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Building climate resilience in Australian homes and households



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

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Summary

Key points

- Many Australian homes, especially older homes, are not designed for current and future climate conditions.
- Building climate-resilient housing stock relies on integrated, hazard-specific design strategies rather than isolated measures.
- The heat resilience of buildings depends on balanced combinations of envelope materials, shading, ventilation, surface reflectance and the appropriate operation of energy-efficient cooling systems.
- Bushfire, flood and cyclone resilience each require tailored structural approaches, such as non-combustible materials, elevation, wet proofing and reinforcement.
- Household resilience is critical for all climate hazards. This varies with health, resources, tenure and community networks, and is strengthened through retrofits, practical preparedness, and institutional and informal support.
- This report develops a set of climate ready housing guidelines that map resilience measures to climate hazards for new-build housing and retrofit pathways for existing homes.
- The key policy and practice opportunities identified in this report include strengthening standards for new homes, scaling up retrofits of existing homes through mandatory and voluntary instruments, investing in household and community level resilience, building capacity to plan for energy and compounding climate risks, and improving ongoing evidence synthesis.

Key context

Climate change has already increased average temperatures and made extreme weather events, such as heatwaves, bushfires, floods and storms, more frequent and severe, and these risks are expected to increase as global temperatures rise. These changes can damage or destroy homes, reduce their comfort and safety, and make them unsafe to live in.

Homes are generally built to last, which means that many of the houses we live in today, and those being built now, will still be standing decades into the future, exposed to a changing climate and used by different households with varying needs. Much of Australia's existing housing stock was built to standards that did not consider future climate conditions. Current regulations focus primarily on new homes and include many requirements that support climate resilience, although gaps remain.

This research forms part of an AHURI Inquiry into achieving a climate-resilient housing stock by 2050. It seeks to establish a framework for government and industry action to build climate resilience into Australia's housing stock. The Inquiry draws on two research projects, of which this project is one. This project defines climate-resilient housing in Australia and develops a set of climate-ready housing guidelines (CRHG) that outline resilience measures for a wide range of climate threats affecting Australian homes. The other project (Moore et al. forthcoming) examines the costs and benefits of retrofitting Australian housing stock for resiliency.

Although regulations for new homes in Australia require certain measures to address hazards such as flood, fire, cyclone and extreme heat, these requirements are not yet aligned with projected future climate conditions. Regulations to systematically improve resilience in existing homes remain limited. This report supports the development of policy and practice aimed at strengthening climate resilience in both new and existing homes by providing guidelines for improving climate resilience in new and existing homes. It also examines how householders engage with their communities and with the physical characteristics of their homes to build resilience. These insights can support policymakers seeking to enhance household, neighbourhood and community-level assets that enable residents to withstand extreme weather events and rising long-term temperatures.

Key methods

This research reviewed existing international academic and grey literature on climate-resilient homes, developed a set of guidelines for Australia, and tested them using case studies of climate-resilient homes and interviews with practitioners with professional experience relevant to climate resilience or housing. It also examined how Australian householders practise climate resilience in their homes.

The research was undertaken in three stages.

Stage 1: Development of guidelines for climate-resilient homes

A rapid review (Section 2.3.1) of the Australian and international academic and grey literature (2005–25) was undertaken to identify international standards, guidelines and frameworks for climate-resilient housing.

The findings were synthesised to create:

- a definition of climate-resilient housing (Section 3.4.6)
- a set of guidelines for climate-resilient housing (Chapter 7).

The guidelines were refined using evidence gathered in Stages 2 and 3.

Stage 2: Testing the CRHG with case studies and specialist stakeholder feedback

Three case studies of exemplar climate-resilient homes were developed through desktop research. Cases were selected according to climate context and climate-resilience features (Section 2.3.2). Climate-resilient features were extracted and compared with the draft CRHG to identify alignment and any additional measures not previously captured.

Practitioner interviews captured insights from property and climate adaptation experts (Section 2.3.2). These interviews gathered feedback on the draft CRHG and the definition of climate-resilient housing.

Stage 3: Examining the climate-resilience experiences of households

Focus groups and interviews explored how households experience climate change and the conditions that influence whether extreme events become crises (Section 2.3.3). Recruitment targeted people with heightened exposure or vulnerability to climate change such as:

- people with climate-affected medical conditions
- older people
- people who have moved to Australia from regions with extreme weather
- people living in regional Australia.

Key findings

Defining climate resilient housing

Our research identified three essential resilience characteristics that, taken together, provide a definition of climate-resilient housing (Table 1).

Table 1: Resilience characteristic definitions

Resilience characteristic	Description
Robustness	The home maintains structural integrity through climate events and long-term, higher-than-average temperatures
Protection	The home continues to function and protects the health, safety and comfort of occupants through climate events and long-term, higher-than-average temperatures
Recovery	The home can be efficiently and affordably returned to acceptable levels of functioning after an extreme weather event, without long-term impacts

Source: Authors.

