Cool Survey of those who would probably be 'concession eligible' (those on Aged Pensions, Disability Support Pensions, Dept of Veterans Affairs benefits and/or Healthcare Card Holders) and those who were not. See Table C1 in Appendix C for details.

Given the lack of differences in responses between those who are likely to be concession eligible and those who are not, results for the whole sample are presented below. This lack of difference is itself a major research finding. It was expected that those who are concession eligible would be less able to afford the ownership and operation of air conditioners and have lower rates of air conditioner ownership and use. But this is not the case.

Likely explanations would appear to reside in three interrelated possibilities:

(a) the medical need to keep cool is a very high priority for people with MS, so the impact of different income levels on ownership and use of air conditioners is minimal;

(b) even for those people with MS who are relatively better off financially, the overall economic impact of MS may operate to encourage them to use their air conditioners only when absolutely necessary; and

(c) price signals combined with increasing awareness and concern about environmental costs moderate usage patterns equally across both groups.

Following a brief overview of the survey participants' demographics, results are reported in summary form. In general national results are reported, although for some key issues/questions, state and territory level results are presented. Appendix C contains more detailed results for some survey questions. Results from the Northern Territory are not reported as the number of participants was too small to be meaningful or valid. Throughout the results section, when state level data is reported the order of the states/territories from top to bottom is the rank order of their respective maximum apparent temperature (see Table 1 above).

Demographics

The demographic profile of this study consists of 79.0% female. Overall, the mean age of the participants was 52 years, with a range of 25–83 years. This gender and age distribution approximates that of the Australian MS population: 74% female, and prevalence rates peak between the ages of 40 and 59 (Access Economics 2005).

Nationally approximately 36% of those surveyed are likely to be eligible for a concession or rebate on their electricity bills. This estimate assumes that eligibility for the concession/rebate will include people with MS who are heat intolerant, and who have Disability Pension, Aged Pension, receiving benefits from Department of Veterans' Affairs, and/or a Healthcare Card. Of those remaining, approximately 54% would not be in receipt of one of these benefits and 10% do not have a problem with the heat. As a consequence of the lack of differences in Keeping Cool Survey responses between those are and those that are not likely to be eligible for a medical cooling concession or rebate (see Table C1 in Appendix C), the results presented below can be interpreted as being equally applicable to both groups, and to people with MS generally.

The proportion of survey participants in each state and territory (Table 1) broadly corresponds to numbers of people with MS in each area, as judged from the membership numbers of MS societies in Australia. There are very few people with MS in the NT, probably because of the heat, but also because the disease has a known 'latitudinal gradient' of occurrence, with a greater incidence and prevalence away from the equator. For instance, the likelihood of being diagnosed with MS is 7 times more likely in Tasmania than it is in Queensland (Richert 2009). Reasons for the latitudinal gradient are currently being investigated, with exposure to ultraviolet light and Vitamin D levels as possible causal factors (van der Mei et al 2007).

Table 2: Number of survey participants by state and territory

State	Number of Participants	Percentage
NT	4	0%
QLD	317	13%
WA	234	10%
SA	200	8%
NSW	755	32%
VIC	682	29%
ACT	70	3%
TAS	123	5%
Australia	2385	100%

Problems with Heat

Only 10% of the survey participants stated that they did not have a problem with heat: 'I cope just fine'. Figure 5 sets out the proportion of survey participants who experience a wide range of different health and lifestyle impacts as a consequence of hot days and hot nights. The frequency with which people reported these problems did vary across states/territories, and this is reported in more detail in Table C2 in Appendix C.

Figure 5: Proportion of people experiencing various impacts from hot days/nights

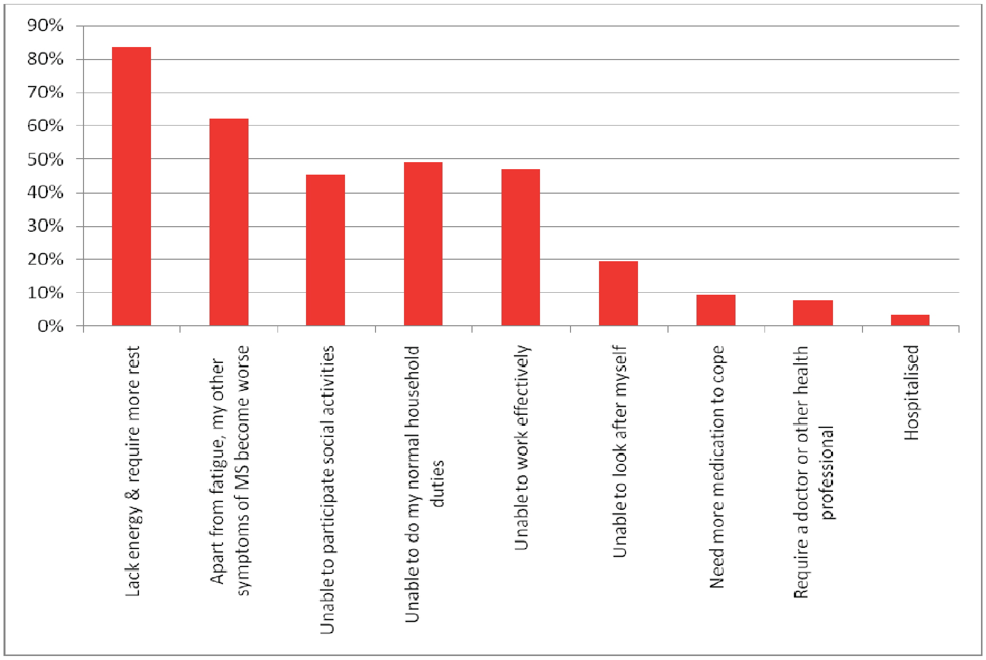


Figure 5 emphasises that the most common problem people with MS experience when they get too hot is an extreme form of fatigue, with most experiencing a general increase in their other MS symptoms as well. Additionally approximately half find the heat renders them unable to participate in social activities, normal household duties and in the workforce. While almost 10% require more medications, or a visit to a doctor or other health professional, 3% report having been hospitalised as a consequence of the impact of heat on their MS symptoms.

While these are relatively small proportions overall in relation to needing some form of medical care, it does serve to highlight the seriousness of this issue for people with MS. The small proportions here are also probably a sign of how well and how much effort and attention people with MS put into managing their exposure to heat, and is an indication of what can happen if they cannot keep cool enough.

Air Conditioners and Their Use

This section incorporates material regarding a number of key issues: types of air conditioners used; their age; the size of the space cooled; and the hours of operation across the year. It is particularly important information in relation to understanding how people with MS use air conditioning at home to keep cool and minimise their MS symptoms.

Additionally, some of this information was later extrapolated into a model to estimate the costs incurred in order to keep cool.

Ownership

Of the survey participants, 82% were using air conditioner to keep cool, with a range of 80–90% (except TAS where 53% were using air conditioners). This is a high level of air conditioner use relative to the national population. In 2005 60% of all households nationally had an air conditioner (ABS 2005: p. 50).

Of the 431 (18%) participants who were not using an air conditioner, 391 indicated a reason for this as outlined in Table 3.

