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Delivering climate-resilient housing in Australia: the costs and benefits



From the AHURI Inquiry into achieving a climate resilient housing stock by 2050

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Summary

Key points

- Australian housing and households are already experiencing increasing financial and social impacts from a changing climate.
- Most of Australia's existing housing stock has not been designed or built to meet current and future climate conditions.
- Available data on the climate-resilience deficit in Australian housing finds that existing dwellings are significantly exposed to further impacts from both acute climate change (e.g. bushfires and floods) and slow-onset climate change (e.g. increasing temperatures).
- Cost-benefit analysis finds that there are financial benefits for some sections of the housing market to undertake resilient retrofit. However, other sections will require financial support to make improvements financially viable.
- Key policy opportunities include developing a resilient-housing retrofit pathway; improving data collection and access; improving householder and industry awareness and normalisation of resilient retrofit; and supporting the most vulnerable households first.

Key context

Housing, households and communities in Australia are already dealing with the financial, social and environmental impact of a changing climate.

Acute climate change (e.g. bushfires and floods) and slow-onset climate change (e.g. increasing temperatures) are costing billions of dollars each year—from rebuilding, due to physical property damage, through to social consequences such as negative impacts to health and wellbeing. As the climate continues to change, the impacts on housing, households and communities is predicted to grow, and is likely to be experienced unequally due to factors including:

- housing quality
- household capacity to respond
- local geographic and climate conditions
- wider built environment impacts, such as heat island effects in urban areas.

Australia's National Climate Risk Assessment estimates that the number of residential buildings in areas at very high risk of climate change impacts is expected to increase from 928,000 at +1.5°C of global warming to 1,224,000 at +3°C (Australian Climate Service 2025).

Most of Australia's existing housing stock was built before modern building code requirements were introduced. Although these requirements have improved since the early 2000s, there is still limited consideration of future climate change; and there are no requirements for existing housing to consider climate change when undergoing improvements.

This report refers to the 'resiliency deficit', by which it means the extent to which Australian housing stock lacks features that are adaptive to the impacts of climate change. While there has been some recent attention on the opportunities, costs and benefits of retrofitting Australia's housing to improve energy and thermal performance, retrofitting for climate resilience has received less attention. There is a lack of understanding around the actual cost of delivering climate-resilient housing in Australia. Our research explores this knowledge gap.

The report is one of two research projects that form part of an AHURI-funded Inquiry into achieving a climate-resilient housing stock in Australia by 2050. The Inquiry seeks to establish a framework for government and industry to build climate resilience into Australia's housing stock. In this report, we examine the costs and benefits of retrofitting Australian housing for resiliency; we draw upon the definitions and housing guidelines of Lang et al. (2026), which is the Inquiry's other project.

Key methods

This research was undertaken across two stages.

Stage 1: Mapping the extent of resiliency deficit in Australia's housing stock

- An audit and review were conducted of publicly available datasets that provide insight on the condition of Australian housing stock, such as structured collections of quantitative information. The analysis considered the breadth, depth, and quality of available data by dataset and in aggregate.
- Australia's housing stock resiliency deficit was mapped by state, based on available data, including housing construction standards over time in relation to major climate hazards. The analysis considered the extent to which housing attributes aligned with climate-ready housing guidelines.

Stage 2: Exploring costs and benefits to retrofit Australia's housing stock for resiliency

- The associations between heat, climate events and health – and how they relate to housing quality and climate resiliency – were analysed based on Household, Income and Labour Dynamics in Australia (HILDA) Survey data.
- Literature on the costs, benefits and feasibility of climate-resilient retrofit was reviewed to determine the empirical basis for retrofitting Australia's housing stock for climate resilience.
- Conservative estimates of the costs and benefits of retrofitting Australia's housing stock for climate resilience was modelled through a cost-benefit analysis (CBA) based on the limited available data.

Key findings

The resiliency deficit in Australia's housing stock

There is a lack of comprehensive public data on the impacts of climate hazards on households, housing quality and condition.

The most comprehensive datasets on housing conditions and retrofit potential relate to energy and thermal performance, including the Australian Housing Conditions Dataset (n=22,500), and the Australian Housing Data Portal (n=~70,000 existing homes, n=1.6 million new homes).

Other climate-resilience attributes have limited coverage in the data. The Climate Council's modelling of flood, storms and bushfire impact on households is the only database that looks at both dwelling retrofit characteristics and climate resiliency. However, it does not account for varied dwelling ages and types, which means that different building code changes are not reflected in the modelled impacts.

Nevertheless, the resiliency deficit in Australian housing stock can be estimated based on the changes to housing construction standards over time. Despite improvements to housing construction standards since 1995, there is still a significant resiliency deficit for new housing in relation to heat, floods and storms, and some elements of bushfire resiliency could be improved.

Without strengthening the housing construction code, newly built homes will require further investment in retrofit to achieve climate-resilient standards, on top of retrofit investment in existing housing, to ensure improved protection for the physical property and for residents.

The costs and benefits of climate-resilient housing retrofit

Conservative estimates of the financial outcomes of climate-resilient housing retrofit ranged from –$270,000 to more than $1,100,000. These figures represent the net present value (NPV).[1] Our research found that climate-resilient retrofit has positive NPVs for scenarios that involve medium- to higher-quality housing, and for areas at medium to higher risk. However, scenarios that involve lower-quality housing and housing in areas at lower climate risk have negative NPVs. Applying a discount rate (the rate of return used to discount future cash flows back to their present value) of 3% – in line with wider climate and environmental economics best practice analysis – results in 73% of scenarios delivering a positive NPV.

This analysis suggests that some households could be financially better off after investing in a climate-resilient retrofit, whereas other households may require financial support to improve the climate resilience of their homes.

1 In the context of this report, NPV measures whether a retrofit project is financially feasible on its own merits by comparing today's value of future cash inflows to its costs. In general, it is considered financially worthwhile to proceed with projects or investments that have a positive NPV. An NPV of zero is also acceptable.

Climate-resilient retrofit investment could provide benefits in the form of reduced healthcare costs. Based on HILDA Survey data, homes with better insulation, draught sealing and heating/cooling systems are associated with a smaller health burden from heat exposure.

The costs and benefits of retrofitting Australian housing for climate resilience lack empirical validation. The limited research exploring the positive benefits for properties that have undertaken resiliency retrofit in Australia and internationally is inconsistent and fragmented – employing varying methods and often focused on one-off events.

A holistic assessment of the costs, benefits and feasibility of climate-resilient housing retrofit requires understanding of the financial dimensions, as well as household needs and preferences along the retrofit journey, industry capabilities, and a range of social and environmental outcomes.

Key policy and practice opportunities

The report identifies four opportunities for policy and practice to support the delivery of climate-resilient housing across Australia.

1. Developing a climate-resilient housing pathway

This research demonstrates that retrofitting existing Australian housing to be resilient to current and future climate change impacts is an urgent challenge with significant financial and social implications.

The extent of resiliency deficit identified across jurisdictions and climate hazards calls for a clear and consistent approach to improving the climate resilience of the housing stock at a national scale. Australia needs a climate-resilient housing pathway to establish a shared direction for government, industry and households.

Drawing on the climate-ready housing guidelines established for this Inquiry (Lang et al. 2026), this pathway can be achieved by:

- Establishing a universal understanding of what climate-resilient housing is and how it is achieved.
- Indicating when requirements and standards for climate-resilient housing will be introduced or improved over time.
- Incentivising stakeholders to develop climate-resilient retrofit and construction-related businesses, products and services.
- Identifying links for integrating climate resilience with existing policies and approaches that regulate housing quality and performance, such as minimum standards.

2. Improving data collection and access

This research identified considerable limitations in Australian housing-condition data for climate resilience. More comprehensive and fine-grained data would provide critical understanding of current housing performance in the face of climate hazards; the locations that climate-resilient housing retrofit has occurred, and with what outcomes; and priority housing segments based on a range of measures.

Improved data collection and access would also enable more effective policy and program design, monitoring and evaluation to scale climate-resilient retrofit uptake. This could be achieved by:

- Leveraging existing survey instruments such as the HILDA Survey and the Australian Housing Conditions Dataset to include questions around climate resiliency
- Using the 2031 Census to collect more comprehensive data on housing conditions and resilience
- Exploring opportunities for Nationwide House Energy Rating Scheme (NatHERS) assessments for new and existing housing to collect information on dwelling resilience

- Introducing mandatory disclosure at point of sale or lease to collect information on more than 700,000 dwellings per year
- Incentivising access to third-party datasets for research and policy making
- Supporting systematic monitoring and evaluation of housing performance post-retrofit to validate and improve the effectiveness of climate-resilient housing retrofit measures.

3. Improving householder and industry awareness

Evidence of the costs, benefits and feasibility of climate-resilient housing retrofit shows that financial benefits alone will not ensure widespread take-up – particularly among privately owned properties. To address the resiliency deficit in the Australian housing stock, households and industry will need support to understand why, and how, to undertake housing retrofit.

Awareness and engagement with this issue can be supported by:

- Establishing clear and consistent language for describing what climate-resilient housing is, why it is needed and how it can be achieved
- Communicating the financial and non-financial benefits of climate-resilient housing
- Enhancing and establishing new tools and services for independently assessing the resilience of existing housing, and recommending cost-effective actions to aid decision-making among homeowners and investors
- Expanding support strategies that reduce complexity and effort for homeowners, and streamline decision-making to convert interest into action.

4. Supporting the most vulnerable households first

Australia's federal, state and territory governments have committed to ensuring homes keep people healthy, comfortable and safe from climate hazards, and that all Australians benefit from improved building performance (Department of Climate Change, Energy, the Environment and Water 2025).

However, our CBA modelling indicates that a climate-resilient housing retrofit may not be financially viable without additional support for lower-value housing. This suggests that households with lower incomes and potentially other vulnerabilities to climate hazards may be excluded if climate-resilient retrofit is left to market-drivers. This would exacerbate existing disadvantage and likely have flow-on economic impacts such as increased healthcare costs.

There is a need for governments to support the most vulnerable households in the transition to climate-resilient housing (Australian Climate Service 2025; Hohmann 2025), which could be done by:

- Identifying excluded and high-risk areas of the population
- Targeting subsidies for climate-resilient retrofits
- Strengthening minimum standards for private rentals
- Developing and expanding home retrofit facilitation services for vulnerable households and housing providers, from information provision through to installation and maintenance
- Supporting supply chain development through initiatives that upskill trades, and by providing subsidies for emerging climate-resilient housing technologies and other solutions.

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Acronyms and abbreviations

ABCB	Australian Building Codes Board
ABS	Australian Bureau of Statistics
AHURI	Australian Housing and Urban Research Institute
BAL	Bushfire Attack Level
BASIX	Building Sustainability Index
BCR	Benefit-to-cost ratio
CBA	Cost-benefit analysis
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DCF	Discounted cashflow
DEWHA	Department of the Environment, Water, Heritage and the Arts
HILDA	Household Income and Labour Dynamics in Australia Survey
LGA	Local government area
NatHERS	Nationwide House Energy Rating Scheme
NCC	National Construction Code
NDRRF	National Disaster Risk Reduction Framework
NEMA	National Emergency Management Agency
NPV	Net present value
QALY	Quality-adjusted life year
RACE for 2030	Reliable, Affordable, Clean Energy for 2030
RCP	Representative Concentration Pathway
SA1/2	Statistical Area Level 1/2
SCQ	Self-completed questionnaire
SF	Short form survey (HILDA data)

Glossary

A list of definitions for terms commonly used by AHURI is available on the AHURI website ahuri.edu.au/glossary.

1. Introduction

1.1 Policy issue

Over recent years, there has been an increase in impacts on Australia's housing stock from climate change (Climate Council and Climate Valuation 2025; Li et al. 2025; Moore et al. 2025; NHSAC 2024). This impact on housing and households is from an increase in frequency and intensity of both:

- acute climate events, such as bushfires and floods
- slow-onset changes occurring over time, such as increased and more severe heat (Bureau of Meteorology and CSIRO 2022; IPCC 2022).

Impacts on housing and households from a changing climate are typically considered in terms of financial costs to rebuild or repair a property (or community) after an acute climate-related disaster. Climate-related rebuilding and repair costs reached $35 billion[2] for the 2010–2019 period in Australia, and are predicted to grow as climate change continues (Climate Council and Climate Valuation 2025).

Some notable climate events that had implications for housing include the 2019–2020 South Australia, Victoria and New South Wales bushfires, which resulted in 3,000 homes destroyed and an estimated $20-billion impact on the economy (Australian Government 2020); and tropical Cyclone Alfred in 2025, which caused more than $2 billion in housing damage in Queensland (Insurance Council of Australia 2025).

The increased frequency of these acute climate events has resulted in a rapidly changing context regarding how we protect our properties and recover from disasters. Further, the impact on housing, households and communities is predicted to grow over the coming decades as the climate continues to change, and is likely to be unequal due to a range of factors including housing quality; household capacity to respond; local geographic and climate conditions; and wider built environment impacts, such as heat island effects in urban areas.

In particular, there has been a significant increase in property insurance premiums in many areas – which means some households can no longer afford to protect their properties against climate-related events (Australian Climate Service 2025; Fuerst and Warren-Myers 2021; Malo 2020). This has flow-on implications for different levels of government, which increasingly need to step in and provide financial and non-financial support to help rebuild or relocate impacted communities (Sanderson et al. 2025; Victorian Government 2021). It also has implications for Australia's construction industry, where there can be increased costs to rebuild after extreme events, and where households can be significantly financially constrained due to cascading recovery costs (Australian Climate Service 2025).

2 All costs in this report are in Australian dollars unless otherwise specified.

The scale of current and future risks to housing and households in Australia is significant.

- There are over 17,000 properties within 150 metres of the coastline at risk of coastal erosion, with a value of $26 billion (Powell et al. 2024b). Queensland ($11 billion) and New South Wales ($9 billion) are the states at highest risk.
- 950,000 Australian homes are at risk of flooding, with a value of $768 billion (Powell et al. 2024c). The states of Queensland (344,453 homes valued at $282 billion), New South Wales (288,878 homes valued at $256 billion), and Victoria (197,342 homes valued at $147 billion) are at the highest risk.
- 5.6 million Australian homes are at risk of bushfire, with an estimated value of $4.6 trillion (Powell et al. 2024a). The states of New South Wales (1.9 million homes valued at $2 trillion), Queensland (1.6 million homes valued at $1.3 trillion) and Victoria (763,000 homes valued at $592 billion) are at the highest risk.
- The recently released *National climate risk assessment* notes that the number of houses currently considered at high risk from climate hazards will potentially double by 2100 (Australian Climate Service 2025).

However, the risks of a changing climate extend beyond physical risk to property to wider social and environmental impacts (Allon 2020; Australian Climate Service 2025; Australian Government 2018; Climate Council and Climate Valuation 2025; Ladds et al. 2017; Moore et al. 2025; Sanderson et al. 2025). For example, social impacts include negative health and wellbeing outcomes, such as stress and respiratory issues (Li et al. 2025) which impact the individual and the wider healthcare system (Tong et al. 2022). A study of heatwave-related fatalities in Australia 2001–2018 found that – where the age of the dwelling was known – the majority of fatalities occurred in houses built before 2006 (Coates et al. 2022). Through its construction and operation, housing also contributes to climate change; for example, mechanical cooling intensifies global warming (Li et al. 2025; Zhang et al. 2026).

Beyond the physical damage and social risks, a changing climate will have impacts on the way Australian housing performs, and the solutions required to protect people from future climate scenarios.

For example, modelling from Wang et al. (2011), Sweltering Cities and Renew (2024) find that across many regions of Australia, the existing housing stock will perform worse from a thermal comfort perspective in the future. This means that without intervention, households will be more reliant on mechanical heating and cooling to maintain safe thermal comfort, with flow-on impacts to household energy costs and risks for those who cannot afford such appliances or energy use (Energy Consumers Australia 2025). In another example, Hill et al. (2021) explore the minimum height rises needed to avoid damage to housing from sea-level rise in different locations around Australia; they find that by 2090, some properties will need to be raised by almost 90cm. These examples highlight the significant challenges facing Australian housing in the future.

However, understanding of the current resiliency of the Australian housing stock is limited, and more research is required to ensure the delivery of a climate-resilient housing stock for existing (and new) housing. Acting early to mitigate disaster is critical, rather than waiting for a household to experience a climate event and realise their home may not be robust, or liveable. In Australia, for every dollar invested in disaster preparedness, there is a $10 return on investment (Commonwealth Scientific and Industrial Research Organisation [CSIRO] 2016). This project aims to contribute to resiliency planning by mapping the resiliency of the existing housing stock and exploring the costs and benefits of delivering climate-resilient retrofit.

In this report, we draw on work by Lang et al. (2026) to define climate-resilient housing as:

> housing that, through climate change and extreme weather events, remains structurally robust; protects the health, safety and comfort of its occupants; and is able to be efficiently and affordably returned to a functioning home after an extreme weather event.

Climate-resilient retrofit is the process of upgrading or improving an existing dwelling to meet these resiliency attributes, and to ensure housing is fit for purpose for likely future climate scenarios.

1.2 Existing policy and practice

This section explores the existing policy and practice settings that inform the wider context for this research. Section 1.2.1 discusses the National Construction Code (NCC), Section 1.2.2 the planning system, and Section 1.2.3 the broader investment in the governance of climate-resilient housing.

- The NCC is developed nationally by the states and territories in conjunction with the federal government. It is implemented individually (or not) by each state or territory. It addresses how something is built, and ensures it meets minimum requirements.
- Planning systems are state- or territory-based. They set out how and where something is built.
- Investment in the governance of climate-resilient housing come from all three levels of government.

1.2.1 National Construction Code

As with many developed countries, Australian states and territories use building codes to set and improve minimum quality and performance requirements of new housing.

The NCC sets the minimum requirements for design, construction and performance of new buildings, including housing, and significant renovations over a certain size. Over recent decades, the NCC has evolved, with new or refined requirements to improve quality and performance largely through a focus on improving thermal performance and energy efficiency. The NCC also sets specific standards for buildings in geographic areas at risk of acute climate events such as bushfires, floods and cyclones.

The NCC has long recognised the impact of climate on building performance, and set minimum requirements for each of the eight different climate zones. This is refined further through the Nationwide House Energy Rating Scheme (NatHERS), which is the most common approach for new residential housing to demonstrate compliance with the NCC. Under NatHERS, there are 69 unique climate zones, which each impact building performance in different ways.

Traditionally, the NCC has used historic climate data within the NCC and NatHERS. Prior to 2022, NCC used climate data from 1970–2005; in 2022, this was updated to data from 1990–2015. While this still means NCC requirements are based on outdated climate data, this change should improve design and construction outcomes to some extent. Furthermore, future climate data files are now available to be used to explore design and performance impact within the suite of approved NatHERS tools – although this cannot yet be used for regulatory compliance. These future climate files contain hourly weather data for:

- three future climate scenarios: Representative Concentration Pathway (RCP)2.6, RCP4.5, and RCP8.5
- four future time periods: 2030, 2050, 2070 and 2090 (CSIRO 2025).

Codes and associated standards are periodically reviewed. They have been reformed to address issues such as increased bushfire and flood resilience, along with thermal efficiency needed to protect houses from extreme heat (see Box 1).