Features of climate resilient housing

Our research found that resilience relies on integrated, hazard specific design, not single measures. We identified approaches to improve resilience to four key climate risks: heat, bushfire, flood and cyclone.

- **Heat-resilience** measures include shading, reflective surfaces, ventilation, insulation and thermal mass. Innovative measures, such as phase change materials, may improve performance in the future. Thermal-resilience measures interact, so performance-based modelling is important to manage risks and trade-offs. Measures to keep houses cooler during hot weather can also make them colder in winter, therefore designs must balance these considerations according to the local climate. Other measures, such as increasing thermal mass, can worsen overheating unless paired with ventilation and shading. All such measures must be assessed holistically. Many homes will require air conditioning, making zoning, airtightness and efficiency of appliances important. This also highlights the importance of energy security.

- **Bushfire-resilience** measures include non-combustible materials, simple building forms and ember protection on exposed points, such as doors, windows and gutters.
- **Flood-resilience** strategies must match local flood projections. Some areas can rely on dry proofing, while others require elevation or wet proofing to enable rapid, mould-free recovery.
- **Cyclone resilience** requires structural reinforcement, secure connections, impact-resistant elements and appropriate siting.

Climate resilience of households

Our research found that the climate resilience of households differs by life stage, health, socio-economic resources, housing tenure and community networks. People build climate resilience for their households and communities through:

- retrofitting or rebuilding
- hazard-specific practices, for example, securing outdoor items before cyclones
- informal community support before, during and after extreme events
- sharing local knowledge.

Household resilience is also shaped by neighbourhood- and system-level factors, such as infrastructure, regulations, neighbouring properties and public spaces.

Insights from case studies and practitioners

Real world case studies demonstrate that:

- measures can be combined to address multiple hazards
- innovation can significantly raise resilience
- high climate resilience does not always equate to high building costs.

Practitioners emphasised the importance of building standards aligned with regional conditions.

In the south of Australia, heat is increasingly the focus, although houses must still protect against cold. In northern regions, prolonged heat and humidity are an ongoing focus, with an emphasis on mould prevention.

Thermal-resilience priorities differ between keeping heat out via insulation and air-sealing, and flushing heat and moisture through ventilation. Well-sealed, air-conditioned cool rooms provide an efficient combined approach.

Resilience measures in the CRHG

A major output of this report is the development of climate-ready housing guidelines. The measures in the guidelines are classified by innovation level (basic, established, innovative) and confidence level (low, mid, high), reflecting the maturity and consistency of available research.

Each measure is mapped against its relevant climate hazard, intended resilience characteristic (robustness, protection, recovery) and potential for amplifying other risks. Climate-zone is also specified, as risk profiles differ across Australia.

Measures in the CRHG differ for new and existing homes. In new homes, mid-to-high levels of innovation dominate because many basic measures are already mandatory. By contrast, in existing homes, basic to established measures should be prioritised.

Key policy and practice opportunities

The report identifies five key opportunities for policy and practice to advance climate-resilient homes and households across Australia.

1. Strengthen standards for new housing

There are several opportunities for the National Construction Code (NCC) to build climate resilience by:

- mandating basic and established resilience measures
- expanding hazard zones based on projected climate exposures
- setting climate triggers for NCC updates
- integrating climate resilience into the Nationwide House Energy Rating Scheme.

2. Rapidly scale up the retrofitting of existing homes

Retrofitting existing homes improves safety, reduces energy hardship and lowers disaster-related costs. There is an opportunity to increase the retrofitting of existing homes using strategies such as setting minimum climate-resilience standards for rental properties, providing targeted support for vulnerable groups, tailoring guidance to local climate zones and housing types, and embedding 'build back better' principles in disaster recovery.

3. Invest in household, neighbourhood and community resilience

Household resilience is shaped by surrounding neighbourhoods and social networks. Community knowledge sharing could be strengthened by supporting peer-to-peer learning, including community insights in planning, expanding tree canopy and water-sensitive design, and extending resilience hubs that offer safe shelter during extreme weather.

4. Build capacity to anticipate, cross-analyse and design for multi-hazard, future-focused planning that recognises emerging and compounding risks

Increasingly sophisticated climate risk projections provide several opportunities to foster resilience, including:

- updating hazard maps and planning controls to reflect shifting risks
- incorporating multi hazard and compounding event scenarios into planning and regulation
- supporting energy security
- providing guidance on navigating trade-offs (e.g. maximising summer shading without compromising winter warmth).

5. Build a 'living' national evidence and guidance system

A dynamic, continuously updated system, similar to living systematic reviews used in medical research, could ensure that guidance on climate risks and effective responses remains current and evidence based.