Table 3: Reasons given for not using an air conditioner

	No problem with hot weather	Cannot afford an air conditioner	Cannot afford the electricity	Broken air conditioner
Number	127	228	25	11
Percentage of those not using an air conditioner (n=431)	32%	58%	6%	3%
Percentage of Total Sample Response (n=2370)	5%	10%	1%	0%

For the small number of people who could 'not afford the electricity' it is important to note that many people would opt to reduce air conditioner use because of operating costs, rather than to not use it at all. Consequently those who cannot use it at all due to operating costs are probably in particularly difficult financial circumstances.

Types of air conditioning

Figure 6 describes the different types of air conditioners used. The percentages exceed 100% because a small number of people had more than one type of air conditioner.

Nationally approximately 56% were split systems, 21% were ducted, 19% were evaporative, and 14% had window units. It should be noted that this question was ambiguous, as 'ducted' can be either evaporative or refrigerated/reverse-cycle. Across the general population in Victoria evaporative air conditioners account for 5 times as many ducted systems as refrigerated/reverse-cycle air conditioners (Roy Morgan 2008: p. 117). Although evaporative air conditioners are much less expensive to operate (approximately one-eighth the cost of reverse-cycle air conditioners for ducted systems), in humid climates evaporative air conditioners are ineffective.

Comparative data are available on types of air conditioners across states and territories for households nationally (ABS 2005). Figure 7 compares air conditioner types (evaporative and refrigerated/reverse cycle) between the Keeping Cool Survey and the ABS 2005 survey. Proportions between the two groups are remarkably similar across states and territories, with the exception of the ACT. To create comparable data, the Keeping Cool Survey categories of split system and window units were combined to create 'refrigerated/reverse cycle', and ducted systems are not incorporated (as noted above they could be either evaporative or refrigerated). So, although ownership of air conditioners is higher for people with MS as noted above, the type of air conditioners used is similar to national trends for different locations.

Figure 6: Type of air conditioner

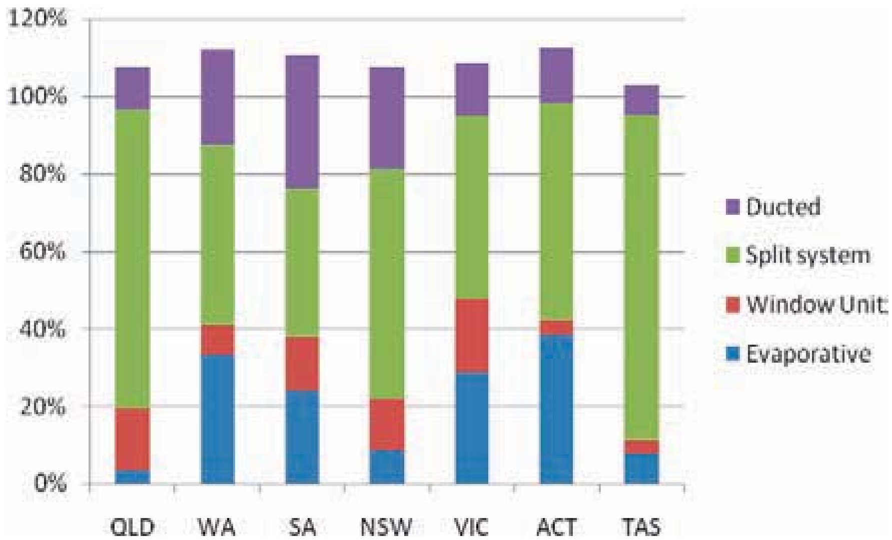
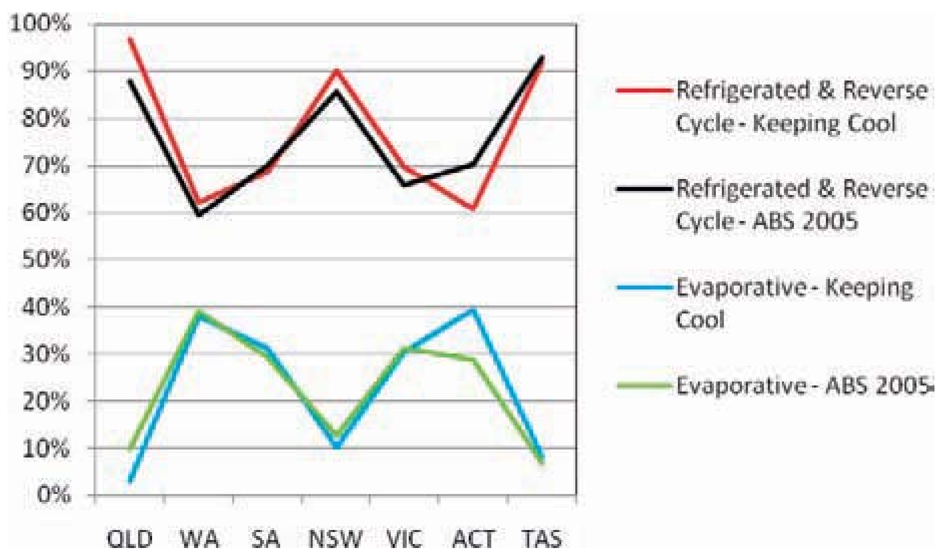


Figure 7: Comparison of types of air conditioning between Keeping Cool and ABS 2005 survey

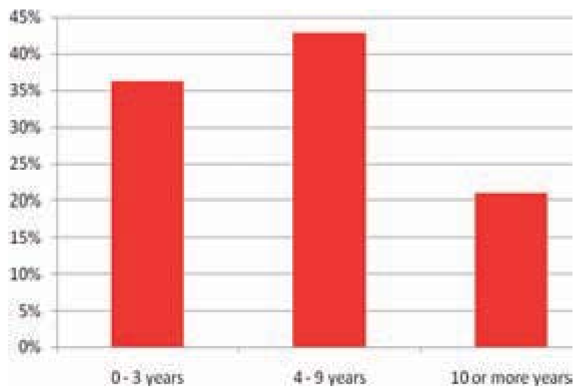


Age of air conditioner

The age of a refrigerated/reverse-cycle air conditioner is an indicator of its efficiency. If it is more than 3 years old, it is very unlikely to have inverter technology which increases cooling efficiency between 20 and 25%. Similarly, air conditioners that are 10 or more years old are likely to be even less efficient as a consequence of less efficient designs and the increased likelihood of requiring maintenance and/or repairs to optimise efficiency.

Figure 8 describes the national distribution of the age of refrigerated/reverse-cycle air conditioners from the survey. More detailed state and territory data is available in Figure C1 and Table C3 in Appendix C.

Figure 8: The age of refrigerated/reverse-cycle air conditioners



Size of space cooled

Another critical element in relation to air conditioner use (and energy consumption and cost) is the size of the space being cooled. Figure 9 summarises the data across states and territories.

Figure 9: Size of space cooled

When these figures are averaged nationally, there is an almost perfectly even distribution across the three categories: 34% (1 room), 33% (2 rooms) and 33% (4 or more rooms). As can be seen in the Figure 9 states/territories were similar, except that WA had more '4 or more rooms' (42%) and fewer '1 room' (21%), and Tasmania had the opposite with 23% and 44% respectively. No survey participants stated that they cooled 3 rooms. That two-thirds of respondents were only cooling one or two rooms is probably another indication of the difficulties many of them have in paying for the cost of keeping cool.

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When is the air conditioner turned on?

Figure 10 summarises the results regarding the external air temperature at which people with MS turn on their air conditioners. One of the things that made responses to this question possible is that most people with MS who are heat sensitive can tell you the precise air temperature point at which their symptoms increase, although this does vary in some areas with highly variable humidity levels (hence the use of ranges rather than exact temperature points).