These codes and standards include:

- ABCB Standard 2012.3 Construction of Buildings in Flood Hazard Areas (ABCB 2019)
- AS 3959:2018 standard – requirements for the construction of buildings in bushfire-prone areas (ABCB 2020)
- energy-efficiency standards – progressively lifted from a 5-star rating in 2006, to a 7-star rating set as the standard under the 2022 NCC (Ma et al. 2025).

Despite these improvements, minimum NCC requirements for new housing continue to lag international best practice (Moore and Doyon 2023). To date, future climate impact has not been part of the NCC. However, climate resilience was added as an objective for the ABCB in 2024, indicating that it is likely to become a more significant focus within the NCC in future updates (Husic 2024; Watt 2024a).

This shift towards considering future climate change across the regulation and governance of the built environment is also reflected in the recent updates to the 2019 *Trajectory for low energy buildings* (COAG Energy Council 2019). In 2025, the objective to 'keep people healthy, comfortable and safe from climate hazards' was added to the updated Trajectory (Department of Climate Change, Energy, the Environment and Water 2025). This will likely extend the requirements already contained within the NCC for acute climate events such as bushfires, floods and storms.

Overall, the NCC has been found to improve outcomes for new housing built since its introduction, particularly in terms of thermal energy performance (CSIRO 2026a). Housing built before these regulatory requirements, however, performs poorly in terms of thermal and energy performance, and has little resiliency for acute climate events such as bushfires, floods and storms (Mason et al. 2012; Moore and Doyon 2023; Roberts 2022). The NCC and other regulatory requirements around housing quality and performance have predominantly focused on new housing with minimal intervention influence on existing housing stock. Existing housing is only required to adhere to particular NCC requirements once an existing dwelling undergoes a significant renovation or extension beyond a certain value and size (ABCB 2026a). In 2025, NatHERS was expanded to apply to existing homes (DCCEEW 2025a), but at this stage, there is no minimum requirement for existing housing to undertake a NatHERS existing-home assessment or ensure any minimum quality and performance outcomes are met, and there are no additional requirements relating to how a home might perform in a future climate scenario. Only the ACT and Victoria have set minimum standards for select existing housing (e.g. rental housing), although utilising policy tools that sit outside the current NCC framework (ACT Government 2026; Tenants Victoria 2026).

There are also continued critiques that the current codes do not go far enough given the extent of wider societal decarbonisation required, and concerns that the increasingly fragmented implementation by individual states and territories will deliver unequal housing quality and performance outcomes across Australia (Green Building Council of Australia 2026; Moore and Doyon 2025; Sweltering Cities and Renew 2024).

Box 1: Key changes to addressing heat and storms across Australia

Heat

Australia's construction codes initially focused on addressing health and safety issues, but shifted in the 1990s to include requirements to improve energy efficiency and thermal performance. Prior to the introduction of minimum ceiling insulation requirements in the early 1990s, there were limited direct requirements to improve heat performance outcomes. The implementation of NatHERS in the late 1990s, followed by the introduction of 5-star requirements from the mid 2000s, and subsequent revisions to 6-star and then 7-star, have improved resilience for heat. This has been typically through improved thermal performance of walls, floors and ceilings – for example, increased insulation levels. While current 7-star requirements are an improvement for new housing, there is still limited requirement for resiliency features as identified in Lang et al. (2026), and NatHERS does not primarily address extreme heat as explored in this research. Nor are there requirements for the improvement of existing housing to meet the resiliency features noted in Lang et al. (2026), beyond minimum standards for private rental housing in Victoria. In New South Wales, the Building Sustainability Index (BASIX) is applied, and aims to deliver similar performance outcomes to NatHERS.

Storms

Storms are generally addressed within the NCC in relation to the setting of minimum performance requirements for improved structural integrity to withstand high wind pressure. Prior to Cyclone Tracy in 1974, there were limited requirements for storms beyond common local building practices that had developed over time. Changes to local building codes following Cyclone Tracy were updated in the 1980s in cyclone-prone areas to require designs to be structurally engineered for wind typical in a cyclone event. These requirements have been updated several times since their introduction in the 1980s, but still only address some of the requirements identified by Lang et al. (2026). In non-cyclone areas there are limited requirements for new housing in relation to storms.

Of particular interest are recent developments in Canada. Revisions in 2025 to the National Model Building Code of Canada – the equivalent of the NCC – mean that future climate projections for a 2.5°C warmer climate are applied within the Code (Canadian Board for Harmonized Construction Codes 2025). This is the first reported instance of this occurring in building codes globally (Jafarpur and Smith 2026). Future climate data is required to be used where there is an expected increase in design demands; however, where there is expected to be a reduction in demands, the historical data will continue to be applied to ensure that new housing quality and performance do not reduce as an outcome of these changes.

As with the NCC, the Canadian Code allows for new homes to meet the requirements holistically rather than setting minimum requirements for each design element. Thus, the practical ways in which improved Code requirements are met will likely be different based upon considerations such as climate zones.

1.2.2 Planning system

The planning system sits at the state or territory government level, with shared implementation delivered with local governments.

Planning systems are tasked with considering short-term and long-term impacts from proposed changes to our built environment, and consider the need for more housing, and associated amenity and infrastructure, and the local suitability for such development. In this way, considerations of the impact of acute climate events, such as bushfires and floods, have typically been addressed through local planning systems (see Box 2).

It is within locally managed state-based planning systems where restrictions can be applied based upon potential risk – although this typically only applies to new construction, rather than requiring existing housing to improve as risk levels change over time.

This has resulted in some areas where construction has not been allowed, or where additional requirements may be needed in order to build something (e.g. elevated floor levels to protect from floods) or rebuild (e.g. after bushfires). Voluntary home-buyback schemes have also been offered, such as in the aftermath of the 2022 Brisbane floods, where the risk level was deemed unacceptable in the current climate (Nyandega and Williams 2025).

Several acute climate events have impacted housing across Australia in recent years, which has exposed the limitations of the planning system to deliver climate-resilient housing. For example, following the 2022 Melbourne floods, it was revealed that local planning decision-making was being done based on historic flood data (Legislative Council Environment and Planning Committee 2024). Updated flood data is being released for Melbourne, which has significantly expanded the number of properties at risk of flooding (Melbourne Water 2026).

In terms of thermal performance and environmentally sustainable design, research has noted the lack of statutory planning instruments and legislation to assess ecologically sustainable development for buildings across Australian states (Moore et al. 2017).

Box 2: Key changes to addressing bushfires and flood across Australia

Bushfire

Bushfire requirements have largely been addressed within planning systems and addressed at a state or local government level. Requirements for bushfire protection emerged in Australia following the reviews into the 1983 Ash Wednesday bushfires. This resulted in minor changes at local planning level to address bushfire outcomes in Victoria. More significant improvements occurred around Australia in the 1990s with the introduction or improvement of planning mechanisms. For example, the introduction in Victoria of the Wildfire Management Overlay in 1997 saw a greater focus on bushfire protection for new housing. Further changes were made in 2009 to both:

- the planning scheme, with the introduction of the Bushfire Management Overlay
- requirements in building codes based upon the introduction of the Bushfire Attack Levels (BAL) through AS3959.

Other jurisdictions have followed similar bushfire protection developments, although timelines have varied for various changes and have typically followed reviews of state bushfire events. Current bushfire protection requirements within the NCC and planning systems address new housing only, and typically address many key elements from Lang et al. (2026) – although not all.

Flood

Similar to bushfire protection, flood protection requirements have largely been addressed in Australia via local planning schemes. Generally, there was an increased focus from the late 1970s with the introduction and then improvement of flood zones and overlays that directed where housing could be built, and requiring housing in risk areas to be built above a certain flood level (generally 1-in-100 years). Some states also touch on flood requirements in Building Acts – for example the setting of minimum floor levels. The requirements around flooding have been revised over time, although recent evidence has found that some planning was informed by outdated flood data, which placed some houses at greater risk.

1.2.3 Broader investment in the governance of climate-resilient housing

All three levels of government in Australia are involved in the development of policies and settings to support increased resiliency in both new and existing housing. Key areas of collaboration are:

- the development and enforcement of building codes and other housing standards by all levels of government
- the administration of post-disaster supports for housing resiliency
- grant programs aimed at improving resiliency ahead of future events.

While programs of proactive and reactive support are spread across the three levels of governance, the scale of funding available is greater from the federal government, followed by state/territory governments, then local governments.

Strategic frameworks, funding and authorities

In recent decades, several strategic frameworks addressing disaster resilience have been developed. They are outlined below.

The **National Strategy for Disaster Resilience** was released in 2011 (COAG 2011). It was the first nationwide resilience-based approach to disaster management, and focused on improving capacity to withstand and recover from emergencies and disasters. It was the initial step before the development of an implementation framework (the National Disaster Risk Reduction Framework).

The **National Disaster Risk Reduction Framework** (NDRRF) was released in 2019. It sets out the foundational work required across all sectors nationally to reduce existing disaster risk; minimise new disaster risk; and deliver better climate and disaster risk information (National Emergency Management Agency [NEMA] 2026). The NDRRF explicitly cited housing and the built environment as a key part of the policy environment, with calls for more attention to remove disincentives and to strengthen planning and development practices (Department of Home Affairs 2019).

The **First National Action Plan** was released in 2020 as part of the NDRRF (Department of Home Affairs 2020), with reference to select housing-related programs, including the bushfire and heat-resistant guidelines in Queensland, which aimed to support households with retrofitting.

The **Second National Action Plan** was agreed upon by National Emergency Management Ministers in 2023, and accompanied by the Disaster Ready Fund as the main approach to funding short- and longer-term improvement for resiliency (NEMA 2025a). With $1 billion in funding over 5 years, it supports a range of projects; recent funding for housing-related projects include pilot schemes for the wet treatment (identifying and preventing moisture entry and repairing damage to prevent mould) of Aboriginal Housing Office properties in NSW, and peer-led community engagement programs on heat stress in inner-Sydney.

In most states and territories, the **Disaster Ready Funds** and grant programs are administered by emergency management agencies, as summarised by Heffernan et al. (2025). Beyond these statutory authorities, the nonprofit Resilient Building Council has been supported by the Disaster Ready Funds plus state and territory funding to provide resources such as FORTIS house – a guide to disaster-resilient housing developed after the 2019–2020 Black Summer bushfires and the later floods (NEMA 2024b).

Government financial incentives and programs for household-level assistance

There are government financial assistance programs for households to retrofit their homes for bushfire resilience, with existing programs focused on households rebuilding after bushfire rather than retrofitting.

- The Victorian Government provided residents affected by the 2019–2020 Eastern Victorian bushfires up to $20,000 for rainwater or septic tank installations and water tanks for firefighter purposes (Victorian Government 2025).
- The NSW Government provided grants for low-income, uninsured residents to undertake essential structural repairs to homes damaged by designated disaster events (NSW Government 2026c).
- The federal government invested in the development of the Resilient Building Council's Bushfire Resilience Rating Home Self-Assessment app, with some insurers now providing discounts for those who use the app and retrofit to achieve a higher level of bushfire resilience (Watt 2024b).
- The Queensland Resilient Homes Fund was established after the 2022 floods. It offered eligible homeowners up to $100,000 for voluntary house buybacks, up to $100,000 for house-raising, or up to $50,000 for retrofitting measures in severely flood-affected areas across south-east Queensland (Queensland Reconstruction Authority 2024). The fund prioritised properties that experienced above-floor inundation during the February and March 2022 floods, targeting areas where repeated flooding poses ongoing risks to community safety and household financial security.
- New South Wales introduced the Resilient Homes Program following the 2022 floods, allocating $38.3 million to reduce flood damage to residential properties in Northern Rivers communities (Resilience NSW 2024). The program provided grants of up to $20,000 for eligible homeowners to undertake flood resilience upgrades, including raising electrical systems, installing flood-resistant materials, and improving ventilation to prevent mould (NSW Government 2025). Unlike Queensland's focus on relocation and elevation, the Resilient Homes Program emphasises modifications that allow homeowners to remain in their properties while reducing future damage costs.

There are also funding opportunities aimed at future disaster resilience. These include:

- the Household Resilience Program in Queensland targeted at homes in cyclone-prone areas (NEMA 2024c)
- the Strata Resilience Program for multi-residential developments (NEMA 2024b)

Both programs are jointly delivered by the federal and state governments, and operate as co-contributions, with government funding up to 75% of works, with the rest coming from the eligible homeowner or body corporate. This funds retrofits including roofing replacements, tie-downs or upgrades, garage door replacement and window and door protections.

In an example of a program targeted at a specific city, Brisbane City Council implemented the Flood Resilient Homes Program in 2018. It targeted 12 Brisbane suburbs that were deemed flood-prone. Selected properties were provided with an in-home assessment of existing flood resilience, with financial incentives linked to recommendations made during those in-home reports (Brisbane Sustainability Agency 2022). As Jarzabkowski et al. (2025) have shown, the support helped the funded properties during the 2022 Brisbane floods, with residents reporting on improved resilience during that event, along with reduced insurance costs.

The work of various governments is often most pronounced in the wake of an extreme weather event. Jarzabkowski et al. (2025) detail the action of federal, state and local governments following flash flooding in Grantham, Queensland, in 2011. This event ushered in the formation of the Queensland Reconstruction Authority, which led to the relocation of residents to land on higher ground. This was facilitated by the purchase of the site by the Lockyer Valley Regional Council and supported by new infrastructure funded by the federal and state governments, and further relocation grants from the state.

After flooding events across 2021 and 2022, the Queensland Government, in partnership with the federal government, rolled out the Resilient Homes Fund across 39 local government areas. On top of voluntary home buybacks for the most badly affected properties, grants were also provided for repairs, retrofits and measures to raise existing homes, along with demolish and rebuild funds (Queensland Government 2025b). A similar program is currently being delivered by the New South Wales and federal governments, focused on the Northern Rivers and Central West LGAs, with grants for flood-affected communities (NSW Government 2025). Heffernan et al. (2025) reported on authorities in Western Australia recommending the use of such voluntary purchase of homes, as opposed to reconstruction. Table 1 summarises some of the examples discussed above.

Table 1: Examples of climate-resilient retrofit programs

Government body	Year	Detail of support/policy	Outcome
Federal government working with states and territories	2006– present	Building codes and standards, including relating to the construction of buildings in flood hazard areas, bushfire-prone areas and energy-efficiency standards	Raising housing construction standards to mitigate against future disasters
Lockyer Valley Regional Council, Queensland Government, federal government	2011	Relocation supports and new infrastructure for the town of Grantham following a flood event	Assisted with relocating 72 households to new blocks of land
Brisbane City Council	2018– 2022	Supports to selected residents in 12 flood-prone suburbs in Brisbane, including in-home assessments of flood resilience	226 households were supported
Queensland Government, federal government	2018– 2024	Household Resilience Program: funding for retrofits for homes in cyclone-prone areas	4,400 households have been supported
Canberra Region Councils, ACT Government, NSW Government	2021–2023	Bushfire Resilient Homes Toolkit: information guide tailored to homes in Canberra region councils	Toolkits disseminated by 10 councils
Mount Alexander Shire, Victorian Government	2024–2025	Home Upgrades for Climate Resilience workbook and assessment program: developed for homes in the Mount Alexander Shire	Trained 5 assessors to undertake 140 in-home assessments
Queensland Government, federal government, local governments	2022–2027	Resilient Homes Fund: support for repairs, retrofits and raising of existing homes, along with demolish and rebuild grants for households affected by the 2021–2022 floods	6,500 registrations, 685 homes bought back voluntarily, 592 homes demolished or relocated
NSW Government, federal government, local governments	2022– 2027	Resilient Homes Program: support for repairs, retrofits and raising of existing homes, along with demolish and rebuild grants for households affected by the 2022 floods	775 homes bought back voluntarily, with 179 being processed

Source: Authors, drawing upon information from Department of the Environment Tourism Science Innovation (2025); Jarzabkowski et al. (2025); Queensland Government (2024); Ross (2026).

While all three levels of government currently offer financial and other proactive and reactive support to households, there is limited coordination about how it is delivered. In particular, some households impacted by a natural disaster event have found it challenging to navigate different government organisations to obtain support as processes may be different; and eligibility requirements differ between the levels of government (Sanders 2026).

Furthermore, much of the financial support has been reactive, aimed at helping communities and individuals rebuild or recover, rather than proactively trying to help improve resiliency before an event occurs. More recent support updates such as the Bushfire Resilient Homes Toolkit (launched 2021) (ACT and NSW) have been developed to provide proactive support.

Investment in voluntary schemes and guidelines

There have been a number of voluntary design guidelines or assessment tools developed in Australia (and elsewhere) to help households retrofit their homes for increased climate resiliency. For example, the bushfire-resilient rating self-assessment tool built by the Resilient Building Council of Australia (Resilient Building Council 2025). This tool allows Australian households to complete a short online assessment to understand how resilient their home is to bushfire, and what opportunities there are to improve resilience. To date, there have been more than 55,000 assessments and more than 6,500 homes have undertaken at least four recommended actions to improve resiliency, resulting in a reduction of up to $800 in insurance premiums for some households (NAB 2025; Resilient Building Council 2024). This tool is about shifting improvements to be made before a home experiences a climate event, rather than responding after the event.

Local and state/territory governments in Australia have also invested in the development of place-specific guidelines to help households understand common challenges and opportunities to improve the housing resilience. For example, the Canberra Regional Joint Organisation, made up of 10 councils and the ACT and NSW governments, has developed a bushfire resilience toolkit for housing in the Canberra region (Canberra Joint Region Organisation 2022). Meanwhile, local governments and health organisations in Victoria's Loddon Mallee region developed the *Home upgrades for climate resilience* workbook (Castlemaine Institute 2024) to guide households in:

- assessing how their home might perform in a climate event
- prioritising relevant upgrades.

There are an increasing number of international examples as well. For example, a set of flood resiliency guidelines has been developed in New Zealand by the Building System Performance branch of the Ministry of Business, Innovation and Employment. The guide was first published in February 2025 (Ministry of Business Innovation and Employment 2025). It is designed to deliver improved flood resilience in dwellings in higher-risk areas, but is applicable to any housing, as it:

- offers easy to understand, practical and affordable strategies for homeowners and those involved in the design and construction process
- can be used by potential buyers as a checklist of flood resiliency features in existing housing
- can be used to inform renovating, retrofitting and repair.

2. Research design

2.1 Research approach

This research brings together two often separate research domains: resiliency and retrofitting. In doing so, it extends understanding and opportunities of resiliency to be more than just how a dwelling performs during extreme weather and acute climate events like bushfires and floods, but to better account for slow-onset climate impacts like heat and sea-level rise. It also extends current framings around retrofit from the focus on improving energy and water efficiency to include addressing elements of resilient housing performance through retrofit actions.

This research report is part of a wider AHURI research Inquiry into achieving a climate-resilient housing stock by 2050. The Inquiry's overarching aim is to understand what is required for the Australian housing stock to be resilient to the impacts of climate change. It seeks to establish a framework for government and industry action to build climate resilience into Australia's housing stock.

The extent to which Australian housing lacks features that are adaptive to the impacts of climate change is referred to in this report as the 'resiliency deficit'.

