Learning the Hard Way:
Energy Practices of International Students in Rental Accommodation

FINAL REPORT

Change for Good at UTS

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About this report

Title: Learning the Hard Way: Energy Practices of CALD International Students in Rental Accommodation – Final Report

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Executive Summary

This report presents the results of the multi-stage multi-method project investigating the energy experiences of Culturally and Linguistically Diverse (CALD) international students living in private rental accommodation.

The combination of qualitative and quantitative methods provides indepth insights into the hardships encountered by this vulnerable group of energy consumers. This is a collaboration between the Sustainable Buildings Research Centre (SBRC) at the University of Wollongong and the University of Technology Sydney in fulfilment of Influence grant #INAPR22007 for Energy Consumers Australia (ECA).

The multi-method multi-stage project spanned an 18-month period and included:

- A targeted survey of energy literacy and thermal comfort with international students
- Semi-structured in-home interviews
- Scorecard home energy and thermal comfort assessment
- In-home monitoring of temperature for comparison with external BOM weather data
- Collection and analysis of household energy bills
- Heating appliance plug-load monitoring

Results demonstrated this group of energy consumers is 1) hard to reach and 2) extremely vulnerable in terms of thermal comfort, energy costs, housing quality and housing security. Though this research is based on a small sample size (n=32) we were able to gather rich qualitative and quantitative data that highlights experiences of energy hardship.

SUMMARY OF KEY FINDINGS

The results from this project indicate that CALD International students:

- living in private rental accommodation experience thermal comfort levels outside of the acceptable range of temperatures for a substantial portion of time.
- live in housing types generally rate low in terms of building performance.
- live in precarious housing arrangements with little knowledge of their rights as renters.
- have low levels of understanding of home energy efficiency.
- are disadvantaged by the current system of university acceptance and visa issue which exacerbates housing scarcity.
- are motivated to use energy efficiently for financial reasons but also cite cultural or religious beliefs as influencing their energy practices.
- experience a range of challenges with some groups (young males living in shared housing arrangements; nuclear families with children in better performing buildings) faring better than others (singles living in bedsits).

SUMMARY OF RECOMMENDATIONS

1 Improve awareness of home energy efficiency, passive heating and cooling measures, the range of available energy retailers and the implications of different energy plans for international students living in Australia.

2 Improve awareness of the rights of international students as renters in the private sector.

3 Recognise how the current private rental sector disadvantages CALD International students in terms of the requirements (Australian identity documents, income statements, bank balances or rental ledgers etc.) and how this often results in reduced housing choices.

4 Provide clearer housing options and opportunities for international students applying to study at Australian Universities between university acceptance and visa approval.

5 Initiate pilot projects for the implementation of home energy star rating systems (e.g., Scorecard or NatHERS Existing Homes) in conjunction with home energy upgrades that focus on improved thermal comfort and lower energy bills for lower end of property market i.e., older less efficient buildings.

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1 Introduction

This report outlines findings from research into the energy and thermal comfort experiences of CALD international students living in private rental accommodation in Sydney, Australia. It was undertaken by the Sustainable Buildings Research Centre (SBRC) at the University of Wollongong and the University of Technology Sydney for Energy Consumers Australia (ECA) between 2022-2025.

1.1 Background

Our focus on the experience of culturally and linguistically diverse (CALD) International students living in Australia is based on previous research that indicates that thermal discomfort at home has a disproportionately high impact on students. In particular, studies have found that low-income households that are often the hardest hit by energy costs and poor-quality building stock in the rental sector (Buzar 2007; Charlier et al., 2019; Krishnamurthy and Kristrom 2019) and that rental properties are generally less energy-efficient than owner-occupied dwellings (Lang et al., 2022, Baker et al., 2020). As well, students have been shown to live in poorer quality housing, experience energy hardship, billing anxiety, and thermal discomfort, and face challenges in navigating the energy market (Hansen et al., 2013; Moore et al., 2016).

A growing body of evidence links thermal discomfort to decreasing cognitive performance. The Building Performance Indoor Environment (BPIE, 2018) review found that for every 1°C reduction in overheating, students' learning performance increased by 2.3 %, with similar findings by Wargocki et al., (2019). In a study of 50 adults, Griffiths and Boyce (1971), found that cognitive performance was progressively impaired as temperature increased or decreased from 18.3°C, in the range 15.6°C to 26.7°C. Pilcher et al. (2002) reviewed four studies within the temperature range of 10.0-

18.3°C, and concluded that exposure to cool environments, of less than 18.3°C, had the most negative effect when compared with neutral and hot temperature exposures.

In the Australian context winter underheating is more problematic than summer overheating. Cold weather has been attributed to cause 6.5% of deaths in Australia—in contrast with 3.7% mortality in Sweden (Gasparrini 2015). This comparison can be considered in terms of the impact of housing performance on physical health – existing Australian homes measured by the Nationwide House Energy Ratings Scheme (NatHERS) were estimated at less than 3 stars out of 10 (Rajagopalan 2023). While new-built homes must now meet a minimum 7-star rating, existing housing stock remains unaffected by these regulations. States have implemented various programs which aim to address the problem of poorly performing housing stock. For example, the Australian Capital Territory introduced mandatory disclosure of Energy Efficiency Ratings in 1999 for both point of sale and lease with only 33% compliance for rental leases (ACT 2023). The Victorian Government has rolled out nationally the Residential Efficiency Scorecard rating scheme. Australia's Energy Ministers have agreed on the Home Energy Ratings Disclosure Framework as a national basis for assessment and disclosure of home energy performance (Australian Government 2024) with NatHERS Existing Homes being currently trialled as the rating tool to underpin the scheme to be released in mid-2025.

The housing situation for international students is further exacerbated by the confluence of the cost-of-living crisis and the housing crisis over the past several years (Parliament of Australia 2025). Given that CALD international students make a significant economic contribution to Australian society - $37.6 billion in 2019 (Australian Government 2019)- and student energy poverty has been highlighted as an issue in other jurisdictions (Butler & Sherriff, 2017, Morris and Genovese, 2018, Nazahari et al., 2021), this research fills a significant lacuna in this context. We hypothesise that energy hardship impacts on health, well-being and learning outcomes and is exacerbated by the cultural background of CALD students who may have a lack of English literacy skills, little family or social support, may be on a low income, are living independently for the first time, come from different climate zones, and may have underlying health conditions that worsen due to living with energy poverty in poor performing Australian housing stock.

1.2 Project Aims

This project aims to document the energy experiences of CALD tertiary students aged over 18 years, who come to study in Australian Educational institutions and live in private rental accommodation.

The project is guided by three research questions

1. What is the current energy performance of rental housing for CALD international students in Australia, in terms of base building energy performance, tenant practices, and thermal comfort?
2. What are the everyday energy practices of CALD international student tenants?
3. What energy dilemmas are faced by CALD international students in private rental properties in Australia?

1.3 Approach

This interdisciplinary research correlates the lived experience of thermal comfort in rental accommodation against quantitative measures of internal and external temperatures across winter and summer periods, building energy ratings, and energy billing information, energy consumption rates and costs.

The combination of qualitative and quantitative methodologies provides rich insights into the unique experiences of international students living in private rental accommodation in Sydney. This project has enabled the production of definitive quantitative rating measures of private rental homes and supports previous work which illustrates that the housing stock in the Australian rental market is generally of poorer quality than that of owner occupiers (Department of Environment, Land, Water and Planning, 2018). We provide evidence to show that CALD international students on low incomes struggle to maintain adequate temperatures that ensure comfortable living conditions which we argue has an impact on physical health, mental well-being, social connectedness, and academic outcomes.

This information can inform policy development which seeks to raise awareness of the need for disclosure of energy and thermal comfort ratings of rental accommodation alongside tools that help prospective renters to estimate comparative energy bills of different homes. This can improve the living conditions of vulnerable rental households through targeted advocacy and materials that support residents' agency, whilst also helping to decrease household energy consumption and cost (Heffernan et al., 2021).

Through this report we raise awareness of experiences of energy poverty, and related high rates of stress and anxiety that accompany high energy bills in low-income homes, with the aim of prompting landlords to consider retrofitting properties to alleviate these conditions (Lang et al., 2022). The data provided in this report will be of use to agencies which provide support to CALD students, for example advocacy groups, university housing officers, international student organisations and agencies.

Further, we highlight the opportunity to embed provisions for the well-being of CALD international students (especially those with disabilities or health concerns) into institutional processes related to course acceptance, visa issuance, and support to secure rental accommodation as a duty of care for educational providers.

2 Methods

This multi-stage multi-method project is an interdisciplinary collaboration. As such, different methods were used at each stage from 2022-2024.

STAGE 1		Quantitative survey to measure energy efficiency knowledge, thermal comfort, energy hardship, health impacts of housing, health and well-being, satisfaction with energy provider, and billing hardship.
STAGE 2		Qualitative semi-structured interviews.
STAGE 3		Quantitative building audits using scorecard tool.
STAGE 4		In-home monitoring of temperature over the winter and summer periods. Some homes also had plug-in appliance energy monitors installed at the same time.

2.1 STAGE 1
QUANTITATIVE SURVEY

We developed an online survey instrument using established and validated measures to understand energy efficiency knowledge, thermal comfort, energy hardship, health impacts of housing, health and well-being, satisfaction with energy provider, and billing hardship.

The online survey included 8 sections, had a range of question formats, could be completed on a mobile phone, and took around 15-20 minutes to complete.

The Qualtrics survey was distributed from 7th November 2023 to 13th July 2024.

The Qualtrics survey operated as a recruitment tool for the follow-on stages of the study and all respondents who indicated a willingness to participate in further research were contacted. To supplement this, the CALD research assistant used personal networks to recruit a total of 32 international students.

The recruitment criteria were that participants had to be CALD international students living in private rental accommodation (not including university-provided accommodation) and that they did not have plans to move residence within the next 9 months. In addition, a diversity of demographics was sought with some targeted recruitment in the latter stages to engage more female students and in particular from Climate Zone 6 in Western Sydney.

We discuss some of the limitations of the survey and the recruitment strategy in section 2.5 but emphasise the value of the data captured due to the transience and mobility of this cohort.