Nationally the average temperature at which people with MS turned on their air conditioners was 29.2°C, with many turning on their air conditioner at lower temperatures (see Figure 10). The lowest average temperature when air conditions were turned on was observed in TAS with 26.4°C, while the highest was observed in SA and WA, 30.6°C and 30.2°C respectively. Additional information about the differences between states/territories is in Table C4 in Appendix C.

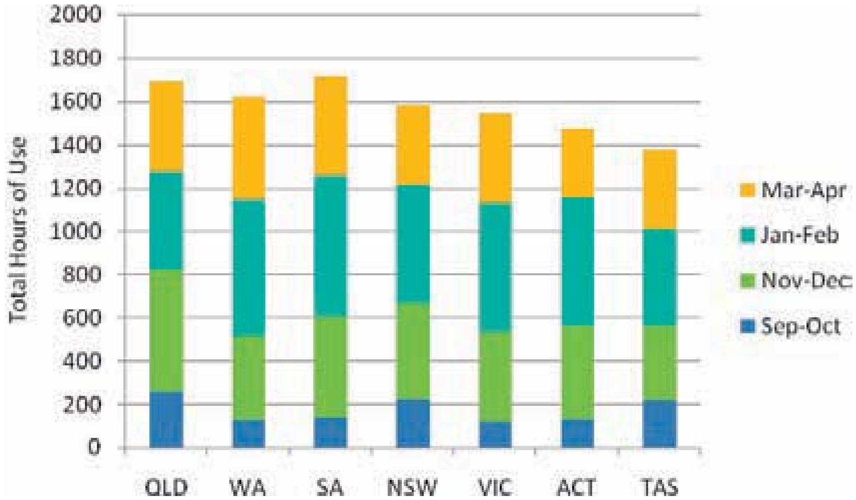
Figure 10: Outside air temperature at which air conditioners are turned on

Hours of air conditioner use

Finally, the other major determinant of energy use and cost in relation to keeping cool is the number of hours that people with MS operate their air conditioners. In order to keep the survey form short and maximise response rates, usage data were collected in two-month increments (see Figure 11). Also, although data was collected for 12 months, only the 8 months of warmer weather and air conditioner use are reported here. As with all surveys requesting remembered or 'historical' information, it is possible that some recall bias may be present in the data, and this possibility should be taken into account when interpreting the results on air-conditioner usage.

Figure 11 illustrates the changing hours of air conditioner use across the warm months and between states and territories. The average total hours of use nationally for people with MS was 1,616. The apparently high levels of use in November–December and March–April relative to January–February is an indication that it does not need to be extremely hot for people with MS to require the use of air conditioning. As noted in Figure 9, more than half of them (54%) turn on their air conditioners before the external temperature reaches 30°C.

Figure 11: Imputed household average total hours of use for September to April



Note: this is an imputed average as it is derived using the mid-points from the categories selected by participants: 0=0; 1–6hrs=3.5hrs; 7–12hrs=9.5; 13–18hrs=15.5; 19–24hrs=21.5.

When reading Figure 11 (as with all other figures in this section of the report), it is useful to remember that the order of the states/territories from right to left is in the rank order of their respective maximum AT. More detailed information regarding hours of air conditioner use for each state/territory can be found in Figures C2–C5 in Appendix C.

In relation to Figure 11, other research in VIC has found that average total number of hours air conditioners were used in the warmer months was 107 hours (Roy Morgan Research 2008: p. ix). This data was based on recall and the completion of a questionnaire – similar to the Keeping Cool Survey.

While it is unclear what is meant by 'warmer months' in the Roy Morgan Research, the imputed total for average VIC household usage for someone with MS in the Keeping Cool Survey was 1,544 hours from September to April (414 hours in Nov–Dec, 599 hours in Jan–Feb; and 413 in Mar–Apr). Given the similarity in methods and the similar possibility of recall bias, the difference in the results between the two surveys is striking: in VIC people with MS average 1,544 hours compared to average household use of 107 hours.

This suggests that people with MS have their air conditioners on almost 15 times as much as average households.

Figure 12 illustrates the hours of air conditioner use during the months from September to April from the Keeping Cool Survey. The different levels of usage in the warmer months are more apparent here than in Figure 11. It is particularly notable that a small number of households appear to use their air conditioners continuously across this 8-month period. These are likely to be households living in the hottest areas of the country, or people whose threshold for heat is particularly low.

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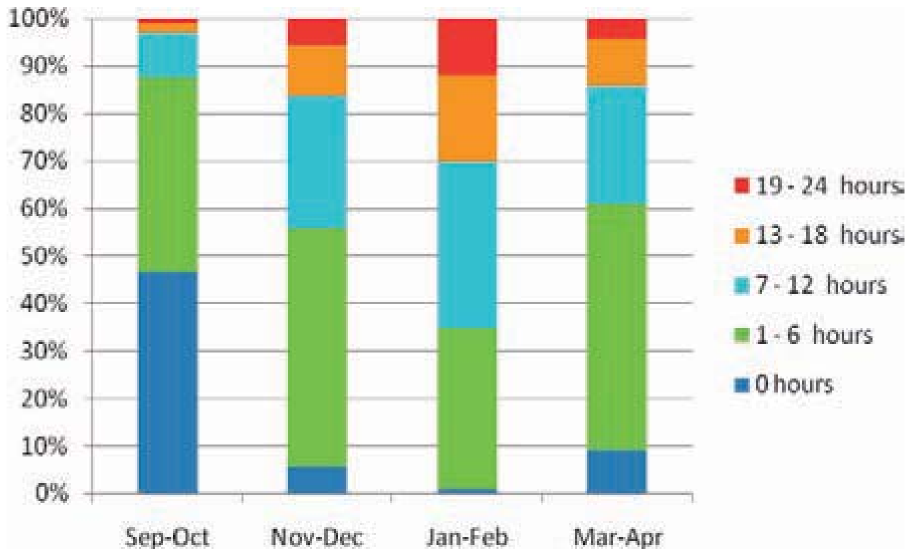
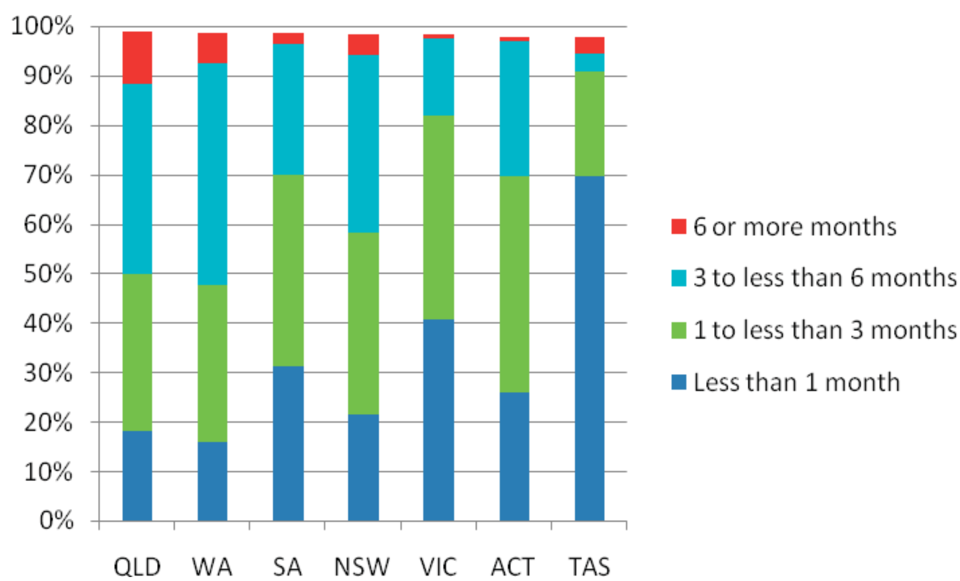
Figure 12: Average proportion of people using their air conditioners for different time periods every 24hrs from September to April



National data on the number of months in which people used their air conditioners is another useful reference point for comparisons between people with MS and the general population. Figure 13 presents data from a 2005 ABS survey, and the relatively large proportion of people using their air conditioners for less than 3 months or less (ranging from 48% in WA to 90% in Tasmania) is a remarkable contrast to the patterns seen above for people with MS.