The Inquiry draws on two research projects:

- *Building climate resilience in Australian homes and households* (Lang et al. 2026) defines climate-resilient housing in Australia, and develops climate-ready housing guidelines that outline resilience measures for a wide range of climate threats affecting Australian homes.
- *Delivering climate-resilient housing in Australia: the costs and benefits* (this project) builds on Lang et al. (2026) by contributing two key inputs to the Inquiry:

1. Mapping the extent of resiliency deficit of the Australian housing stock to contribute to an understanding of how vulnerable it is.
2. A cost-benefit analysis of delivering climate-resilient retrofits.

2.2 Research questions

The project aimed to answer two questions:

1. What is the extent of resiliency deficit in the Australian housing stock?
2. What are the financial and non-financial costs and benefits to retrofit the housing stock for resiliency?

2.3 Research methods

This research drew on five data collection methods across two key stages of analysis.

Stage 1: Mapping the extent of resiliency deficit in the Australian housing stock.

- data review and audit.
- housing stock resiliency mapping.

Stage 2: Exploring costs and benefits to retrofit the housing stock for resiliency.

- HILDA Survey analysis.
- a literature review.
- cost-benefit analysis.

The following sections outline method used in this research.

2.3.1 Mapping the extent of resiliency deficit

This section describes the methods applied for Stage 1 of the research.

Housing resiliency data review and audit

A desktop review of resiliency evidence was undertaken to identify relevant public data sources for the Australian housing stock. A Google search was performed independently by four members of the research team using search criteria including combinations of these terms: housing, climate resilience, statistics, quality, performance, sustainability, Australia. This search was added to by the researchers' own knowledge of potential datasets.

The initial search identified 33 possible datasets that included at least some data on Australian housing characteristics, such as dwelling age and type; energy efficiency and thermal efficiency retrofits; and climate hazards (heat, bushfires, floods and storms).

An initial screening of the potential datasets was undertaken by the research team to ensure they met the criteria for the project. Datasets that were not fully publicly available, or were a combination of previously identified datasets, or were more than 20 years old were excluded. This narrowed the datasets down to 16 that met the relevant search criteria. Datasets were then analysed for what they included against the characteristics noted in Table 2. The retrofit and climate hazard categories were identified by Lang et al. (2026), while dwelling characteristics and scale/scope and relevance were added to understand depth and quality of datasets.

Table 2: Criteria for analysis of datasets

Dwelling characteristics	Retrofits	Climate hazards	Scale/scope & relevance
Housing type	Draught-proofing	Heat	Scale: household, SA1/2, local government area (LGA), state or nationwide data
New/existing dwellings	Insulation	Bushfire	
Tenure	Glazing	Flooding / storms	Number of homes included in the dataset
Building fabric	Shading	Other	
Energy assessment / rating	Electrification		Currency of the data
Building codes	Appliances		Publicly available
	Solar PV		
	Battery		
	Rainwater storage		
	Storm water		
	Other		

Source: Authors.

Each dataset was reviewed by one member of the research team. Initial results were then cross-checked by two other team members to ensure accuracy and consistency of the results. Note: for this research, 'publicly available' means that the dataset was permanently available online, or there was a clear process for gaining access (e.g. to use for academic purposes).

Identifying Australia's housing stock resiliency deficit

Using the resiliency guidelines developed in Lang et al. (2026), in conjunction with the resiliency dataset audit (see Section 2.3.1), a top-down and bottom-up mapping of resiliency deficit was undertaken. The map was developed for state-level housing stock and can be used to understand the national housing stock overall. The resiliency deficit was mapped against the four main climate events applied in Lang et al. (2026): heat, bushfires, floods and storms (including cyclones).[3]

A review of building code and planning system changes in Australia was undertaken. These codes and systems have been the primary mechanisms for requiring particular outcomes relating to housing quality, performance and location. This review resulted in the identification of key points in time where significant regulatory changes impacted the design and construction of new housing in Australia, and presented time horizons to group the wider housing stock into. These time horizons were reviewed by experts in planning and housing building codes, in addition to the wider Inquiry team. Based upon feedback, four key time horizons were confirmed for the analysis:

- Pre–1985: before the introduction of holistic energy-efficiency requirements and key requirements for bushfire, floods and storms.
- 1985–1990: requirements for storms introduced or strengthened in some states specifically in relation to cyclone protection.
- 1991–2005: minimum insulation requirements introduced from 1991 in some states, improvement to planning schemes in relation to bushfire and flooding.
- 2006–current: more holistic minimum-energy-efficiency requirements introduced and improved across all states, in addition to strengthening of building code and planning schemes in relation to bushfires and flooding.

The mapping is based upon the year a property was initially constructed, with much of the resiliency design and material elements locked in at this stage. Renovation or retrofit can improve these outcomes. However, there is currently a low rate of deep sustainability retrofit in Australia (Willand et al. 2020). As explored in the data review (Section 2.3.1), there is limited data on resiliency retrofits and the rate and depth at which they are being undertaken. While some properties may have had work done to improve them, it is assumed that a limited number of properties would have been retrofitted to the resiliency standards outlined in Lang et al. (2026).

Analysis was then undertaken by the research team for each housing period and what minimum requirements were required in relation to the resiliency elements identified in Lang et al. (2026). This resulted in the mapping of housing in each jurisdiction as presented in the following section. These results were then provided to academic and industry stakeholders to comment on, with feedback integrated into the results presented in Chapter 3.

3 Herein 'storms' refer to storms and cyclones.

2.3.2 Cost-benefit analysis of delivering climate-resilient retrofit

This section describes the methods applied for Stage 2 of the research.

Associations between heat, acute climate events and health

Associations between heat, acute climate events and health were analysed using data from the HILDA Survey, an annual representative household survey that follows approximately 17,000 people each year. This analysis was restricted to HILDA waves 1–19 (2001–2019) for the temperature analysis, and waves 10–19 (2010–2019) for the disaster analysis, reflecting more complete disaster-declaration data from 2010 onwards. Analysis deliberately stops prior to the COVID-19 pandemic to avoid confounding from the acute social and economic disruption in 2020 and beyond. Health data collected in HILDA was matched to local temperature data using daily weather station observations from the Bureau of Meteorology, and local (LGA-level) acute climate-related events such as bushfires and floods from the Disaster Assist database.

Changes in health were measured using the HILDA Short Form Survey-6D (SF-6D) health utility index from within the longer 36-Item SF-36 instrument. Health outcomes are expressed as quality-adjusted life years (QALYs).

QALYs are widely used in economic evaluations. They summarise health on a scale from 0 to 1, where 0 represents a health state equivalent to death, and 1 represents a full year of good health. QALYs are monetised at $50,000 each, in line with Australian economic evaluation guidelines (Reed et al. 2024). The analysis supplemented the SF-6D index with the eight SF-36 domain scales: physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional and mental health. These are reported on a 0–100 transformed scale, where higher scores indicate better health.

Associations between heat, acute climate events and health were estimated using fixed-effect regression models that control for person-level unobserved time-invariant factors that can also influence health – such as underlying health conditions. The specification also controls for LGA-level fixed effects, absorbing time-invariant local characteristics such as geography and long-run climate, and state-by-year fixed effects, which absorb economic and policy changes that vary across states over time, such as state-level disaster recovery payments or broader economic conditions. This specification identifies within-person associations between changes in local environmental exposures and health, net of stable individual and area characteristics and state-year shocks. The main disaster analysis sample includes 88,954 person-year observations for the SF-6D outcome; the temperature analysis sample includes 149,051 person-year observations.

In addition to estimating direct associations, analysis was undertaken to determine whether underlying dwelling quality, as measured using latent housing-condition factors derived from four HILDA material-deprivation items, moderates the association between climate exposures and health. Those material-deprivation items are roof/gutter condition, secure doors and windows, overall dwelling security, ability to keep a room adequately warm.

For further details of the HILDA analysis, including variable descriptions, sample construction and model specifications, please refer to the Technical Appendix.

Literature review: costs, benefits and feasibility of climate-resilient retrofit

Drawing upon the resilient retrofit options identified in Lang et al. (2026) as a starting point, a literature review was undertaken to identify the costs, benefits and feasibility of current traditional retrofit and resilient retrofit approaches: technologies, materials and designs that exist in the market and could potentially be delivered at scale. This review looked at solutions currently available in Australia, as well as relevant international locations.

A search for relevant articles was conducted for key academic databases including Scopus and Google Scholar using search criteria including: (climate OR resilient) retrofit AND (hous* OR dwelling OR home), (climate OR resilient) AND (refurbishment OR retrofit) AND (hous* OR dwelling OR home), and [hazard] AND (impact OR cost OR risk) AND (hous* OR dwelling OR home). The climate hazards included were heat, bushfires, floods and storms. Given the rapidly changing financial context of building materials and technologies, the focus was on literature from the past decade: 2015–2025. After screening potential papers, the search identified 91 journal articles, government reports, industry reports and relevant websites that met the relevant search criteria.

Each article or wider output was then reviewed against the following criteria:

- costs of resilient retrofit action
- benefits of resilient retrofit action
- feasibility to scale-up resilient retrofit action.

Articles and wider outputs that aligned to a particular climate event were reviewed by members of the research team. Analysis was then cross-checked by other members of the research team to ensure consistency and completeness.

Cost-benefit analysis

A bottom-up CBA discounted cashflow (DCF) Microsoft Excel–based model was developed, drawing upon the evidence collected in Section 5.1. The inputs required for the analysis were:

- annual probability of the climate event occurring
- level of property damage expected
- loss of property value expected
- increase in dwelling operating cost expected
- impacts on health and wellbeing, and monetised loss of community cohesion.

The assumptions for the CBA model were refined through feedback from academic and policy experts, and the final assumptions applied are presented below.

The literature supports a range of probabilities for each climate event, as the evidence is too mixed to support the use of a specific probability. The CBA therefore uses a range, with 'optimistic' representing the lower end of the distribution of possible probabilities drawn from the literature (Table 3). This research defines a 'likely' and a 'pessimistic' scenario based on the literature review synthesis.

Table 3: Assumed annual probabilities of climate event occurring

Climate event	Optimistic	Likely	Pessimistic
Bushfire	1.25%	2.50%	5.00%
Severe storm	1.00%	2.00%	4.00%
Flood	1.00%	2.00%	4.00%
Extreme heat	12.50%	25.00%	50.00%

Source: Authors, based upon CSIRO (2026b), Powell et al. (2024a, b, c) and DELWP (2019).

Table 4 and Table 5 summarise the likely levels of property damage and loss of property value assumed for each type of climate event. Although these tables have three columns, they do not map onto the three columns shown in Table 3 for climate event probabilities. Instead, they represent alternative property type / location scenarios. The middle column is based on the estimated rebuild cost for the average Australian property. The other columns represent a lower end of the market or remotely located property type, and a higher-specification or larger property type, respectively.

Table 5 is based partly on the assumptions set out in Table 4, but also reflects findings from the literature review that suggest stronger evidence for a loss of property value associated with bushfire and flood events. There is no real evidence that severe storm events adversely affect property values, and so these assumptions were set to zero. This also makes intuitive sense, given that bushfire and flood events are much more closely associated with location than severe storms or extreme heat events.

Table 4: Assumed levels of climate-event-related property damage

Climate event	Lower-end specifications	Average	Higher specifications
Bushfire	$400,000	$600,000	$1,000,000
Severe storm	$117,900	$198,700	$279,500
Flood	$151,500	$225,750	$300,000
Extreme heat	$0	$7,500	$15,000

Source: Authors, based upon Delahunty (2026), Frasers Property (2025), Goss (2026) and Taylor (2025).

Table 5: Assumed levels of climate-event loss of property value

Climate event	Lower-end specifications	Average	Higher specifications
Bushfire	$50,000	$100,000	$200,000
Severe storm	$0	$0	$0
Flood	$30,000	$75,000	$150,000
Extreme heat	$9,000	$18,000	$27,000

Source: Authors, based upon Creagh et al. (2025), DEWHA (2008) and Powell et al. (2024a, b, c).

Table 6 summarises the assumed monetised costs of health, wellbeing and loss of community cohesion and, in the final column, the assumed impact of each climate event on dwelling operating costs.

Table 6: Health, wellbeing, community cohesion and operating cost assumptions

Climate event	Health, wellbeing, community	Operating costs
Bushfire	$15,780	$5,400
Severe storm	$22,800	$1,500
Flood	$22,800	$27,000
Extreme heat	$1,150	$550

Source: Authors, based upon Ademi et al. (2023), AHURI (2020), Committee for Sydney (2024), Deloitte (2022), Johnston et al. (2021), Manne (2026), and HILDA analysis presented in Chapter 5.

Table 7 shows the assumed climate-resilience retrofitting costs associated with each of the four event types. As with earlier tables, there are three sets of assumptions, but these are independent of the structure of earlier tables. In Table 7, there are three levels of retrofit options or costs, and these have been labelled as 'light', 'average' and 'robust' to distinguish them from other scenarios, based either on probability of occurrence or property type/location/market value.

Table 7: Climate-resilient retrofit costs

Climate event	Light	Average	Robust
Bushfire	$11,450	$33,140	$63,300
Severe storm	$4,750	$9,500	$19,000
Flood	$50,000	$100,000	$200,000
Extreme heat	$20,533	$26,075	$44,388

Source: Authors, based upon Abode Construction (2025), Armstrong et al. (2023), Dale et al. (2021), NEMA (2024a), NSW Government (2026b), Penman et al. (2017), Queensland Government (2025a).

Table 8 shows the final table of assumptions required to allow the DCF tool to function. For each climate-resilient retrofit strategy, an assumption was made about what proportion of the associated costs or damage is avoided by having invested in the retrofit. The assumptions were based upon the literature review and exploring outcomes of real-world climate events. However, actual damage mitigation requires research and validation.

Table 8: The assumed impact of retrofit strategies

Climate event	Light	Average	Robust
Bushfire	10.00%	30.00%	50.00%
Severe storm	20.00%	40.00%	80.00%
Flood	20.00%	40.00%	80.00%
Extreme heat	30.00%	60.00%	90.00%

Source: Authors.

In summary, the CBA tool rests on numerous assumptions, but by providing several levels or ranges for the main inputs, it is possible to provide a range of simulated outcomes. The CBA assumes a 30-year forward period and applies a discount rate of 7% (in line with Australian Government requirements) and undertakes sensitivity analysis for a 3% discount rate (in line with wider sustainability economics best practice analysis).

The CBA tool can be used to simulate each climate-event type, or all four events together. The probability of an event occurring is assumed to be independent both over time and between the event types. For example, the probability of a bushfire does not change for a given year or property if the simulation sets a flood or a severe storm occurring in that given year. This is a limitation of the tool, but is preferable to making further assumptions about interaction effects between probabilities of different types of climate event. The decision also reflects the unavailability of data on this issue.

2.4 Research limitations

There were some research limitations for this project, as outlined below.

- Challenges accessing privately held data for the resiliency of Australian housing stock mean that there may be better datasets available that could provide a more nuanced analysis for the mapping of resiliency deficit (e.g. insurance companies).
- The lack of consistency across what datasets included, and the level of detail provided, meant that a more granular level of analysis for the mapping of resiliency deficit was not possible for different housing typologies or characteristics.
- Lack of consistency across wider cost and benefit data meant wide ranges within the data assumptions applied within the CBA model. Sensitivity testing was undertaken to explore the impact of this on the analysis.
- HILDA provides only a small number of dwelling-condition indicators, and these are not consistently available across all waves. Important aspects of housing quality, such as insulation levels, energy efficiency, cooling capacity and retrofit status, are not directly observed. This limits the ability to precisely identify which housing features drive resilience and to quantify the full benefits of specific retrofit interventions.
- There is limited empirical evidence on the outcomes of climate-resilient retrofit for Australian housing in the literature, which may be explained by limited household uptake to date. This means that the cost-benefits modelled in this study require further empirical validation.
- This research focused on improvements of resiliency to individual dwellings. In reality there may be financial, environmental or social benefits to delivering resiliency at different scales, such as flood barriers around a specific geographical area. This scale analysis was outside the scope of this report and would require further analysis.

3. The climate resilience of Australia's housing

This chapter responds to research question 1: What is the extent of resiliency deficit in the Australian housing stock? Section 3.1 presents the resiliency data review and audit for the 16 identified datasets that met the search criteria, and Section 3.2 presents the mapping of housing resiliency deficit across Australia.

3.1 Housing resiliency data review and audit

The data review and audit summary of relevant and publicly available data on the resilience of Australia's housing is presented in Figure 1. Dark-red shading indicates that the dataset includes detailed self-reported/individually assessed data on the characteristic indicated in the left-hand column (e.g. insulation or dwelling age). Light-red shading indicates that the dataset accounts for this characteristic in some way, but that this may be limited or unreliable data.

For example, the Climate Risk/Council dataset assumes each dwelling is a 'standard modern dwelling', thus this data likely does not account for the diverse age and building standards of existing housing stock. No shading indicates that the dataset did not contain information about that criterion or that the information was not publicly available in the dataset. Data sources and datasets often focus on either dwelling characteristics *or* housing resilience, with fewer of the latter publicly available. Key datasets are briefly discussed below before discussing the overall strengths and limitations of available data around Australia's housing climate resiliency.

Figure 1: Dataset audit

Dataset element	Australian Bureau of Statistics	Australian Housing Conditions Dataset	Australian Disaster Resilience Index	Australian Housing Data Portal	Climate change and Indigenous housing performance in Australia: A dataset	Climate Risk/ Climate Council	HILDA	National Social Housing Survey	Resilient Building Council	Scorecard	Australian Housing Data Analytics Platform	BASIX	Building resilience rating tool / Insurance Council Australia Data	Council data
Dataset notes	Self-reported	Self-reported	Model applying multiple secondary datasets	Computer model	Whole building simulation, based on previous fieldwork and housing audit	Modelled	Self-reported	Self-reported + administrative data		Independent accredited assessment				As per building plan
Housing type														
Dwelling age														
New housing														
Existing housing														
Tenure														
Building codes														
Planning scheme														
Retrofit elements														
Structural/ building quality														
Energy rating/ assessment														

Figure 1 (continued): Dataset audit

Dataset element	Australian Bureau of Statistics	Australian Housing Conditions Dataset	Australian Disaster Resilience Index	Australian Housing Data Portal	Climate change and Indigenous housing performance in Australia: A dataset	Climate Risk/ Climate Council	HILDA	National Social Housing Survey	Resilient Building Council	Scorecard	Australian Housing Data Analytics Platform	BASIX	Building resilience rating tool / Insurance Council Australia Data	Council data
Retrofit elements														
Draught-proofing														
Insulation														
Windows														
Shading/ shutters														
Electrification														
Appliances														
PV														
Batteries														
Rainwater tank														
EV charging station														
Solar / heat pump hot water														
Smoke detector														
Sources of energy & water used														

Figure 1 (continued): Dataset audit

Dataset element	Australian Bureau of Statistics	Australian Housing Conditions Dataset	Australian Disaster Resilience Index	Australian Housing Data Portal	Climate change and Indigenous housing performance in Australia: A dataset	Climate Risk/ Climate Council	HILDA	National Social Housing Survey	Resilient Building Council	Scorecard	Australian Housing Data Analytics Platform	BASIX	Building resilience rating tool / Insurance Council Australia Data	Council data
Hazards														
Heat														
Flood														
Storms (including cyclones)														
Bushfire														
Scale														
House level														
SA2														
LGA					Other: select locations only									
State														
Nationwide														
Number of homes	All	22,500		1.7 million	N/A	All	17,000	9440	55,000 assessments to date	13,000+		500,000+		New build/ renovated properties only
Currency of the data									Not reviewable				Not reviewable	
Data publicly available?	Yes	Yes, on request	No	Public summary, details can be accessed via CSIRO	Yes	Paid	Yes	Yes, on request	No	No, but access for research can be obtained				No, only to property owners

Source: Authors.