2.2 STAGE 2
Qualitative semi-structured interviews

The interviews explored how the cultural experiences of students influenced their use (or not) of domestic appliances in the home. We explored how people have an embodied history of climate which influences how they perceive levels of thermal comfort and discomfort, and how they may be able to embrace adaptive practices to improve levels of thermal comfort and reduce billing anxieties associated with high energy costs. Yet, while adaptive practices may reduce energy anxieties, it is important to recognise that this may lead to higher levels of physical discomfort, with the potential for physical and mental health impacts that can lead to reduced well-being (Waitt and Harada, 2019) and impact on the ability to achieve educational outcomes (Banerjee et al., 2022).

We also explored how CALD students make decisions around the use of energy in the home in relation to the physical infrastructure of the home. For example, what measures can CALD students take to improve the energy efficiency of their home (purchase and install insulating curtains or window coverings, purchase energy efficient appliances)? What are the ethical implications of CALD students living in private rental accommodation when they are unable to improve the property performance (e.g., should they appeal to real estate agents or landlords)? What strategies do CALD students use when they are unable to afford the cost of energy to

maintain a minimum standard of comfort (e.g., spending little time at home, reducing food consumption or spending on essentials like medication)? We investigated how CALD students experience energy poverty in terms of the effect on physical health, mental well-being, social connectedness, academic outcomes. We asked about their energy providers, plans, costs and what they knew about energy efficiency to give insights into how their practices brought together knowledge, beliefs, and understandings that related to the housing type and building performance.

Semi-structured interviews were conducted in student homes between 03/06/2024 and 17/12/2024. All interviews were audio recorded with participant consent and transcribed.

Interviews were analysed in qualitative software NVivo 12.

Participants received a $100 Coles voucher to thank them for their engagement in the interviews.

2.3 STAGE 3
Quantitative building audits

All 32 student homes were assessed using the Residential Efficiency Scorecard developed and administered by the Victorian Government. The Scorecard is a home energy and thermal comfort rating tool for existing homes across Australia. This tool generates a star rating out of 10 as an indication of how much energy is expected to be consumed by a typical household for that sized home and includes a breakdown of energy consumption by appliance/function. The tool also provides an indication of how the home performs in hot and cold weather without any heating or cooling energy.

Scorecard assessments required documented evidence of multiple aspects of the building. For example, the external construction, size and orientation of the building including eaves and roof and wall colour. Heating, cooling and hot water appliances were documented according to type, star rating, and year of purchase. Data for each room included the floor area, insulation in ceiling, walls and subfloor, heating/cooling appliance selection, window details (size, construction, orientation, glazing type, opening type, external and internal coverings) air leakage gaps (at windows, doors, floorboards, exhaust fans, chimneys, downlights and other envelope penetrations). Pool/spa pumps and rooftop solar system size are also documented.

These assessments were conducted by an accredited Scorecard assessor during the first home visits (usually concurrent with the semi-structured interviews to minimise the participant disruption) between 3 June 2024 and 25 September 2024 with the first 14 completed by 21 June and the remainder being delayed by recruitment difficulties.

Participants received a $100 Coles voucher to thank them for their engagement in the home energy assessments and indoor thermal comfort monitoring tasks.

2.4 STAGE 4

In-home monitoring of Indoor temperature and plug-in appliance loads

Figure 2.1: Hobo UX100 and Hobo MX1101 temperature and humidity data loggers.

All homes had a temperature and humidity monitor installed in the main living area. The Hobo UX100-003 and MX1101 data loggers, depicted in Figure 2.1, were used to collect indoor thermal comfort data at 15-minute intervals over the duration of the project. They were attached by double sided removable tape to an internal wall in a position that was not impacted by direct sunlight or heating sources. The data were stored on the devices and downloaded on collection at the end of the monitoring period.

Participants were asked to provide energy bills for the 12-month period which covered the indoor temperature and humidity monitoring period. This allowed the research team to correlate seasonal (quarterly) energy consumption against measured thermal comfort.

Figure 2.2: Meross smart energy monitor for daily energy consumption logging.

Participants who used plug-in heaters were asked if they were willing to have a WiFi connected energy monitor installed for the duration of the study.

The Meross smart energy monitor logs daily totals of energy consumption for plug loads. This data provides more granular and heating-specific energy data that may be cross correlated with indoor temperature data to build a picture of energy and thermal comfort behaviours in practice.

2.5 Limitations, Generalisability and relevance

We acknowledge the limitations of this research because of the small sample size and limited geographical coverage. Data collected from Stages 2 and 3 are focused on two climatic zones and provide a limited comparative sample. Our national survey response does not allow for generalisable findings.

We point to the political climate as a significant factor which impacted on our ability to undertake this research. First, the media discourse around the current housing crisis in Australia has focused on the additional strain on housing availability and affordability caused by international migrants. Caps on international student numbers, increases in international student fees, and consequent job cuts in the university sector have resulted in more media and public focus on international students in the community.

Second, the time delays between university acceptance and issue of a student visa contribute to a situation where student accommodation quickly reaches capacity. For students waiting on visa issue, there were limited choices in terms of housing availability, and many turned to the private rental market. Within the private rental market, the requirements and competition for properties put international students

at a disadvantage-they experienced challenges with supplying Australian identify documents, proof of income, or rental references. As a result, many students were forced to find accommodation through personal or online networks. Within our cohort they reported either staying with friends or family, living in single rooms in a family home, living in granny flats or alternative housing arrangements.

During the monitoring period of this research the transience and vulnerability of the cohort presented a raft of challenges to data collection. Despite, screening participants for not planning on relocation for 12 months, out of 32 participants, 14 relocated homes before the end of the summer monitoring period of the study. Further, 4 participants lost the installed sensors due to moving home and the data and sensors were unable to be recovered.

Despite a sustained and consistent effort to engage with international students for this project we also met with a high level of reticence and hesitation. Participants expressed that they were unwilling to complain about the poor thermal performance of their housing, or energy bill-sharing arrangements. Our recruitment success came primarily through word of mouth starting with personal networks and cultural communities of trust. For these reasons we were unable to recruit any participants at all from the more diverse climate zones of either Brisbane or Canberra and had to consolidate across the more similar BCA Climate Zones 5 (warm temperate) and 6 (mild temperate).

The relevance of findings from this research would be strengthened by investigating CALD international student housing in multiple climatic zones to generate data that covers different jurisdictions, universities, climatic zones and housing types.

Comparisons are made within each field site, and between each field site to generate energy biographies and understandings of how these are made through the relations between ethnicity, housing type, climate and jurisdiction. Energy biographies point to the way that structural forces alongside embodied knowledge of climate and culture influence how people negotiate social and material environments that are underpinned by energy usage.

The interdisciplinary triangulation of the quantitative survey data, qualitative interview data and the quantitative building performance, thermal comfort, and energy consumption data adds a tangible depth and breadth to the energy biographies.

3 Results

Results are briefly presented for each of the research methods. The different types of data allow a comparison of multiple perspectives for the whole cohort.

We found that CALD international students had some knowledge of energy efficiency, yet their practices often did not demonstrate efficient energy usage. Four case studies are then presented to provide a context for understanding the lived experiences of different households. We provide examples that illustrate how resident practices and beliefs, building performance, climate zone and energy appliances may contribute to a range of thermal discomfort and potentially energy hardship. While we present data under each category, at times we draw on other types of data to strengthen our findings. We discuss the implications from these findings in the discussion section which follows.

3.1 Survey

Data from the survey were analysed using logical regression models. We examined: i) energy and energy efficiency knowledge; ii) satisfaction with thermal comfort; iii) impacts of housing on physical and mental health; and vi) housing typologies.

i) Energy and energy efficiency knowledge

Overall, around half demonstrated some knowledge of energy consumption and energy efficiency. Most reported a fairly strong belief in the importance of saving energy and had a sense of agency that their energy usage decisions have an impact at a society level. International students correctly identified that lighting was one of the lowest consuming energy devices in the home. They indicated that the highest consumption of energy was due to heating and cooling appliances. However, we point to how hot water heating did not figure in energy consumption understandings as a significant portion of household energy costs. Respondents perceived hot water energy consumption equally as low as lighting and lower than both refrigeration and cooking.

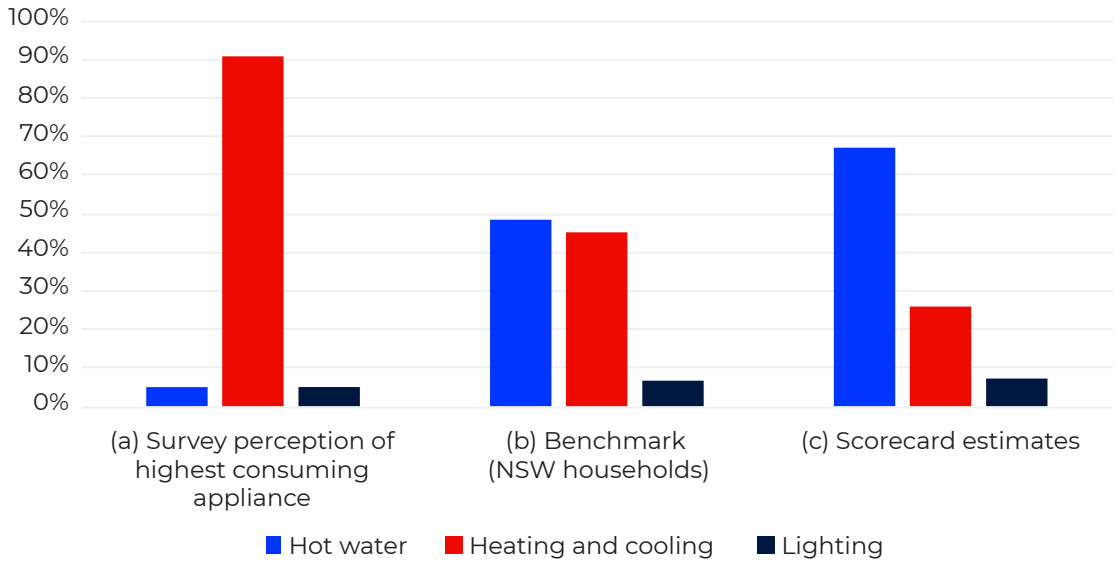

Figure 3.1: Average energy consumption percentage by fixed appliance type—a comparison of perception against NSW benchmarks and Scorecard estimates. (a) Survey participant perceptions of which appliance type uses the most energy; (b) NSW household benchmark (NSW 2025); (c) Scorecard estimates from this study.