Figure 13: Number of months of air conditioner use by all Australians by state



Source: ABS 2005, Table 4.14

Minor Home Modifications for Thermal Efficiency

Participants were also asked to identify minor home modifications (including existing construction elements) that related to their homes' thermal efficiency. For example, ceiling/roof insulation can reduce energy consumption up to 45% in summer and winter (ABS 2005). Table 4 describes the results from the Keeping Cool Survey for people with MS, and data in brackets are general Australian household figures from the 2005 ABS survey.

Table 4: Percentage of people with minor home modifications

State	External window blinds, awnings, etc	Internal window blinds, drapes, etc	Roof insulation	Roof vents	Wall insulation
QLD	31	78	58 (41)*	27	15 (11)*
WA	30	84	75 (65)	17	11 (6)
SA	52	83	77 (77)	19	37 (27)
NSW	38	80	67 (53)	26	25 (18)
VIC	48	79	72 (71)	12	32 (29)
ACT	40	86	86 (78)	7	53 (34)
TAS	17	86	77 (73)	6	38 (25)
Australia^	40	80	70 (59)	19	27 (19)

**Source*: ABS 2005, Tables 2.11 & 2.14. ^Australian figures here, as throughout the report unless otherwise noted, exclude Northern Territory data.

As can be inferred from the national ABS figures in brackets for roof and wall insulation, in many instances households that include a person with MS have taken extra steps to improve the thermal efficiency of their homes relative to the general population. Additionally it appears that the variations between states and territories for the Keeping Cool Survey approximate national trends.

Also, although state-level details are not reported, the ABS survey results found that 'outside awnings and/or shutters were the principal form of window protection applied in over 30% of dwellings in Australia, mainly in SA (43% of dwellings) and VIC (38% of dwellings)' (ABS 2005: p. 12). Again at 52% for SA and 48% for VIC, people with MS exceed the national trends in their efforts to keep cool.

This is vital information in relation to focusing programs in the future to improve thermal efficiency in these homes. The low levels of roof insulation in QLD, and to a lesser extent in NSW, and the limited use of wall insulation and roof vents overall are particularly notable, but increases in efficiency could be increased across the spectrum.

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Estimated Costs of Air Conditioning Use

An economic model for estimating costs of air conditioner use by people with MS was developed that utilised the survey results. Results from the modelling are presented in Table 5.

In brief, the modelling included:

(a) exclusion of evaporative and ducted systems from the cost model;

(b) average household hours of use;

(c) costs were adjusted for efficiency through:

   (i) age of the air conditioner as a proxy for efficiency star ratings, and

   (ii) adjusting cooling load resulting from climate variation across states (using average maximum apparent temperature data);

(d) costs were calculated using two costs per kWh, at $0.15 and $0.20, to take into account existing variations across states/territories (see Appendix D for more cost modelling details).

Additionally, sensitivity analysis was undertaken on the economic modelling with respect to three variables: (a) hours of use; (b) hourly costs with efficiency weightings; and (c) utilisation of average maximum apparent temperature to take into account climatic variables given that hourly costs with efficiency weightings were based on Victoria. The sensitivity analysis indicated that, in general, the modelling is highly robust with the results being relatively insensitive to variations in (a), (b) and (c).

For example, in relation to hours of use (as the variable tested) in NSW the mean cost is $489 (at $0.15/kWh) with a standard deviation of $40. This gives a 95% confidence interval of $409–568, which means that we can be 95% confident that the actual costs are in this range. The results for other states and nationally are similarly robust for variations in hour of use. This is also true for variations in efficiency weightings. The results for variations in apparent temperature are also robust except for Queensland and WA, where they show somewhat larger standard deviations relative to the mean, and therefore somewhat larger confidence intervals. This result is consistent with much higher apparent temperature in Queensland and WA compared to the other states. See Tables D1 and D2 in Appendix D for details of the sensitivity analysis. The results from the sensitivity analysis should be taken into account when interpreting the results in Table 5.

In Table 5 it is also useful to observe the very significant impact that as little as a $0.05 difference in price per kWh can make to overall costs. This is of particular concern given rising electricity costs generally and the impending introduction of smart meters and time-of-use peak pricing tariff structures in many jurisdictions (see Background section).

Table 6 provides estimates cooling costs for all Australian households 2007 (Dept of the Environment, Water, Heritage and the Arts 2008), and is a useful comparison point in relation to people with MS.

Table 5: Estimated average household costs of air conditioner use by people with MS from September to April (excluding evaporative and ducted air conditioning)

State	Average hours of air conditioner use	Cost at $0.15/kWh	Cost at $0.20/kWh
QLD	1574	$753	$1004
WA	1250	$560	$747
SA	1430	$570	$760
NSW	1362	$489	$651
VIC	1335	$406	$541
ACT	1139	$297	$396
TAS	1168	$300	$401
Australia	1374	$488	$650

Notes: Cost figures are not a direct multiplication of hours x cost, as air conditioners are not operating at full capacity at all times when they are on. See Appendix D for details of cost modelling.

Table 6: Estimated cooling energy use and cost by state/territory in 2007 for all Australian households

	Cost at $0.15/kWh	Cost at $0.20/kWh
QLD	$112	$149
WA	$61	$82
SA	$80	$107
NSW	$54	$72
VIC	$17	$22
ACT	$22	$29
TAS	$0	$0
Australia*	$49	$66

*Australian average excludes Northern Territory.

Source: Dept of the Environment, Water, Heritage and the Arts (2008), from Table 9, p. 39: 'Space Cooling Energy Consumption in Petajules by State from 1990–2020' Data was converted to average household data by converting petajules to kWh and dividing by total households.

In comparison to estimates for all Australian households (see Table 6), costs of keeping cool for people with MS (see Table 5) is approximately 10 times higher in relation to national averages. This translates into a very significant economic burden for people with MS. Given these costs for people with MS, it is all the more remarkable that there are no differences in air conditioner use between those who can most afford it (not likely to be concession eligible) and those who can least afford it (those likely be concession eligible). The most probably conclusion from this is that keeping cool is a very high priority for people with MS, irrespective of their capacity to pay.

4 Conclusions and Recommendations

Approximately 90% of the 20,000 people in Australia with MS are adversely affected by the heat. They run their air conditioners approximately 15 times as much as average Australian households to meet their medical need to keep cool and minimise their MS symptoms.