Note: Red = dataset includes detailed data. Blue= dataset has limited or unreliable data. No shading = dataset did not publicly contain information about that criterion

3.1.1 Datasets focused on dwelling characteristics

The **Australian Bureau of Statistics (ABS)** captures self-reported data about households and housing every five years. The ABS began publishing statistics about solar electricity in 2011 (ABS 2025). It also has data on housing quality and performance (ABS 2026), such as insulation, windows and appliances. However, this data is largely from more than a decade ago (when the ABS stopped collecting such data) and of limited relevance, given the significant number of new housing construction and renovation/improvements undertaken to existing housing in recent years.

The **Australian Housing Conditions Dataset** (including the Australian Rental Housing Conditions Dataset) was launched in 2016, and is led by Adelaide University in partnership with multiple other Australian universities (Baker et al. 2026). It has been updated every 2 to 4 years, with the latest release in 2024. The dataset is one of the most comprehensive datasets of dwelling structural, tenure and retrofit characteristics. The data is self-reported and contains approximately 22,500 households.

The **Australian Housing Data Portal** has been collecting information contained within Nationwide House Energy Rating Scheme (NatHERS) certificates since 2016, and contained more than 1.68 million properties in the database at the end of 2025 (CSIRO 2026a). While primarily focused on new dwellings across Australia, the dataset does contain a more limited number of assessments undertaken on existing dwellings. The publicly available data is presented at an aggregated national, state, LGA, postcode and climate zone level, although more detailed data access is possible through the CSIRO. The Building Sustainability Index (BASIX) captures similar information to NatHERS, but is limited in geographic scope to New South Wales (NSW Government 2026a).

The **Victorian Residential Efficiency Scorecard** (Scorecard) database was established by the Victorian Government in 2017 and expanded nationally in 2018–2019 (Victoria Government 2026). The Scorecard aimed to comprehensively capture the quality and performance of existing housing, and has been used for more than 13,000 dwellings, including a portion that have evaluated pre- and post-retrofit outcomes. This dataset scores highly for its currency. Unlike much other housing data captured in Australia, the data is captured onsite and independently verified. The Scorecard was phased out in 2026 due to the development of NatHERS for existing homes.

Australian local governments or councils hold data for all dwellings requiring a planning or building permit, including dwellings upgraded under local flood or fire overlays, and whether (and to what extent) a building's design meets energy and building code requirements. Individual household data is only available to the property owner.

3.1.2 Datasets focused on climate hazards

Climate Council and Climate Risk maps use data that models climate change hazards for the modern Australian dwelling (Climate Council 2026). The modelling of flood, storms and bushfire risk for households is the only database analysis that looks at both retrofit characteristics and climate hazards. This mapping provides neighbourhood-level accounts of the risks for Australian households. However, it does not account for varied dwelling ages and types, which means that different building code or planning system changes are not reflected in the modelled impacts.

The Resilient Building Council has a freely available tool that uses self-reported data about a dwelling's material make-up and location to assess its bushfire resilience (Resilient Building Council 2025). It captures bushfire-relevant dwelling information, such as when the dwelling was built, external roof and wall materials, Bushfire Attack Level (BAL) certification, bushfire shutters and rainwater storage details. This data is not publicly available, but is available to the household undertaking the assessment. There have been more than 55,000 assessments via this tool to date, and more than 6,500 of these have implemented at least four recommendations (NAB 2025; Resilient Building Council 2024).

Other datasets: The Insurance Council of Australia has a Building Resilience Rating Tool, which considers information about a dwelling's design and location (including its climate zone) to determine a resilience rating. This data is not publicly available, but is reflected in insurance quotes/costs for individual households. Insurance Australia Group and SGS Economics also analysed LGAs that face the greatest risk of natural disasters and climate hazards (SGS Economics & Planning 2016). While this data is publicly available, it does not include housing data.

3.2 Housing stock resiliency deficit

Given the limitations of the available data on the climate resilience of Australian housing shown in Section 3.1, understanding resiliency deficit requires comparison of construction standards over time in relation to the attributes of a climate-resilient home. The mapping of housing resiliency deficit for different climate hazards is presented in Figure 3. The data demonstrates that there is a significant to moderate deficit across all climate hazards and across all housing ages, assuming limited climate-resilient retrofit uptake across the housing stock. Broadly, states have followed similar approaches to the development and introduction of minimum requirements through the building code or through local planning schemes. Thus, the change in resiliency deficit is similar across states.

Figure 2: Map of state-based housing resiliency deficit for different climate hazards

		2025 climate scenario			
State/Territory	Hazard	Pre-1985	1985–1990	1991–2005	2006–2025
Victoria	Heat	Significant deficit		Moderate deficit	
	Bushfire				Low deficit
	Flood				
	Severe storms	N/A			
New South Wales	Heat				
	Bushfire				
	Flood				
	Severe storms				
Queensland	Heat				
	Bushfire				
	Flood				
	Severe storms				
South Australia	Heat				
	Bushfire				
	Flood				
	Severe storms				
Australian Capital Territory	Heat				
	Bushfire				
	Flood				
	Severe storms				
Northern Territory	Heat				
	Bushfire				
	Flood				
	Severe storms				
Western Australia	Heat				
	Bushfire				
	Flood				
	Severe storms				
Tasmania	Heat				
	Bushfire				
	Flood				
	Severe storms				

Source: Authors. Draws upon: ABCB 2019; ABCB 2020; ABCB 2026b; ABS 2025; ABS 2026; Baker et al. 2026; Climate Council 2026; Cook 2017; CSIRO 2026a; Gonzalez-Mathiesen et al. 2019; Lang et al. 2026; Henderson et al. 2022; Northern Territory Government 2026; NSW Government 2005; NSW Government 2024; NSW Government 2026a; Resilient Building Council 2025; Victoria Government 2026

Note: Dark red = significant deficit. Light red = moderate deficit. White = low deficit. Grey = not applicable.

Improvements to resiliency deficit for heat, bushfires, floods and storms have occurred at key points of policy development.

Heat

Improvements are related to the introduction of minimum insulation requirements in different states in the early to mid-1990s, and the development of NatHERS and the minimum star-rating approach in the mid-2000s. Some jurisdictions had different implementation times for such changes, but housing built from 1991 onwards typically meets significantly improved energy-efficiency outcomes compared to housing built prior. However, current requirements (as per the NCC 2022) do not meet all the requirements set out in the resiliency guidelines (see Lang et al. 2026).

Bushfires

Improvements for resiliency to bushfires generally occurred through local planning requirements, but increasingly through building code requirements from the 1990s onwards. Although there were some revisions and improvements of bushfire protection in the early 2000s in some jurisdictions, more significant changes occurred after significant bushfires in 2009 – including the introduction or strengthening of the BAL. These changes resulted in new housing largely meeting the resiliency requirements of the guidelines, although there are:

- some points from the resiliency guidelines that are not yet being required
- no requirements for existing housing to upgrade to meet new bushfire standards.

Floods and storms

Responses to floods and storms have perhaps had the least improvement over the last 40 years. Most states and territories have some requirements for flood and storm protection in their local planning and building code requirements. These typically refer to restrictions on where a dwelling can be built, or to the minimum floor level a property can have in a certain area. The use of outdated flood data to inform planning requirements has been discussed in recent years, after several flooding events in cities such as Melbourne highlighted the limitations of existing flood protection approaches. Other elements of flood and storm protection, as outlined in the guidelines, are still not typically required.

Storms were mostly focused on in terms of cyclones, which are currently only relevant to certain areas of Queensland, the Northern Territory and Western Australia. Key improvements for resiliency in relation to cyclones occurred post-1980, following Cyclone Tracy in the Northern Territory in 1974 (Henderson et al. 2022). While this has seen the improvement in the performance of newer housing in cyclone-prone areas, there are still several considerations in the guidelines that are not mandatory within building codes or local planning requirements in relation to severe storms.

3.3 Discussion

The analysis of the datasets found that there are limited but growing data on the energy and thermal performance of Australia's existing housing stock.

However, there is an absence of publicly available data on the impacts of climate hazards on households and housing quality or condition. This is not unexpected, as the research and policy focus in Australia has largely been on improving housing quality and performance, with resiliency and impacts from climate a more recent area of focus (Berry et al. 2013; Hulathoowage et al. 2025; Moore and Doyon 2023; Pablo et al. 2024).

In relation to datasets on energy and thermal performance, the Australian Housing Conditions Dataset, the Scorecard and the Australian Housing Data Portal are the most comprehensive datasets on dwelling retrofit elements. The Australian Housing Conditions Dataset is the most comprehensive dataset of dwelling structural, tenure and retrofit characteristics of existing housing. It currently contains 22,500 dwellings in the dataset, which is around 0.2% of the housing population in Australia, and the data is self-reported, meaning there is potential for inaccuracy in responses. The Scorecard is another dataset that comprehensively captured the quality and performance of existing homes and could be used to track or measure retrofit outcomes with data collected by an accredited assessor. More than 13,000 assessments were completed by the time the assessment tool ceased in 2026.

The Australian Housing Data Portal contains modelled characteristics for more than 1.68 million homes (at the end of 2025), but the majority of these are for new homes (96.1%), and the existing homes assessed account for about 0.6% of the total Australian housing stock. While new home assessments are relevant for understanding these homes once they become 'existing', it is unlikely those homes will undertake significant retrofit for resiliency or performance for several years. With the Scorecard ceasing operation in 2026, it is expected that NatHERS for existing homes assessments will see the Australian Housing Data Portal have a significant increase in data on existing housing over the coming years.

In relation to climate resiliency, the Climate Council's modelling of flood, storms and bushfire on households is the one database that looks at both dwelling retrofit characteristics and climate resiliency. This mapping provides neighbourhood-level accounts of the risks for Australian households. However, it does not account for varied dwelling ages and types, meaning that different building code changes are not reflected in the modelled impacts.

The analysis of housing resiliency deficit demonstrates that there is a significant to moderate deficit across all climate hazards and across all housing ages. This is not unexpected, given that a significant focus on improving quality and performance outcomes of new housing has only emerged over recent decades (Berry et al. 2013, Moore and Doyon 2023). Additionally, changes to requirements to improve protection from acute climate events like bushfires and floods have tended to be reactive rather than proactive, and often occur after reviews into large-scale events such as Cyclone Tracy in 1974 and the 2009 Black Saturday bushfires.

Across all climate events, there have been resiliency improvements from the pre-1995 housing to the housing delivered in 2026. However, there is still a significant gap for heat, floods and storms in comparison to the resiliency requirements set out in Lang et al. (2026). Even bushfire standards, which have potentially seen the most improvement for resiliency, do not address all requirements identified in Lang et al. (2026).

The implications are that most existing housing in Australia is not fit for purpose in relation to resiliency, and will need to undergo resiliency retrofit for one or more climate impacts to ensure improved protection for the physical property and households.

3.4 Implications

There is a lack of trusted publicly available data on the quality and performance of the resiliency of Australian housing. It is critical that this data gap be addressed if policy makers and the wider housing sector are to respond to the growing challenges presented by climate change.

Good policy and wider government support programs must be based upon high-quality data and evidence to ensure that the improved outcomes are achieved. Furthermore, households are unlikely to know where to start or what to do to make resiliency improvements without first having some base information about their dwellings, as well as effective retrofit measures. This is an important component to supporting households to undertake retrofit.

The introduction of NatHERS for existing homes, along with the potential voluntary or mandatory introduction of disclosure, may help expand the knowledge of existing housing in Australia. This has been done in New South Wales, and the ACT already has an existing framework. However, as the Scorecard assessment tool showed, it could take time for such data to be collected if it remains voluntary. With more than 700,000 property settlements in 2024 (PEXA 2025), and more new rental agreements started, disclosure is key to collecting more suitable data about quality, performance and resiliency across the wider housing stock. But for this data to be useful for understanding resiliency, there will need to be additional data collected beyond the current focus on thermal and energy performance.

The data-review search identified that there are likely datasets held by insurance companies and financial institutions that may have a more granular level of detail on individual properties, and which could also be used for larger-scale analysis of property condition and opportunities to improve resiliency outcomes. This data could not be publicly accessed but may help with wider research and policy understandings around the resiliency of the Australian housing stock.

It was beyond the scope of this project to access such data. Future research should work with holders of private data to better understand the context of Australian housing and its climate resiliency. These challenges around availability, depth and consistency of data for housing and resiliency have also been noted elsewhere (Sanderson et al. 2025).

4. Health impacts of heat, natural disasters and the mediating role of housing quality

This chapter contributes to research question 2: What are the financial and non-financial costs and benefits to retrofit the housing stock for resiliency? It presents an analysis examining how heat exposure, acute climate events and underlying dwelling conditions affect health and wellbeing in Australia. Section 4.1 presents the results discussion, with Section 4.2 presenting implications for policy and practice.

Full details of the data, variable construction, model specification and estimation samples for the analysis presented in this chapter, along with complete regression results, are provided in the Technical Appendix.

4.1 Results and discussion

4.1.1 Association between health and natural disasters

Living in an LGA that experienced a declared natural disaster in the previous 12 months is associated with a 0.0032 point reduction in SF-6D utility (p-val = 0.013, 95% Confidence Interval [CI]: -0.0057 to -0.0007).

In terms of quality-adjusted life years (QALYs), this is equivalent to losing 1.17 days of full health per person per year, with a monetised value of $160 per person-year.[4] These estimates reflect an average association across all individuals living in disaster-affected LGAs and across all types of disaster events.

Associations are likely to vary, with larger associations plausible for individuals who are more directly exposed or affected, and for more severe disasters relative to milder events. When examining the various domains of the SF-36, these associations are concentrated in mental health, vitality, role-emotional functioning and social functioning, rather than physical functioning. This pattern is consistent with evidence that the health burden of disasters in high-income countries operates primarily through psychological and social pathways, since physical injury is comparatively rare and concentrated in the acute period, rather than in the following months captured by the HILDA interview (Johar et al. 2022).

4.1.2 Association between health and heat exposure

Short-run heat exposure, measured as the average maximum temperature over the four weeks prior to interview, shows a weak, imprecisely estimated association with declines in health. A 1°C increase in average monthly temperature is associated with a reduction in the SF-6D health utility of approximately 0.00036, though this estimate is not statistically significant at conventional levels (p-val = 0.069, CI: −0.00075 to 0.00003) and should be interpreted as suggestive rather than conclusive. This corresponds to 0.000028 QALYs lost per person exposed over a four-week period, equal to $1.40 per person per extra degree Celsius.[5]

4 i.e., -0.0032 × 365 = 1.168 days in full health. 0.0032 × $50,000 per QALY = $160.
5 i.e., -0.00036 × (4 weeks / 52 weeks) = 0.000028 QALYs. 0.000028 QALYs × $50,000 per QALY = $1.40.

While these small associations may seem modest at the individual level, they could accumulate to a larger total when aggregated across large populations and multiple warmer months and years, which are projected to increase in frequency under climate change. These estimates also reflect average associations across individuals, locations and temperature conditions.

In practice, associations are likely to vary, with potentially larger associations for individuals more exposed or vulnerable to heat, and during more extreme temperature events. Associations with heat extend across multiple domains of health, with statistically significant declines in physical functioning, vitality, social functioning, role-emotional and mental health, which indicates that climate-related health burdens are not limited to traditional physical health measures alone.

4.1.3 The role of housing quality

To assess whether dwelling characteristics relate to vulnerability to climate stressors, two measures of housing quality using HILDA data were constructed:

1. Structural integrity: capturing dwelling soundness and security; for example, secure doors/windows, absence of leaks.
2. Thermal resilience: the ability to keep at least one room adequately warm in cold weather.[6]

These measures represent relatively stable characteristics of dwellings and households. While their direct associations with health cannot be estimated within a fixed-effect regression framework, they can be used to assess whether housing quality moderates the association between heat or disaster exposure and health.

The analysis finds no statistically significant evidence that the structural integrity measure moderates this association for either heat or acute climate events. The estimated coefficient is in the expected (protective) direction for disaster exposure, but is imprecisely estimated. This may reflect either:

- a true absence of moderation
- insufficient power to detect it given the limited set of structural attributes captured in HILDA data.

Other aspects of building quality, such as construction materials, insulation, dwelling age or specific retrofit features, are not observed, and are likely to play an important role in resilience.

In contrast, the interaction between thermal adequacy and heat exposure is statistically significant. Households that are able to keep their homes adequately warm in cold weather are associated with substantially smaller declines in health during hot periods. This measure reflects broader thermal performance and energy capability, including insulation, adequacy of heating/cooling, and the affordability of energy use. The pattern suggests that households lacking thermal resilience are more vulnerable to temperature extremes in general, not just cold conditions.

However, thermal adequacy is not randomly assigned: households with thermally adequate homes likely differ systematically on characteristics such as income, wealth, energy affordability and area. While the person-level fixed effects absorb the main effect of thermal adequacy itself, they do not absorb its interaction with exposure, since this interaction varies over time whenever exposure does. The interaction may therefore partly reflect broader household advantage rather than a specific causal role of thermal performance in isolation, and should be read as a descriptive pattern consistent with, but not proof of, thermal performance mattering for resilience.

6 HILDA does not include a parallel question about the ability to keep the home cool in hot weather. However, the cold-weather thermal adequacy measure reflects broader aspects of a dwelling's thermal performance, such as insulation quality, heating and cooling capability, and the affordability of maintaining indoor comfort, and is therefore a reasonable proxy for resilience to both cold and heat.

4.2 Implications

These results highlight several key implications for the feasibility and value of housing resilient retrofits, as follows.

- Thermal performance is associated with climate resilience. Homes with better insulation, sealing and heating/cooling systems are associated with smaller health burden from heat exposure. Over time, the health benefits will likely increase following resilient retrofit as both warmer and cooler temperatures are predicted to occur more frequently and to last longer.
- While there has been increased focus on retrofit of existing housing to improve thermal and energy performance for affordability and sustainability, there is a need to ensure that the resiliency benefits are included, so that households, policy makers and industry stakeholders better understand the impacts within the context of a changing climate.
- The implication for policy and practice is that existing retrofit and housing energy performance programs should explicitly account for resilience benefits when setting priorities or eligibility criteria. Thermal upgrades already being pursued for affordability and sustainability reasons are also likely to reduce climate-related health burdens, providing a rationale for incorporating resilience objectives into existing retrofit policy channels rather than treating them as a separate program.
- Health benefits are primarily realised through mental and social wellbeing. This suggests that retrofit programs should be evaluated not only in terms of physical safety or energy efficiency, but also broader wellbeing outcomes. This wider consideration of wellbeing may help improve the feasibility of resilient retrofit (see Chapter 5).
- Benefits accumulate at scale. Even small individual health effects translate into large aggregate gains when applied across populations and repeated heat and disaster events. Evidence of rapidly increasing health costs relating to a changing climate is starting to emerge in Australia. For example, Tong et al. (2022) identified significant financial costs from increased hospitalisations during heatwaves in Australia. Policy makers should be considering the health impacts of resilient retrofit to help understand the impacts of resiliency.
- A key finding of this analysis is the limited availability of detailed housing-quality data. HILDA provides only a small number of dwelling-condition indicators, and these are not consistently available across all waves. Important aspects of housing quality, such as insulation levels, energy efficiency, cooling capacity and retrofit status, are not directly observed. This limits the ability to precisely identify which housing features drive resilience and to quantify the full benefits of specific retrofit interventions. Addressing these data gaps would substantially improve the evidence-base for housing and climate policy, and enable more precise targeting of retrofit programs. The implication for policy and practice is that these data gaps are a direct barrier to more precise targeting of retrofit programs: without granular housing-condition data, policy makers cannot readily identify which dwellings or households stand to benefit most from resilience retrofit, and this limits the ability to direct limited public funding toward the highest-return interventions.