This suggests that this vulnerable cohort are actively frugal with heating and cooling energy consumption, but that hot water heating energy is not perceived as significant. This may be partly due to how the control of hot water energy consumption is less tangible with little household control apart from adapting washing and bathing practices, while heating and cooling appliances are more visible and controllable in terms of use, temperature and timing.

ii) Satisfaction with thermal comfort

We found that a high proportion of respondents reported being either dissatisfied or very dissatisfied with the thermal comfort of their accommodation, especially in winter with 27% reporting that they were unable to keep their home warm enough when needed. A high number of respondents also reported problems with condensation, damp and mould which can have significant health implications, and points to the generally poor quality of Australia's private rental housing stock, particularly at the lower end of the rental market where many international students are living. Summer temperatures are perceived as more of an issue for Australian housing when in fact there is a significant lack of fixed appliances for heating in winter.

iii) Impact on physical health and well being

The survey revealed that more than one in three respondents reported that their productivity was reduced by physical health issues, while more than one half of respondents reported that their productivity was reduced by emotional problems. There emotional problems were mostly related to feeling tired and worn out and to a lesser extent feeling anxious or depressed. These problems interfered with social activities to a moderate to extreme degree for 37% of respondents. The high levels of emotional problems are explored further in the results from the qualitative interviews.

iv) Household sizes were typically 3 person or more from survey data, but the building audits provided greater insight into the housing typologies.

3.2 Household typologies

Options for student housing are limited. Larger corporate models of student accommodation offer a standardised experience of high-density apartments located close to university campuses, with shared study facilities, and electricity and internet included in the rental price. Private rental houses or rooms were the other option that more than 75% of our participants chose. They shared with others from their country of origin (through community groups); or family members, sometimes sharing a room or a bed. Household arrangements were categorised into the following typologies listed in Table 3.1 with the count of participants for each category. Overall, there was a mix of housing types, and differences in household arrangements e.g., singles, groups, couples etc.

Table 3.1: Household arrangement typologies for the cohort

Type	Rental arrangement	Facilities sharing	Energy cost arrangement	Count
Single occupant bedsit	Individual formal rental agreement	Bedsit, kitchenette, bathroom	Included in rent	5
Single boarding shared	Individual formal rental agreement	Bedroom; shared kitchenette, bathroom	Included in rent	2
Landlord control shared home	Single room/ Landlord arranged	Private bedroom; shared facilities	Included in rent	4
Student-led share home	House sourced and rented by student	Whole house shared, individual bedrooms.	Bills split evenly	8
Family shared home	Family living arrangements	Single room, shared facilities, relatives	Bills split informally	4
Independent family home	Family living arrangements	Nuclear family only	Bills paid separately	9

3.3 Building audit

Home energy and thermal comfort assessments were conducted in the homes of all 32 participants. Scorecard ratings were finalised for 28 homes The remaining 4 homes were landlord-controlled share houses where we did not have access to assess other private bedrooms of the home. Building construction ranged from a 1930s fibro shack of 101m^2 housing 3 couples, to a 170 m^2 2-storey brick veneer family home constructed in 2018.

The building audit revealed that:

Ceiling insulation average observed was R1.2, which was strongly influenced by the number of apartments with concrete ceilings with no insulation but neighbouring conditioned rooms. For comparison, new builds required R4.1 (light coloured roofing) value is while R5.1 (dark coloured roofing) for climate zones in this study.

Three participants homes had confirmed no ceiling insulation.

Heating appliance type: 21 had reverse cycle AC for energy efficient heating, 7 used plug-in heating appliance(s), while 4 reported having no heating appliances at all.

Hot water system type: 15 had shared gas hot water systems typical of newer apartments with reticulated supply; 4 had gas instantaneous; 10 had an electric storage system (none had off peak); 1 heat pump and 2 solar with electric boost. So, 59% of homes had gas hot water and 41% were electric storage tanks.

Scorecard thermal comfort ratings are indicated in a histogram in Figure 3.2 illustrating the range of housing ratings across the project. Homes were slightly more likely to have very poor (1/5) thermal comfort than a very good rating (5/5). This is an indication of how comfortable a home is expected to be without any heating or cooling energy, which is an important measure for frugal households.

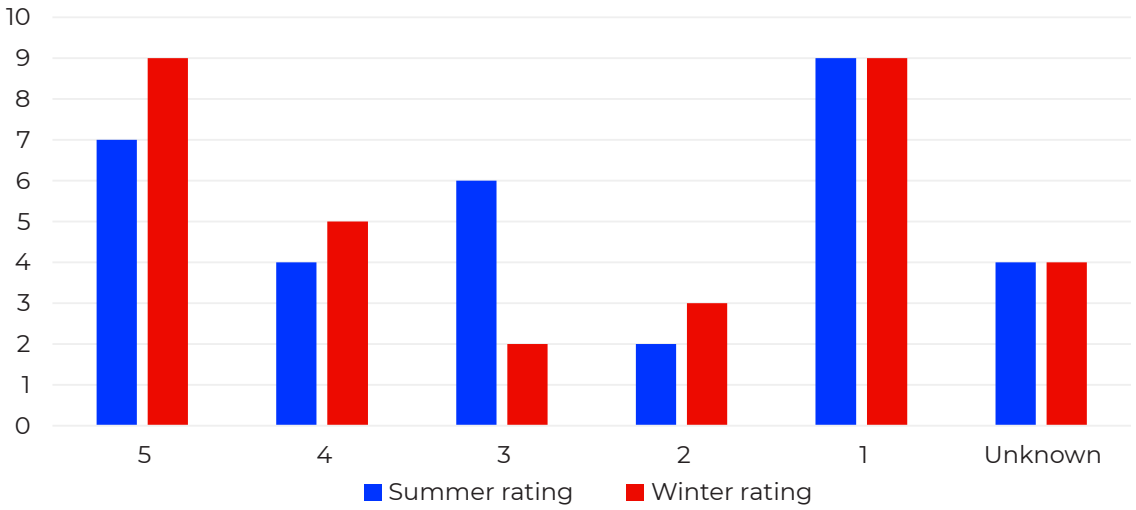

Figure 3.2: Histogram of Scorecard thermal envelope ratings for summer and winter, where ratings are out of 5 with 5 being excellent and 1 being very poor.

3.4 Semi-structured interviews

Beyond this, our qualitative investigation uncovered some alarming vulnerabilities for particular groups of international students. Young males fare better in choosing private rentals. They discussed how sharing with others from similar cultural backgrounds was a vital element of coping with social isolation, the inadequacies of their housing, and the financial pressures that they were under. For young women, many were more concerned about the security and safety of their accommodation and opted to live alone in often very compact or even cramped spaces rather than in shared accommodation due to personal, religious or cultural beliefs.

Students narrated the difficulties of securing accommodation in Australia in terms of availability of student accommodation and affordability.

> So I applied for university accommodation, but I did not get it. And I was talking to my friends, one of them lives in the university accommodation and he tells me it's very competitive. And so for an international student who doesn't know much about Sydney and coming here and having no idea what the house prices are and what the median is, basically how are you going to get a house? *P5*

> Yeah, when I started looking for accommodation, especially I started within the university. I started with finding something within the university. But the thing is, I couldn't find any because I mean, they had a waitlist of like one semester. And then they had some space in the residential colleges, but they were like $850 per week, which is just so expensive. I couldn't afford that. *P7*

> I didn't found any property and any agent accept me because I don't have a history, I don't have, as well, I'm not working. So I still, maybe, I got temporary accommodation like refugee, like that, maybe around three, four months. After that, I just moving from hotel to hotel, from hotel to hotel. That's, and that's time I try to apply, apply, apply, but ...online, yeah, but no one accept me actually, I don't have history...Yeah, very difficult and still I feel myself homeless, I am not comfortable because I am not stable. *P28*

As a result, students often found themselves in informal and temporary housing arrangements, staying in family homes of people they met online. The housing offered was often of low quality and ranged from converted garages to individual rooms in large, converted houses.

> When I didn't have the aircon, I felt like, oh my god, I'm in kind of hell kind of thing. Because that house, the material they use, it was kind of metal... it just purely metal throughout and when you enter it's like a volcano kind of thing like that. Oh my goodness, it was very bad at the, I couldn't focus on because it's very hot and the night when it gets cooler it's okay, it's better. At that time, we could sit and study few things, but in the daytime we try to spend our time in the malls because it's cooler there instead of sitting in the house. And that time, that house was not suitable for living in the summer. *P25*

> My desk room. Yes. Because there is a leaking. Yes, there is a leaking. Even in a master bedroom or sleeping, there's a leaking in the window... So, you can feel the cold air coming in. *P4*

In such arrangements, properties sometimes had no fixed heating or cooling appliances, or in cases where they existed, at times students were asked not to use those appliances when electricity was included in the rental cost.

> Some of my friends, they live in a private house, they don't have air conditioner, and he told me he feel extremely cold... one of my friends, he live in Newcastle because he put on the air condition. So the landlord just get him move out the house because the landlord didn't allow him to use, but he buy this one (RCAC remote control) to put on the air conditioner, the landlord...he get kicked out. *P18*

> And that felt a bit unfair, but I didn't have any standing, I couldn't say anything. I had the fear that at best they'd say go find another place. And in a position like that, when you're an international student, vulnerable, I don't think you can afford to let go of good places that you find. *P31*

A lack of knowledge about the rights of people who rent sometimes left students unsure of their options for keeping comfortable, and many were hesitant to complain about housing conditions, or verbal arrangements about electricity consumption for fear of having to find alternative accommodation.

> I think for starters, one thing that I know is subleasing and sub subleasing is not legal. So I was like an illegal renter and currently still am. I just know that it's illegal. I don't know anything further or I don't have an idea of the rights as well. *P31*

> I couldn't get used to it, (winter) but I think, like, at night especially, it gets very, very cold, and, again, the heater thing, I don't know what to do with it, couldn't get used to it, but I think, like, at night especially, it gets very, very cold, and, again, the heater thing, I don't know what to do with it.. .I don't really understand electrical appliances without my dad, so I don't know what to do.. And I'm not too sure what's allowed, if I'm allowed to bring in a heater or no. *P9*

We point to how this lack of knowledge and poor-quality housing, along with the impacts of living alone for the first time put international students in a very vulnerable position. Aware of the media and public discourse that assigns much of the blame for the housing crisis in Australia to international migration, international students frequently recounted how they agreed to conditions that would be unacceptable to the majority of the Australian population.