Costs to people with MS to keep cool are estimated to be 10 times that of the average Australian household: ranging from $488–650 for people with MS, compared to $49–66 for average Australian households (cost ranges are based on costs of electricity varying between $0.15 and $0.20 per kWh). People with MS undertake additional measures to improve the thermal efficiency of their homes in an effort to keep their cooling costs down and minimise carbon emissions more often than the average Australian household.

The high number of hours that air conditioners are used can be explained through several factors. First, people with MS are more likely to be home during working hours as 80% of them are unemployed within 10 years of diagnosis. Second, people with MS are more likely to stay home and indoors during hot weather to keep cool. Third, the threshold at which their symptoms increase is lower than the temperatures at which most people turn on their air conditioners. Finally, the use of air conditioners by people with MS (82%) is also well above Australian air conditioner ownership (60%).

The high use of air conditioners, air conditioner ownership and household modifications to improve thermal efficiency all result in a significant additional financial costs to people with MS that must be met from lower than average incomes already severely diminished by other disease-related expenses.

The lack of difference in patterns of air conditioner ownership and use between people with MS on lower incomes (as indicated by the likelihood of concession/rebate eligibility) and those on higher incomes reinforces how important keeping cool is in their daily lives. In particular, keeping cool assists them to maximise their capacity for everyday activities (social, household and work) and minimise medical costs (medication, visits to health professionals and occasionally hospitalisation).

From a societal perspective this raises a number of public policy issues and challenges:

- ensuring that community service obligations to people who are heat intolerant are met in a way that is effective and equitable;
- maximising the efficiency of cooling for these households to minimise both the economic and environmental costs; and
- minimising the impact of catastrophic events such as power-blackouts on this group.

These public policy issues and challenges must be resolved in ways that will continue to be effective and equitable in a rapidly changing policy environment which includes:

- the development of national electricity markets;
- the implementation of smart meters, and time-of-use peak pricing tariff structures;
- rapidly increasing electricity costs now and into the foreseeable future; and

- more hot days and nights nationally, increasing the need for medical cooling and the associated increasing costs for households.

Public policy responses to heat intolerance will be most effective and equitable if they are aimed broadly at the wide range of people who are heat intolerant, such as those serviced through the existing VIC and WA concession programs. Additionally, across all of the issues and recommendations outlined below, developing and implementing effective responses to the need for people with MS and other heat intolerant people to keep cool involves actions by individuals; families; health, community and professional organisations that work with them; energy retailers and suppliers; and governments at all levels. On all these issues and recommendations, leadership and support from state and territory governments in particular will be essential to ensuring that people with heat intolerant conditions are not further disadvantaged by their condition, and are able to lead full lives.

The high levels of electricity use by this group along with their low incomes make them especially vulnerable to any increases in electricity costs (through smart metering and/or general increased costs). Community service obligation schemes must be engineered to make sure they can afford to run their air conditioners enough to keep cool on hot days and nights.

***Recommendation 1*: Current public policy responses such as electricity rebates are a useful and effective means of assisting people with heat intolerance. Experiences in both VIC and WA indicate that rebates are effective for people who are heat intolerant and relatively low cost for government. Rebates must be set at meaningful levels and be regularly adjusted to take into account residential electricity price increases. Rebates need to be developed and implemented in all states and territories, as they currently exist only in VIC and WA.**

Maximising the efficiency of cooling for these households to minimise both the economic and environmental costs involves three interrelated strategies. First, programs should be implemented that replace older, less efficient air conditioners. Given that 74% of people with MS have air conditioners that are 4 or more years old, replacing all of these would provide an immediate 20–30% reduction in both costs and environmental impacts.

Although replacing existing air conditioners with direct load control technology (which enables electricity retailers to manage the energy consumption of air conditioners) does not increase the air conditioners' efficiency, it does have the capacity to help electricity retailers and suppliers more effectively manage electricity supplies during periods of peak energy demands – especially spikes in demand on very hot days/nights. Consequently any program established to help supply new high-efficiency/low-carbon-footprint air conditioners to people with heat intolerance should examine the feasibility and value of installing air conditioners that incorporate direct load control technology.

Second, programs to provide energy audits and minor home retrofits aimed at improving thermal efficiency are needed. The Commonwealth's ceiling insulation program is a good example of one such program. There are also other, more comprehensive programs already in operation, such as the program run by Kildonnen (part of Uniting Care in Victoria) which undertakes energy (and water) audits, helps seek funding, and implements minor home retrofits and appliance replacements, as well as advising on behavioural aspects of reducing consumption. Funding such programs for people with

MS and other heat intolerant conditions who are high users of air conditioners would also help reduce economic and environmental costs.

Finally, programs are needed that advise people with a medical need to keep cool in relation to how they can improve the cooling efficiency of their home, and change behaviours that can help to reduce demand while still keeping them cool. These should be a combination of programs aimed at: the general public; people with heat intolerant conditions and their families; and professionals who work with people with heat intolerant conditions and their families.

Recommendation 2**: New programs should be developed, and existing programs should be better targeted at people who need to keep cool for medical reasons to maximise the efficiency of cooling for these households, and to minimise both the economic and environmental costs. This involves three interrelated strategies: (a) replacement of older inefficient air conditioners; (b) minor home retrofitting such as ceiling insulation and external window coverings; (c) advice to the general public; people with heat intolerant conditions and their families; and professionals who work with them on steps they can take to minimise energy consumption and keep cool.**

The recent trend in some areas for electricity blackouts during heat waves is of particular concern for this group. A combination of strategies is likely to be the most effective, including the provision of advice and assistance to particularly vulnerable groups about how they might keep cool when blackouts occur. A wide range of measures is possible such as: cold baths; creating a cool room; arrangements with friends or family; identification of vulnerable households and not blacking them out, or arranging transport to a cool public space before supplies are cut off, and so forth. Responsibility for identifying and implementing these measures will vary across jurisdictions, but likely to include a combination of energy retailers, health and community services, local government, state/territory governments, and non-government organisations. It is vital that state/territory governments provide leadership, oversight and incentives to ensure this occurs.

Recommendation 3**: It is essential that heat wave and electricity blackout responses by state and local governments, and energy retailers and suppliers are developed for all locations before next summer, and that the needs of people with MS and other heat intolerant conditions are included routinely and effectively in these responses.**

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6 Appendixes

Australian MS Longitudinal Study (AMSLS)

"Keeping Cool" Short Survey 2008

Your Study ID Number is: ☐☐☐☐

Purpose of Survey: People with MS sometimes have trouble with hot weather and keeping cool. *MS Australia* would like to know the extent of this problem, so they can work toward improving the situation for people with MS, including making informed requests to government agencies for increased financial assistance for air-conditioning costs, etc. By completing this survey and returning it in the enclosed reply-paid envelope, you will be helping with this advocacy work. Please note there is no guarantee that any survey participant will personally benefit.

Please do not write your name on the questionnaire. Those entering the data will not know who you are, and only anonymous, grouped results will be analysed and made public. Please answer all questions on both sides of the page by ticking the appropriate boxes.

1. Do you use an air conditioner at home to keep cool on hot days or nights?

YES [ ] — Please go to Question 3. **NO [ ] — Please go to Question 2.**

2. I do not use an air-conditioner at home because… (please tick all applicable reasons):

(a) I do not have a problem with hot weather [ ]

(b) I do have a problem with hot weather but cannot afford to buy an air conditioner [ ]

(c) I have an air conditioner and need to use it, but cannot afford the electricity [ ]

(d) I have an air conditioner and need to use it, but it is broken [ ]

IF YOU HAVE ANSWERED QUESTION 2, PLEASE GO DIRECTLY TO QUESTION 9, OVER PAGE.