5. Costs and benefits of climate-resilient retrofit

This chapter responds to research question 2: What are the financial and non-financial costs and benefits to retrofit the housing stock for resiliency?

Section 5.1 presents analysis of a literature review examining the costs, benefits and feasibility to deliver resiliency retrofit at scale. Section 5.2 presents a cost-benefit analysis (CBA). Section 5.3 discusses the results and presents a number of implications for policy and practice.

5.1 Literature review

The following sections present the wider literature found exploring the costs, benefits and feasibility of resilient retrofit for:

- heat
- bushfires
- floods
- storms.

Across the climate events, there is a limited but growing body of Australian and international evidence as to the impact of such events on properties in terms of potential physical damage – as well as wider impacts to things like property values, insurance premiums, operating costs such as energy bills, and social impacts to health and wellbeing.

Some of the evidence is presented as clear benefits (e.g. reduced energy bills), while other data is presented as negative impacts if changes are not made or included, such as reduction of property values. Additionally, there is a variety of research and data on the potential costs and solutions to delivering various resiliency retrofits for the different climate events. Where relevant, the variety of research is presented below and drawn upon for the CBA in Section 5.2.

Sections 5.1.1–5.1.4 present literature around costs and benefits for each resilient retrofit hazard, with feasibility of delivering such outcomes presented in Section 5.1.5 due to overlap between the hazards.

5.1.1 Heat-resilient housing retrofit

Overall, research on the costs, benefits and feasibility of heat-resilient retrofits is overly focused on general retrofit approaches, of which improving for all weather is typically included (Elsayed et al. 2022; Fox-Reynolds et al. 2021; Gonzalez-Caceres et al. 2022; Robertson et al. 2025; Saffari and Beagon 2022).

Within the general residential retrofit literature, the focus has been more on improving overall thermal comfort and energy performance outcomes. While such improvements have been recognised as helping in a changing climate, the focus is not typically on future climate scenarios or just on extreme heatwaves to inform retrofit outcomes (Hulathdoowage et al. 2023; Liyanage et al. 2024; Zahiri and Gupta 2023). The research has covered the costs of undertaking retrofit and the range of packages of retrofit which can deliver various improved outcomes, in addition to the cost of not undertaking retrofit, typically in terms of increased energy bills and impact on health and wellbeing (Armstrong et al. 2023; Page et al. 2022).

There is also some research which suggests an increased resale value for housing that has improved thermal and energy performance, although again this is largely not framed as specifically around heat resiliency, but improving quality and performance more broadly (DEWHA 2008; Fuerst et al. 2015; Fuerst et al. 2016).

Costs and benefits of heat-resilient housing

Internationally, there is an emerging focus on the passive survivability (Samuelson et al. 2015) or thermal autonomy (Levitt et al. 2013) of dwellings – in other words, the ability of a dwelling to maintain safe indoor conditions during a heatwave without air conditioning, in different contexts. Retrofit for heat resilience for passive survivability shifts significantly from existing thermal comfort approaches (Baniassadi et al. 2018; Horne et al. 2026; Le et al. 2025), with natural ventilation and changes to insulation levels needed to be considered across different climates.

There is also increasing focus on how liveable existing housing will be as houses and households are exposed to more extreme heat in future years. For example, modelling by Le et al. (2025) show that under future climate heatwave conditions a typical 4- or 5-star detached Australian house will fail to maintain safe indoor temperatures during a heatwave and power outage. Similar outcomes have also been found in earlier Australian research (Sweltering Cities and Renew 2024; Wang et al. 2010). Meanwhile, analysis of temperature data from vulnerable households in New Zealand found significant increase in the number of homes that will overheat during the day and overnight by the year 2100 (Chen et al. 2026).

Research by Le et al. (2025) recommends that existing approaches to retrofit for heat-resilient passive design prioritise natural ventilation, light-coloured roofs and climate-based approaches to insulation to limit risks of overheating. Other Australian-focused research has pointed to the implications of existing building codes to retrofit for heat resilience. Analysis of climate files and building performance standards as they relate to single-storey, double-storey and multi-unit dwellings in Western Sydney found that:

- Nationwide House Energy Rating Scheme (NatHERS) climate files are outdated (last updated in 2022)
- BASIX-approved dwellings become thermally unsafe during extreme heat without air conditioning (Upadhyay et al. 2022).

These findings will have implications for households, not just now but into the future as the climate continues to change.

A systematic review of passive cooling strategies for residential buildings (Hu et al. 2023) found passive strategies can:

- reduce indoor temperature by 2.2°C
- reduce cooling loads by 31%
- deliver energy savings of about 29%
- provide a thermal comfort hour extension (an extension of the time a dwelling is thermally comfortable) of 23%.

The researchers note that the five most effective passive strategies for cooling are:

- exterior roof thermal property and colour
- exterior wall thermal property and reflectivity
- windows and glazing
- optimising cross-ventilation
- window-to-wall ratios (Hu et al. 2023).

However, not all of these passive cooling strategies can be easily retrofitted, with many limited by the initial dwelling design and construction.

Roof colour is one passive cooling strategy that has been gaining more attention in the Australian context. In NSW, light-coloured roofs have been estimated to save an average household almost $700 in utility costs compared to a dark roof (Pfautsch and Paolini 2024). In 2022 the New South Wales Government announced plans to ban dark-coloured roofs. This plan never eventuated because of pushback from developers, thus locking households into poorer performing housing, especially during heat events (Pfautsch and Paolini 2024).

In the USA, Williams et al. (2020) modelled detached single-family homes built between 1990 and 2010 across 10 different cities. Two retrofit scenarios were applied:

- light retrofit: air infiltration, roof albedo, roof and wall insulation, improved glazing U-values
- deep retrofit: a light retrofit plus incorporation of phase change materials (materials that absorb and release large amounts of energy when they change phases).

The cost would be US$25 billion (light scenario) and US$212 billion (deep scenario) to retrofit approximately 3.6 million properties across the 10 cities. The cost estimates of the retrofit strategies ranged from about US$5,100–$8,600 per unit for light retrofits and US$52,000–$67,000 per unit for deep retrofits. Benefits were measured based on energy, health, utility and climate. Despite the household and wider community benefits from retrofit, the researchers concluded that deep retrofits were not financially viable, even though the light retrofits had an average payback period as low as 6 years. This highlights the global challenges of delivering the levels of deep retrofit required for the type of climate we are likely to see in future years.

In the local context, modelling of different energy and thermal performance upgrades of archetypal Australian homes – detached house, townhouse and apartment – and studies of energy and thermal upgrades show demand reduction and health benefits. ClimateWorks (Armstrong et al. 2023) modelled energy and thermal performance renovations, including upgrades to achieve ‘climate-ready homes’. They modelled three refurbishment bundles: quick fix, modest and climate-ready (see Table 9).

Table 9: ClimateWorks' retrofit scenarios

Parameter	Quick fix	Modest	Climate-ready
Retrofit inclusions	R3.0 ceiling insulation	As per 'Quick fix', plus R2.0 underfloor insulation	As per 'Modest', plus R2.0 wall insulation
	Draught-proofing	As per 'Quick fix'	As per 'Modest'
	Curtains and external roller shutters	As per 'Quick fix', plus retrofit double glazing / film	As per 'Modest', plus double glazing
	Installation of an energy efficient electric heat pump for heating and cooling	As per 'Quick fix'	Efficient electric heat pump with HRV Efficient 85% heat recovery
	Efficient hot water and cooking	As per 'Quick fix'	As per 'Quick fix'
	Solar PV (max. roof area)	Solar PV (medium roof area)	Solar PV (minimum roof area)
Cost of upgrades	$14,800–$20,600	$20,600–$26,300	$40,300–$45,200
Energy bill savings (annual)	$1,845	$1,883	$2,195
Private/household benefit-cost ratio	1.69	1.24	0.72
Societal benefit-cost ratio	2.27	1.67	0.99

Source: Authors, based upon Armstrong et al. (2023).

Note: PV = solar panel, HRV = Heat Recovery Ventilation

ClimateWorks' quick-fix and climate-ready upgrades reduce annual peak demand by 1.4–3.5 kW per home. The report notes that this is equivalent to 'a 30–77 % reduction in peak household demand', with 'climate-ready' thermal upgrades resulting in the greatest reduction in annual peak energy demand across all home types modelled.

For over half the households in the ClimateWorks research, quick-fix and modest thermal upgrades are cost-effective, with a benefit-cost ratio above 1. However, climate-ready upgrades would need financial assistance to make them financially viable. The modelling also found that 'quick-fix' and 'modest' retrofits could result in energy cost savings of between $1,845 and $1,883 per year, with climate-ready retrofits resulting in energy cost savings of up to $2,195. Like much of the retrofit research, this study focused on the wider impacts from a changing climate, not just heat.

The One Million Homes retrofit plan by RACE for 2030 finds that basic building envelope retrofits could reduce energy consumption by 18–31%, with comprehensive retrofit packages delivering reductions of almost 100% (Fox-Reynolds et al. 2021). Similar to the ClimateWorks study, it was noted that there was a balance between retrofit improvements and financial benefits.

In Victoria, the Healthy Homes randomised controlled trial investigated the health benefits of energy performance and thermal shell upgrades (Page et al. 2022). Although it focused on the impacts of winter cold, it found healthcare benefits, physical health benefits and quality of life benefits for occupants of upgraded homes, with healthcare system savings equal to $887 per person over the winter period. Earlier research by Howden-Chapman et al. (2009) modelled the health gains, energy and CO2 emissions savings of retrofitting insulation, and found the benefits were one and a half to two times the magnitude of the cost of the retrofit (Howden-Chapman et al. 2009). Given that many retrofit activities to improve winter thermal comfort can also improve summer thermal comfort, it could be expected that there would be significant financial and healthcare benefits in summer as well.

While most of this research looks at how to make the whole home more resilient, there is also research that explores how to deliver climate-safe rooms within dwellings (Geelong Sustainability 2023).

Climate-safe rooms are a more affordable option to help low-income households, in particular, improve liveability (or survivability) during peak weather events. One pilot program from Geelong, Victoria, found significant benefits from the delivery of climate-safe rooms for 16 vulnerable households, which included:

- adding to or installing ceiling, wall and underfloor insulation
- adding secondary glazing
- sealing of exhausts
- adding ceiling fans (Geelong Sustainability 2023).

The pilot study found that in summer, participants felt 100% more comfortable and encountered 75% fewer days where they experienced excessive heat discomfort. Including solar with the climate-safe room resulted in energy bills being reduced by 45% across summer, and delivering feed-in-tariff credits for excess energy generation of $168 per household. The average cost of a climate-safe room retrofit was $7,860, which is significantly less than the costs for a deep whole-of-home retrofit (Armstrong et al. 2023; Geelong Sustainability 2023).

While not directly about residential retrofit, there is an increasing focus from sustainability advocates to address urban heat island impacts as part of a wider strategy to help improve the performance of individual properties (Arifwidodo et al. 2021; Rajagopalan et al. 2020; Roxon et al. 2020). (A heat island refers to the additional heat held in the built environment.) Researchers found that the ambient air temperature difference between well-vegetated areas and areas with limited or no vegetation could be up to 12°C during a heatwave, which then has implications for internal air temperatures of a dwelling (Duncan et al. 2019).

Ensuring that ambient air temperatures are lower during a heatwave will likely result in the need for less mechanical cooling during such periods. This has implications for wider considerations, such as health, wellbeing and productivity (Jay et al. 2021; Romanello et al. 2025). For example, research from Sydney (Committee for Sydney 2024) calculates that the financial impact from exposure to high heat is $304 on health and $153 on productivity per person. By the 2070s, these numbers are predicted to grow to $716 for health and $332 for productivity, highlighting the significant wider costs from heat.

There is limited research to date on the physical damage caused to housing from increased exposure to extreme heat, and this is overlooked in comparison to other acute climate events. However, research from the UK indicates that the costs for damage may be high. The 2022 UK heatwave generated 23,000 subsidence claims, with UK insurers expected to pay out £219 million – which is the highest annual subsidence payout since 2006. The average subsidence claim per property was £9,600 (approximately AUD $18,700) (Goss 2026).

There is also increasing research on the added resale value of dwellings that demonstrate improved sustainability performance. Much of this research has focused on Europe and other jurisdictions that have in place mandatory disclosure at the point of sale or lease (Fuerst et al. 2016; Fuerst and Warren-Myers 2018; Kok and Kahn 2012; Marmolejo-Duarte and Chen 2019; Taranu et al. 2020; Zhang et al. 2018). The research is mixed, but tends to indicate additional resale value from improved sustainability outcomes. In the USA, for example, Zhang et al. (2018) found a market premium of almost 12% for homes with an energy certificate, and in England, Fuerst et al. (2015) revealed a 5% price premium for dwellings with the highest Energy Performance Certificate (A) compared to dwellings rated D.

Within the Australian context, the Australian Capital Territory has had disclosure in place for more than 20 years, with research finding that for each star-rating increase, an added resale value of $9,000 could be achieved (DEWHA 2008). Given consumers' increased understanding of sustainability it is reasonable to assume that there is even greater resale value in the current market, as suggested by wider grey literature (Domain 2025). Much of this evidence is based upon a range of sustainability considerations, which makes it difficult to identify the potential increase due to heat resiliency alone.

5.1.2 Bushfire-resilient housing retrofit

Research on the costs, benefits and feasibility of bushfire-resilient retrofits is limited, both in Australia and internationally. The research has focused on potential opportunities to reduce risks from bushfire, mainly in new housing, but also in existing housing. There is emerging evidence around the cost of not taking action, largely in terms of impacts on negative property values (Penman et al. 2017; Powell et al. 2024a; Resilient Building Council 2024; Salam et al. 2025). This research includes:

- studies involving property assessments (Barrett and Quarles 2025; Borate et al. 2025; Horing et al. 2025; Thurman 2022)
- cost analyses (Barrett and Quarles 2025; Elmira and Vanessa 2018; Shum and Zhong 2022)
- household surveys (Ergibi and Hesseln 2020; Shum and Zhong 2022).

There has also been wider research on improving performance of housing in higher-risk bushfire zones for new housing, and impacts on communities after bushfire events.

Costs and benefits of bushfire-resilient housing

In the Australian context, bushfire retrofit costs and benefits have been analysed based on property assessments.

Based on 10 homes on the New South Wales Central Coast, Penman et al. (2017) estimate the cost of retrofitting standalone housing to construction levels associated with the Bushfire Attack Level (BAL) to indicate the importance of building upgrades. Retrofit costs are identified for achieving a BAL-40 standard of construction, meaning the property is at risk of 'increasing levels of ember attack and burning debris ignited by windborne embers together with increasing heat flux with the increased likelihood of exposure to flames' (Penman et al. 2017). Building upgrades and other preparedness measures are estimated to cost (in 2017 Australian dollars) between $8,527 to $46,856, with an average of $24,596, which is equivalent to around $63,000 in 2026 (Penman et al. 2017). Most of the building retrofit cost is attributed to upgrading walls, windows, doors, decks and verandas. (Penman et al. assume the windows have 5mm toughened glass and that timber decks or verandas are made of bushfire-resistant timber.)

A more recent study by Salam et al. (2025) provides a qualitative analysis of bushfire retrofit costs, informed by an assessment of three homes in the Bega region of New South Wales. Salam et al. define retrofit measures that align with construction standards for bushfire-prone areas (AS3959:2018) and rank them by priority, effort and cost. Table 10 summarises the recommended retrofit measures. Most retrofit measures, including the roof, external walls, windows, doors, deck and grounds are high priority. Double-glazed windows are considered low priority and high effort. Trimming and replacing trees is considered high priority and high effort. The high-cost measures include:

- double-glazed windows (low priority)
- protecting re-entrant corners and the bottom of all ground level walls (moderate priority)
- using non-combustible materials for deck and outdoor furniture (high priority).

Table 10: Summary of retrofit measures and rankings

Building element	Building retrofits	Priority	Effort	Cost
Roof	Install non-combustible / corrugated steel roofing Repair or replace gutters, gutter shielding, sarking	High	Moderate	Moderate
Roof	Install sprinkler heads in roof cavity	High	Moderate	Low
Roof	Install closed gutters Gutter maintenance (clean debris)	High	Low	Low
Roof	Seal eaves	High	Low	Low
External walls	Seal gaps and apply metal mesh to vents and weepholes	High	Moderate	Low
External walls	Repaint and reapply fire-retardant where damaged	High	Moderate	Moderate
External walls	Sand and paint rough-sawn timber finishes	High	Moderate	Low
External walls	Protect re-entrant corners and bottom of all ground level walls with non-combustible materials / class 1 durability timber	Moderate	High	High
Windows	Fill gaps in window frames	High	Moderate	Low
Windows	Install window shutters	High	Moderate	Moderate
Windows	Repair and repaint damaged surfaces and reapply fire-retardant treatments	High	Moderate	Moderate
Windows	Install tight steel mesh and heat-resistant fibreglass fabric with a heat-reflective outer layer	High	Moderate	Low
Windows	Upgrade windows to double glazing	Low	High	High
Doors	Upgrade to fire-resistance doors	Moderate	Moderate	Moderate
Doors	Remove any obstacles in the doorway and slippery mats	High	Low	Low
Doors	Install tight steel mesh and heat-resistant fibreglass fabric with a heat-reflective outer layer	High	Moderate	Low
Subfloor	N/A in this study			
Deck and outdoor area	Use non-combustible materials for deck and outdoor furniture	High	Moderate	High
Deck and outdoor area	Remove eucalyptus and overhanging trees close to the house	High	Moderate	Low
Sprinkler systems and cameras	Install sprinklers and water tank to cool down external walls Install outdoor camera	Moderate	Moderate	Moderate
Other landscaping	Trim tall trees near the house. Replace trees along driveway with fire-retardant trees	High	High	Moderate

Source: Authors, based upon Salam et al. (2025).

Only one research article identified in this review empirically analysed the benefits of bushfire-resilient home retrofit measures. Shum and Zhong (2022) simulated the cost-benefits of ventilation systems in relation to indoor air quality and health risk mitigation for detached homes in cities in Western Canada. They recommend multi-filter mechanical ventilation systems for regions prone to severe PM2.5 exposure, but portable air cleaners were not considered justifiable based on price.