The youngest students in this project were aged 18 years, and often they had come to Australia from their family home, being acclimatized to different climatic temperature ranges, and with no experience of independent living. They had to negotiate managing costs, social relationships, study requirements, and cultural differences which caused considerable emotional stress.

> It feels like you're very unsupported here because you suddenly become lonely you're living all alone managing all alone you need to meet your own friends here and if you see like locals can never understand that how international students think there are some very good locals but on the other hand there's some who makes you feel that you're a burden here even if you're paying a lot here *P7*

> Here we have stress level, stress of work, stress of university, stress of coping with the things, expenses. Everyone has like, if, frankly speaking, honestly speaking, actually, if, if Australian has, for example, 10% stress level, then any international person would have 70%. Like so many things you have to manage single-handedly...it's hurt your mental health. Sometime you just went worried, thinking about your planning calculations, like what to do if I could not earn this much this week, then what would be for the next week? *P24*

> It's difficult for us. Some people other from from other different background or different traditional different culture, not suitable for my culture, for example I feel not I feel not comfortable, for example, if I shared with with them. But I am I do that because I did that because I'm I'm necessary to do that. But make me not comfortable. Even if I want to study, I'm not comfortable. Emotion, physical. They change my mind. *P28*

This situation was often compounded by the high costs of energy, poor building performance, and bill shock. Coming from different climatic zones and with different understandings of acceptable comfort ranges meant that for some students heating or cooling appliances were used according to previous household or personal norms.

Many narrated how on receiving their first electricity bill caused them to reassess their energy consumption patterns and drastically reduce heating and cooling to lower the cost of their electricity bills.

> I used to live with my family, my parents, my sister, so we got AC in each room and we used to run for the AC maybe 10 to 12 hours a day. And we used to pay the bills used to come around 15,000 Taka, which is equivalent to maybe $150 to $200 a month, which compared to here it's cheaper. *P25*

> I think the first time that we received the energy bill, we were all a bit, I mean me or less and them more, they were like, oh, this is a lot more than we were expecting. So we were a bit more mindful of how we're using energy, keep the lights off when you're not using, you're not in the room. I was told that. Yes, so it was a bit of a shock. *P31*

> I would say people came from Saudi Arabia. Most of them, I would say ignorant about energy either in terms of money, energy consuming or environment. But let's say the more touch on them money. So for example, parents or fathers or the one who make arrangements, living cost, they die to try to learn them or to teach them how they should be efficient for the energy. Because it's a kind of behaviours and customs for example, they didn't just get rid of it. So they just use the energy as they do back home, which is a nightmare by the end of each month when the bills is coming out. *P4*

In light of the costs of energy, many international students narrated how they endured hot or cold conditions or reduced their use of other electrical appliances in order to save money.

> The conversation we had, (with the family) you have to be strong enough to resist the weather. Don't complain. Never complain... And we don't use heater in the morning. We just use it early night up to maybe two hours in the night, and we switch it off. *P10*

> We try not to cook food, which is more energy consuming. Other than that, we actually try to put our lights off when we are not there. We are continuously telling each other, if you're not in the room, please switch off the light. Like yesterday, I went to sleep and my heater wasn't off ... So, my sister woke up in the morning and she was like, you better put a timer on it because it's energy consuming. It's a lot and the bill will come and we're going to suffer then. *P11*

Often, on extreme temperature days the research team found themselves very uncomfortable while visiting participant homes in both summer and winter due to either a lack of cooling and heating appliances, or no use of those appliances in participant homes. Yet, the majority of the participant cohort were very stoic, often saying that they found the conditions reasonably comfortable. Many participants displayed extraordinary resilience and adaptability when living in private rental accommodation and it took time to build relationships with them where they felt comfortable enough to share stories of hardship. While our sample size is quite small, we feel the stories that the participants trusted us with are extremely valuable and deserve to be told.

3.5 In-home temperature monitoring

Indoor thermal comfort results are represented in this report by plotting indoor temperature against prevailing mean outdoor temperature, with a separate characteristic chart for each monitored room. Some 26,000 temperature data points sampled over the nominally 9-month monitoring period are plotted as a 2-dimensional histogram "heat map", where the orange and yellow boxed areas indicate the more frequently repeated data bins. The grey area represents the thermal comfort acceptance range for adaptive thermal comfort.

Table 3.2: Percentages of sample points outside the 80% acceptable comfort bounds.

Participant	Climate Zone	Room	BuildingType	Too Cold (%)	Too Hot (%)	Total Outside (%)	Start of available data	End of available data
P01	5	Bedroom	Studio	10.5	3.8	14.4	2024-06-03	2024-12-25
P03	5	Bedroom	Apartment	42.2	0	42.2	2024-06-03	2024-10-17
P03	5	Living room	Apartment	0.3	0.3	0.5	2024-08-01	2025-03-06
P04	5	Living room	Apartment	1	5.8	6.9	2024-06-26	2024-12-30
P05	5	Bedroom	Studio	20.8	0.3	21	2024-06-04	2024-10-21
P06	5	Bedroom	Apartment	3.8	0	3.8	2024-06-04	2024-10-07
P06	5	Living room	Apartment	26.9	0	26.9	2024-06-04	2024-07-28
P10	6	Bedroom	Apartment	3.7	3.7	7.4	2024-09-25	2025-03-23
P10	6	Living room	Apartment	12.3	2.1	14.5	2024-09-25	2024-11-21
P11	5	Bedroom	House	10.9	8.9	19.8	2024-06-26	2024-11-25
P11	5	Living room	House	18.9	0	18.9	2024-06-26	2024-11-25
P12	5	Bedroom	House	4.1	10.4	14.5	2024-06-24	2025-03-18
P12	5	Living room	House	20	0.5	20.5	2024-06-24	2025-03-18
P13	5	Bedroom	Apartment	0	4.3	4.4	2024-06-20	2025-03-23
P13	5	Living room	Apartment	0	0.6	0.6	2024-06-20	2025-03-23
P14	5	Bedroom	Apartment	15.9	0.4	16.3	2024-06-24	2025-03-25
P14	5	Living room	Apartment	21.4	4.2	25.6	2024-06-24	2025-03-25
P15	5	Bedroom	Studio	0.3	5.1	5.4	2024-07-26	2024-12-29
P16	5	Living room	Studio	9.5	0.3	9.8	2024-06-20	2025-03-18
P17	6	Bedroom	Apartment	30.1	1.6	31.6	2024-06-24	2025-01-06
P17	6	Living room	Apartment	18.3	0.5	18.8	2024-06-24	2025-01-06
P18	5	Bedroom	Studio	34.8	0.9	35.6	2024-07-26	2025-01-12
P19	5	Bedroom	Apartment	9.9	4.2	14.1	2024-08-02	2025-03-06
P19	5	Study room	Apartment	11.8	2.3	14.1	2024-08-02	2025-03-06
P20	5	Bedroom	Apartment	16.8	7.5	24.3	2024-08-02	2025-03-06
P20	5	Living room	Apartment	49.7	2.4	52.1	2024-08-02	2024-09-20
P21	5	Bedroom	Apartment	16.1	7.8	23.9	2024-08-02	2025-03-06
P22	6	Living room	Apartment	0.3	10.6	11	2024-08-08	2025-03-16
P23	5	Bedroom	Studio	14.7	10.4	25.1	2024-09-18	2025-03-09
P24	5	Bedroom	Apartment	5.5	0	5.5	2024-09-18	2024-11-30
P24	5	Living room	Apartment	47.4	0.1	47.5	2024-09-18	2024-09-28
P25	6	Bedroom	Apartment	10.5	10.6	21.1	2024-09-19	2025-02-28
P25	6	Living room	Apartment	3.2	13.6	16.8	2025-03-08	2025-03-23
P26	5	Bedroom	Apartment	10.9	0.5	11.3	2024-09-19	2025-02-16
P26	5	Living room	Apartment	0	0	0	2024-09-19	2025-02-16
P27	5	Bedroom	Apartment	0	0.7	0.7	2024-09-19	2025-03-16
P27	5	Living room	Apartment	0	0	0	2024-09-19	2025-03-16
P28	5	Bedroom	Apartment	21.9	3	24.9	2024-09-19	2025-01-01
P28	5	Living room	Apartment	22.8	4.9	27.7	2024-09-19	2025-01-01
P29	6	Living room	Apartment	26.2	2.9	29.1	2024-09-25	2024-11-21
P30	6	Bedroom	House	11.4	2.1	13.5	2024-09-25	2025-03-25
P31	6	Bedroom	House	10.5	7.5	17.9	2024-09-25	2025-03-25
P31	6	Living room	House	14	3.8	17.8	2024-09-25	2025-03-25
P32	6	Bedroom	Apartment	1.3	17.7	19	2024-09-25	2025-03-25

While international students actively tried to limit the amount of electricity consumed when they need to pay for it in addition to rental payments, it was common that students cited their lived energy histories and cultural beliefs about a more general consumption of public resources. In circumstances where energy costs were included in the rental payment, we found very little difference in consumption rates. In other words, regardless of who paid for the electricity, international students in this project exhibited very low rates of energy consumption which only marginally impacted on the level of thermal comfort.

> It's both cultural and religious things as well, do not waste the resources you have. *Uzma*.

> I also convince other people do not waste energy, use less energy all the time. Doesn't matter where you are, you're at home, at office or wherever, but you always use less amount of energy. *Asad*

> I think because this come from the angle of Islam and our culture, the life is not just for yourself. We have to live with your community, the resource for the community, the resource for the all peoples. You have to think about not only think about just yourself and use them and spend everything just for yourself. You have to this collective thinkings. Think about the people, think about the other resource. *P17*

This points to responsible energy use by this group, motivated by financial pressures but also because of cultural beliefs, and reinforces the need for better performing housing stock that can improve thermal comfort levels without excessive energy consumption.

3.6 Energy monitoring

The available energy billing data for the case study participants is presented in *Figure 3.3* in terms of total energy consumption per day. These comparisons illustrate the value of home energy and thermal comfort rating systems as well as the intricacies and impact of household practices on energy consumption.