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

20 – 24 ^{0}C [ ] 25 – 29 ^{0}C [ ] 30 – 34 ^{0}C [ ] 35 – 39 ^{0}C [ ]

4. What type of air conditioner(s) do you have?

Split system [ ] Window unit(s) [ ] Ducted [ ] Evaporative [ ]

5. How OLD is your air conditioner?

0 – 3 Years [ ] 4 – 9 Years [ ] 10 or more Years [ ] Don't know [ ]

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6. Which rooms in the house do you usually try to keep cool with your air conditioner(s)?

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

7. How many <u>hours</u> do you run your air conditioner each day/night (24-hour period) during the following months of the year:

(a) Jan to Feb: 0 hrs [ ] 1 – 6 hrs [ ] 7 – 12 hrs [ ] 13 – 18 hrs [ ] 19 – 24 hrs [ ]

(b) Mar to Apr: 0 hrs [ ] 1 – 6 hrs [ ] 7 – 12 hrs [ ] 13 – 18 hrs [ ] 19 – 24 hrs [ ]

(c) May to June: 0 hrs [ ] 1 – 6 hrs [ ] 7 – 12 hrs [ ] 13 – 18 hrs [ ] 19 – 24 hrs [ ]

(d) July to Aug: 0 hrs [ ] 1 – 6 hrs [ ] 7 – 12 hrs [ ] 13 – 18 hrs [ ] 19 – 24 hrs [ ]

(e) Sept to Oct: 0 hrs [ ] 1 – 6 hrs [ ] 7 – 12 hrs [ ] 13 – 18 hrs [ ] 19 – 24 hrs [ ]

(f) Nov to Dec: 0 hrs [ ] 1 – 6 hrs [ ] 7 – 12 hrs [ ] 13 – 18 hrs [ ] 19 – 24 hrs [ ]

8. In addition to an air conditioner, do you have any other home modifications that help you to keep cool? Please tick any items that apply:

<u>External</u> window blinds, awnings or other coverings [ ]

<u>Internal</u> window blinds, drapes or other coverings [ ]

Roof insulation [ ] Roof vents [ ] Wall insulation [ ]

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

(a) Nothing, I cope just fine [ ]

(b) I lack energy and require more rest [ ]

(c) Apart from fatigue, my other symptoms of MS become worse [ ]

(d) I am unable to participate in normal social activities (time with family or friends) [ ]

(e) I am unable to do my normal household duties (e.g. cleaning, cooking, etc.) [ ]

(f) I am unable to work effectively [ ]

(g) I am unable to look after myself in the usual manner [ ]

(h) I need more medication to cope [ ]

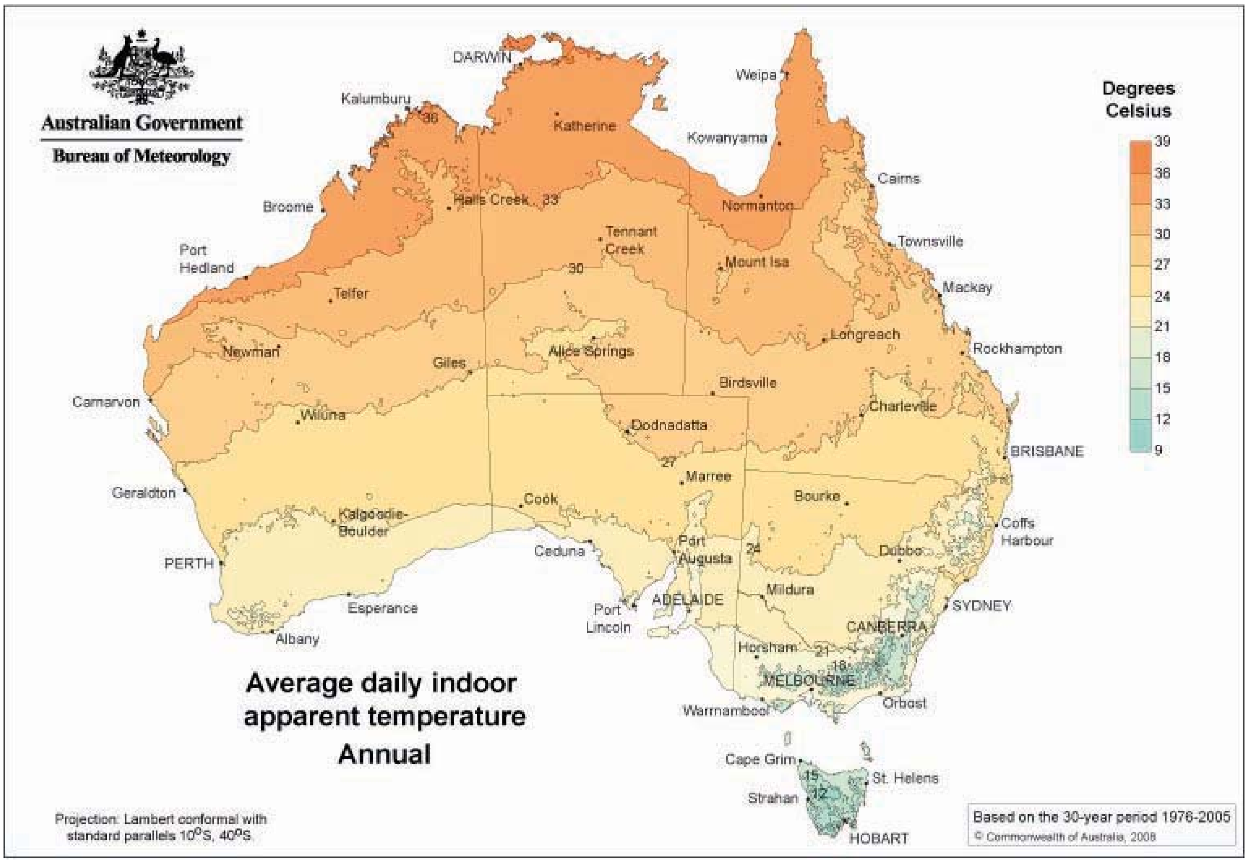
(i) I have felt sufficiently unwell to require a doctor or other health professional [ ]

(j) I have been hospitalised because of heat [ ]

END OF SURVEY. Thank you for your participation. Please return this form promptly in the enclosed reply-paid envelope, or mail to:

Australian MS Longitudinal Study, Level 2 East, Building 5, Canberra Hospital WODEN ACT 2606

Appendix B: Apparent temperature gradient map for Australia



Appendix C: Additional results and data

This appendix contains a variety of additional results and data referred to in the main text. The first table reports the results of statistical tests on different questions between those that are likely and not likely to be concession-eligible. The following tables and figures report details and differences in results from question at a state and territory level.

In Table C1 parametric tests were used to test categorical variables (Chi-square test), and non-parametric test were used for ordinal data such as; Kruskal Wallis test and Mann-Whitney test. As noted in the report, no p-values approached significance, meaning that there are no differences in responses to survey questions between those that are likely to be concession eligible and those that are not.