In terms of other financial impacts, the cost to rebuild a property and replace the contents can be significant. Recent data finds that the average new-build cost in Australia at the end of 2024 was $443,000, but that a range of factors, such as location, size and quality and the average value of contents was around $100,000 (Delahunty 2026; Frasers Property 2025; Taylor 2025). However, the cost of higher-end and larger properties could be significantly more than $1 million. There are currently challenges with the high cost of building materials, which means that costs for repair and replacement could also increase. Also, the above costs do not cover the costs associated with clearing damage from a site, such as the remains of a burnt-out property.

There is also an impact on properties at risk of bushfires in terms of a reduction in resale value. Research from Domain finds a 2% decline in property value for each increase in bushfire risk level (Powell et al. 2024a). Their work applies 10 levels within the bushfire risk levels, so a high risk could see a 20% reduction on property value, whereas a general bushfire risk might see a property value reduction of 5%. In some regions, this could result in a decrease in property value of $200,000 or more. In addition, there can be increased insurance costs, with reports of properties at higher risk receiving premiums that have increased 50% (AHURI 2020), and wider media reports of even greater increases (Miller 2026).

In terms of wider impacts, research has found significant social costs from bushfires. For instance, smoke pollution does not just impact those in the fire zone but can impact communities further away. Research from Ademi et al. (2023) estimates the impact of bushfires on communities in Australia across the 2020s. The research puts a dollar cost on the impacts of bushfire:

- $12.7 million: healthcare costs arising from deaths for smoke-related conditions, hospitalisations for cardiovascular and respiratory conditions, and emergency department presentations with asthma
- $25 million annually: the value of lives lost
- $2 billion annually: broader economic losses to the GDP.

However, analysis of recent bushfire events finds these costs might be conservative. Research into the health costs from the 2019–20 bushfires across Queensland, New South Wales and Victoria find that smoke-related health costs were $1.95 billion (Johnston et al. 2021).

5.1.3 Flood-resilient housing retrofit

Overall, research on the costs, benefits and feasibility of flood-resilient retrofits in Australia and internationally is increasingly focused on what improved flood resilience looks like in practice. This is being done through case studies containing information about costs and potential benefits, and there are a growing number of guides to help households undertake flood resiliency improvements (Abode Construction 2025; Chiew et al. 2020; Dale et al. 2021; Deloitte 2022; Fuerst and Warren-Myers 2021; NEMA 2024a; NSW Government 2026b; Nyandega and Williams 2025; Powell et al. 2024c; Taylor 2025).

There is also emerging evidence on the financial and social impacts after flood events, including:

- health and wellbeing
- negative impact on property values in terms of resale value
- added insurance costs (Creagh et al. 2025; Deloitte 2022; Manne 2026).

There is a current focus on flooding across different Australian jurisdictions as local water authorities undertake the process of updating flood-impact maps. This is having immediate impacts on housing, e.g. where houses can be built and cost of insurance.

Costs and benefits of flood-resilient housing

Research around the level of damage caused during a flood event is less clear. Exploring the cost ranges for the various elements of a property, which may need repair or replacement, indicates that the costs could be up to $300,000 or more for some properties (including contents replacement) (Dale et al. 2021; NSW Government 2026b; Taylor 2025).

However, this is highly dependent on how much of the property is flooded and the original quality of the home. In terms of flood-resilient retrofit, it could cost up to $200,000 or more to retrofit existing housing. A large portion of this cost comes from the need to elevate a property off the ground and the preparation and repair work involved with that, such as fixing cracks and repainting (Abode Construction 2025; NEMA 2024a). There are numerous examples of where this has occurred in flood-prone areas although the reported online costs vary, indicating that the work is still largely site- and property-specific.

Similar to bushfires, there is emerging research exploring the wider social impacts of flooding events on households and communities. For example, research into the 2022 Queensland flood event found an average health cost impact of around $2,250 per household (Deloitte 2022). Higher costs have been found in other studies, such as a VCOSS study, which identified health and wider disposable income cost impacts of $22,818 per household from the 2022 Victorian floods (Manne 2026).

The financial benefits of flood resilience retrofitting of housing extend beyond the direct avoidance or reduction of physical damage costs for an individual property, as they include the significant financial costs associated with insurance and resale value (Queensland Government 2019; Wood Solutions 2024). These secondary economic benefits can constitute compelling drivers for flood resilience retrofit, particularly in high-risk locations where market pricing mechanisms increasingly penalise vulnerable properties.

A case study from Graceville, Queensland, illustrates substantial premium reduction potential associated with comprehensive interventions. Following elevation and wet-floodproofing retrofits after the 2011 Brisbane floods, the property owners experienced annual insurance premium reductions from $5,253 to $3,133, which represents a 40% decrease in ongoing insurance expenditure (Queensland Government 2019).

Additional anecdotal evidence from residents in Wilston, Brisbane, reports premium reductions of approximately 50% following resilience upgrades, which suggest that premium savings may vary considerably based on:

- initial risk profile
- retrofit scope
- insurer-specific assessment methodologies (Wood Solutions 2024).

These premium reductions improve retrofit investment returns, and also reduce the risk of insurance market withdrawal from high-risk areas – a phenomenon that is increasingly observed globally in climate-exposed regions. There are numerous examples in wider media and industry analysis highlighting the significant increase in insurance premiums, especially following flood events (Malo 2020).

Recent property market analysis reveals that flood exposure risk is increasingly reflected in residential property valuations across Australia, which creates significant financial losses that particularly affect owners of vulnerable properties (Creagh et al. 2025). A comprehensive assessment indicates that flood-exposed properties are collectively valued $42.2 billion lower than equivalent properties without such risk, which represents a substantial loss in household wealth attributable solely to flood vulnerability (Creagh et al. 2025).

At the individual property level, typical flood-exposed dwellings exhibit a $75,500 resale discount relative to comparable low-risk properties. This differential reflects:

- buyer perception of risk
- insurance cost capitalisation
- anticipated future damage exposure (Creagh et al. 2025).

This resale penalty demonstrates pronounced spatial heterogeneity, with high-impact regions experiencing particularly severe discounting. Lismore, New South Wales, is a locality subjected to catastrophic flooding events in recent years. The resale differential between flood-risk and flood-free properties in Lismore has expanded to 38%, which effectively turns flood-exposed properties into substantially illiquid assets with severely constrained market appeal (Creagh et al. 2025). It is also worth noting that Lismore is one of the locations where property buybacks are being offered by the state government in recognition of the high risk of future flood impacts on some properties.

Importantly, research has found that the above negative financial impacts can be mitigated or avoided by investing in flood resilience measures (Creagh et al. 2025). By demonstrably reducing physical vulnerability through structural and material improvements, affected property owners can credibly demonstrate lower risk to potential buyers and valuers, potentially recovering a substantial portion of the flood-risk discount.

5.1.4 Storm-resilient housing retrofit

Overall, research on the costs, benefits and feasibility of storm-resilient retrofit in Australia and internationally is lacking, with most of the focus in this area to date on improving outcomes for new housing (Qin and Stewart 2022; Smith and Henderson 2015; Stewart and Wang 2011; Stewart et al. 2014).

While much of the wider research in this area focuses on improving new housing, there is research on both:

- retrofitting existing housing
- how housing performs in different storm events.

Like the previous sections on heat, bushfire and floods, there are a number of case studies across the research that present information on the different retrofit opportunities, including information around costs and benefits (Chatterjee et al. 2019; Chiew et al. 2020; Ripberger et al. 2018). Apart from cyclone-prone areas, the wider cost impact on property value from storms is less prominent in the research in comparison to the other climate events explored in this report.

Costs and benefits of storm-resilient housing

The financial damage costs of storms in Australia are significant. In tracking the costs of storms longitudinally, Stewart (2015) discussed the annual insured losses of approximately $300 million between 1967 and 2005 in three Australian states: Victoria, New South Wales and Queensland. In accounting for all natural disasters nationwide, such storm-related losses made up a quarter of the total.

Of more recent events:

- 2022 Brisbane storms: losses an estimated $309 million (Qin and Stewart 2022)
- 2011 Cyclone Yasi: rebuilding and community support costs $800 million (Smith and Henderson 2015)
- 2010 Victorian floods: losses totalling $1.04 billion (Qin and Stewart 2022).

Stewart et al. (2014) modelled direct and indirect costs related to extreme wind in Queensland to the year 2100. The mean losses across Cairns, Brisbane, the Gold Coast and the Sunshine Coast were tracked against three scenarios:

1. Moderate change: losses of $5 billion.
2. Significant change: losses at $14.2 billion.
3. A poleward shift of cyclones to South-East Queensland: losses at $20.5 billion.

Scenario 3 modelled by Stewart et al. could see losses of up to $31 billion. Per-property damage costs could be significant, causing damage of $280,000 or more, depending on factors such as severity of the storm, location, size and quality of the property (Delahunty 2026; Frasers Property 2025; Goss 2026).

In attempting to mitigate against these real and projected cost impacts, several Australian-focused analyses have studied the cost-benefits of interventions for the housing stock. This has generally split interventions into efforts addressing new builds as opposed to retrofits to existing housing. Within this, the type of solution, such as adaptations to roofs or windows, has also featured as a point of difference.

For retrofits, Suncorp commissioned a series of studies to understand the benefits of measures on existing houses in northern Australia, particularly North Queensland. In building on the mitigation options outlined by Smith and Henderson (2015), economic consultants Urbis (2015) found the best benefit-cost ratios were:

- community awareness campaigns: payback period <1–6 years
- low-cost roofing adaptations (strapping only): payback period 2–4 years.

These options were compared cost-wise against high-cost roof adaptations (over-batten systems) and window opening protections.

Qin and Stewart (2020) undertook a CBA on the implementation of a range of climate adaptation measures in both new housing and retrofits, in Brisbane and Melbourne. For cost-effectiveness, strengthening the resistance of windows was deemed an appropriate measure in both cities. In Brisbane, the installation of window shutters was deemed cost-effective to reduce the economic costs of wind and rainfall damage. Overall, they find that:

- window shutters could be retrofitted onto existing buildings
- increasing windows to a higher resistance rating, strengthening roof cladding, and using water-resistant materials needed to be implemented at the design and construction stage.

In extending their Brisbane research, Qin and Stewart (2020) showed that the installation of window shutters (which could be retrofitted), led to a mean risk reduction of 95%. This compares to a 12% mean risk reduction from window resistance, and a 4% mean risk reduction from the strengthening of roof cladding connections. Other literature suggests that retrofit costs for significant storm protection could be $19,000 or more (Queensland Government 2025a).

In addressing scenarios facing new housing in Queensland, Stewart et al. (2014) studied the potential of increasing wind classifications in the state to anticipate the aforementioned scenarios of moderate, significant and poleward shift. In tracking the potential changes for new homes in both North Queensland and south-east Queensland, the study found a mean cumulative net benefit for all cities of up to $10.5 billion by 2100, as a result of the suggested wind classification changes.

A further study of Brisbane, Sydney and Melbourne showed that wind classification changes as per the Australian Standard AS4055 could yield risk reductions of between 50–80%, to an estimated cost of 1% of house replacement value (Stewart 2015).

Stewart and Wang (2011) modelled the cost-benefit of measures implemented in new houses and retrofitted existing housing using a 2100 time horizon. In looking at the potential losses from wind damage for Brisbane, Rockhampton, Townsville and Cairns, they found the highest benefits came from increasing the wind classification standards for new housing, with a mean net benefit of $8.3 billion by 2100. By contrast, retrofitting older houses was a more costly adaptation, making a net loss.

There is limited attention in the wider literature to the potential storm impact on property values. This is likely due to storms occurring across all regions, whereas floods and bushfires occur in specific geographic locations.

5.1.5 Feasibility and implementation

Across the different climate hazards discussed in Sections 5.1.1–5.1.4, there is no evidence of holistic large-scale climate-resilient retrofit in Australia or elsewhere. Existing research on the challenges and opportunities of retrofitting housing for extreme heat, bushfire, storm and flood shows that the technical, material and design elements are available, and there are some examples of larger-scale retrofit programs targeting individual hazards.

However, beyond improvements in resiliency for new housing gained through upgrades to the NCC, most of the evidence within Australia indicates that implementation is largely occurring through ad hoc individual household action, rather than through systematic scaling of climate-resiliency retrofit. The literature highlights key feasibility considerations for delivering climate-resilient retrofit, including:

- financial viability
- awareness and capabilities
- complexity and facilitation
- tenure and housing type
- industry capacity.

The financial viability of climate-resilient retrofit relates to the upfront cost of retrofit, avoided costs and estimated cost savings post-retrofit, the financial resources available to the homeowner or housing investor, and provision of incentives. Across different hazards financial viability and support varies, for example:

Flood resilience: Flood resilience measures are some of the most costly resiliency retrofits, which may mean there is less capacity for households to engage, or to deliver, deep resiliency retrofit outcomes.

Heat resilience: The research on energy and thermal comfort improvements suggests that low to medium levels of retrofit are financially viable and, due to conservative assumptions and data limitations, the benefits could be greater than current estimates (Armstrong et al. 2023; Samuelson et al. 2015; Williams et al. 2020). Deeper levels of retrofit likely require additional financial support, where upfront cost is the primary barrier. This is especially the case for areas characterised by lower economic resources, where take-up of a Victorian Government energy efficiency retrofit program has been lower (Willand et al. 2020).

Bushfire resilience: Potential incentives include insurance premium discounts and targeted financial assistance for effective high-cost actions (Borate et al. 2025; Ergibi and Hesseln 2020; Horing et al. 2025; Penman et al. 2017; Salam et al. 2025, Willand et al. 2026).

Storm resilience: Most of the research focuses on what financial incentives might encourage deployment of resiliency measures in retrofit and during construction. Building on previous analyses of the rollout of window shutters in Brisbane, Qin and Stewart (2021) modelled three forms of incentive to householders over a 10-year time horizon: loans, rebates and insurance premium discounts. They found that discounted premiums or rebates would be most feasible.

Other research has explored household preferences for retrofit incentives. Jasour et al. (2018) studied homeowner preferences for incentives for retrofitting against hurricane damage – roofs, openings, flood damage and roof-to-wall connections – in the US state of North Carolina. Their interviewees expressed greatest support for grants, rather than loans or insurance premium reductions.

At the same time, perceptions around effectiveness, ease of implementation, and the effect of intervention on resale value were found to be important motivations, where addressing window openings was most favoured. These factors need to be accounted for in any incentive program, along with locational or other demographic factors. Chiew et al. (2020) extended on these findings with an allied study that showed grants being offered led to a threefold increase in receptivity to retrofit, with a greater percentage of cost increasing the probability of the householder choosing to retrofit. These studies suggest that governments, with limited budgets, should prioritise grant programs over other incentives.

Another uptake barrier identified is awareness. For bushfire resilience, studies have found varied levels of risk awareness; lack of awareness of government programs; and different perceptions of who is responsible for protecting private property (Ergibi and Hesseln 2020; Penman et al. 2017).

There are mixed findings regarding the effect of perceived risk of bushfire on retrofit action. Borate et al. (2025, p.11) find 'no significant link between threat appraisal and household mitigation behaviour.' However, Ergibi and Hesseln (2020) find that for those individuals who had heard of the government program FireSmart Canada, the perceived risk of damage from wildfire is the most influential factor for adopting the recommended actions. Ripberger et al. (2018) looked at homeowner support for enhanced building codes to support mitigation against tornadoes in the US state of Oklahoma, which is relevant for storm-resilient retrofit. The study found that homeowner worldview exerted a greater effect on support, rather than understandings of risk or even experience of damage, which suggests a need for improved information provision about risk for households is needed to break through entrenched values.

Thus household capabilities are understood as important conditions for retrofit uptake, and should be considered when designing interventions. In addition to the financial resources and knowledge about retrofit options noted earlier, research on bushfire retrofit finds key factors to be the complexity and effort associated with retrofit, including:

- physical capability and cognitive load (including stress and trauma), particularly for older people
- confidence in the effectiveness of retrofit measures and self-efficacy (Borate et al. 2025; Ergibi and Hesseln 2020; Horing et al. 2025; Penman et al. 2017; Salam et al. 2025; Willand et al. 2026).

For bushfire resilience, identified barriers are:

- the complexity of retrofit choices and fire safety regulations
- time required
- administrative burden
- effort required for property assessments, landscaping and maintenance (Penman et al. 2017; Salam et al. 2025; Willand et al. 2026).

These insights highlight the value of facilitation interventions to enable uptake. In bushfire-related studies, potential enablers include:

- property-specific retrofit advice
- simplified guidance
- technical support
- support for households to engage service providers (Penman et al. 2017; Salam et al. 2025; Willand et al. 2026).

Smith and Henderson (2015) examined the potential of community engagement in retrofitting programs through a combination of more formal inspections by qualified assessors, along with self-assessment mechanisms by households – including via smartphone applications. For home energy upgrades, ongoing applied research is understanding how local programs led by local government and community organisations can engage harder-to-reach households and provide independent and streamlined advice and information, and what support is needed to enable these trusted local intermediaries to establish such programs (RACE for 2030 2026a).

Tenure and housing type is identified as a structural barrier to retrofit, where renters rely on landlords or government to undertake retrofits (Daniel et al. 2020). Single-family households are more likely than others to undertake structural bushfire resilience retrofits (Borate et al. 2025). Conversely, research on the take-up of a Victorian Government energy-efficiency retrofit program showed lower take-up of retrofit in areas with lower economic resources and higher shares of rented dwellings (Willand et al. 2020).

Finally, industry capacity and consumer protection is a critical consideration for scaling delivery of climate-resilient housing retrofit. There have been some examples of individual retrofit measures that have rapidly scaled in Australia, such as ceiling insulation and solar PV, which demonstrates that some elements of retrofit could scale-up quickly with the right financial, industry and government support (Horne et al. 2026, Moore 2018).

However, the Australian Government's Home Insulation Program (2009–10) provides an example of how issues can occur (Hanger 2014), underscoring the need for caution to ensure that programs are safe and consumers are protected. The Home Insulation Program was developed by the federal government as part of a wider financial stimulus to protect the Australian economy from the Global Financial Crisis. The program was abruptly shut in 2010 following several house fires and the deaths of four installers. While the Program improved thermal comfort for 1.2 million homes, it was criticised for its design and administration, especially as a significant increase in inexperienced installers emerged to deliver the work (Hanger 2014; Moore 2018). Recent research has revealed a lingering stigma attached to the negative outcomes of the Home Insulation Program, which have impacted subsequent attempts by the insulation industry and policy makers to increase retrofit outcomes (Padilla Gil et al. 2025). Scaling-up of resilient retrofit is likely to be limited by industry capacity, as:

- more workers are needed to deliver such retrofit
- protections need to be in place to ensure scaling-up focuses on quality outcomes for consumers.

There are an increasing number of international examples of larger-scale retrofit and support programs, including:

- My Safe Home Florida (USA): scheme improving resilience to hurricanes through more than 40,000 free inspections and co-funding for retrofits (Department of Financial Services 2026).
- Build Back Better (UK): over 62,000 participants since 2024 accessing up to £10,000 for flood retrofit improvements (UK Government 2026).
- KfW energy retrofits (Germany): low-interest loans of up to €150,000 to more than 5.4m households since 2006 (Federal Ministry for Economic Affairs and Energy 2019).

While these examples show that it is possible to scale retrofit programs, no holistic resilient retrofit program has been identified that has delivered the 10 million+ retrofits required in the Australian context.

