PROJECT REPORT 2024

# FUTURE CLIMATE IMPACTS ON HOME ENERGY STANDARDS

This report has been produced by Sweltering Cities and Renew in order to analyse how changing climate conditions impact Australian home energy efficiency.

# ABOUT OUR PROJECT

The purpose of this project has been to explore whether the use of historical climate data to set energy efficiency standards in Australia will impact our resilience in rising temperatures and extreme heat. This is the first stage of a larger project; the scope of this work is to deliver a technical report and communications plan demonstrating the importance of this issue, potential for impact and the need for further analysis and advocacy.

This report has been prepared by Sweltering Cities and Renew with the support of Energy Consumers Australia. At a stakeholder consultation in December 2023 the technical report and analysis was presented to over 40 stakeholders for feedback. Those comments have been integrated into this final report.

# THE BACKGROUND

Australian building standards require homes to meet energy efficiency standards (NatHERS). These NatHERS ratings measure how much energy is needed to heat and cool homes in a range of climate zones, setting limits for heating and cooling loads to achieve star ratings. The climate zones are designed using existing weather data: until 2022 these were based on weather data from 1970-2005; from 2022 the data is from 1990-2015.

Using past climate data for how we design our homes will reduce resilience to future climate extremes, particularly heat. Historical climate data does not accurately reflect the increasing frequency and intensity of heatwaves, and as global temperatures rise, using out of date data will lead to underestimating the severity of future heatwaves. This will result in homes that are ill-equipped to deal with extreme heat. In 2023 the Intergovernmental Panel on Climate Change (IPCC) stated that “Human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming, with global surface temperature reaching 1.1°C above 1850-1900 in 2011-2020.” As the climate is hotter than the historical average, there will be a higher cooling load required to keep homes at a safe temperature. Therefore the star ratings given to new buildings and renovations underestimate how much energy the home will require, and that difference will grow over time.

The National Construction Code is the regulatory instrument used to set energy efficiency standards across Australia. The NCC is updated every three years with a focus on different areas for consideration. The next update of residential energy efficiency ratings will be in 2028.

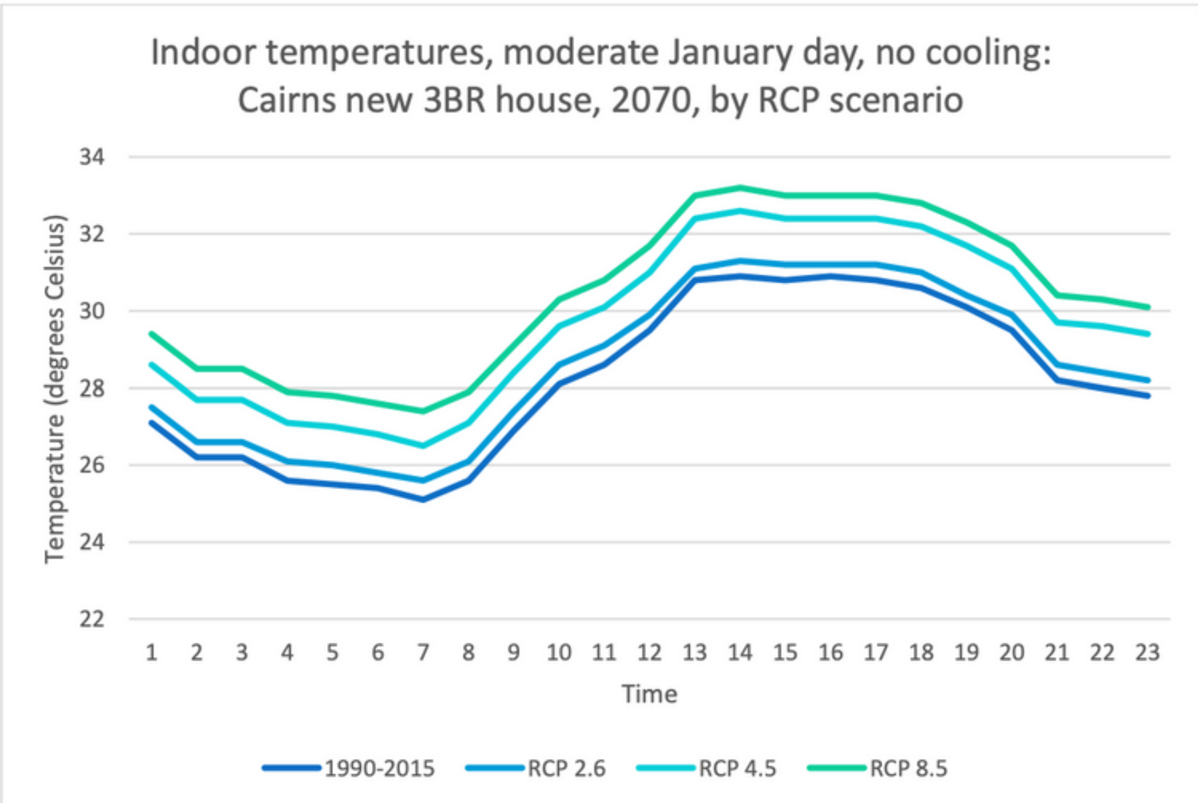
Using projected climate data provided by the CSIRO and FirstRate5 software we have analysed a new home and a poorly performing home in Melbourne, Adelaide, Cairns and Brisbane. We have compared the climate files used in the current and recently updated NCC, as well as projections for 2050, 2070 and 2090 according to Representative Concentration Pathway (RCP) scenarios. 2.6, 4.5, and 8.5. RCP 2.6 correlates to strong emissions mitigation; RCP 4.5 correlates to moderate emissions mitigation; and RCP 8.5 correlates to business as usual or no significant mitigation.

**A detailed technical report is attached to the end of this summary report.**

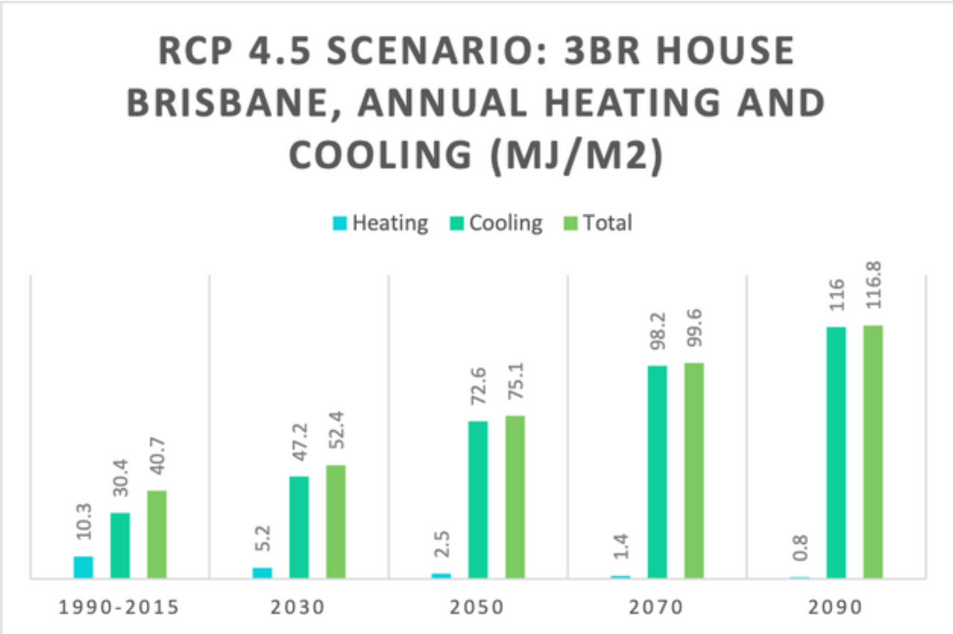
# SUMMARY

Using out of date historical data to set the thresholds of energy efficiency ratings in Australia is resulting in an underestimation of the cooling required to keep homes a safe temperature in summer. This is already happening, but as the planet warms this gap will grow and homes that meet current standards for new builds will have higher indoor temperatures and require more energy to run. The biggest difference between predicted performance under historical data or future data scenarios is in hot climates and older homes.