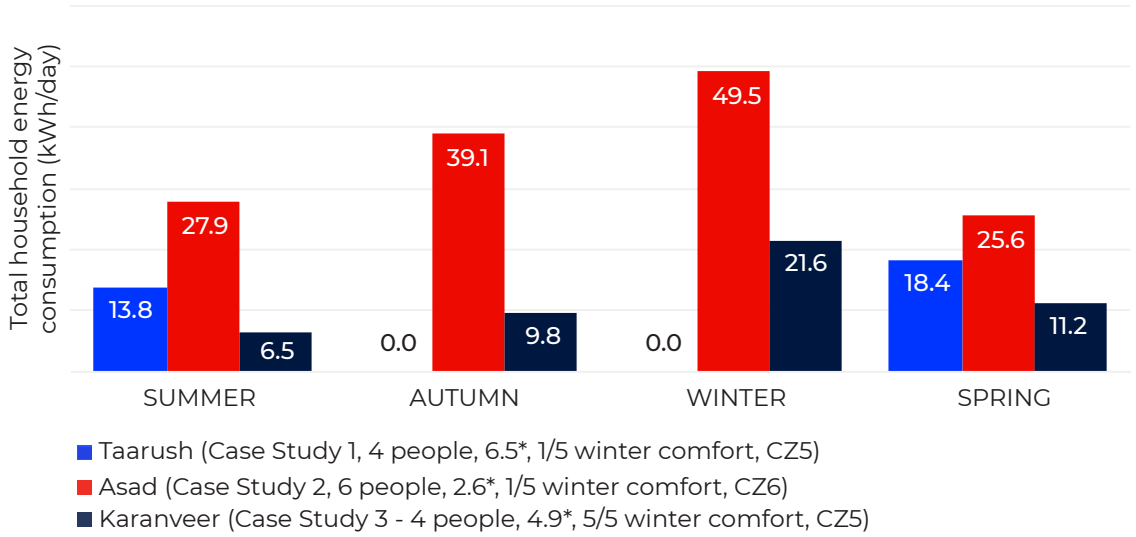

Figure 3.3: Seasonal energy consumption for case study participants, where energy bills were available.

In addition to energy billing data, 8 Meross smart plugs were installed.

An example of daily plug load energy consumption against indoor and outdoor temperature is presented in Figure 3.6 in CASE STUDY 1. This demonstrates the potential of these devices to collect more granular heating energy consumption data that can be correlated with indoor temperature measurement for a more detailed deciphering of heating practices and thermal comfort results. However, this method requires more active engagement of participants, which limited the value of this data for this study.

Case study overview

CASE STUDY 1 and CASE STUDY 3 have similar characteristics - both households have four male students with similar cultural backgrounds, in the same climate zone.

CASE STUDY 1 is the coldest home and has approximately twice the energy consumption as CASE STUDY 3.

CASE STUDY 2 has the lowest Scorecard rating of the whole cohort at 2.6 stars out of 10, the lowest winter comfort rating (1/5), the lowest summer comfort rating (1/5), has the highest energy bills, and is in the cooler Climate Zone 6.

CASE STUDY 4 has an average Scorecard rating (4.3), low thermal comfort ratings hot weather comfort rating 1(1/5) and cold weather rating (2/ 5) with no billing data.

3.7 CASE STUDY 1

Above average scorecard rating (5.4), thermal comfort signature very cold and very hot, high bills

Taarush is a 24-years old master's student from Pakistan who shares a 2-bedroom apartment with three friends. The apartment is the upstairs half of a divided 2-storey 1970s clad home with no insulation in the ceiling, walls or floor (see Figure 3.4), located in Climate zone 5 (warm temperate). One bedroom has a fixed ceiling fan while the other has a free-standing fan purchased by the occupants. There are no fixed heating appliances.

Figure 3.4: No ceiling insulation in a readily accessible ceiling cavity.

The Scorecard rating of 5.4 out of 10 stars is due largely the solar hot water system which reduces hot water heating energy to an estimated 8% of fixed appliance consumption, and the compact size of the apartment. Winter heating, without any installed heating appliances, is estimated to be 88% of the household energy

consumption. Rental is $560 per week split equally between four and does not include electricity costs.

> The student life is a bit difficult. Yeah, definitely. Without family, being away from them, you have to cook your food, do your dishes, laundry and stuff. So, yeah, for us, it's a bit hard...So when we use electricity, so definitely is too expensive...So we try to use as minimum as possible, so we have to pay less, but it's still expensive.

The apartment share arrangement has many benefits for Taarush. He discusses how they cook meals individually, though at times they might share cultural food. Not only do they share an apartment, but they may also travel together at holiday times to visit other states.

> Yeah, it's good for me to have such a good company. We all have the same understanding, so it's good to live together when you have same minded people around you. So I love spend time with them. We have good time. So yeah, it's good for me to live in together. And they're also from Pakistan, so a bit easier for us. The same language, same culture.

Apart from when cooking in the kitchen, the four students spend very little time in the shared spaces which are uncomfortably cold according to the thermal comfort signature charts (Figure 3.5 below). Instead, often all four of them tend to gather in the warmest bedroom in winter.

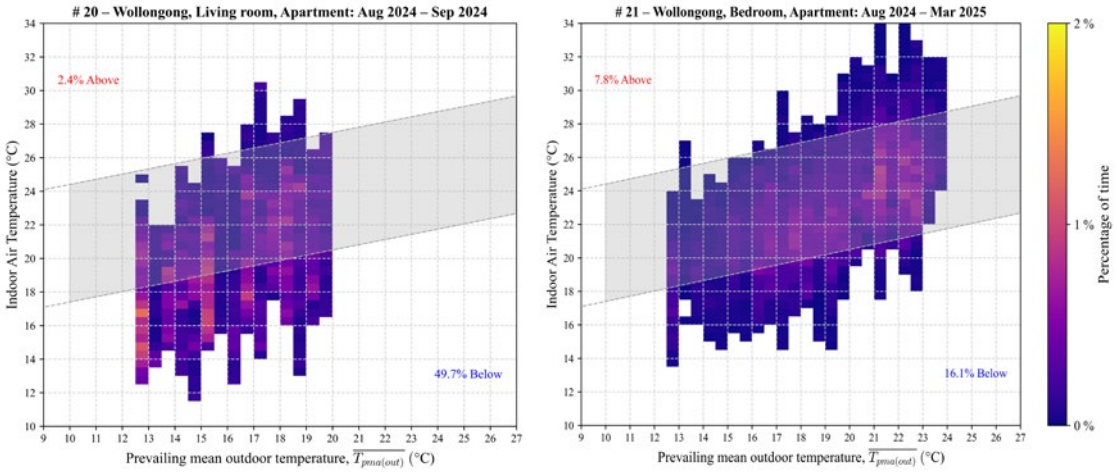

Figure 3.5: Thermal comfort signature charts for the living area and bedroom of participant 20. Note that this living area temperature is below the lower acceptance limit almost 50% of the cold weather period and is down to as low as 8°C below the comfort acceptance limit.

This is the most uncomfortably cold home in the cohort with indoor temperatures below the lower acceptance limit almost half of the time in the living room and temperatures reaching as low as 8°C below the thermal comfort lower limit. The temperature sensor in the living room only collected data through the cold weather period so the high proportion of cold discomfort is skewed to winter discomfort. Bedroom temperatures are only slightly higher than the living room and demonstrate substantial summer discomfort above the upper thermal comfort limit 7.5% of the time.

The energy bills reveal 18.4 kWh/day in winter-spring (3/08/2024 – 25/10/2024) falling to 13.8 kWh/day in spring-summer (26/10/2024 – 28/01/2025). The plug-in heating appliance consumption for one of the bedrooms is presented in Figure 3.6 against the outdoor and indoor temperature with an average consumption of 5.3 kWh/day on a plug-in fan heater in this bedroom. This energy consumption is indicative of an 1800W fan heater for only 3 hours per day. The time series indicates that the heater was turned on multiple times for very short periods in response to external temperatures and then quickly turned off again. The same appliance load logger was used in the second bedroom, but the data indicates that it was only used a little for 3 days then was not switched on again which is consistent with the interview data that all four tended to gather in one bedroom.

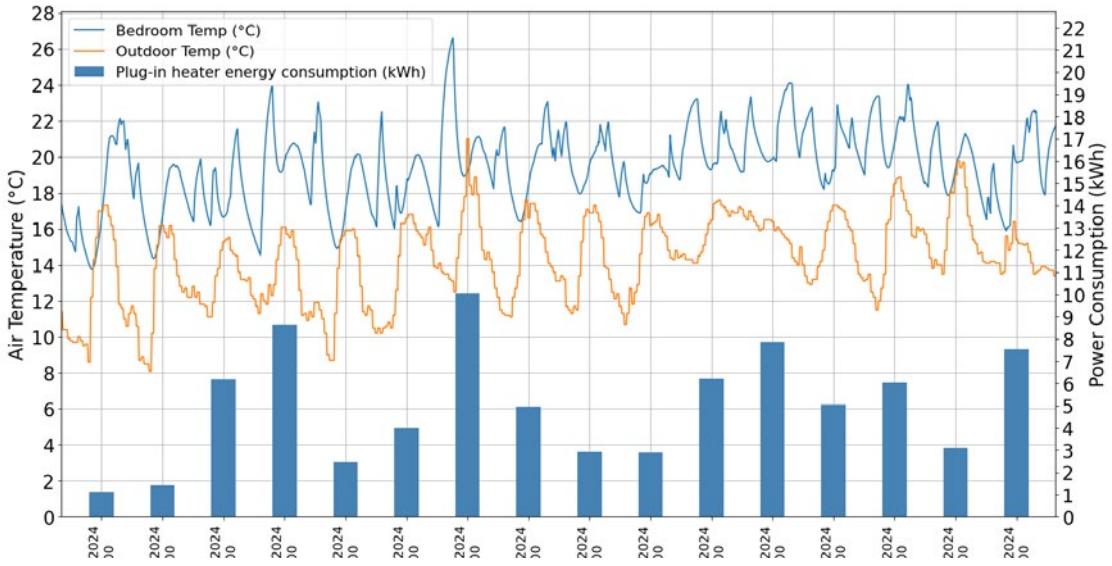

Figure 3.6: Plug-in heater energy consumption patterns for 2 weeks in August 2024.

This is a frugal share household living in a very cold home with a reasonably high energy star rating. This case study illustrates the importance of home star ratings needing to convey the importance not only of the star rating, but also of the thermal comfort rating, especially for frugal households who are more inclined to operate their home without substantial heating input.

Taarush worries that four people cooking on the electric stove is a large contributor to the energy bill which is around $500 per quarter, and he often talks with his housemates about the need to reduce energy consumption.