5.2 The costs and benefits of climate-resilient retrofit

Analysis of the potential benefit-to-cost ratios (BCR) or net present values (NPV) that could arise from undertaking climate-resilient retrofit strategies is presented below. A simulation model was constructed in Excel to generate alternative distributions of BCRs based on the following.

1. The assumed probabilities of bushfire, severe storm, flood and extreme heat events.
2. The scale of damage association with each event.
3. The cost associated with three different levels of adaptation designed to mitigate the damage caused by those climate events.
4. The value of the damage avoided by those mitigation strategies.

Given the large number of combinations possible from this range of possibilities, the CBA tool randomly draws values from the probability distributions defined from the literature review. A discounted cashflow analysis (DCF) calculates the NPV, which is a proxy for return on investment (ROI). The CBA tool repeats 10,000 times, with each iteration involving fresh random draws from the probability distributions.

This process helps address the limited data availability for the climate event / mitigation strategies because a large number of iterations generates a distribution of results which give both:

- a central measure – typical or average cost-benefit
- a sense of how wide the distribution is.

The CBA DCF tool produces results for a single hypothetical property, reflecting that there is no publicly available, credible and robust data on the number of properties that exist in the dwelling stock in every combination of climate zone (climate-event type risk). To avoid making too many assumptions, the tool was designed to work at the level of the hypothetical dwelling. In the future, as improved data is identified, the tool could be refined to provide improved analysis for different scenarios. In theory, it would then be possible to aggregate or scale-up the analysis to provide an Australian total for costs and benefits associated with each retrofit option.

Subsection 5.2.1 presents initial results, before exploring certain sensitivity analysis to better understand the assumptions and input variables applied.

5.2.1 Cost-benefit analysis results

The results shown in Table 11 are a summary of the 10,000 DCF iterations produced for the average Australian property (in terms of estimated rebuild cost), assuming a 3% discount rate (in line with wider sustainability economics best practice analysis) and the central or 'likely' climate-event probabilities.

As Table 11 demonstrates, undertaking an average climate-resilience retrofit for the typical Australian property appears to make financial sense, assuming the central or most likely climate-event probabilities and a low (3%) discount rate. The purpose of the table is to show the separate contributions of the four climate-event types to the overall BCR and NPV metrics.

Note: because each scenario is run separately, uses random probability sampling and follows 10,000 iterations, the four climate-event results will not converge exactly with the results shown in the first column. This is a limitation of the model, but the random variations between simulation runs are trivial (around $1,000–$3,000 in magnitude). The severe storm, bushfire and extreme heat retrofit options have the highest BCR, but this is only a part of the picture, as discussed later.

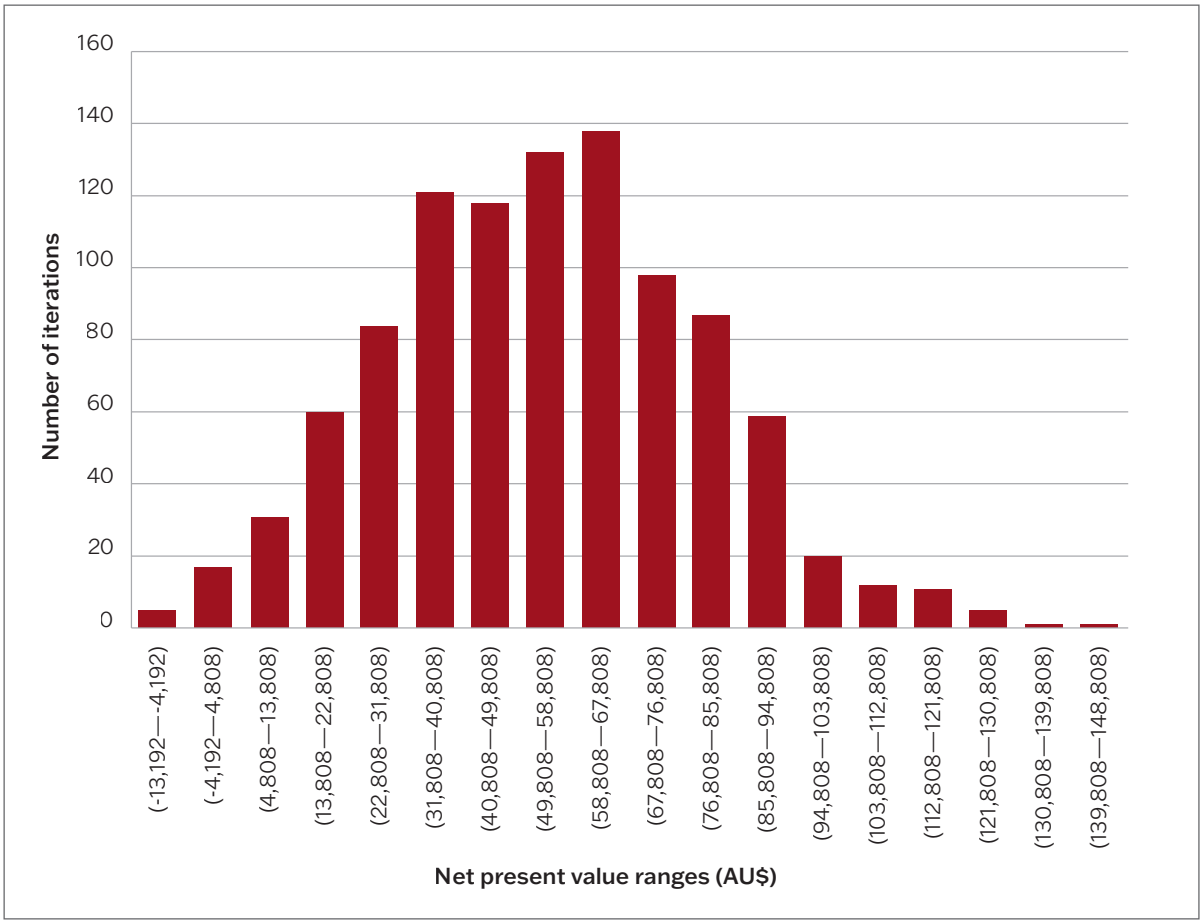
Table 11: Summary of NPV estimates for the average Australian property with 3% discount rate

Metric	All events	Bushfire	Severe storm	Flood	Extreme heat
Probability NPV > 0	73.0%	53.2%	47.3%	23.5%	99.0%
Mean PV Benefits	$279,383	$104,187	$37,054	$54,745	$80,218
Mean PV Costs	$168,715	$33,140	$9,500	$100,000	$26,075
Mean BCR	1.66	3.14	3.90	0.55	3.08

Source: Authors.

Figure 3 gives a flavour of the distribution of results arising from the DCF simulation for all four climate-event types included in the simulation together. The histogram shows that a large number of combinations of assumptions and scenarios give rise to an NPV as low as –$13,000 or as high as +$148,808. The results are visibly approximately normally distributed. From Table 11, we can infer an approximate overall NPV of around $100,000 for this central set of assumptions. Table 11 also indicates, though, that the probability of a positive NPV is only around 73%. This reinforces the widespread results that can arise from having a large number of input variables, each with a considerable spread.

Figure 3: Distribution of NPVs produced by the DCF simulation tool



Source: Authors.

Table 12 sets out a sensitivity test in relation to the discount rate. The three columns relate to the climate-event probabilities: optimistic, likely and pessimistic. The first row shows the NPV for the average Australian property with a 3% discount rate, and the second row provides a like-for-like comparison using a 7% discount rate.

Table 12: Sensitivity check based on discount rate assumption for average Australian property

Discount rate	Optimistic	Likely	Pessimistic
3%	–$55,508	$85,998	$365,926
7%	–$107,844	–$5,220	$161,365

Source: Authors.

Note: For this table, 'optimistic' and 'pessimistic' refer to the likely climate scenarios occurring, not the investment opportunity. According to the Intergovernmental Panel on Climate Change (IPCC), we are more closely aligning with the pessimistic scenario.

Table 13 provides a sensitivity check with respect to the climate-resilient adaptation strategy and the discount rate. The table also includes a higher-value or higher-specification dwelling scenario in addition to the average Australian dwelling, as well as two additional levels of retrofit solutions:

- 'light' touch – more basic and low cost
- more 'robust' – more holistic and higher cost.

The results reveal several interesting insights:

5. Property value – whether based on location or specification – has a powerful impact on predicted NPV. This finding is in some ways self-evident. For a given probability of event occurrence and relatively fixed retrofit costs, higher-value dwellings benefit disproportionately from retrofit. The choice of the discount rate is very important. When 3% is chosen (in line with sustainability economics best practice analysis, or as a proxy for inflation or annual rise in cost of living), the financial wisdom of retrofitting is much clearer (i.e. greater financial benefit) than the choice of 7% (Australian Government financial analysis requirement, or a proxy for the cost of borrowing).

Table 13: The influence of retrofit assumptions and cost of capital

Scenario	Light	Average	Robust
Average: 3% discount rate	$23,411	$85,998	$97,878
Higher specification: 3% discount rate	$85,132	$210,107	$335,088
Average: 7% discount rate	–$16,606	–$5,220	–$71,020
Higher specification: 7% discount rate	$19,516	$89,146	$81,328

Source: Authors.

Finally, Table 14 neatly summarises the variation in predicted NPVs that can arise from the large number of combinations of assumptions and scenarios that input to the model. The table shows the extremes: the highest and lowest possible NPVs arising from the model. From an investment perspective, the worst metrics are provided by the higher discount rate for a lower-valued property in the event that climate-event probabilities are at the low end, but the climate-resilient investment approach is at the more expensive ('robust') option. This produces a negative NPV of around –$270,000. The best-case scenario is represented by the lower discount rate for a higher-value property with higher climate-event probabilities and a robust retrofit strategy. This produces a positive NPV well over $1,100,000.

Table 14: Extreme values arising from the simulation exercise

Scenario	Lower specifications	Average	Higher specifications
High discount, low event probabilities, robust retrofit	–$270,540	–$221,358	–$159,790
Low discount, high event probabilities, robust retrofit	$183,634	$565,913	$1,137,858

Source: Authors.

5.3 Discussion

It is clear from the literature review that there is limited, but growing, research into the costs and benefits of delivering climate resiliency to the housing sector. Much of the existing research is focused on the cost of damage from acute climate events and the negative market outcomes from these events: higher property insurance, lower resale values. There is some limited research that has attempted to explore the positive benefits of properties which have undergone resiliency retrofit but there is a lack of consistency across this research, which indicates more evidence is required to support the findings around the potential benefits.

Research from Australia and internationally tends to focus on one-off acute climate events, which makes it challenging to compare outcomes when different methods or scope of research are applied. For example, some of the wider social impacts from acute climate events are reported as a total number; at other times they are reported across multiple categories – such as health and wellbeing, productivity – or with some categories left out altogether. This has implications for trying to identify consistent and robust data to draw upon, which was one of the limitations of the CBA in this report.

The CBA results offer an initial starting point for understanding resiliency retrofit at a larger scale. The results indicate that there are some scenarios which currently support undertaking resiliency retrofit, largely for medium- to higher-quality housing and for areas at medium risk to higher risk.

This raises questions about who owns responsibility for initiating or driving climate-resilient retrofitting. The positive, and in some scenarios very high, NPVs generated by the CBA tool suggest that in a well-functioning market, there should be no need for policy intervention to encourage or ensure retrofitting: when retrofitting makes investment sense, it should occur automatically. However, subsection 5.1.5 highlights that the climate-resilient retrofit journey is not straightforward, and thus cannot be reduced to market-rational decision-making. Nevertheless, the CBA highlights three aspects of informational inefficiency that could prevent mass-market uptake without government intervention. In detail, these three aspects are:

Probability and homeowner perception: First, homeowners cannot easily observe the probability of a severe climate event and its impact on their homes, and therefore may not realise that retrofitting makes sense as an investment (Armstrong et al. 2023, Climate Council and Climate Valuation 2025; Jansen 2024, Moore et al. 2025). To illustrate, the CBA tool (e.g. Table 14) shows particularly high NPVs when event probabilities at the high end of the range are applied, but NPVs become much lower or even negative at the low end of the probability ranges. If the 'true' probabilities are at the high end but homeowner beliefs sit at the lower end, this would trigger market failure in the form of neglecting to invest in retrofitting.

Homeowners and the time value of money: Second, it is difficult to directly observe homeowners' views on the time value of money. Indeed, this is likely to depend partly on personal preferences, socio-economic background and financial factors such as non-property financial wealth and each household's level of indebtedness. This is one of the reasons that the NPV sensitivity was tested with respect to the discount rate: each homeowner's decision to retrofit (or not) will partly depend on whether that investment is drawn from cash or equity, or borrowed from the bank (proxied by the 3% and 7% scenarios, respectively). Furthermore, given the likely impacts a changing climate will have on the Australian housing stock, a negative NPV is not a reason not to pursue resilient retrofit. Rather, it highlights that additional government and industry support will likely be required to ensure that all homes can achieve improved climate resiliency.

Vulnerable households in lower-quality housing: The wider research finds that some of the most vulnerable households who live in lower-quality housing are often most at risk during and after climate events. The CBA shows that lower-value housing or locations are much more likely to generate low or negative NPVs. This is particularly the case when higher-cost retrofit options are considered. The low or negative NPVs suggest that it essentially does not make financial sense for homeowners to invest in retrofitting in some of the scenarios examined. Therefore, there needs to be a focus on how to support such households to affordably engage in resiliency retrofit.

5.4 Implications

The analysis finds that sections of the housing market should recognise financial value in undertaking resilient retrofit. This is important, as it means that market-driven responses should be possible with households valuing and seeking out improvements, and the wider construction/building industry providing relevant services to meet those needs. As a resilient retrofit industry grows in Australia, it should provide improved options and competition for Australian households to deliver more affordable resilient housing options.

However, given the potential high upfront costs of undertaking comprehensive climate-resiliency retrofit, the CBA points to the need for housing policy and resiliency interventions to support households experiencing disadvantage or living in areas at higher risk of climate change impacts to retrofit their homes. Without such support, it is likely that key sections of the housing market will not be financially able to participate in any resiliency retrofit agenda. These households would continue to be exposed to climate and housing performance risks and may result in the government needing to further support such households in future – with, for example, additional energy bill support. This would have flow-on economic impacts such as healthcare costs, based on the HILDA analysis. Early intervention by government to support those households where the CBA does not deliver positive outcomes may help reduce longer-term government support and associated costs.

Due to the various data limitations identified during the data collection phase of this research, the CBA model could not present certain scenarios, such as for different housing types; for example, high- and medium-density housing. The use of a hypothetical detached dwelling is a starting point for the analysis, and future CBA modelling should be conducted as more refined data is obtained. From a policy perspective, the limited publicly available data means that a more robust CBA is needed to inform design of policies and programs to deliver resilient housing outcomes.

It would be beneficial for governments to work with key insurance and banking peak bodies or other stakeholders to access improved housing quality and climate risk data, and to make this data accessible to the research community. This access would deliver a more nuanced CBA model and broader research on effective policy and implementation based upon improved data and assumptions; and provide enhanced analysis and recommendations.

6. Policy and practice opportunities

Housing, households and communities in Australia are already dealing with the financial, social and environmental impact of a changing climate, whether that be acute (bushfires, floods and storms) or slow-onset (increasing temperatures).

Climate change is resulting in billions of dollars spent each year rebuilding from physical damage to properties, along with wider short- and long-term social impacts such as negative health and wellbeing. The impacts on housing, households and communities are predicted to grow over coming decades as the climate continues to change.

Most existing housing stock in Australia was built before more modern building code requirements were introduced. And although building code requirements have improved since the early 2000s, they are still limited in their consideration of future climate change, and there are no requirements for existing housing to consider climate change when undergoing improvements.

There is a general lack of understanding around the cost to deliver climate-resilient housing in Australia.

This research, which forms part of an AHURI-funded Inquiry into achieving a climate-resilient housing stock by 2050, aimed to address this knowledge gap by answering the following questions:

1. What is the extent of resiliency deficit in the Australian housing stock?
2. What are the financial and non-financial costs and benefits to retrofit the housing stock for resiliency?

A **summary of key findings** for each question is presented below, followed by policy and practice opportunities.

The resiliency deficit in the Australian housing stock

- There is a lack of comprehensive public data on the impacts of climate hazards on households and housing quality and condition. Data on the energy and thermal performance of Australia's existing housing stock is growing, which is relevant for extreme heat. However, there is an absence of publicly available data on the impacts of other climate hazards on households and housing quality/condition.
- The most comprehensive datasets on housing conditions and retrofit potential relate to energy and thermal performance, including the Australian Housing Conditions Dataset (n=22,500), the Scorecard (n=~13,000), and the Australian Housing Data Portal (n=~70,000 existing homes, n=1.6 million new homes).
- Other climate-resilience attributes have limited coverage in the data. The Climate Council's modelling of the effect of flood, storms and bushfire on households is the one database that looks at both dwelling retrofit characteristics and climate resiliency, but it does not account for varied dwelling ages and types, which means that different building code changes are not reflected in the modelled impacts.

- Nevertheless, the resiliency deficit in Australian housing stock can be estimated based on the changes to housing construction standards over time. Across all climate hazards, there have been resiliency improvements from housing constructed or significantly renovated pre-1995 to the housing delivered in 2026.
- Despite these improvements, there is still a significant resiliency deficit for new housing in relation to heat, floods and storms, and there are some elements of bushfire resiliency that could be improved. Therefore, most existing and new housing in Australia is not fit for purpose in the context of climate change, and will likely need to undergo resiliency retrofit for one or more climate impacts to ensure improved protection for the physical property and residents.

The costs and benefits of climate-resilient housing retrofit

- The research produced conservative estimates of the financial outcomes or net present value (NPV) of climate-resilient housing retrofit ranging from −$270,000 to more than $1,100,000.
- The cost-benefit analysis (CBA) shows that climate-resilient retrofit has positive NPVs for scenarios involving medium- to higher-quality housing, and for areas at medium to higher risk. However, scenarios involving lower-quality housing, and housing in areas at lower climate risk, were found to have negative NPVs.
- Applying a discount rate of 3% – in line with wider climate and environmental economics best practice analysis – results in 73% of scenarios delivering a positive NPV.
- These estimates suggest that some households could be financially better off following investment in climate-resilient retrofit, but other households may require financial support to improve the climate resilience of their homes.
- Climate-resilient retrofit investment could provide benefits in the form of reduced healthcare costs. Analysis of HILDA Survey data shows that homes with better insulation, draught sealing, and heating/cooling systems – which are all thermal performance attributes – are associated with a smaller health burden from heat exposure. Over time, the health benefits will likely increase following resilient retrofit, as warmer and cooler temperatures are predicted to occur more frequently and to last longer. Furthermore, small effects at the individual level could accumulate at scale.
- The costs and benefits of retrofitting Australian housing for climate resilience lack empirical validation. There is limited, but growing, research into the costs and benefits of delivering climate resiliency to the housing sector. Much of the existing research is focused on the cost of damage from acute climate events and the negative market outcomes from these events, such as higher property insurance and lower resale value. The limited research exploring the positive benefits for properties that have undertaken resiliency retrofit in Australia and internationally is inconsistent and fragmented, often focused on one-off events and employing varying methods.
- A holistic assessment of the costs, benefits and feasibility of climate-resilient housing retrofit requires understanding financial dimensions alongside household needs and preferences, along with industry capabilities and a range of social and environmental outcomes.