The degree of increasing cooling load in a home will depend on the extent of climate change and successful emissions mitigation:

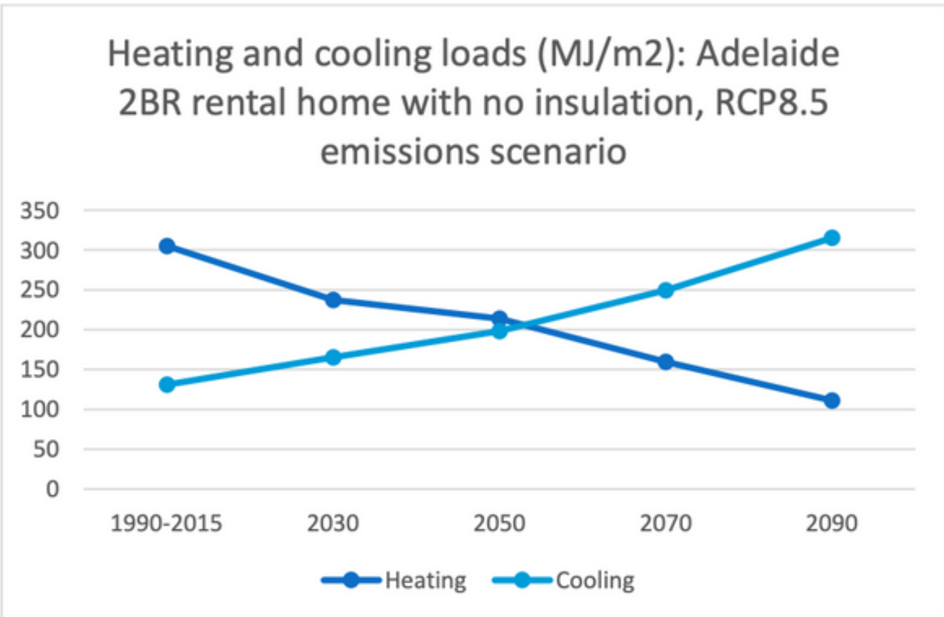


In hotter climates such as Cairns and Brisbane, this increase in temperatures means an overall increase in energy loads.




*In this graph and others MJ/m2 refers to megajoule per square metre of thermal energy load, an indication of energy needed for heating or cooling*

In cooler climates, reduced heating use offsets increased cooling when calculating total energy use. In the case of Adelaide, a severe climate scenario would see primary home energy use shifting from heating to cooling:




However, an overall reduction in total energy use does not negate the potential danger of high temperatures during heatwaves. These results should not be seen as a reason not to review home energy efficiency climate data. Thermal comfort during extremes should be accounted for.

## What other work has been done?

This project builds upon work from organisations including the Western Sydney Regional Organisation of Councils (WSROC) and Waverley Council, researchers in Universities across Australia and government agencies.

The 2022 WSROC 'Future proofing residential development in Western Sydney' focuses on the impact of using out of date climate data on homes in Western Sydney. The graph below displays their analysis of how different climate data compares and demonstrates that the 2022 NCC update is already cooler than the current climate in Richmond, Sydney.

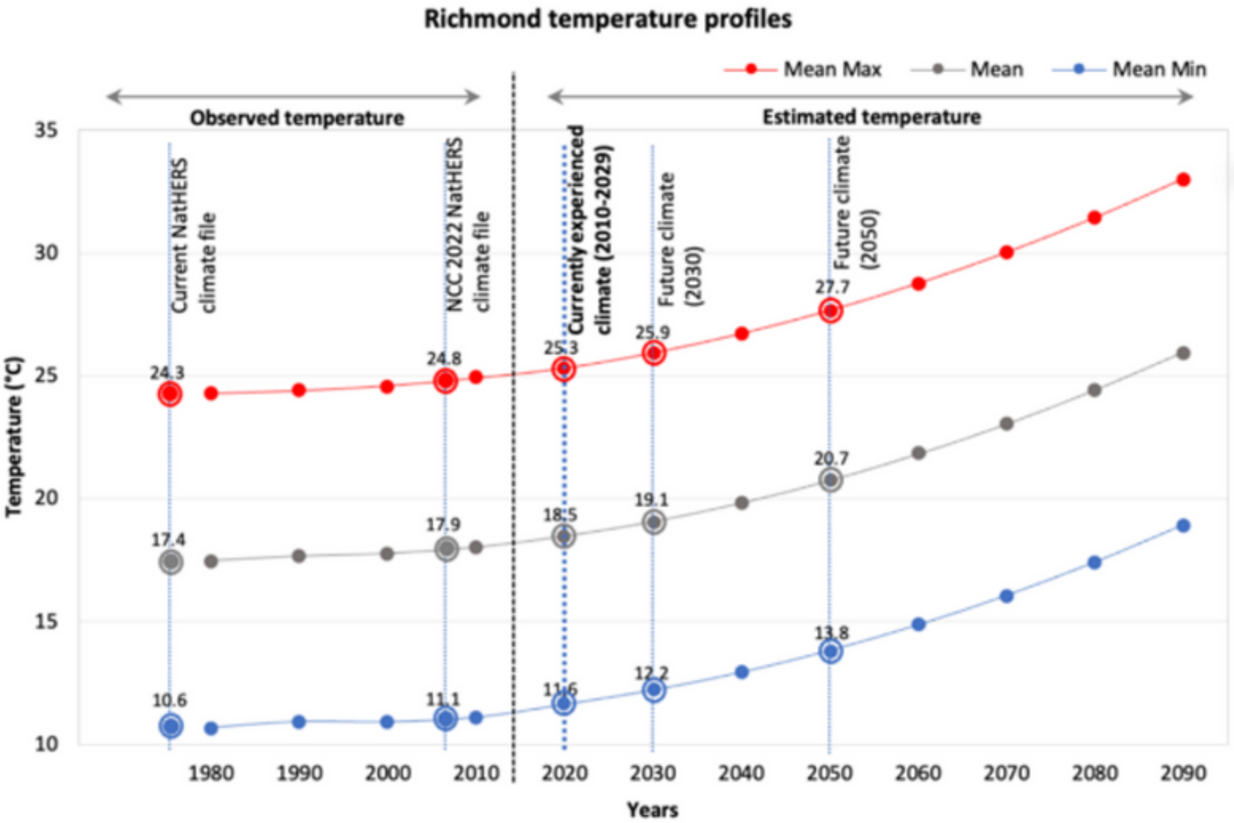



Figure 6: Richmond temperature profile presents observed mean maximum, mean and mean minimum temperatures from 1980 to 2010 and estimated temperatures from 2020 until 2090. Raw yearly temperature data is normalised by taking 20 years of running average, i.e., temperature for 1980 is derived by taking average of 1970 – 1989 (Data source: Commonwealth of Australia 2022)

The Waverley Council 'Future Proofing Residential Development to Climate Change' states that "results show it is possible the dwellings approved for construction now will be unsuitable for occupation by 2070, without extremely high levels of mechanical cooling to maintain comfortable, safe and liveable conditions." The below graph demonstrates that by 2030 most homes that are currently estimated to require more heating than cooling will all require significantly more cooling.

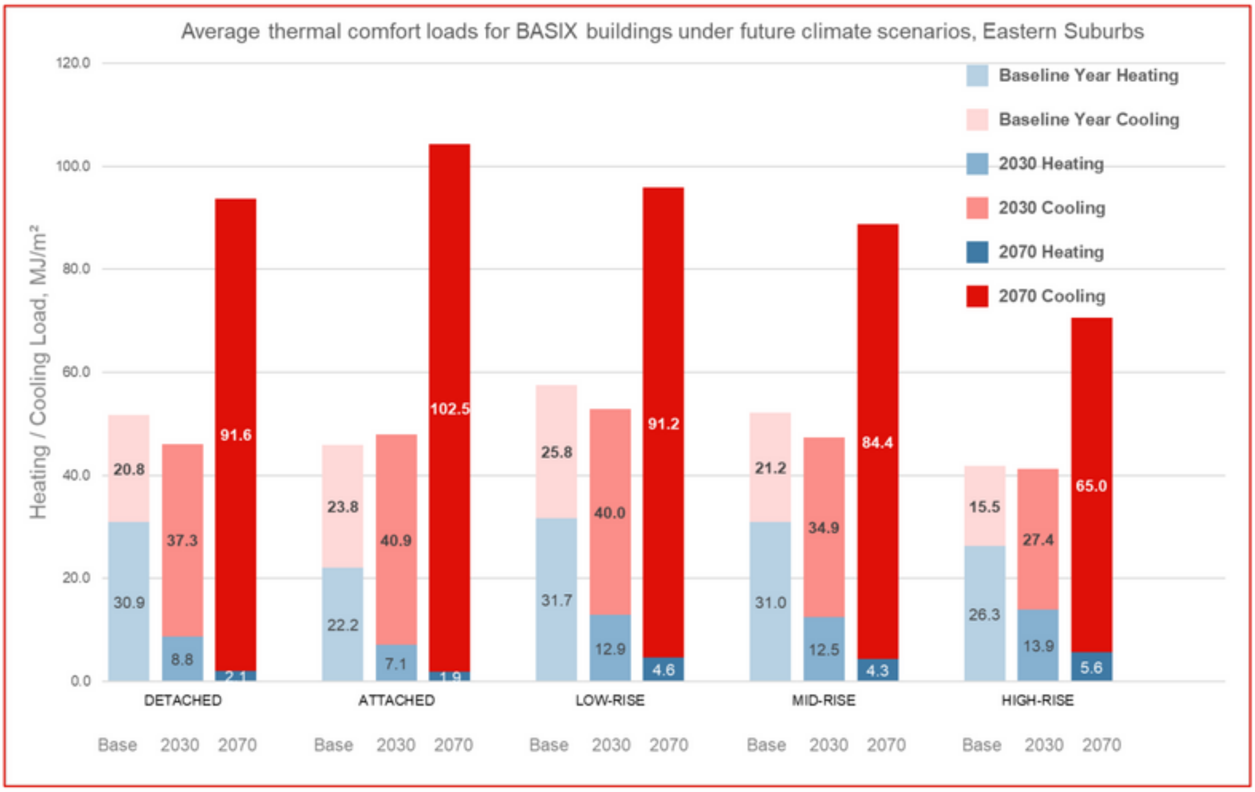



Figure 5.6 Comparison chart of average thermal comfort loads by building type, for Baseline Year, 2030 and 2070