Table C1: Statistical test results examining response differences between those who may and may not be concession eligible

Questions	Health Care card or Concession card holders	No HCC or CCH	p-value
Q1. Air conditioner used at home to keep cool on hot days	507	774	0.377
Q2a I do not have problem with hot weather	37	49	0.568
Q2b Have problem with hot weather, but can't afford to buy air conditioner	64	96	0.981
Q2c Have air conditioner and need to use, but can't afford electricity	Numbers too small to be meaningful	Numbers too small to be meaningful	n/a
Q2d Have air conditioner, need to use it, but it is broken	Numbers too small to be meaningful	Numbers too small to be meaningful	n/a
Q3 Outside temperature and running air conditioner	632	944	0.330
Q4 Type of air conditioner	501	765	0.577
Q5 The age of air conditioner	632	944	0.162
Q6 Which room in the house do you usually cool	632	944	0.513
Q7aHours per day air conditioner run in January-February	632	944	0.382
Q7b Hours per day air conditioner run in March–April	632	944	0.660
Q7c Hours per day air conditioner run in September–October	632	944	0.270
Q7d Hours per day air conditioner run in November–December	632	944	0.150

Table C2: What happens to you when you get too hot? (% of responses to each item for each state/territory)

State	No Problems	Lack energy & require more rest	Apart from fatigue, my other symptoms of MS become worse.	Unable to participate social activities	Unable to do my normal household duties	Unable to work effectively	Unable to look after myself	Need more medication to cope	Require a doctor or other health professional	Hospitalisation
QLD	7	84	68	51	52	51	25	12	11	5
WA	12	84	53	39	44	44	12	8	6	3
SA	12	86	59	43	45	42	20	12	8	5
NSW	11	84	63	46	52	49	19	9	7	3
VIC	10	83	63	47	48	47	21	8	7	4
ACT	11	84	59	27	37	41	10	10	4	1
TAS	12	87	57	43	49	42	17	8	4	0
Total	10	84	62	45	49	47	19	9	7	3

Figure C1: Age of air conditioners by state/territory

Additionally, statistical tests were undertaken to determine whether or not the differences in air conditioner age across states/territories was statistically significant. If results are statistically significant, this means that when generalising from the sample that took part in the survey to the broader MS population, that apparent differences from the survey do translate to actual differences in the population. See Table C3 for the results of these statistical tests.

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Table C3: Age of air conditioner with state/territory comparisons

State/territory comparison for differences	Result: p-values
ACT vs. NSW	0.480
ACT vs. QLD	0.654
ACT vs.SA	**0.015**
ACT vs. TAS	**<0.0001**
ACT vs. VIC	0.118
ACT vs. WA	0.079
NSW vs. QLD	0.503
NSW vs. SA	**0.004**
NSW vs. TAS	**<0.0001**
NSW vs. VIC	0.056
NSW vs. WA	0.078
QLD vs. SA	**0.001**
QLD vs. TAS	**<0.0001**
QLD vs. VIC	**0.030**
QLD vs. WA	**0.031**
SA vs. TAS	**<0.0001**
SA vs. VIC	0.093
SA vs. WA	0.267
TAS vs. VIC	**<0.0001**
TAS vs. WA	**<0.0001**
VIC vs. WA	0.666

Note: results in bold are statistically significant, meaning that apparent differences from the survey can be generalised to the broader MS population.

Table C4 is similar to Table 3C in that it outlines the results of the statistical tests regarding differences in survey results between states/territories. Table C4 focuses on differences regarding the outside air temperature at which people turn on their air conditioners. Again, statistically significant results are in bold.

Overall there is a difference between states/territories (Kruskal Wallis test, $p<0.0001$). Mann-Whitney test used to test for state differences.

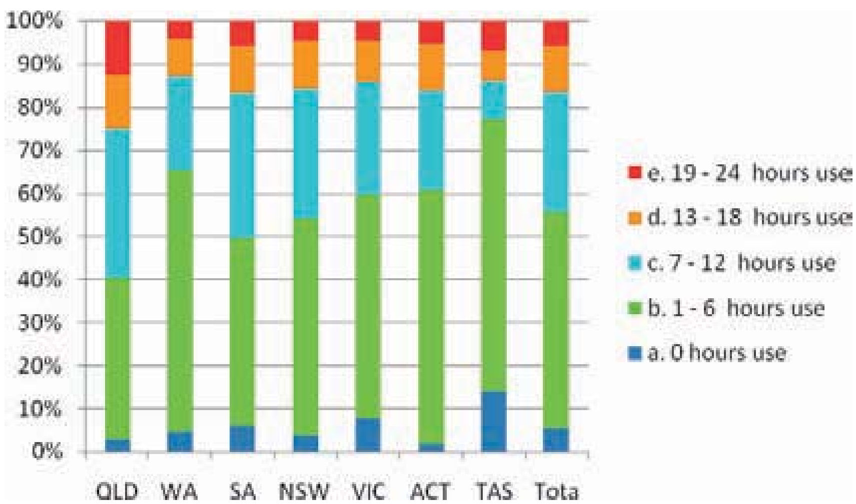
Table C4: Comparisons between states/territories for the outside air temperature at which air conditioners are turned on by people with MS

State/territory comparison for differences	Result: p-values
ACT vs. NSW	0.808
ACT vs. QLD	0.394
ACT vs.SA	**0.001**
ACT vs. TAS	**0.002**
ACT vs. VIC	0.949
ACT vs. WA	**0.016**
NSW vs. QLD	**0.037**
NSW vs. SA	**<0.0001**
NSW vs. TAS	**<0.0001**
NSW vs. VIC	0.678
NSW vs. WA	**<0.0001**
QLD vs. SA	**<0.0001**
QLD vs. TAS	**<0.0001**
QLD vs. VIC	0.088
QLD vs. WA	**0.009**
SA vs. TAS	**<0.0001**
SA vs. VIC	**<0.0001**
SA vs. WA	0.213
TAS vs. VIC	**<0.0001**
TAS vs. WA	**<0.0001**
VIC vs. WA	**<0.0001**

Figure C2: Average proportion of people using their air conditioners for different time periods every 24hrs for September–October

Statistical testing of these results found that overall the apparent differences between states/territories were statistically significant (Kruskal Wallis test $p<0.001$). The lowest number of hours used per day/night during the September–October to cool the house were observed in TAS (average = 1.5 hours day/night), while the highest number of hours used per day/night were observed in QLD and ACT (average = 3.8 and 3.1 respectively).

Figure C3: Average proportion of people using their air conditioners for different time periods every 24hrs for November–December



Again, statistical testing of these results found that overall the apparent differences between states/territories were statistically significant (Kruskal Wallis test $p<0.001$). The lowest number of hours used per day/night during the November–December to cool the house were observed in TAS (average = 2.7 hours day/night), while the highest number of hours used per day/night were observed in QLD and SA (average = 7.4 and 6.7 respectively).

Figure C4: Average proportion of people using their air conditioners for different time periods every 24hrs for January–February

Statistical testing of these results found that overall the apparent differences between states/territories were statistically significant (Kruskal Wallis test p<0.001). The lowest number of hours used per day/night during the January–February to cool house were observed in TAS (average = 7.5 hours day/night), while the highest number of hours used per day/night were observed in SA and QLD (average = 10.9 and 10.7 respectively).