This research indicates **a need for policy and practice interventions** to achieve climate resilience for Australia's existing housing stock. This includes:

- developing a climate-resilient housing pathway
- improving data collection and access
- improving householder and industry awareness
- supporting the most vulnerable households first.

Developing a climate-resilient housing pathway

This research demonstrates that retrofitting existing Australian housing to be resilient to current and future climate change impacts is an urgent challenge with significant financial and social implications.

The extent of resiliency deficit identified across jurisdictions and climate hazards calls for a clear and consistent approach to improving the climate resilience of Australia's housing stock at a national scale. There is a need and opportunity for policy to mobilise the housing sector to respond to current and future climate change impacts and reap the benefits of resiliency.

Despite its importance, there is currently limited consideration of the resiliency of Australian housing within current policies, housing quality and performance datasets and wider research compared with sustainability and energy efficiency. Delivering improved resiliency will require the involvement of a range of stakeholders. As such, a climate-resilient housing pathway would provide a shared policy direction for government, industry and households. This pathway should be developed by National Cabinet, similar to the pathway set out by the *Trajectory for low energy building*s developed for decarbonising housing stock (COAG Energy Council 2019).

Drawing on the climate-ready housing guidelines developed by Lang et al. (2026), a resiliency pathway should map out plans for both existing and new housing, and it should link to the evidence around the likely future impacts and costs if action is not taken. This would contribute to climate resilience being positioned as a critical social, financial and environmental goal for housing. This pathway can be achieved by:

- Guiding the housing industry towards scaling-up resiliency across existing and new housing – by establishing a universal understanding of what resilient housing is, how it is achieved (e.g. materials, technologies and design), and indicating when requirements and standards for resilient housing will be introduced or improved over time.
- Incentivising stakeholders to develop and grow existing and new climate-resilient retrofit and construction-related businesses, products and services. Attention should be paid to industry capacity, supply chains, quality and accreditation. Existing financial services for energy efficiency and electrification, such as mortgage-linked and discounted loans, mortgage repayment pauses, product payment plans, and other personal loan options (often tied to performance outcomes and standards) could be considered for climate-resilience retrofit to help households take action.
- Broadening outcomes for housing quality and performance to include resiliency in policy and practice objectives and targets.
- Identifying potential links for integration of climate resilience with existing policies and approaches regulating housing quality and performance, such as minimum standards or mandatory disclosure.
- Normalising the idea of resiliency as a valued housing attribute across society.

A key challenge will be developing a resiliency pathway in a policy environment where the NCC is being streamlined and some jurisdictions have paused implementation of further amendments. However, the impact that climate change is having on the housing sector – and the likely financial and social costs to government, households and communities of not taking proactive resiliency action – means that this is not a sufficient reason to delay. The following opportunities provide concrete steps for developing and implementing this pathway.

Improving data collection and access

This research identified considerable limitations in Australian housing-condition data for climate resilience. There is a clear opportunity for government, industry and researchers to improve the quality, depth and access to resilient housing data. More comprehensive and fine-grained data would provide critical understanding of:

- current housing performance in the face of climate hazards
- where climate-resilient housing retrofit has occurred, and with what outcomes
- priority housing segments, based on a range of measures.

This project faced significant challenges in relation to access to sufficient publicly available data to understand the current resiliency retrofit context. However, there were indications that third-party datasets – such as those of banks and insurance companies – may contain more detailed information and could help to develop a better understanding of the resiliency of Australian housing.

Improved data collection and access would enhance analysis of the current situation and the cost-benefit of climate-resilient retrofit. In turn, quality data and insights would enable more effective policy and program design, monitoring and evaluation to scale climate-resilient retrofit uptake, such as through incentives and household engagement. This could be achieved by:

- Collecting data on more houses in the short term by leveraging existing survey instruments. This could include adding key questions around resiliency to surveys like HILDA and the Australian Housing Conditions Dataset to ensure that their next collection cycle starts to collect relevant data. Questions could be coordinated across datasets to ensure consistent data collection.
- Using the 2031 Census to collect more comprehensive data on housing conditions and resilience. This will be a significant opportunity to collect information across the wider housing stock, and to address gaps in representation of different housing segments.
- Exploring opportunities for Nationwide House Energy Rating Scheme (NatHERS) assessments for new existing housing to collect information on the resilience of the dwelling. NatHERS ratings already provide an indication of housing performance under extreme temperatures. A more holistic assessment of climate resilience would include performance against other climate hazards, including bushfires, floods and storms.
- Introducing mandatory disclosure at the point of sale or lease to collect information on more than 700,000 dwellings per year. This would be a significant opportunity to collect and update resiliency data over time.
- Incentivising access to third-party datasets for research and policy making. Exposure of housing portfolios to climate hazards is already critical information for insurers, mortgage lenders and the real-estate industry. Data-sharing could be enabled through collaborative initiatives that deliver mutual value.
- Supporting systematic monitoring and evaluation of housing performance post-retrofit to validate and improve the effectiveness of climate-resilient housing retrofit measures across housing types and climate zones.

An obstacle to the efficacy of data-driven analysis for climate resiliency is that these data collection opportunities, other than those related to the HILDA Survey and the Australian Housing Conditions Data, are longer-term projects. To obtain better data sooner, other strategies for collecting data are needed. One short-term option could be scaling-up the number of participants of the other surveys in order to gather more data on housing.

Improving householder and industry awareness

Evidence of the costs, benefits and feasibility of climate-resilient housing retrofit shows that financial benefits alone will not ensure widespread take-up, particularly among privately owned properties. To address the resiliency deficit in the Australian housing stock, households and industry will need support to understand why and how to undertake climate-resilient housing retrofit. Evidence from existing research indicates that consumers and building industry professionals have limited understanding of what constitutes a climate-resilient home, or how to achieve it – much as was the case during the early days of energy-efficiency retrofit.

At the same time, the provision of information is not likely to be sufficient by itself to increase climate-resilient retrofit uptake. The challenges associated with mainstreaming housing energy efficiency and electrification provide important lessons for delivering climate-resilient housing, including the role of trusted intermediaries and social networks. As data and information about the resiliency of housing improve, there are opportunities to improve householder and industry awareness of climate resilience and effective home retrofit strategies, as well as engagement.

Stimulating demand and facilitating uptake of climate-resilient housing retrofit measures can be supported by:

- Establishing clear and consistent language for describing climate-resilient housing, why it is needed, and how it can be achieved in existing and new homes. Information and examples of climate-resilient housing practice can be integrated into existing knowledge dissemination approaches and channels, such as the *Your Home guide* (Australian Government 2026), and in the education and training of building, planning, financing and real-estate industry professionals.
- Communicating the financial and non-financial benefits of climate-resilient housing (building on existing momentum around electrification and thermal comfort) and promoting existing resiliency incentives in different jurisdictions.
- Establishing new tools and services – and enhancing current ones – for independently assessing the resilience of existing housing to present and future climate hazards, and for recommending cost-effective actions to aid decision-making among homeowners and investors.
- Expanding effective engagement and support strategies to reduce complexity and effort for homeowners, such as providing guidance on sequencing retrofit measures based on affordability or impact. This could encompass knowledge platforms and tailored advice services that consolidate information and retrofit options and streamline decision-making to convert interest into action.

The challenge will be normalising the concept of resilient housing within the context of wider housing challenges, such as affordability. However, this socialisation of climate-resilient retrofit needs to occur to foster the development of a market for climate-resilient retrofit. Part of this approach will be continuing to leverage households' willingness to undertake property improvements after experiencing a climate event (when they realise that their property may not be sufficiently robust, or even liveable, during such events). It also needs to focus on encouraging households to make improvements before they experience further climate events.

Supporting the most vulnerable households first

Through the *Update to the Trajectory for low energy buildings* (DCCEEW 2025b), governments have committed to ensuring homes keep people healthy, comfortable and safe from climate hazards, and that all Australians benefit from improved building performance.

Our CBA indicates that, for lower-value housing, retrofit may not be financially viable without additional support. Additionally, it must be noted that even had the modelling indicated that resilient retrofit across all housing types and locations was financially viable, lower-income households would nonetheless struggle to afford the capital costs to implement some of the retrofit activities recommended.

General government subsidies to alleviate upfront cost barriers for energy retrofits have been found to benefit higher wealth households and areas only. This inequity exacerbates existing disadvantage and will likely have flow-on economic impacts such as increased healthcare costs. The risk that a proportion of the population will be left behind in the transition to climate-resilient housing presents a policy imperative for additional or alternative action to subsidies, such as regulation and targeted public investment. In turn, such regulation and investment would enable the industry to develop delivery capacity for wider uptake, as has occurred in energy efficiency and electrification.

Supporting vulnerable households to promote equitable outcomes could be achieved by:

- Identifying excluded and high-risk areas of the population, including prevalent climate hazards impacting housing now and in the future. This could be done through improved data collection and analysis.
- Securing funding for partial and full subsidies for climate-resilient retrofits where upfront cost is prohibitive in private and social housing. Strengthening minimum standards for private rentals to incentivise landlord engagement and investment.
- Developing and expanding facilitation services for vulnerable households and housing providers. For example, the *RACE for 2030 Energy Upgrades for Australian Homes* project (RACE for 2030 2026b) is developing strategies to enable more local government and community organisations to develop programs that effectively engage diverse communities and provide trusted, independent advice to convert interest into action.
- Supporting supply chain development, including through initiatives that upskill trades and provide subsidies for emerging technologies and other solutions.

The challenge in this policy and practice area will be providing sufficient funding to support significant improvements, given the wider financial and housing affordability and supply context in Australia. Funds to support targeted resilient retrofit should be framed as potentially offsetting future costs for rebuilding and repair.

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Appendix A: HILDA Survey analysis

Data and measures

HILDA Survey and sample

We use data from the HILDA Survey. HILDA is an annual, nationally representative longitudinal survey that has followed around 17,000 individuals since 2001. For this analysis, we restrict to waves 1–19 (2001–2019), deliberately stopping prior to the COVID-19 pandemic to avoid confounding from the acute social and economic disruption in 2020 and beyond.

The primary outcome is health-related quality of life, drawn from the SF-36 instrument administered as part of HILDA's self-completed questionnaire (SCQ). We use the SF-6D health state classification index with Australian weights (variables ghsf6ap and ghsf6an, depending on whether the index is positive or negative). This index ranges from 0 (equivalent to death) to 1 (full health) and is widely used to construct quality-adjusted life years (QALYs) for economic evaluation. We supplement the SF-6D index with the eight SF-36 domain scales: physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional, and mental health. These are derived on a 0 to 100 transformed scale, where higher scores indicate better health.

Disaster exposure

To capture exposure to climate-related disasters, we use the Australian Government's Disaster Assist database of declared natural disasters, accessed via data.gov.au. The database records officially declared events such as floods, bushfires and storms, along with their spatial coverage and affected LGAs. The HILDA sample is linked to Disaster Assist at the LGA level using HILDA's LGA identifiers and the date on which respondents completed the SCQ (which is when the SF-36 is completed). We construct an indicator for whether the respondent's LGA was subject to at least one disaster declaration in the 12 months prior to the SCQ date. This captures the medium-run health impact of living in a community affected by a disaster over approximately the preceding year.

The Disaster Assist data are available from 2006 onwards. Coverage in the early years is patchy, so for the disaster analysis we restrict the sample to HILDA waves 10–19 (roughly 2010–2019), where the recording of disaster declarations is more complete and consistent. The main disaster analysis sample for the SF-6D outcome includes 88,954 person-year observations.

Temperature exposure

To measure heat exposure, we use daily maximum temperature observations from the Bureau of Meteorology (BOM). For each LGA in the HILDA sample, we identify the five closest BOM weather stations that were open over the relevant period and recorded daily maximum temperatures for at least 95% of days during the sample period. For each day, we compute a distance-weighted average of maximum temperature across these five stations, weighting by the inverse of squared distance between the station and the LGA centroid. This provides a daily series of local maximum temperatures at the LGA level.

We then link these LGA-level daily temperatures to HILDA respondents via their LGA and SCQ date. For each respondent, we calculate the mean daily maximum temperature over the 28 days (four weeks) prior to the SCQ date. This 4-week window is chosen to align with the SF-36 recall period ('during the past four weeks'), ensuring that our temperature measure reflects the conditions most relevant to the health questions. For the temperature analysis we use all available pre-COVID waves (1–19), yielding 149,051 person-year observations for the SF-6D outcome.

Housing quality

To proxy housing quality, we use four material-deprivation dwelling items: whether the home has a roof and gutters that do not leak (mdhhrg), secure doors and windows (mdhhsl), a decent and secure home overall (mdhhsh), and whether the household is able to keep at least one room adequately warm in cold weather (mdhehaw). All variables were coded so that 1 indicates adequate housing quality and 0 indicates a housing deficiency. These items are administered in HILDA waves 14, 18 and 22 only. We use each respondent's Wave 14 (2014) measure and treat this as time-invariant across the panel. As a result, the interaction models reported in Table 17 below are restricted to the subsample of respondents observed in Wave 14; respondents not interviewed in Wave 14 do not contribute to these models.

Empirical approach

Fixed-effects regression model

We estimate fixed-effects panel models of the form:

$$H_{it} = \beta X_{it} + \alpha_i + \gamma_a + \delta_{st} + \varepsilon_{it}$$

where H_{it} is health utility for individual *i* in time *t*; X_{it} includes either disaster exposure or temperature measures, depending on the model being estimated; α_i are individual (person)-level fixed effects; γ_a are area-level (LGA) fixed effects, capturing time-invariant local characteristics (geography, long-run climate); δ_{st} are state-by-year fixed effects, capturing economic and policy changes that differ across states over time; and ε_{it} is an idiosyncratic error term. This specification identifies within-person associations between changes in local environmental exposures and health, net of stable individual and local characteristics, and state-year shocks. Our main coefficient of interest, β, measures the association between environmental exposures and health.

Analogous models are estimated for each of the eight SF-36 domain scores, using the same fixed-effects structure.

Housing quality analysis

We conduct a factor analysis using four material-deprivation dwelling items from HILDA. We then explore whether dwelling-quality factors moderate the association between climate stressors and health. Specifically, we test interaction terms between housing-quality factors and (a) medium-run disaster exposure and (b) short-run heat exposure, estimating models with the same fixed-effects structure as outlined above. This allows us to identify whether poor-quality housing is associated with larger declines in health following climate exposure.

All analysis was conducted in STATA version 19.

Results

Our estimation results, which are discussed in the main text, are presented below.

Table 15: Associations between exposure to climate factors and the SF-6D health utility index

Panel A: Natural disasters	
LGA experienced disaster last 12 months	-0.00320**
	(0.00128)
N	88954
Panel B: Temperatures	
Average maximum temperature last 4 weeks	-0.00036*
	(0.00020)
N	149051

Source: Authors.

*Note: Table reports point estimates with robust standard errors in parentheses for the estimated associations between disaster exposure (Panel A) and temperature (Panel B) and the SF-6D health utility index. All models include individual, LGA, and state-by-year fixed effects. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.*

Table 16: Associations between climate factors and eight health dimensions of the SF-36

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Physical functioning	Role-physical	Bodily pain	General health	Vitality	Social functioning	Role-emotional	Mental health
Panel A: Natural disasters								
LGA experienced disaster last 12 months	-0.06270	-0.19488	-0.11009	-0.10493	-0.34279***	-0.21454	-0.62272***	-0.30010***
	(0.11617)	(0.22655)	(0.13289)	(0.09204)	(0.10314)	(0.13750)	(0.21224)	(0.09064)
N	91260	91167	91569	91115	91693	91989	91136	91694
Panel B: Temperatures								
Average maximum temperature last 4 weeks	-0.03685**	0.03607	0.01741	-0.00734	-0.05142***	-0.04962**	-0.09526***	-0.04738***
	(0.01801)	(0.03372)	(0.02047)	(0.01461)	(0.01596)	(0.02094)	(0.03188)	(0.01409)
N	153526	153279	154276	153329	154650	155309	153203	154631

Source: Authors.

*Note: Table reports point estimates with robust standard errors in parentheses for the estimated associations between disaster exposure (Panel A) and temperature (Panel B) and the eight health dimensions of the SF-36. All models include individual, LGA, and state-by-year fixed effects. *** p < 0.01, ** p < 0.05, * p < 0.10*

Table 17: Associations between climate exposure, the SF-6D utility index, and moderating impacts of dwelling-quality factors

	Natural disasters		Temperature	
	(1)	(2)	(3)	(4)
Exposure	-0.00375***	-0.00397***	-0.00030	-0.00069***
	(0.00136)	(0.00145)	(0.00022)	(0.00023)
Exposure * Structural factor	0.00329		-0.00032	
	(0.00254)		(0.00041)	
Exposure * Thermal factor		0.00312		0.00144***
		(0.00272)		(0.00040)
N	86,004	86,004	129,349	129,349

Source: Authors.

*Note: Table 17 reports point estimates with robust standard errors in parentheses for the association between disaster exposure, temperature, and their interactions with housing characteristics (structural and thermal factors) and the SF-6D health utility index. The exposure variable in columns (1) and (2) is a binary indicator equal to one if the respondent lives in an LGA that experienced a declared disaster in the 12 months prior to the HILDA Survey, and zero otherwise. The exposure variable in columns (3) and (4) is the average daily maximum temperature over the four weeks prior to the HILDA Survey. All models include individual, LGA, and state-by-year fixed effects. *** p < 0.01, ** p < 0.05, * p < 0.10.*

Limitations

Internal validity

The fixed-effects specification absorbs time-invariant person-level factors, time-invariant local characteristics, and state-by-year shocks. It does not absorb time-varying confounders operating at the LGA level within a state-year that may be correlated with both climate exposure and health, such as localised economic disruption following a disaster. This possibility should be kept in mind when interpreting the reported associations, and rules out a causal interpretation of the coefficients.

Generalisability of estimates

Regressions do not apply HILDA's population weights, since standard cross-sectional weights are not designed for the within-person de-meaning transformation used in a fixed-effects estimator. Estimates should therefore be interpreted as describing associations within the sampled HILDA panel rather than as population-representative estimates for Australia as a whole.

Housing quality measurement

Housing-quality measures are derived from a single cross-sectional measure at Wave 14 and treated as time-invariant across the panel. This restriction may introduce some measurement error for individuals who changed dwellings or undertook renovations between Wave 14 and the other waves in which their health and exposure outcomes are observed. Such measurement error would generally attenuate rather than inflate the estimated interaction effects, meaning the reported interaction should, if anything, understate the true relationship.

Valuation of health outcomes

The SF-6D/QALY approach captures reductions in health-related quality of life among the surviving interviewed HILDA population only, and does not capture mortality or hospitalisation, which represent a separate cost category. Estimates should therefore be interpreted as a lower bound on the health cost of heat and disaster exposure.

Distributional impacts

The estimates presented are averaged associations across the estimation sample. HILDA does not directly capture several characteristics likely to be relevant to differential vulnerability, including homelessness or rough sleeping, and detailed measures of social isolation. Moreover, further segmentation of an already restricted sample is likely to produce imprecise estimates. Distributional analysis of climate-related health associations using data sources better suited to it is an avenue for further research.



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