The Waverley Report clearly states:

**"Our residential dwellings need to be designed now for the 2030 climate scenario, because buildings built to the current standards will have a higher cooling load than expected when they are less than 10 years old."**

# IMPACTS


## Health

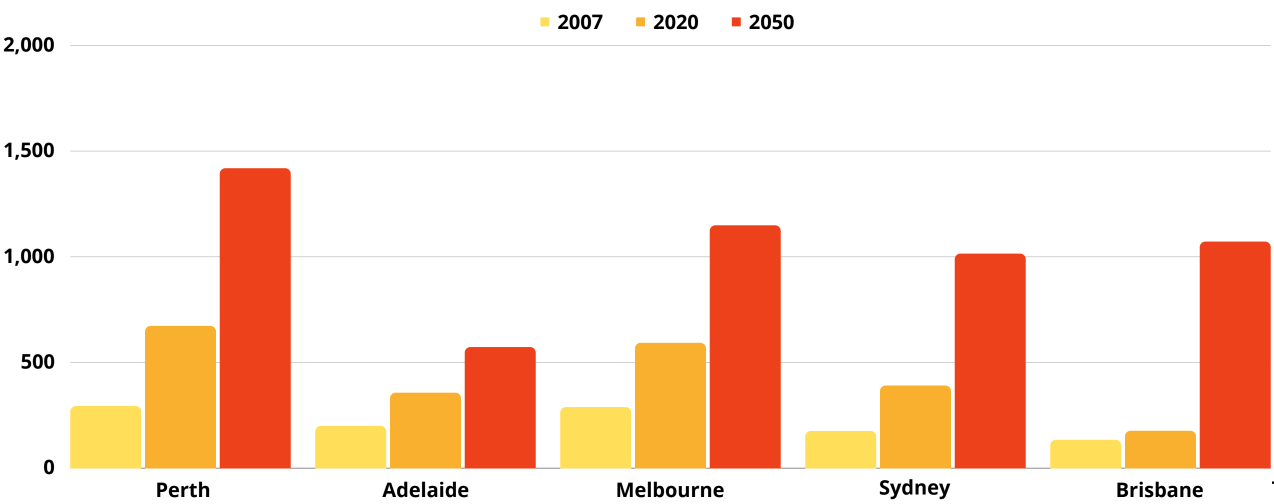
Heatwaves are the deadliest environmental disaster in Australia, they kill more people than all other disasters combined. Living in a hot home is a risk factor for heat-related disease including both physical and mental health impacts. Some of the most vulnerable cohorts are older people, young children, people with chronic illnesses and disabilities, and low-income households. Financial stress intersects with extreme heat as people struggle to afford simple measures like turning on the air con or fan, or leaving their homes to go somewhere cool.

Energy efficiency standards that use out of date climate data will result in higher than predicted internal temperatures during summer, even in homes that are built to a seven star rating now.

The health costs of extreme heat will be felt by the community and our health system. This will be especially true in Urban Heat Islands across the country, where temperatures can be 10° or more warmer than in cooler coastal suburbs or surrounding rural areas.

By updating the NCC climate data to incorporate future climate data, the Australian Government can reduce heat related illnesses and deaths in the future.

***Predicted average heat deaths per year (State of the Environment report 2021)***



## Energy Grid

Australian energy agencies use household energy data and climate and weather predictions to estimate future energy grid demand. Using out of date climate data that underestimates the cooling load needed during summer may result in underestimations of the energy needed to power the grid during heatwaves. Using more accurate future climate data will allow government agencies, industry and other stakeholders to more accurately predict Australia's energy needs. This will likely avoid more frequent black-outs during heatwaves, which result in stress and crisis across the community and economy.

> **Urgent warning about energy use in one state as mercury spikes to 40C**
>
> Australians are being told to reduce their energy use during peak hours, as temperatures soar around the country to uncomfortable degrees.
>
> **Anthony Anderson, Elena Couper and Emma Cam**
>
> **3 min read** December 14, 2023 - 12:07PM **NCA NewsWire**

## Reducing carbon emissions

**According to the Department of Climate Change, Energy, the Environment and Water:**

Data from the department shows buildings account for around 19% of total energy use and 18% of direct carbon emissions in Australia.

Energy efficiency in buildings plays an important role for households, businesses and the wider economy. Improving energy efficiency can:

- reduce energy bills
- improve the comfort and health of occupants
- ensure energy security and affordability
- reduce the risk of blackouts by reducing peak demand
- lower carbon emissions.

Using accurate data to set energy efficiency ratings across Australia will have a significant positive impact and will support our transition to net zero carbon emissions by both reducing future energy demand and allowing for more accurate planning by government and industry.

Energy efficiency is a key component of the plan to reduce carbon emissions, and growing household energy demand for cooling will undermine efforts to meet state and federal targets.

# WHAT NEXT?

We look forward to contributing this analysis to ongoing relevant federal and state strategies and processes including the National Adaptation Plan, National Climate Risk Assessment, Trajectory for Low Energy Buildings and other related frameworks.

We believe that updating the climate data in the NCC supports the sector plan for the built environment to reach 43% reduction in carbon emissions by 2030 and net zero by 2050 and state based carbon emission reduction targets.

The 2023 National Health and Climate Strategy included:

**Action 6.8**
**Considering climate resilience in updates to the National Construction Code**
*The Australian Government will work with states, territories, and the Australian Building Codes Board to progress opportunities to embed sustainability and climate resilience principles in the National Construction Code, and in doing so will consider the health impacts of climate change.*

We believe this includes updating the climate data used in the NCC to build in resilience to a hotter climate and will be advocating for the health impacts of climate change to be considered as per this strategy.

The next NCC update will concern commercial buildings. In that update, future climate data and high emission climate predictions will be considered. The 2028 update will cover residential buildings, and we believe that is the best opportunity to update climate data for regulations across the country. However, there may be opportunities to integrate improved climate resilience by updating regulations at other levels of government in specific jurisdictions.

Successfully advocating for an update to the climate files in the NCC will require both collaborating with government agencies, and working with industry and community stakeholders to lay out the benefits of improving energy efficiency. We look forward to kicking off this next stage of this ambitious project in 2024.

## THE VISION

Australia's planning regulations support communities and businesses to be safe in a warming climate, and reduce carbon emissions in the built environment.

## THE PLAN

- Produce further technical analysis that demonstrates the importance of urgent action to update climate data in the NCC
- Collaborate with stakeholders from NGOs, industry, government, and research centres on advocacy.
- Mobilise community members to demonstrate support and neutralise opposition at key moments.
- Integrating climate change forecasts into the NCC sets a precedent for planning all parts of our society using the best available science.

This report was published in January 2024.

For further information, please contact:

rob.mcleod@renew.org.au
emma@swelteringcities.org

Sweltering Cities is a health and climate advocacy NGO that works directly with communities impacted by extreme heat to win more liveable, sustainable, and equitable cities.
Find out more at www.swelteringcities.org

Renew is a national, not-for-profit organisation that inspires, enables and advocates for people to live sustainably in their homes and communities.
Find out more at www.renew.org.au

This report was produced with the generous support of Energy Consumers Australia.

# Future home climate resilience: technical notes and analysis

Rob McLeod, Policy and Advocacy Manager, Renew

6 December 2023

## Summary

**This consultation paper provides the initial findings of an analysis of the future energy performance and resilience of homes under changing climate conditions.**

Using CSIRO projected weather data and FirstRate5 software, we have modelled the energy use and internal temperatures of a range of case study homes across four locations: Adelaide, Melbourne, Brisbane, and Cairns. Our case studies include newly built homes (meeting current NCC standards) and older, poorly performing homes requiring retrofits.

Our findings include:

- Projected changes to energy loads for heating and cooling for each home and climate scenario in the years 2030, 2050, 2070, and 2090
- Projected changes to star ratings based on changed energy use
- Simulated indoor temperatures during hot conditions for each case study

Please see results and analysis section for findings and data.