> Some of them they forgot to turn off the lights and they went to their jobs and it's been open for two or three hours, so just wasting the light and money. So yeah, we had a conversation so we were trying to not use the things in daylight time and the hours or peak time hours, so we try to use as much as less possible...The first priority is definitely to save money, and yeah, this is the concern because we are students and we're struggling with financial, so we are a bit budget conscious.

Taarush understands how the building performance impacts on thermal comfort and energy consumption costs. He has spoken to the landlord about the possibility of installing insulation to improve thermal comfort, yet he feels that this will not occur and is already planning to find more suitable accommodation that would help to reduce energy bills.

> We are looking to move out from here in this October, maybe, because this house needs to be repaired, and the owner is not, like, I don't think so he's going to cooperate with us. if we got a good, insulated home, probably we don't need to use heaters as well... because I'm looking for a good house, which has a good insulation.

In the meantime, the winter thermal comfort is still very poor with all four tenants trying to study in uncomfortably cold conditions. We argue that such poorly performing buildings are implicated in the high levels of student mobility we encountered in this project.

Key learnings: The recommendations for this home would be to request the landlord install ceiling insulation and install an energy efficient reverse cycle air conditioner in the shared living area. These improvements would be expected to both greatly improve the thermal comfort while also reducing the energy bills.

3.8 CASE STUDY 2

Low scorecard rating (2.6), fluctuating cold and hot indoors (1/5), very high energy bills

Asad is a 30-year-old master's Student from Bangladesh who has lived in Australia since 2023. He stayed with a family friend for a few months before moving to a private room in a shared house. When his wife wanted to join him from Bangladesh he moved into a larger free-standing shared house. The three-bedroom house is shared by six people (3 couples), and the rent is $750 excluding utilities. The building is a very old and draughty single-story fibro construction with no insulation. Two of the bedrooms have old less efficient split system air conditioners (see Figure 3.7 below), and in the other two bedrooms the occupants have purchased their own portable heaters. It is located in Climate Zone 6 with a below average 2.6-star Scorecard rating out of 10 and very poor comfort ratings for both cold weather and warm weather.

Figure 3.7: Bedroom with study area and dentist practice workstation. Ceilings are high, there is an older split system air conditioner, and fibro walls show evidence of mould. Asad has taped up the ventilation ducts to minimize draughts.

Externally, the house appears quite dilapidated, is not well maintained and there is little evidence of any attempt to improve the thermal performance of the building.

Asad explains that he and his wife turn on the heater in winter only if the temperature drops to 5- or 6-degrees C.

> So, it was not that comfortable in winter, like mainly July and August. Like because I felt like almost like the outside temperature is coming inside, like the almost non-existent insulation like kind of thing... There'd be (heater use) 8:00 PM to 11:00 PM when the night starts and after that because of the blanket. So, we, I know we have to also save the energy so we have in mind that.

While Asad's room has a fixed reverse cycle air conditioner, he often chooses not to use it and instead uses a portable bar heater in the bedroom despite knowing that this is less energy efficient. With high ceilings and wooden floors, it takes time to warm the room.

> It's a portable kind of thing, radiant, sometimes in the room it gives instant heat, that's why. Because if I turn on the air conditioning, so it will take maybe 20 minutes almost.

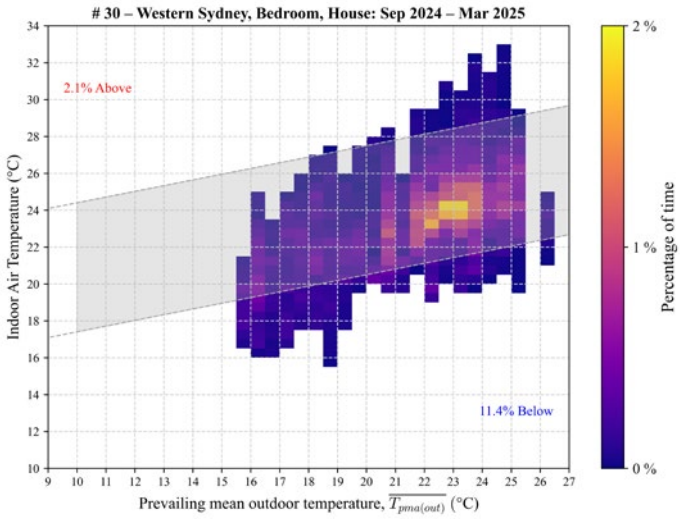

Figure 3.8: Thermal comfort signature for participant 30 bedroom/study/ work station.

Figure 3.8 demonstrates that Asad and his wife experience significant periods of time outside the range of acceptable comfort when in their bedroom.

While the home is cold in winter, Asad's room remains cooler in summertime because it receives no direct sunlight and there are trees outside his window. Asad reiterates how summer overheating creates difficulties for his housemates without fixed air conditioning.

> They can't cool the thing (bedroom). In the summer, they are fucked up, like, really. No, they are… Actually, we put that to the owner that, okay, we can pay anything, but if you can install another air con, if it is possible by the electricity load and something, everything, then we are happy to pay.

Yet, this household is struggling with by far the highest electricity bills of the cohort with daily winter consumption of 49.5 kWh/day with summer consumption still at 27.9 kWh/day and shoulder season consumption similar to or higher than summer. The quarterly bills ranging from $895 up to $1543 had accrued during the project period to over $6000 at which point the retailer disconnected power and reconnected only after two previous bills had been paid. The disconnection and reconnection fees charged were $631each totalling $1262 on top of already alarmingly high bills and arrears. Asad and his housemates therefore pay between $75 and $130 per week in energy bills.

> I'm a bit worried now, at this moment. Yeah, I'm saying that's $1200 or maybe sometimes $900. But still, it's money at a time. Not like instalments. So, a little bit worried. But if the energy bill is cheaper, I would not worry that much and focus on other things, like maybe roaming (day tripping).

The available energy billing data for the case study participants is presented in *Figure 3.3* in terms of total energy consumption per day. The household of Asad clearly has by far the highest energy consumption, even allowing for the larger household size.

Key learnings: Recommended upgrades should start with draught-proofing the floors, walls, windows, doors and the ceiling insulation, however it would be very difficult to get this home to a modern standard. The participant has already taken the initiative to tape plastic over the multiple wall vents to address to major air leakage gaps in the bedroom, as depicted in Figure 3.7. A heat pump hot water system

upgrade would make the most impact on electricity bills. Encourage residents to contact energy retailers early to arrange payment plans. The communications records were not available to the research team, however, although the responsibility to pay on time lies with the customer, in this case with potential language and payment vulnerabilities, energy retailers could be made to be more proactive in contacting unresponsive customers in arrears by SMS with clear consequences of disconnection fees and disruption and payment plan options.

3.9 CASE STUDY 3

Average Scorecard rating; (4.9) reasonably stable indoor temperature but quite cold and hot (5/5); high bills

Karanveer comes from Punjab in India and is pursuing a master's degree in data science. He lives in a shared 3-bedroom apartment with three friends from India, and they pay $1150 per fortnight in rent excluding bills. The apartment was leased before they had physically inspected the property and the group felt lucky to have at least secured accommodation in the present Australian housing market.

> When I moved from India over here, everything was quite expensive. As you know, there is housing crisis going on and initially it was really hard to find an apartment to stay. So, me and my friends, like university made a group where we can find the students that will be incoming in the next semester. So, they reached out to me and for a couple of days we booked an apartment from India. It took us, we have been waiting for quite a while and for almost like a month. And when our flight, our flight was on 14th and just before two or three days ago, we found an apartment to stay there.

The building (Figure 3.9) has an above average Scorecard rating of 4.9 stars and with very high (5 out of 5) comfort ratings for both hot and cold weather due to the construction date of early 2000s after the introduction of minimum efficiency standards and the apartment format with a high proportion of external walls, ceilings and floors shared with neighbour's conditioned rooms. The apartment has one reverse cycle air conditioning unit in the lounge room, and one in one of the bedrooms.

Figure 3.9: Busy west-facing streetscape of the early 2000s apartment of participant 14, with deep-set windows blocking sunlight until late afternoon.

This apartment faces west onto a busy city shopping centre road and, due to the windows being deeply set back into recesses in the walls, does not receive direct sunlight except for late afternoons meaning that the building remains cold in winter. The Scorecard rating does not account for these more specific external shading details. Karanveer narrates how because of concerns over the cost of the energy bill, the air conditioner in the lounge room is never used, while the bedroom air conditioner is used for 1-2 hours daily when all members gather in the room to socialise. Karanveer has purchased a small fan heater from Kmart that he rarely uses in his room. While Holland blinds were present in the bedroom and drapes in the living room these were not utilised leaving the windows as large heat leakage pathways in winter.

> I think it's not really easy to keep warm because the air comes during the night. The air comes through the windows. I don't know, the windows are closed but still the air comes somehow.

The thermal comfort signature charts (Figure 3.10) indicate that these two rooms are typically not heated in winter since when the prevailing mean outdoor temperature falls below 13°C the indoor temperature is largely below the lower thermal comfort acceptance limit. It appears that the bedroom is modestly heated for a small proportion of the time in line with the stated household pact to minimise heating expenses.

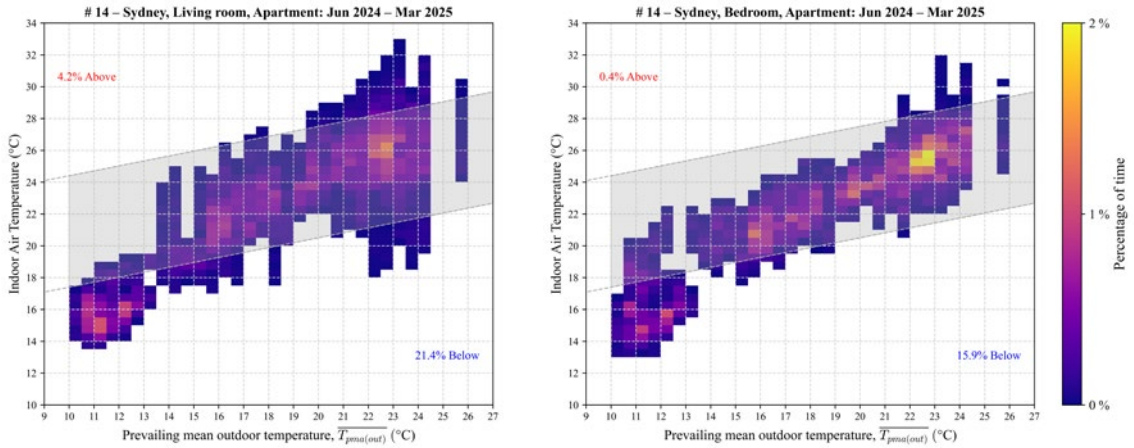

Figure 3.10: Thermal comfort signature charts for Participant 14 living room and bedroom. Grey band maps the acceptable comfort range, and frequency of time spent in temperature range is indicated by colour. These rooms display substantial winter discomfort and little use of heating appliances. The four students who often huddle into one bedroom room to share the more efficient air conditioner comfort

Karanveer and his friends are constrained by the cost of energy and cut their energy consumption at the cost of thermal comfort.