Figure C5: Proportion of people using their air conditioners for different time periods every 24hrs for March–April

Finally, statistical testing for this last set of results found that overall the apparent differences between states/territories were statistically significant (Kruskal Wallis test p<0.001). The lowest number of hours used per day/night during the March–April to cool house were observed in TAS (average = 2.7 hours day/night), while the highest number of hours used per day/night were observed in SA and WA (average = 6.7 and 6.1 respectively).

Appendix D: Economic modelling for air conditioner use costs

1. Evaporative air conditioners were excluded as their operating costs are minimal relative to refrigerated/reverse-cycle air conditioners. Additionally, ducted cooling was excluded because, based on Victorian data (Roy Morgan 2008 found that there were 5 times as many evaporative as refrigerated/reverse-cycle ducted systems), it is likely that most of these systems are evaporative, with the possible exception of NSW given its higher humidity levels in coastal areas (see Figure 6 in the main text on types of air conditioners owned).

2. Calculating imputed average hours of air conditioner use between September and April (12 months of data were collected, but these 8 months represent the months in which air conditioners were used to keep cool). Mid-points of the ranges were used for this: 0=0, 1-6=3.5hrs, 7-12=9.5hrs, 13-18=15.5hrs, 19-24=21.5hrs. See Figure 10 in the main text for a graphic representation of the data.

3. Based on Victoria's Sustainable Energy Authority's 2002 *Operating Costs of Electrical Appliances* costs per hour of air conditioner use were calculated based on two price points (see below).
   a. Published estimates were: $0.33-35/hr for 1-2 star rated air conditioners, and $0.24-$0.27 for 4-6 star rated units.
   b. These cost estimates were extrapolated to an average cost for each of three sets of star ratings: 1-2 stars = $0.34, 3-4 stars= $0.2975, 5-6 stars= $0.255
   c. The age of air conditioners was used as a proxy for efficiency, with 5-6 star weightings applied to those 3 years or less, 3-4 stars for 4-9 years, and 1-2 stars for 10 years or older.
   d. A weighted average cost per hour of air conditioner operation for state/territory was then calculated taking into account varying ages of air conditioners across states.
   e. Note that these estimates from the Sustainable Energy Authority are based on reverse-cycle air conditioning for cooling a small-moderate sized space an average sized house of 150 square metres (which is the average size of an Australian dwelling) with 2.4 metre high ceilings, and a cost of electricity at $0.15/kWh. This was appropriate because (when evaporative and ducted systems are excluded) 80% of respondents were cooling moderately sized spaces of 1 or two rooms (20% were cooling 4 or more rooms).
   f. Because Victorian figures were used to estimate actual costs up to this point, these were then weighted for differential cooling loads, using Victoria as the reference point and Apparent Temperature as the weighting factor.

4. Hours of air conditioner use were then multiplied by the different costs per hour for each state/territory (based on different weightings for efficiency). The results as noted above assumed a cost of electricity supply at $0.15/kWh. Another set of figures was produced at $0.20/kWh.

   The maximum and minimum cost figures for each state/ territory of $0.15 and $0.20 approximate the lower and upper ends of domestic electricity pricing nationally: tariffs vary within and between states/territories, with a complex mix of flat rates, time of use rates, and off-peak rates.

5. Sensitivity Analysis was then undertaken for the three key variables: hours of air conditioner use, costs weighted for air conditioner efficiency, and costs weighted for variations in apparent temperature (using Victoria as the reference point). As noted in the main text, this analysis found that the results were robust across hours of use and efficiency. The results for variations in apparent temperature are also robust except for QLD and WA, which show somewhat larger standard deviations relative to the mean, and therefore somewhat larger confidence intervals. This result is consistent with much higher apparent temperature in Queensland and WA compared to the other states. See Tables D1 and D2 for results of sensitivity analysis.

Table D1: Sensitivity analysis of economic modelling at $0.15/kWh

	Mean	Standard deviation	95% confidence interval		SD/Mean
Hours of air conditioner use					
QLD	$753	$62	$630	$876	0.08
WA	$560	$46	$469	$652	0.08
SA	$570	$47	$477	$663	0.08
NSW	$489	$40	$409	$568	0.08
VIC	$406	$33	$340	$472	0.08
TAS	$301	$25	$252	$350	0.08
ACT	$297	$24	$249	$346	0.08
Australia	$488	$40	$408	$567	0.08
Average cost per hour weighted for efficiency					
QLD	$753	$62	$630	$876	0.08
WA	$560	$46	$469	$652	0.08
SA	$570	$47	$477	$663	0.08
NSW	$489	$40	$409	$568	0.08
VIC	$406	$33	$340	$472	0.08
ACT	$297	$24	$249	$346	0.08
TAS	$301	$25	$252	$350	0.08
Australia	$488	$40	$408	$567	0.08
Averages weighted for apparent temperature					
QLD	$620	$109	$402	$838	**0.18**
WA	$475	$69	$336	$614	**0.15**
SA	$507	$51	$405	$610	0.10
NSW	$451	$31	$388	$513	0.07
VIC	$406	$0	$406	$406	0.00
ACT	$325	$23	$280	$371	0.07
TAS	$336	$29	$279	$394	0.09
Australia	$454	$27	$400	$509	0.06

Notes: The confidence interval assumes that that the cost estimate is normally distributed. Notable results are in bold. Robustness of the model is determined through the relationship of the standard deviation (SD) to the mean. Results throughout are robust, except in relation to variations in apparent temperature for QLD and WA, which show somewhat larger standard deviations relative to the mean, and therefore somewhat larger confidence intervals. This result is consistent with much higher apparent temperature in Queensland and WA compared to the other states.

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Table D2: Sensitivity analysis of economic modelling at $0.20/kWh

	Mean	Standard deviation	95% confidence interval		SD/Mean
Hours of air conditioner use					
QLD	$753	$62	$630	$876	0.08
WA	$560	$46	$469	$652	0.08
SA	$570	$47	$477	$663	0.08
NSW	$489	$40	$409	$568	0.08
VIC	$406	$33	$340	$472	0.08
ACT	$297	$24	$249	$346	0.08
TAS	$301	$25	$252	$350	0.08
Australia	$488	$40	$408	$567	0.08
Average cost per hour weighted for efficiency					
QLD	$753	$62	$630	$876	0.08
WA	$560	$46	$469	$652	0.08
SA	$570	$47	$477	$663	0.08
NSW	$489	$40	$409	$568	0.08
VIC	$406	$33	$340	$472	0.08
ACT	$297	$24	$249	$346	0.08
TAS	$301	$25	$252	$350	0.08
Australia	$488	$40	$408	$567	0.08
Averages weighted for apparent temperature					
QLD	$620	$109	$402	$838	**0.18**
WA	$475	$69	$336	$614	**0.15**
SA	$507	$51	$405	$610	0.10
NSW	$451	$31	$388	$513	0.07
VIC	$406	$0	$406	$406	0.00
ACT	$325	$23	$280	$371	0.07
TAS	$336	$29	$279	$394	0.09
Australia	$454	$27	$400	$509	0.06

Notes: The confidence interval assumes that that the cost estimate is normally distributed. Notable results are in bold. Robustness of the model is determined through the relationship of the standard deviation (SD) to the mean. Results throughout are robust, except in relation to variations in apparent temperature for QLD and WA, which show somewhat larger standard deviations relative to the mean, and therefore somewhat larger confidence intervals. This result is consistent with much higher apparent temperature in Queensland and WA compared to the other states.

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