## Background context

The National Construction Code (NCC) requires new homes to meet basic energy efficiency standards and sets limits on the heating and cooling loads required to maintain comfortable indoor temperatures. Under the 2022 NCC (currently in process of implementation according to differing state and territory timelines), new homes are required to meet 7-Star NatHERS ratings as a minimum standard.

Alongside the increase to 7-Star standards, NCC2022 updated the climate data used to calculate NatHERS ratings. This weather data is made up of actual recordings across a 25-35 year period, in line with international standards. Prior to the 2022 NCC update, the weather data was from the period 1970-2005. Following the 2022 NCC update, the data used is currently from 1990-2015. Changing the weather files used resulted in changes to calculated NatHERS scores.

NatHERS measures the energy loads needed to heat and cool a home per m2. Localised weather data in 69 climate zones is used to calculate expected energy use; this allows NatHERS to take into account the different amounts of energy needed for heating and cooling in hotter and colder climates while still providing a meaningful energy efficiency rating. (For example: a 7-Star home in Hobart uses more energy than a 7-Star home in Brisbane.)

Using past climate data for how we design our homes may reduce resilience to future climate, particularly heat. The eight hottest years on record globally have all occurred since 2015; 2023 is expected to be the hottest year on record.

## Methodology

Our analysis uses projected climate data provided by the CSIRO to develop a set of case studies for the future energy performance and climate resilience of homes.

The CSIRO projected climate data use Typical Meteorological Year (TMY) climate files from 1990-2015 to develop predictive files. The files provide hourly weather data in 83 Australian locations in the years 2030, 2050, 2070, and 2090. Three climate scenarios are provided for each year and location, based on the IPCC Representative Concentration Pathway (RCP) scenarios 2.6, 4.5, and 8.5. RCP 2.6 correlates to strong emissions mitigation; RCP 4.5 correlates to moderate emissions mitigation; and RCP 8.5 correlates to business as usual or no significant mitigation.

We have used FirstRate5 energy modelling software to simulate NatHERS star ratings, heating loads, and cooling loads in each year, location, and emissions scenario for each case study. We have furthermore used FirstRate5 to simulate indoor temperatures during a nominal range of dates during a hot summer week in early January, assuming no use of cooling (free running mode). Indoor temperature simulations are not intended to provide absolute predictions about indoor heat, but rather to allow for a relative comparison between homes and scenarios.

We have selected four locations: **Brisbane, Cairns, Melbourne, and Adelaide.**

For each location we modelled two homes as case studies: a new home (compliant with current building regulations and with the exception of Adelaide meeting a 7 Star standard); and a poorly performing home, representative of many older homes lacking basic energy efficiency features such as insulation. Each home was modelled on existing floorplans; in the case of the new homes, some amendments were made to insulation, windows, and ceiling fans to ensure NCC compliance across locations.

The case studies modelled are as follows:

| # | Location | Description | NatHERS star rating (1990-2015 climate data) |
|---|---|---|---|
| 1 | Brisbane | New detached house: 3BR | 7.4 |
| 2 | Brisbane | Older duplex: 2BR | 1.7 |
| 3 | Cairns | New detached house: 3BR | 7.1 |

| | | | |
|---|---|---|---|
| 4 | Cairns | Older duplex: 2BR | 1.6 |
| 5 | Melbourne | New detached house: 5BR | 7.0 |
| 6 | Melbourne | Older duplex: 2BR | 1.1 |
| 7 | Adelaide | New detached house: 5BR | 6.6 |
| 8 | Adelaide | Older duplex: 2BR | 1.1 |

## Results

### *Energy loads and star ratings*

The following section provides the results of modelled star ratings; heating loads; cooling loads; and total heating and cooling loads. Energy loads are given in MJ/M2 of internal conditioned space.

*1. Brisbane – new home*

| Year | RCP | Star rating | Heating | Cooling | Total |
|---|---|---|---|---|---|
| **1990-2015** | **N/A** | **7.4** | **10.3** | **30.4** | **40.7** |
| 2030 | 2.6 | 5.7 | 6.2 | 50.3 | 56.5 |
| 2050 | | 4.8 | 3.8 | 66.3 | 70.1 |
| 2070 | | 5.3 | 5 | 56.1 | 61.1 |
| 2090 | | 5.4 | 5.4 | 53.7 | 59.1 |
| 2030 | 4.5 | 6.1 | 5.2 | 47.2 | 52.4 |
| 2050 | | 4.4 | 2.5 | 72.6 | 75.1 |
| 2070 | | 3.6 | 1.4 | 98.2 | 99.6 |
| 2090 | | 3.1 | 0.8 | 116 | 116.8 |
| 2030 | 8.5 | 4.9 | 2 | 64.7 | 66.7 |
| 2050 | | 3.5 | 1.1 | 101.6 | 102.7 |
| 2070 | | 1.9 | 0.1 | 169.8 | 169.9 |
| 2090 | | 0 | 0 | 244.2 | 244.2 |

*2. Brisbane – older home*

| Year | RCP | Star rating | Heating | Cooling | Total |
|---|---|---|---|---|---|
| **1990-2015** | **N/A** | **1.7** | **84.5** | **94.2** | **178.7** |
| 2030 | 2.6 | 1.2 | 65 | 138.2 | 203.8 |
| 2050 | | 0.6 | 52.9 | 180.3 | 233.2 |
| 2070 | | 0.9 | 61.4 | 157.2 | 218.6 |
| 2090 | | 1.1 | 62.8 | 148.5 | 211.3 |
| 2030 | 4.5 | 1.4 | 61.4 | 134.5 | 195.9 |
| 2050 | | 0 | 44.1 | 199 | 243.1 |
| 2070 | | 0 | 34.2 | 260.2 | 294.4 |
| 2090 | | 0 | 26.7 | 304.3 | 331 |

| | | | | | |
|---|---|---|---|---|---|
| 2030 | 8.5 | 1.1 | 38.5 | 173.2 | 211.7 |
| 2050 | | 0 | 29.7 | 252.9 | 282.6 |
| 2070 | | 0 | 11.6 | 402.2 | 413.8 |
| 2090 | | 0 | 6 | 557.4 | 563.4 |

### *3. Cairns – new home*

| Year | RCP | Star rating | Heating | Cooling | Total |
|---|---|---|---|---|---|
| **1990-2015** | **N/A** | **7.1** | **0** | **111** | **111** |
| 2030 | 2.6 | 5.4 | 0 | 150 | 150 |
| 2050 | | 5.7 | 0 | 144.7 | 144.7 |
| 2070 | | 5.6 | 0 | 147.6 | 147.6 |
| 2090 | | 5.6 | 0 | 145.6 | 145.6 |
| 2030 | 4.5 | 5.4 | 0 | 150.8 | 150.8 |
| 2050 | | 4.4 | 0 | 182.5 | 182.5 |
| 2070 | | 4.1 | 0 | 191.9 | 191.9 |
| 2090 | | 2.1 | 0 | 269 | 269 |
| 2030 | 8.5 | 5 | 0 | 163.4 | 163.4 |
| 2050 | | 1.9 | 0 | 279.8 | 279.8 |
| 2070 | | 1.6 | 0 | 292.4 | 292.4 |
| 2090 | | 0 | 0 | 362 | 362 |

### *4. Cairns – older home*

| Year | RCP | Star rating | Heating | Cooling | Total |
|---|---|---|---|---|---|
| **1990-2015** | **N/A** | **1.6** | **2.8** | **289.7** | **292.5** |
| 2030 | 2.6 | 0 | 2 | 369.9 | 371.9 |
| 2050 | | 0 | 1.6 | 349.8 | 351.4 |
| 2070 | | 0 | 1.7 | 356.6 | 358.3 |
| 2090 | | 0 | 1.7 | 356.8 | 358.5 |
| 2030 | 4.5 | 0 | 2 | 364.9 | 366.9 |
| 2050 | | 0 | 1.4 | 434.7 | 436.1 |
| 2070 | | 0 | 1 | 447.4 | 448.4 |
| 2090 | | 0 | 0.4 | 605.9 | 606.3 |
| 2030 | 8.5 | 0 | 1.3 | 392.7 | 394 |
| 2050 | | 0 | 0.4 | 620 | 620.4 |
| 2070 | | 0 | 0.4 | 633.3 | 633.7 |
| 2090 | | 0 | 0.2 | 763.9 | 764.1 |