> Coming here to Australia, we have a lot of responsibilities on our shoulders because back in India the culture is completely different. We rely on our parents and here in Australia the kids like to be independent after 18. So, there is a cultural change, I guess. And coming here to Australia now, we need to manage our expenses as well...I think it's really hard because as I already mentioned, because we do part-time jobs to pay our bills, just bills, not even our fees. And even in that case we restrain ourselves a lot so that we don't get that much electricity bill. So I guess they need to think about it so that we can focus more on our studies and less about the other headaches.

This group of students, however, emphasizes the social benefits of shared culture, language and food. They prepare meals together, attend festivals and support each other financially and emotionally.

Key learnings: resident practices may have a negative impact on thermal comfort levels despite average or good Scorecard ratings.

3.10 CASE STUDY 4

High scorecard rating with tiny footprint

Uzma is an 18-year-old female student from Pakistan who has come to study Business information systems and entrepreneurship. She explained how most of the university accommodation was too expensive and was not available for when she arrived in Australia.

> I started with finding something within the university. But the thing is, I couldn't find any because I mean, they had a waitlist of like one semester. And then they had some space in the residential colleges, but they were like $850 per week, which is just so expensive. I couldn't afford that.

As a single Muslim woman, Uzma is not keen to share a rental property with others and so found a bedsit apartment online. The first-floor apartment is on one of Sydney's busiest roads but is close to her university and is almost affordable at $300 per week including electricity.

> If you see the space here, it's like hardly for one person. But the thing is, like I just stay in university all the time or if I'm working, I'm at work. So, it really doesn't matter.

In NSW the smallest permissible floor area for a studio apartment is 35 m^2. But a private room in a boarding house may be as small as 12m^2 for a single person, excluding any space used for private kitchen or bathroom facilities. So, at 12 m^2, this unit is purported to be the smallest available accommodation on the market (Figures 3.11, 3.12). That said, the space is well-utilised with a single murphy bed, desk, kitchenette in a narrow entry hall with a separate toilet and small shower.

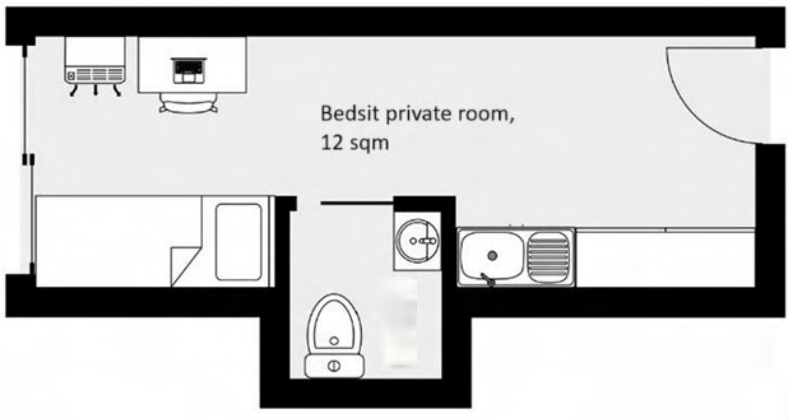

Figure 3.11: Floor plan of participant 7 who lived in the smallest permissible private boarding house room, at 12m^2.

Figure 3.12: Stock photos of the room illustrating the tight functional space. The photo on the left is taken from the entry door through the narrow kitchenette into the bedroom/study with the bed packed away. The photo on the right is with the bed lowered and the small balcony.

The Scorecard star rating of 4.3 out of 10 stars is above average but again the thermal comfort ratings are low with the hot weather comfort rating 1 out of 5 and cold weather rating 2 out of 5. The very small size of the apartment with neighbours above, below and on three sides means that the exposure of the external envelope to outside air is limited to just 5m^2 on the west-facing external wall. Despite the high scorecard rating, Uzma narrated that during the summertime opening the balcony door for air was not a possibility because of the proximity to a very busy and noisy road, and that she needed to purchase a portable air conditioning unit 'to survive'.

> In summers, it's terrible living here. See this air conditioner? I just purchased it in the middle of summers because like after 3 or 4pm, when the sun starts going down, it's right there. And this room is burning at that time. It's really hard to even breathe here. ..I just lost my job. And when I had to be in this room for all this time, I just realized that I just can't take it because it was so suffocating... Because it was a very humid weather and there was lots of noise coming. It was really hard.

Uzma discusses the challenges of being a young woman living alone for the first time in a foreign country. She reflects on how she feels isolated, and somewhat worried about her physical and mental health due to the small size, location, and condition of her apartment. She had not shared photographs of her apartment with her parents because she did not want to worry them.

> You get a little lonely here sometimes. Yeah. A lot of times because in this building usually they're very old people so they're very confined to their own places...this is so small no one can live here. If I showed this my parents would probably make fun of me saying that okay you live like a hen. You can't even move. It ...just you know it will affect your health. My father calls me like twice a day 'go out and have a walk'.

Uzma has limited knowledge of the cost of energy or of energy efficiency and this has further dissuaded her from looking for shared apartments where she may have to pay separate energy costs.

> When we come here, we don't know anything except Kmart just rush to Kmart and buy anything you want so it should be like I feel like there should be some program to teach international students how the system runs here, how your bills are calculated, which things use a lot of energy, which use less energy, how you need to you know balance these things.

Instead, she makes do with the very minimal space of her apartment because energy costs are included in the rental price despite the potential impacts to her mental and physical wellbeing and being socially isolated.

Key learnings: Because of this compact format, focused upgrades to window sealing, shading and blinds can make a substantial impact with a very low cost.

3.11 Building performance versus resident practices

In this section, we make some general points about building performance and resident energy consumption practices and how these impact on overall rates of energy consumption, thermal comfort, health, and cost.

Inefficient use of appliances with policy implications

Mikheil is a 20-year-old student who comes from Russia but has spent the last five years living with his parents in New Zealand. He pays $350 per week for a single room on the top floor of a relatively new corporate student apartment building. The cost of electricity is included in the rental price. Mikheil is used to cold climates and is not particularly bothered by winter temperatures in Australia saying that it is 'refreshing'. He uses a small fan heater some mornings to warm his feet for 10 or 15 minutes. While his cultural preference for cooler climates means he finds his apartment relatively comfortable during winter, in the summertime Mikheil has had to purchase his own portable air conditioner.

> *Well, summer is a struggle for me. Yeah. Australian summers get pretty hot sometimes. I remember this, it was 42 degrees one night and I was not feeling great. That's why I needed to buy a portable AC because my room is getting too hot and too, there's no airflow here, so I could not manage. I have to open windows, but they're really small and even when I open them there's no airflow, which just the room, it gets really hot. ..It was a lifesaver. I don't think I could make it through without it. It because sometimes it was getting so hot I couldn't sleep during the night probably, which is really inconvenient for me. But yeah, not used to really hot weather I guess.*

Figure 3.13: Portable air conditioner duct is passed through a broken open window frame with gaps unremediated..

Being on the top floor of the building means that his room is exposed to a prolonged period of direct sunlight making it uncomfortably hot. Even with windows open Mikheil cannot effectively cool the room through natural ventilation. The solution has been for a portable air conditioning venting tube to protrude through the only available window which remains unrepaired (Figure 3.13). This is an extremely energy inefficient arrangement which consumes a high amount of electricity and is not particularly effective at maintaining a reduced indoor temperature.

Mikheil feels fortunate that he does not have to consider energy bills. He has heard from his fellow students the dilemmas of sharing energy costs.

> I think for my mates that rent, for them it's the bigger question -electricity. People get in a fight sometimes with their neighbours, sometimes they leave for example, the lights on or the AC on and then the bill just goes up.

Even though Mikheil has been brought up in a family that strictly controls energy consumption to minimise costs, because of relatively poor building performance and included electricity costs, he is encouraged to use more energy.

> I definitely use more energy here than I used to back home because I guess there my parents more controlling about it and then restrict me more. But here I don't think I have to make a decision about it, I just use it as much as I please. I just put it (the air conditioning) on sometimes go the whole day and just go study in the library, come back to the nice and cold room.

Key learnings: when electricity costs are included in student rental costs there may be instances where energy consumption increases, energy efficiency decreases, and energy costs for providers increase.

Over-reactive control of the indoor environment with energy policy implications

Basit is 33 years old and is from Saudi Arabia. He studies public health and lives with his wife and 5-year-old son in a 2-bedroom relatively modern apartment in Climate Zone 5. His wife has Rheumatoid Arthritis, and his son has asthma, so Basit tries to keep the indoor environment comfortable for them especially in winter. He discusses this in terms of using energy to be comfortable and saving money and the environment. The way that Basit uses heating and cooling appliances, however, is not particularly beneficial to either health, saving money or the environment. Basit explains that when he uses the air conditioning it is constant cycle of turning it on and off as he believes this is an effective way to save money and conserve electricity.

> We just switch off when feel hot, we turn off, we turn on, and so forth.

So, while his main motivation to warm the home in winter is for the wellbeing of his wife and son, it is also because he comes from a hot climate that his preference is to be warm rather than cold. While the apartment has a relatively good scorecard rating which should indicate that it does not take much energy to heat or cool, Basit has the highest energy bills in the project cohort. Again, as in the above example, we point to how building performance can be undermined by resident practices and reiterate the need for greater knowledge and awareness of how to use energy efficiently. We illustrate this point through a comparison of different thermal comfort signatures which depict how resident practices impact on thermal comfort. Thermal comfort signatures reflect a combination of the building characteristics, as well as occupant ventilation and air conditioning practices.

Figure 3.14 represents Basit's use of air conditioning in the home through mapping the temperature range experienced in the living room, and the frequency with which those temperatures are experienced. What is depicted is an over-reactive control of the air conditioning in both winter and summer that fights to reverse the naturally conditioned adaptive comfort model at the cost of higher energy consumption. The naturally conditioned adaptive comfort model (ACM) posits that people in naturally ventilated buildings are more comfortable with seasonal temperature variation compared to people in air-conditioned buildings.

