Climate Change Adaptation Research Grants Program
- Settlements and Infrastructure Projects

Project title:
A Framework for Adaptation of Australian Households to Heat Waves.

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Objectives:
Recent tragedies in Australia have demonstrated the need to adapt to severe unusual weather events. Increasing frequency and severity of heat waves have increased the mortality rates for the more vulnerable in the community. The problem is compounded by the prospects of higher energy costs and escalating peak electrical demand, as people become more reliant on air conditioning. The research aims to evaluate the likely impact of heat waves on households and on the electricity infrastructure in various Australian climatic regions as well developing a framework for an integrated national response for adaptation to these events. The project aims to:

a) Develop new summer design conditions for 2030 and 2050 for up to 100 Australian climate zones.
b) Establish new adaptive thermal comfort criteria for buildings incorporating anticipated climate change;
c) Evaluate the impact of climate change on annual household cooling energy use and peak power demand;
d) Examine current behaviour of householders during heat waves and develop equitable design and policy options to achieve improved response to ensure safety and comfort during heat waves;
e) Develop affordable new design options for buildings and cooling equipment to avoid heat stress.

Project design and methods:
1. Climatic Data and Design Temperatures This task incorporates the impact of climate change on weather variables. The CSIRO Technical Report for Climate Change in Australia (2007) gives guidance on how to view the impacts of climate change on key climate variables. A significant amount of the information is contained in Appendix B. Alterations can be performed in line with the 10, 50 and 90 percentiles for any of the three suggested emissions scenarios of the Intergovernmental Panel on Climate Change (IPCC). Once the algorithm is derived for alterations of the data files, any of these options can be added, and new TMY data developed. What is significant, however, is melding the projected changes in means with a number of other indicators. For example, in the same Appendix, there are projections for increases in the number of days over 35o C. There is also reference to this phenomenon in Chapter 5 of the report. In the same chapter, there is also reference to an increasing frequency of warm nights. Additionally, a difference between the rise in maximum temperature compared to minimum temperature is expected. This will require an alteration of the profile over the day for expected hourly temperatures. In line with previous research by the team, the Fourier Series representation of expected hourly solar radiation and temperature as represented in these publications can be altered through a simple optimisation routine to cater for a rise in the daily mean with differing amounts of rise in daily minimum and maximum. This process will enable TMY data for up to 100 zones, as specified by NatHERS, to be developed for 2030 and 2050.

2. Adaptive Comfort with Climate Change. An investigation of the response of households to heat waves will be conducted. Monitoring systems for 20 homes in both Sydney and Brisbane will be established measuring indoor temperature and air conditioner use. Interviews of these households will be conducted in parallel to the monitoring. The collated data will be used to investigate the increase in the temperature settings within households over successive heat waves during summer. The results will provide data for a new empirically derived definition for thermal comfort during heat waves. This data will also be compared with the updated trigger temperatures for starting and stopping the cooling system based on projected increases in outdoor temperatures developed with future climate scenarios.

3. Impact on Existing Housing and System Designs This research component will focus on selecting and analysing 6 existing house designs representing the range of size, age and types of Australian dwellings as specified by the ABCB. The thermal performance of each dwelling will be modelled in all relevant 8 climate zones in Australia, when both conditioned and unconditioned, applying today's and future TMY and design temperature settings. This will identify the total number of hours of thermal discomfort for unconditioned homes and the increase in total cooling demand and number of peak cooling hours for conditioned homes... The modelling work will identify the increase in peak power demand on the grid over and above current projections based on information collated by the SA Government for all of Australia. Furthermore, the maximum increase in peak power demand can be investigated for the less frequent extreme heat wave. The modelling results will also be used in estimating the additional annual cooling energy use and cost. The outcomes will be communicated to the ABCB, electricity regulators, air conditioning designers and relevant state government agencies for use in developing response strategies.

4. Behaviour During Heat Waves Interviews and surveys will be conducted in Sydney, Brisbane and Adelaide, yielding data from a representative sample about the impact of heat waves in diverse climatic zones. This will be conducted with support and input from Uniting Care Australia who will facilitate the interview processes. They will also provide and collate survey data on household impact on electricity price signals. The outcomes will inform strategies for Uniting Care Australia. Semi-structured interviews with 15 key informants from sectors related to housing, welfare and community services, ageing, maternal and child health, and engineering/ architecture, will provide information about current household and air conditioner use in relation to heat-discomfort mitigation and about the issues that vulnerable populations encounter in responding to heat waves. Twenty interviews of focus groups with people from different income brackets and different household composition and employment patterns will generate insight into perceptions of comfort and other factors underlying current behavioural responses to heat waves and the socio-demographic factors influencing likely responses to future heat mitigation strategies among different segments of the population. This phase will inform the development of an online survey, the results of which will be used in the study of existing house designs. The survey will have a minimum sample size of 500 in three locations (Brisbane, Adelaide and Sydney), representative of varying income level, age, gender and household type. The survey will have approximately 30 closed questions about sociodemographic information; current behavioural response to heat stress and behaviour during heat waves; home ownership; potential responses to various energy pricing mechanisms, housing characteristics (size, number of bedrooms, cooling systems etc); the likelihood of adopting particular heat mitigation strategies in the future and what would assist adopting these strategies. This will yield knowledge of the factors that inhibit and enable particular household types to respond effectively to increases in temperature..

5. Building and System Design Solutions Building design solutions will be developed based on the information derived from the behavioural study. This study will provide information as to which features of low energy building design options are compatible with expectations of different population groups. It is probable that higher income households are less likely to accept restrictions on occupancy than lower income households. Current building designs will be modified considering these factors and appropriately implementing the cool room concept in order to provide a heat wave shelter in the absence of mechanical cooling. New designs will be developed for existing and new constructions, based on existing construction systems.

6. Overall Impacts of Heat Waves on Australian Households and Electricity Infrastructure The final research element involves integrating the outcomes of the project to evaluate the social, economic and health impacts of heat waves on Australian households and developing a framework for responding to heat waves in Australia. This work with involvement of the SA Government and DCCEE, will also estimate of anticipated associated electricity infrastructure augmentation costs for selected regions, including estimated additional generation and transmission costs and the impact on the national electricity grid. In addition, specific recommendations on adaptation strategies for minimising the impacts of heat waves on the housing sector will be provided. This milestone also includes coordinating the dissemination of project outcomes among all stakeholders.