### *5. Melbourne – new home*

| Year | RCP | Star rating | Heating | Cooling | Total |
|---|---|---|---|---|---|
| **1990-2015** | **N/A** | **7** | **39.5** | **22.2** | **61.7** |
| 2030 | 2.6 | 7.1 | 31.6 | 29.1 | 60.7 |

| | | | | | |
|---|---|---|---|---|---|
| 2050 | | 7.1 | 29.4 | 31.2 | 60.6 |
| 2070 | | 6.9 | 30.5 | 31.9 | 62.4 |
| 2090 | | 7 | 30.5 | 30.7 | 61.2 |
| 2030 | 4.5 | 7.1 | 31.7 | 27.9 | 59.6 |
| 2050 | | 6.9 | 26.3 | 36.1 | 62.4 |
| 2070 | | 6.9 | 19.8 | 42.7 | 62.5 |
| 2090 | | 6.6 | 22.8 | 46 | 68.8 |
| 2030 | 8.5 | 7.1 | 26.8 | 33.3 | 60.1 |
| 2050 | | 6.9 | 23.7 | 41 | 64.7 |
| 2070 | | 5.9 | 18.4 | 63.6 | 82 |
| 2090 | | 5.1 | 10.4 | 92.7 | 103.1 |

### *6. Melbourne – older home*

| Year | RCP | Star rating | Heating | Cooling | Total |
|---|---|---|---|---|---|
| **1990-2015** | **N/A** | **1.1** | **347.2** | **64.6** | **411.8** |
| 2030 | 2.6 | 1.4 | 288.6 | 85.7 | 374.3 |
| 2050 | | 1.4 | 275.3 | 91.2 | 366.5 |
| 2070 | | 1.3 | 284.3 | 94.4 | 378.7 |
| 2090 | | 1.3 | 284.4 | 92.9 | 377.3 |
| 2030 | 4.5 | 1.3 | 295.5 | 81.7 | 377.2 |
| 2050 | | 1.4 | 253.4 | 105.2 | 358.6 |
| 2070 | | 1.7 | 206.2 | 124 | 330.8 |
| 2090 | | 1.4 | 223.9 | 140.5 | 364.4 |
| 2030 | 8.5 | 1.4 | 260.1 | 97.6 | 357.7 |
| 2050 | | 1.4 | 236 | 120.5 | 356.5 |
| 2070 | | 1.3 | 190.2 | 186.7 | 376.9 |
| 2090 | | 1.2 | 121.6 | 275.4 | 397 |

### *7. Adelaide – new home*

| Year | RCP | Star rating | Heating | Cooling | Total |
|---|---|---|---|---|---|
| **1990-2015** | **N/A** | **6.7** | **31.1** | **38.9** | **70** |
| 2030 | 2.6 | 6.7 | 23.9 | 46.9 | 70.8 |
| 2050 | | 6.6 | 21.3 | 50.5 | 71.8 |
| 2070 | | 6.6 | 23.9 | 48.4 | 72.3 |
| 2090 | | 6.5 | 24.4 | 49.1 | 73.5 |
| 2030 | 4.5 | 6.5 | 23.5 | 49.8 | 73.3 |
| 2050 | | 6.3 | 21.5 | 55.6 | 77.1 |
| 2070 | | 6.4 | 16.3 | 58.3 | 75.2 |
| 2090 | | 6.1 | 18.8 | 62.6 | 81.4 |
| 2030 | 8.5 | 6.6 | 21.9 | 50.4 | 72.3 |
| 2050 | | 6.3 | 19.2 | 59.5 | 78.7 |
| 2070 | | 5.8 | 13 | 75.4 | 88.4 |
| 2090 | | 5.2 | 7.9 | 95.3 | 103.2 |

*8. Adelaide – older home*

| Year | RCP | Star rating | Heating | Cooling | Total |
|---|---|---|---|---|---|
| **1990-2015** | **N/A** | **1.1** | **305** | **131** | **436** |
| 2030 | 2.6 | 1.3 | 249.7 | 152.9 | 402.6 |
| 2050 | | 1.4 | 232 | 166.2 | 398.2 |
| 2070 | | 1.3 | 251.4 | 162 | 413.4 |
| 2090 | | 1.2 | 254.6 | 167.4 | 422 |
| 2030 | 4.5 | 1.3 | 248.1 | 166.1 | 414.2 |
| 2050 | | 1.3 | 232.5 | 182.3 | 414.8 |
| 2070 | | 1.4 | 191.4 | 193.5 | 384.9 |
| 2090 | | 1.2 | 207.9 | 208.6 | 416.5 |
| 2030 | 8.5 | 1.3 | 237.4 | 165.4 | 402.8 |
| 2050 | | 1.3 | 213.8 | 198.4 | 412.2 |
| 2070 | | 1.3 | 159.5 | 249.2 | 408.7 |
| 2090 | | 1.2 | 111.1 | 315.1 | 426.2 |

## *Internal temperatures*

A wide range of projected internal temperature data was calculated for each location. For each case study and climate scenario, hourly temperature data has been generated in each room across a year.

The TMY weather files used to generate the projected data are primarily used to model average annual energy use and NatHERS ratings, rather than resilience to specific heat events. The projected hourly temperatures should not be used as predictions of temperatures on specific dates, but rather how a home has been simulated to perform in given weather conditions.

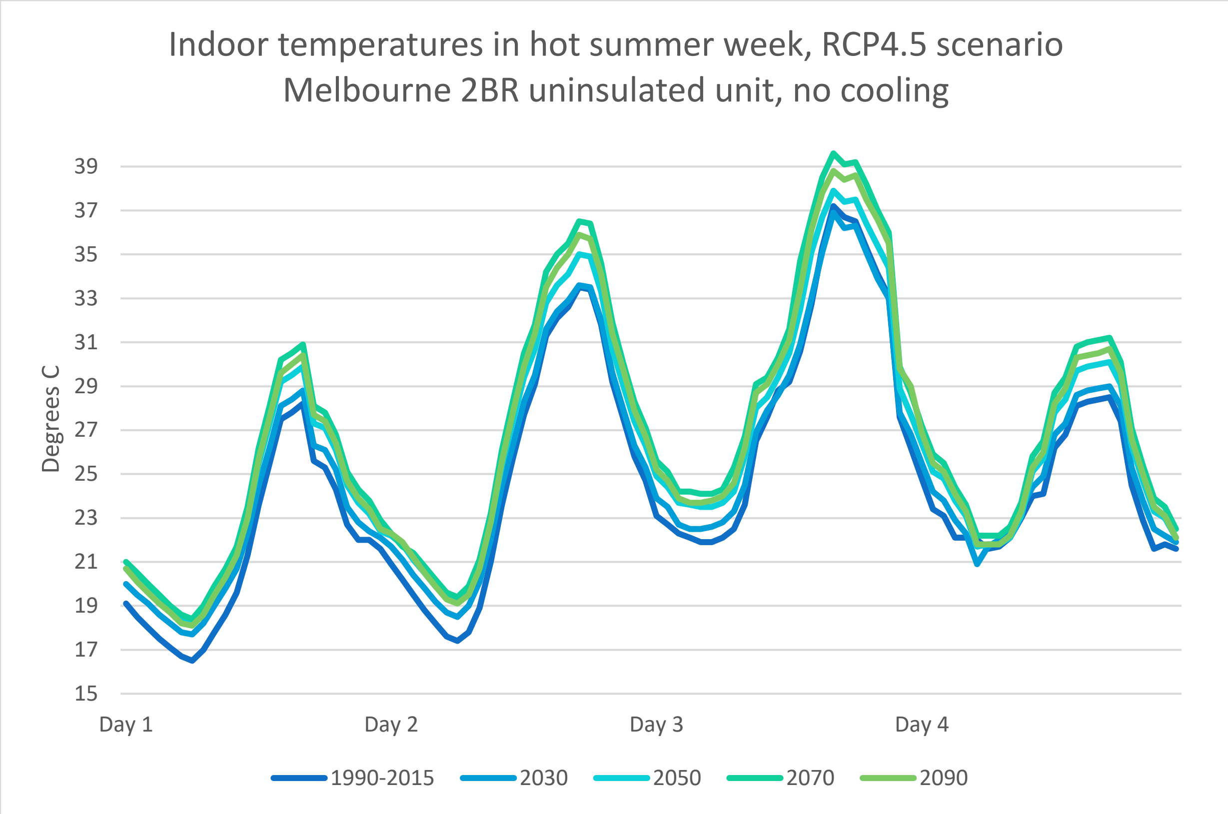
Temperature data has been calculated using 'free running' mode, which assumes no use of air conditioning or heating. This approach provides an insight into the resilience of buildings, however in practice heating and cooling mean that these temperatures are not experienced in many or most homes. Higher internal temperatures in free running mode indicate higher energy needs for cooling.

**A selection of findings is presented below for the purposes of discussion.** Further scenarios and data can be provided on request.