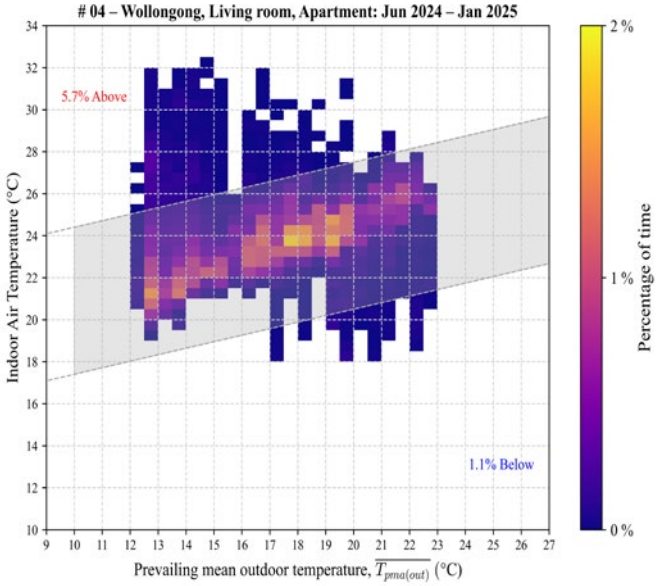

Figure 3.14: Thermal comfort signature charts for apartments in Climate Zone 5. a) An over-reactive control of air conditioning in both winter and summer that fights to reverse the naturally conditioned adaptive comfort model at the cost of higher energy.

We point to two issues with Basit's air conditioning practices. Firstly, by cycling indoor temperatures between 21°C to 32°C it is difficult for the body to adapt and acclimatise and introduces mild thermal shock. Second, creating a temperature differential of 22°C across the thermal envelope greatly increases the heat losses. A more stable lower thermostat set point would be both more energy efficient, cost effective, and more consistently comfortable.

There is a substantial proportion of cold weather samples where the indoor temperature is up to 32°C (7°C above the adaptive acceptance limit). Contrast this against the highest recorded indoor temperature in summer (higher prevailing mean outdoor temperatures) of 29°C. This indicates that the overheating above the upper acceptance limit in winter is an over-reactive heating choice by the occupant. Similarly, in summer, there is a noticeable, albeit less substantial, proportion of hot weather samples where the indoor environment is over-actively cooled to below the lower thermal comfort acceptance limit, with only modest increases in energy cost.

Heating control practices for Basit are further explored in the time series data for a 48-hour period presented in Figure 3.15. The indoor temperature spikes indicate the living room AC being switched on with the thermostat set to the maximum possible temperature set point of around 32°C.

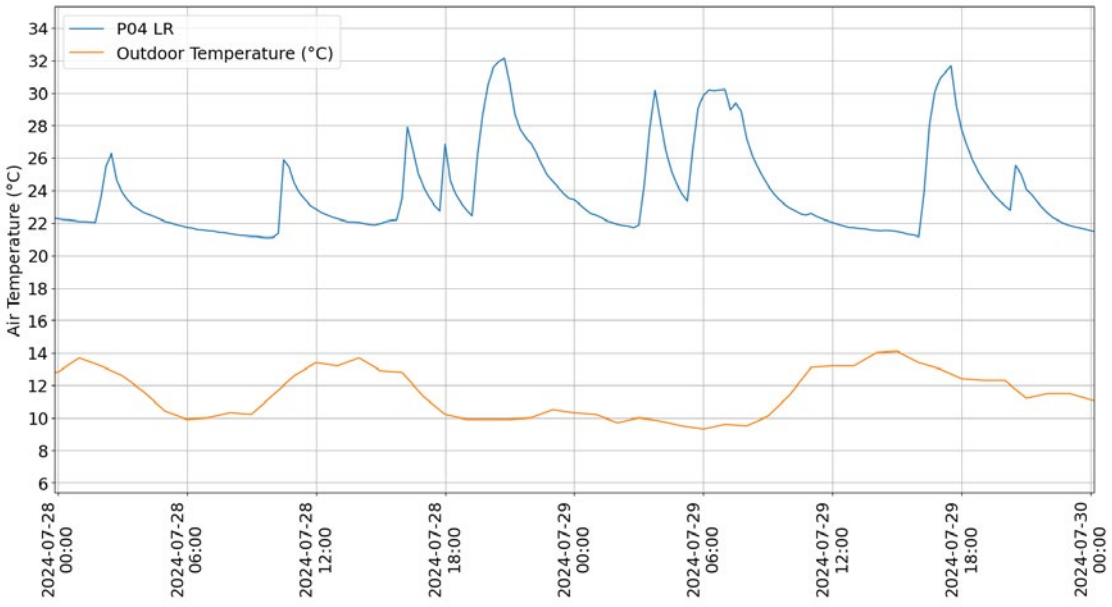

Figure 3.15: Time series indoor and outdoor temperature illustrating use of the heater with varying thermostat setting up to 32°C and switching ON/OFF frequently.

Basit's use of air conditioning demonstrates an anomaly between the range of acceptable winter temperatures up to 32°C, and summer temperatures as low as 18°C which may be due to cultural preferences, or misinformation and erroneous beliefs about energy efficiency.

Key learnings: improving energy efficiency knowledge may decrease rates of energy consumption and energy costs, as well as having positive impacts on physical wellbeing.

4 Discussion and Implications

We have drawn together the results from our multi method, quantitative and qualitative research project to provide a rich story about the difficulties faced by international students living in private rental accommodation in Australia.

This research is valuable in the context of the cost-of-living crisis and the housing crisis which is ongoing at the time of writing in mid-2025. We have provided insights into multiple dimensions of the international student experience which come together to create an inequitable situation for the everyday wellbeing of the approximately 600,000 students who choose to study in Australia.

We have highlighted some of the difficulties related to securing accommodation and pointed to the potential for greater support of students through improving information, support, and advocacy. We have drawn attention to the issues that create delays and barriers for students seeking to secure appropriate and affordable housing. Because Australian universities rely on the intake of international students for a substantial proportion of their income and have the best information on student housing projections for this very localised and student-specific rental market segment, we urge consideration of improved academic intake approval processes. We suggest

that there should be a corresponding duty of care for sponsoring universities to be more proactively engaged with the student rental market in ways that can help to reduce housing stress for international students.

The poor performance of the Australian rental housing stock is highlighted in many of the examples we draw upon in this report. We support actions to encourage the mandatory disclosure of home energy performance ratings for the rental market. While this is currently addressed by the National Construction Codes for new builds, there need to be further implementation of energy performance rating tools like the NatHERS existing homes tool to provide greater accountability in the rental housing market. This will be of benefit to all Australian renters who will be better informed about the building performance, energy fixtures, energy costs and overall thermal comfort levels of available housing options. This is also relevant for the vulnerable international student rental market.

Further, we advocate for the development of social marketing materials that support students with information on rental rights and practices across a range of local accommodation types. As well, our report emphasises the opportunity for social marketing material that can provide basic information about the Australian energy market, the range of energy providers, tariffs, rates and plans, as well as options for payments plans and available subsidies. Also of value would be material that can promote energy efficiency knowledge, and provide practical advice on maintaining thermal comfort, reducing energy costs, and improving wellbeing. There are many other opportunities to promote advocacy, wellbeing services, and social connectivity for international students in light of the findings of this report that illustrate the financial, physical and emotional stresses that surround living and studying in Australia.

5 Policy implications

The National Construction Codes (NCC 2022) minimum efficiency standards for new builds are a step in the right direction to improve the performance of housing stock in Australia. However, this is unlikely to impact the most vulnerable households living in existing rental properties.

This presents an opportunity to highlight the usefulness of the mandatory disclosure of home energy performance ratings for the rental market. Although disclosure of home energy and thermal comfort ratings will not enforce improved standards for existing rental properties, with the proper presentation and supporting energy billing calculation tools, this can improve the agency of renters to make better informed decisions to choose more energy efficient housing that may be slightly higher in rental cost yet provide more comfort and savings on energy bills in the long run. Engagement, involvement, and collaboration with key real estate bodies would benefit the implementation of a scheme of consistent energy performance ratings.

A further practical implication arising from our findings is that hot water system upgrade incentives similar to previous programs (low flow shower heads, energy efficient light bulbs) for landlords could help address the highlighted issue of the high level of hot water heating energy consumption for vulnerable rental households.

6 Conclusion and Recommendations

Conclusions

Our findings point to several important conclusions. One of the most powerful is that international students in Australia are facing a range of barriers and challenges in their living arrangements that impact on their health and wellbeing and quality of the student experience. The quality of housing stock and the cost of electricity are key factors in how students fare in an increasingly changed climate that demands coping with more extreme temperatures. We found that in the Australian context around Sydney, while there are examples of summer overheating, winter underheating is a greater problem amongst the CALD student cohort, many have little knowledge of energy efficiency or energy provider options, cost and plans available, and there are opportunities to encourage a reduction in the overall levels of energy consumption as part of the transition to net zero.

Recommendations

- Develop materials that can assist to increase awareness of home energy efficiency, passive heating and cooling measures, the range of available energy retailers and the implications of different energy plans for international students living in Australia. These should take into consideration cultural practices and beliefs.
- Development of social marketing materials that support students with information on rental rights and practices across a range of local accommodation types. This should particularly highlight the high consumption of hot water systems for frugal households and could include energy efficiency and thermal comfort tips for maintaining wellbeing as well as avenues for advocacy, wellbeing services, and social connectivity.
- Universities to be more proactively engaged with strategies to understand and assist with the housing stress of their students.
- Advocate for hot water system and thermal comfort upgrade incentives for landlords at the lower end of the rental market. This could be conducted in conjunction with a NatHERS Existing Homes rating trial with results before and after the upgrades.

Future Work

We have several suggestions for ongoing research that can ameliorate the hardships experienced by international students in Australia. First, further research that measures the impact of social marketing and behaviour change materials and programs that seek to improve thermal comfort, and energy efficiency knowledge, while reducing energy consumption, informing energy practices and reducing energy costs for vulnerable households such as student populations.

Second, the development and implementation of trial hot water system targeted retrofitting project for vulnerable frugal households with energy bill stress, to illustrate the energy savings that could be made.

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