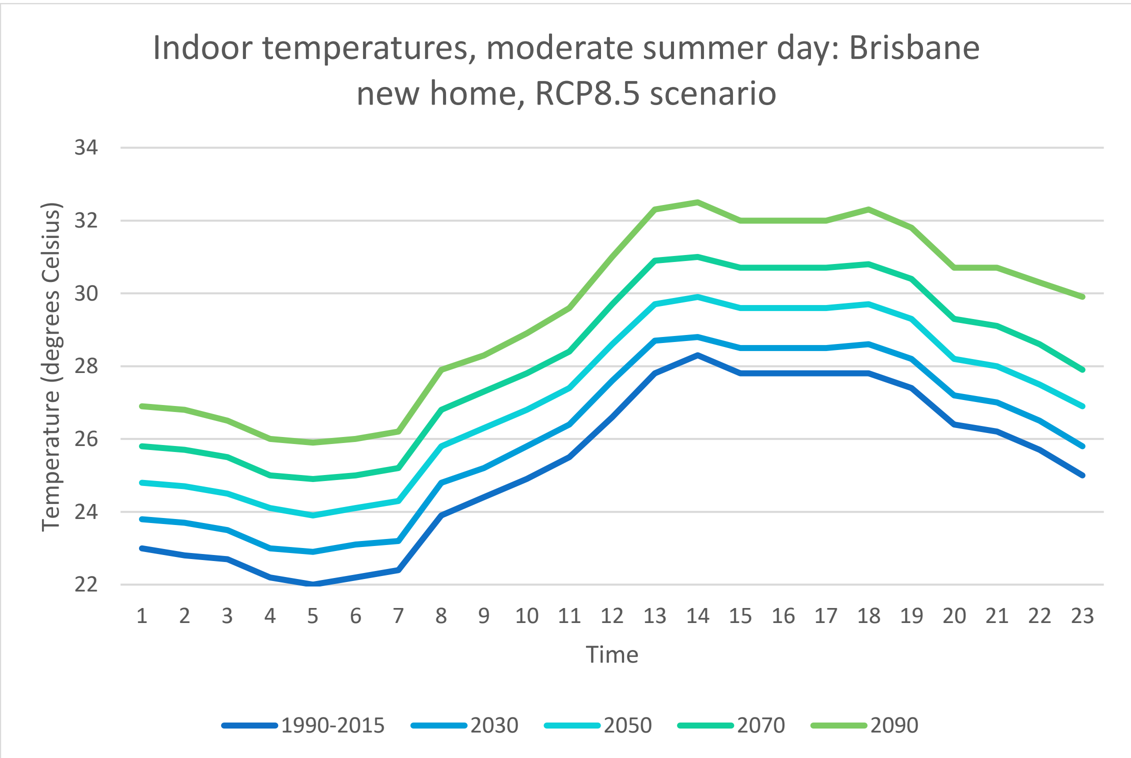
1. Daily temperatures in hot conditions

Hotter outdoor temperatures increase the internal temperature of homes in all locations and scenarios. Examples of selected hot weather temperatures are as follows.

Melbourne uninsulated unit, four days during January including heatwave conditions: maximum indoor temperatures modelled to increase by approx. 2-3 degrees depending on scenario and date.



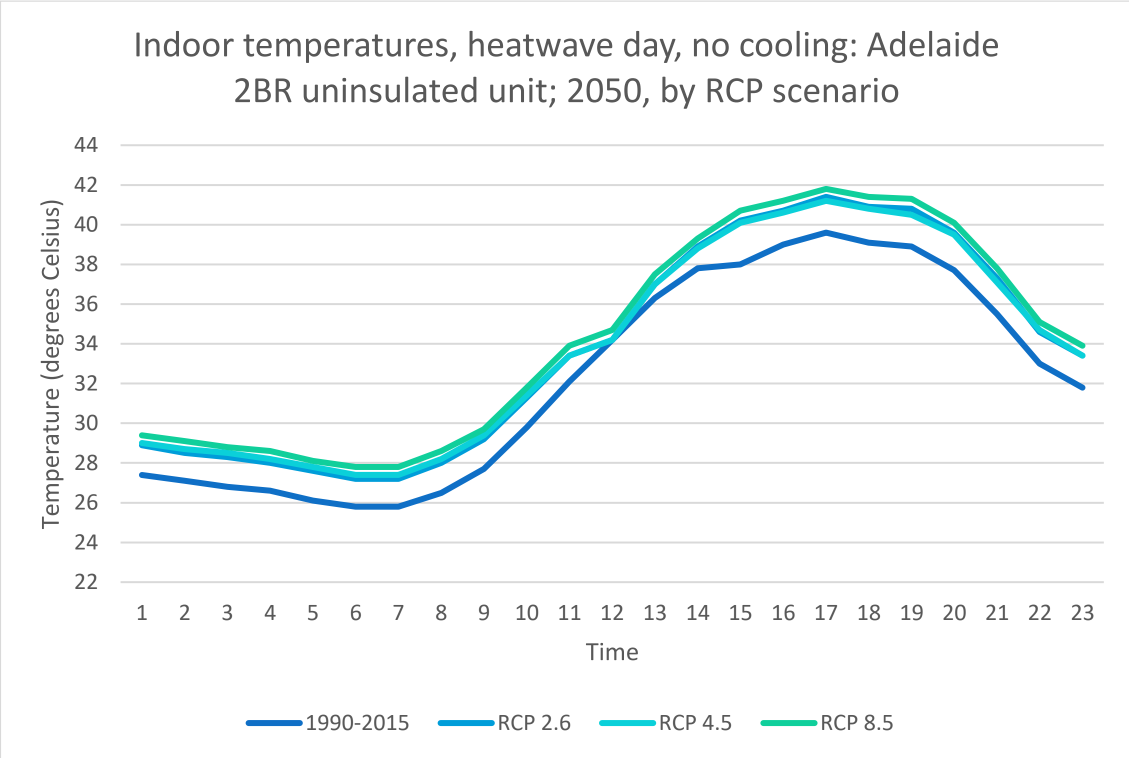

Brisbane new home, one day during January (max temperature 29 degrees in 1990-2015), RCP8.5 scenario: indoor temperatures modelled to increase over time, up to four degrees by 2090 under severe climate scenario.



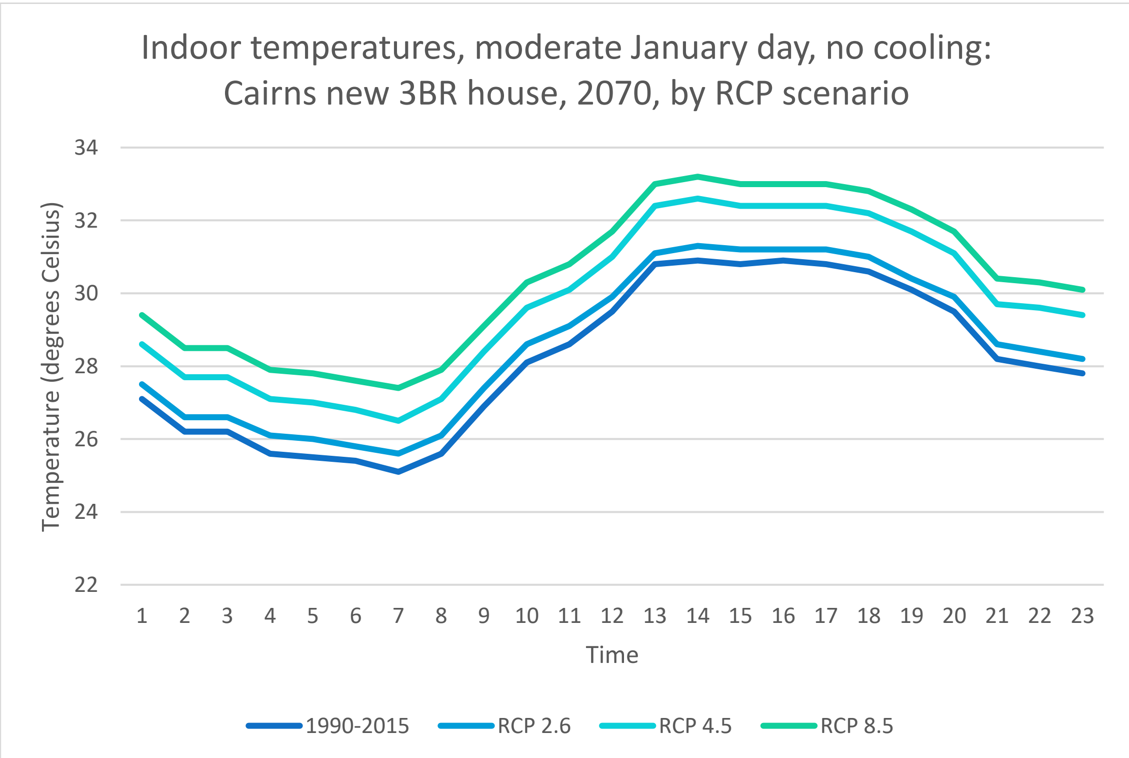

2. Impact of climate mitigation and RCP scenarios

Comparing internal temperatures in the same year and case study home across different RCP scenarios allows for an analysis of the projected impact of emissions mitigation.

Adelaide uninsulated unit, internal temperatures during heatwave conditions, one day in early January; comparison of 1990-2015 temperatures with 2050 temperatures in each RCP scenario:



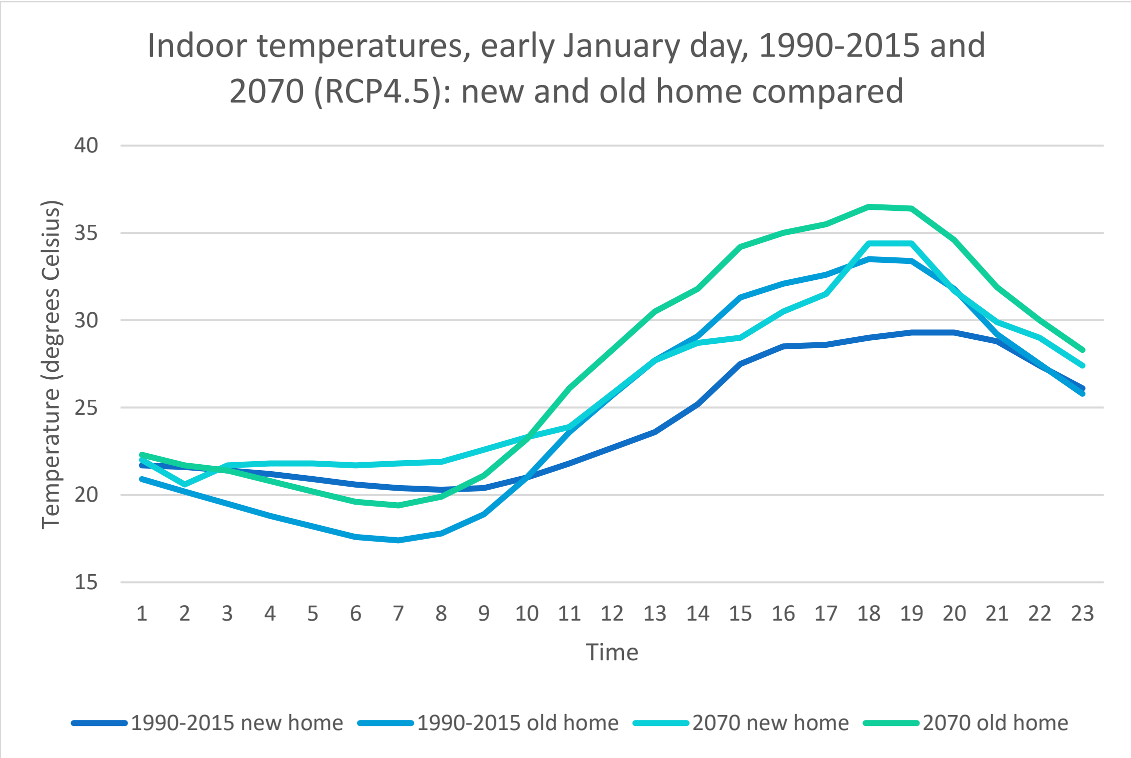

Cairns new home, one day in early January, 1990-2015 and 2070 across RCP scenarios:



In the case of the Cairns new home case study, an RCP8.5 scenario was modelled to experience internal temperatures close to 2 degrees hotter during the afternoon than an RCP2.6 scenario in 2070.

3. Impact of building design and energy efficiency

A significant difference was modelled in internal temperatures between new homes (NCC compliant) and older homes.



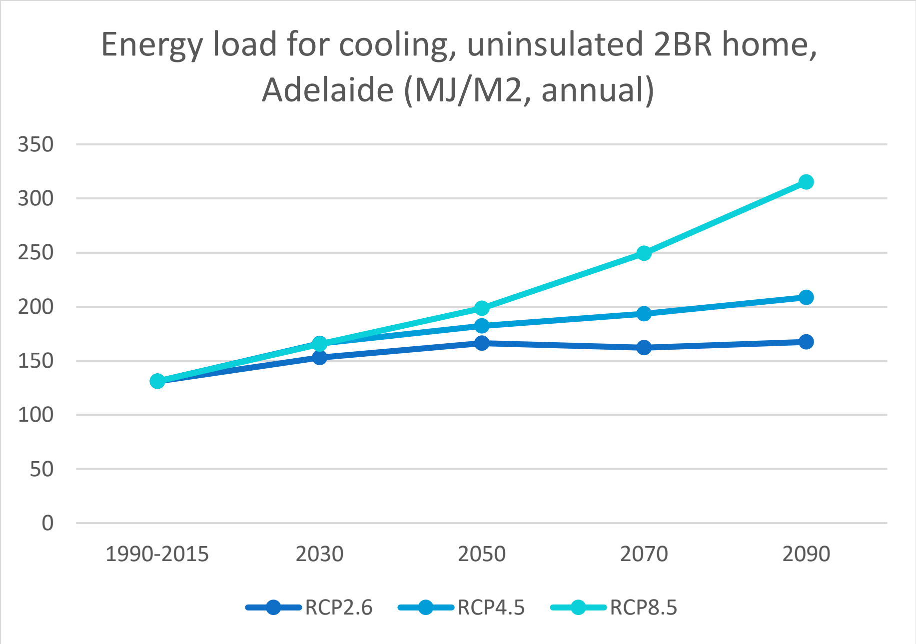

In the case of this scenario, the internal temperatures of a 7-Star home built in 2023 were modelled to be similar (or slightly higher at peak) in 2070 than those of an uninsulated 1.1-Star home under 1990-2015 climate conditions.

## Analysis and discussion

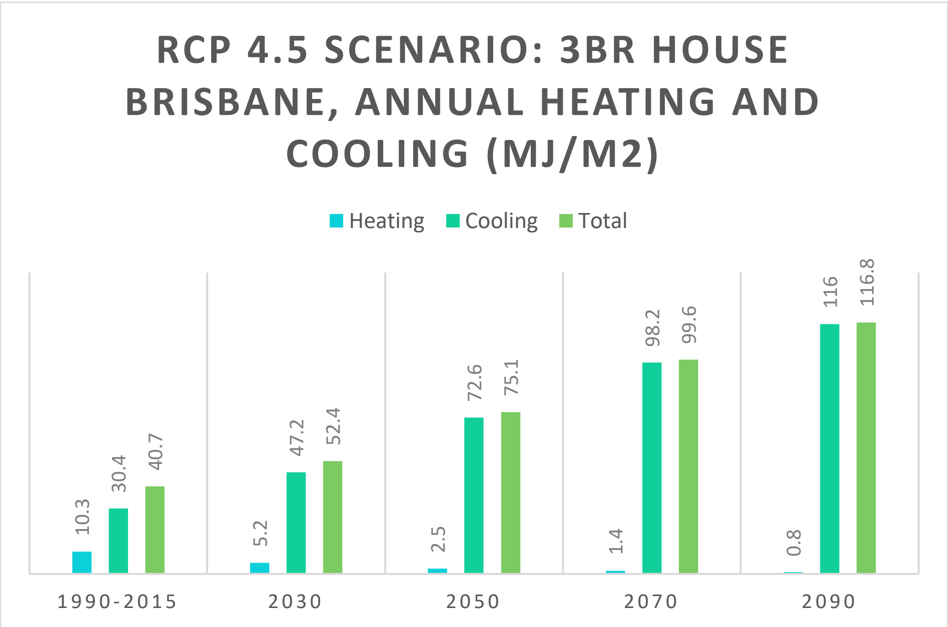
*Increased cooling loads*

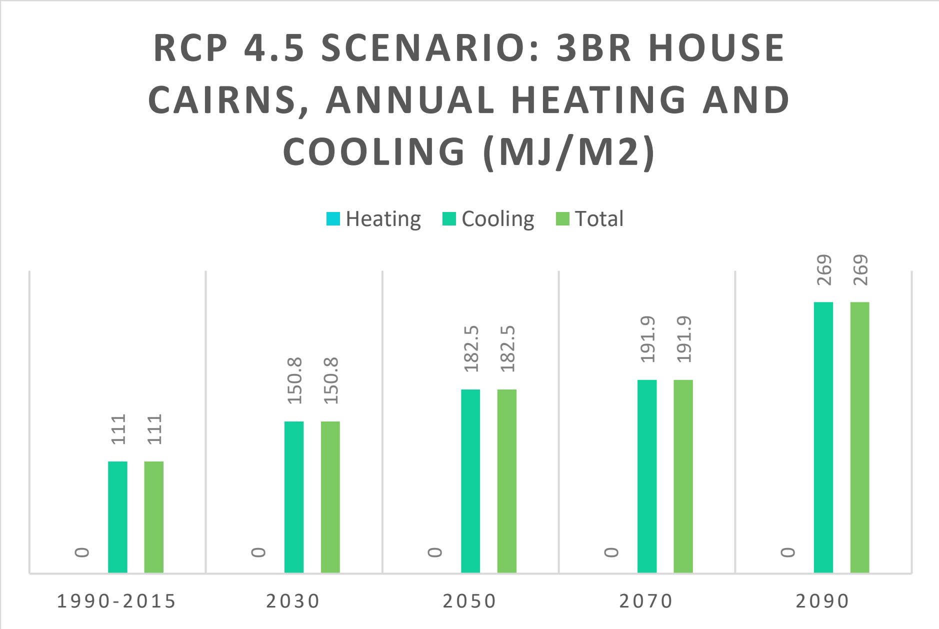
A key trend is that energy loads required for cooling to maintain comfortable internal temperatures are projected to increase as temperatures rise. Because current data includes years as far back as 1990, significant differences were found between the performance of homes according to currently used data and expected energy use in 2030.

The level of increase varies according to the extent of climate change and successful emissions mitigation:

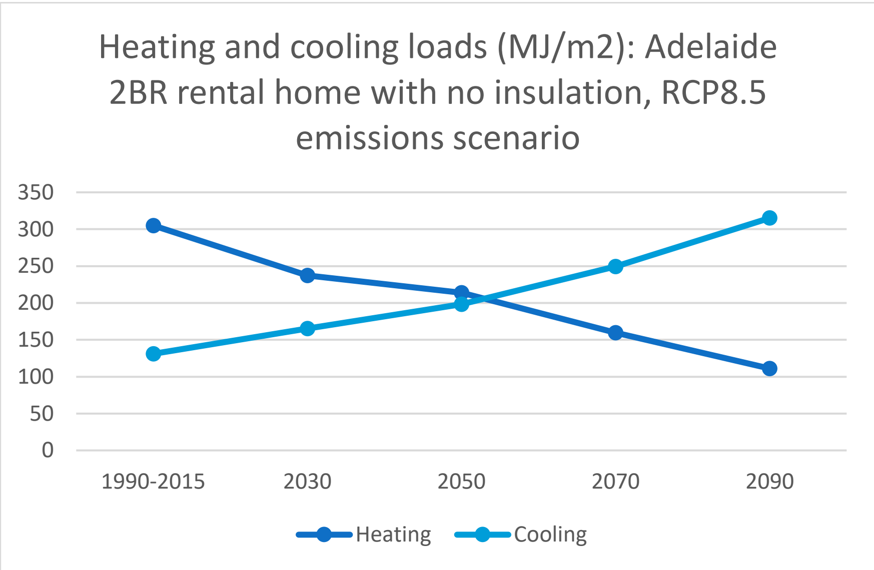



In hotter climates such as Cairns and Brisbane, this increase means an overall increase in energy loads.

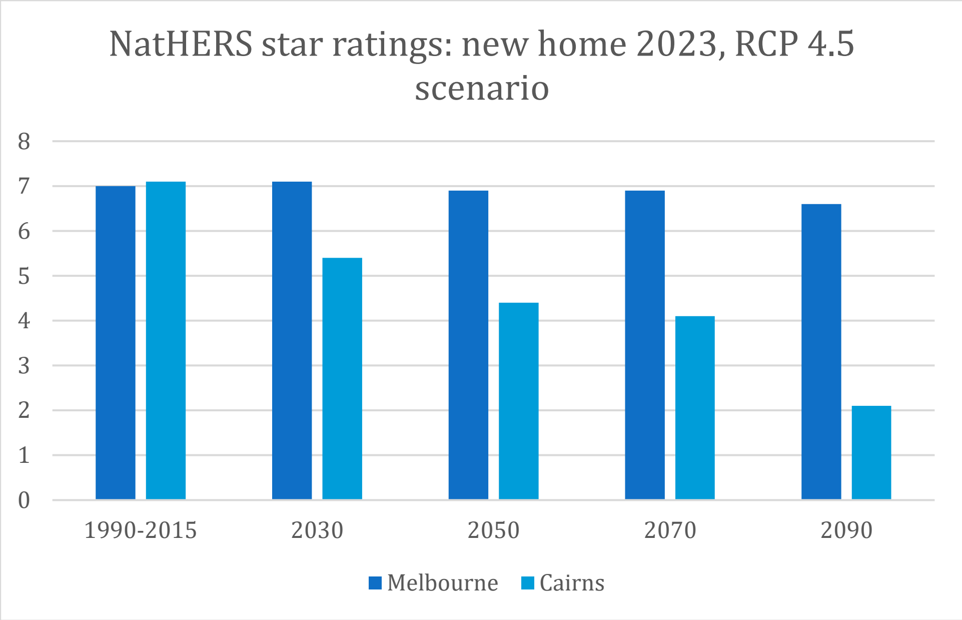





In cooler climates, reduced heating use offsets increased cooling when calculating total energy use. In the case of Adelaide, a severe climate scenario would see primary home energy use shifting from heating to cooling:



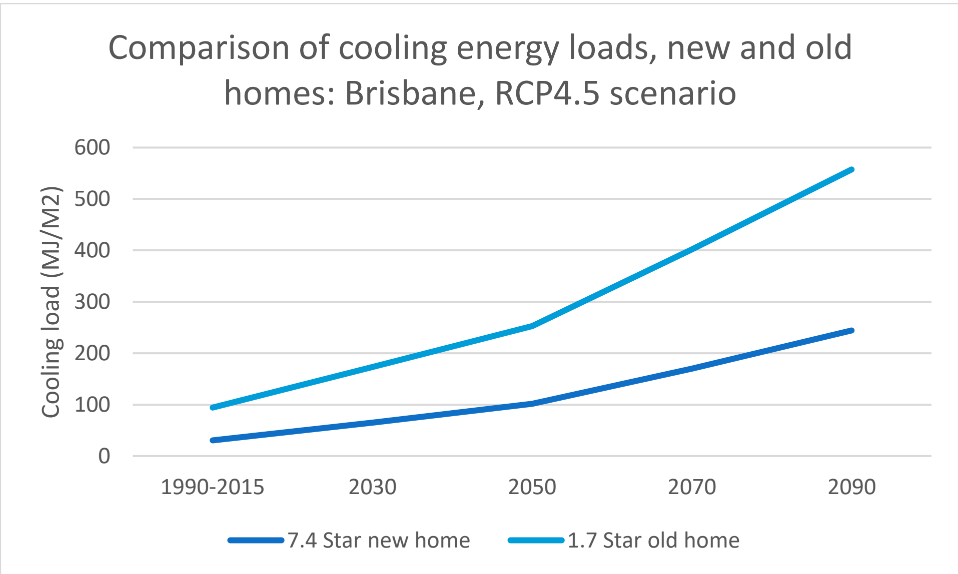

NatHERS star ratings are calculated according to total energy loads (heating and cooling combined). As such, applying 2022 NatHERS star rating bands to future climate scenarios led to significant decreases in hotter climates; however, the reduction in heating requirements in colder climates offset those increases in colder climates and led to smaller effects on NatHERS ratings:




In the case of poorly performing homes in Brisbane and Cairns, a star rating of zero was expected as soon as 2050 and 2030, respectively.

*Impact of design and energy efficiency*

Building design and energy efficiency ratings were found in our modelling to have an increasing impact on overall energy use (and particularly cooling loads) in a range of scenarios. While further analysis should be undertaken of this effect, this indicates the importance of home retrofits and building standards.




*Resilience to extreme temperatures*

A core consideration is that overall annual energy use does not necessarily correspond to resilience to extreme temperatures. Designing to minimise annual energy loads may at times be in tension with maximising resilience in extreme heat conditions; this appears to be particularly the case in colder climates where heating loads are expected to decrease. Nonetheless, our initial analysis indicates that improved energy efficiency can be consistent with resilience to heatwave conditions; in our view this is a critical area for further technical analysis.

## Next steps and further work

The case studies suggest further opportunities for technical analysis, including:

- Assessment of further building types, including apartments
- Assessment across all NatHERS climate zones
- Detailed assessment of the impacts of design choices and optimisation of design for future climate
- Assessment of impacts of specific design principles in Climate Zones 1 & 2 (northern Australia)
- Specific analysis of heatwave resilience (alongside analysis using annualised energy data)
- Analysis of impacts on energy grids, peak demand and DER integration
- Analysis of the potential impacts of home retrofits for existing homes
- Analysis of further impacts of land use change and changed urban heat island effects

Our initial analysis and case studies indicate that the impact of increasing temperatures on home resilience and energy use is a significant public policy issue. The technical analysis forms part of a broader project to understand and communicate the required policy response. Further discussion of this element of the project will be held during stakeholder consultations.

## Comments and feedback

Please email Rob McLeod at rob.mcleod@renew.org.au