Contents

Summary ii

List of tables x

List of figures x

Acronyms and abbreviations xi

Glossary xi

1. Introduction 1

1.1 Australia's changing climate 1

1.2 Existing policy and practice 2

1.2.1 Climate change adaptation policies 2

1.2.2 Climate-related housing policies 2

1.2.3 Housing after climate disasters 3

2. Research design 4

2.1 Research approach 4

2.2 Research aims and questions 4

2.3 Research methods 4

2.3.1 Rapid review 5

2.3.2 Case studies and practitioner interviews 8

2.3.3 Householder focus groups and interviews 9

2.4 Climate-ready housing guidelines development 11

3. Review findings and definition of climate-resilient housing 13

3.1 Climate resilience 13

3.2 Literature profile 14

3.3 Included papers 16

3.4 Defining climate-resilient housing 18

3.4.1 Thermal resilience 18

3.4.2 Flood, bushfire and cyclone resilience 18

3.4.3 Resilience to multiple climate events 19

3.4.4 Resilience during and after climate events 19

3.4.5 Environmental sustainability 19

3.4.6 Proposed definition of a climate-resilient home 19

3.5 Implications 20

4. Climate-resilient housing and retrofitting 21

4.1 Climate resilience for new housing and retrofitting 21

4.1.1 Regions within Australia will need different approaches 21

4.1.2 National Construction Code zones may need to change 22

4.1.3 Approaches to improving thermal resilience 22

4.1.4 Approaches to improving flood resilience 22

4.1.5 Approaches to improving bushfire resilience 23

4.1.6 Approaches to improving cyclone resilience 23

4.2 Rapid review findings: climate-resilience measures 24
4.2.1 Wall systems 24
4.2.2 Floor systems 26
4.2.3 Roof systems 26
4.2.4 Doors and windows 27
4.2.5 Energy systems and technology 28
4.2.6 External structures 29
4.2.7 Other design measures 30
4.3 Implications 31
5. Case studies and stakeholder perspectives 33
5.1 Learning from innovative properties 33
5.2 Case study 1: Flores House (Casa Flores) by FUSTER + Architects 34
5.3 Case study 2: Eco-House Leura by Marra + Yeh Architects 35
5.4 Case study 3: 10 Star House by SUHO 36
5.5 Practitioner perspectives on the draft CRHG 37
5.5.1 Perspectives on flooding and cyclones: wet proofing is increasingly important 37
5.5.2 Perspectives on thermal resilience: passive and active approaches have advantages and disadvantages 38
5.6 Implications 39
6. Households and climate resilience 40
6.1 Asset-based community development framework 40
6.2 What we know about household climate resilience 41
6.3 Householder experiences of extreme weather 41
6.3.1 Lived experiences shape understanding of climate resilience 41
6.3.2 People manage their homes to improve resilience 42
6.4 Factors shaping household climate resilience 43
6.4.1 Individuals vary in vulnerability and capacity 43
6.4.2 Community assets and support 43
6.4.3 Formal institutions 44
6.4.4 Physical assets 44
6.4.5 Goods and energy services 45
6.4.6 Shared narratives shape climate-resilience decisions 45
6.5 Implications 46
7. Developing climate-ready housing guidelines 48
7.1 Guidelines for climate-resilient housing 48
7.2 Categories in the climate-ready housing guidelines 49
7.2.1 Elements of a home interact 49
7.2.2 Measure levels 49
7.2.3 Confidence levels 49

7.2.4 Climate events and resilience characteristics 50
7.2.5 Risks potentially amplified 50
7.2.6 Climate zones 51
7.2.7 References 51
7.3 Guidelines for new homes and retrofits 51
7.4 Implications 61
8. Policy and practice opportunities 62
8.1 Households and climate resilience 62
8.2 Best practice in developing climate-resilient homes 63
8.2.1 Levels of innovation and confidence 63
8.2.2 Resilience characteristics 63
8.2.3 Risks that may be exacerbated 64
8.2.4 Climate zone relevance 64
8.2.5 Additional best practice considerations 64
8.3 Five policy and practice opportunities 64
8.3.1 Strengthen and modernise standards for new housing 64
8.3.2 Rapid scale up of retrofitting: Australian housing's greatest resilience gap 65
8.3.3 Invest in household, neighbourhood and community resilience 66
8.3.4 Build capacity for multi-hazard, future-focused planning 67
8.3.5 Build a 'living' national evidence and guidance system 67
References 69
Appendix A: Housing actions in climate adaptation plans of Australian jurisdictions 75
Appendix B: CRHG part 3: measures already included in the NCC 76

List of tables

Table 1: Resilience characteristic definitions iv
Table 2: Inclusion and exclusion criteria: study type 6
Table 3: Rapid review search terms 6
Table 4: Householder participant locations 10
Table 5: Data synthesis into CRHG 12
Table 6: Included papers: academic 16
Table 7: Included papers: grey literature 17
Table 8: Resilience characteristic definitions 20
Table 9: Climate risks and resilience characteristics 50
Table 10: CRHG part 1: guidelines for new homes 52
Table 11: CRHG part 2: guidelines for existing homes 56

List of figures

Figure 1: Rapid review screening 7
Figure 2: Climate events in included literature 15
Figure 3: Included papers: year of publication 15

Acronyms and abbreviations

ABCD	asset-based community development
AC	air conditioning
AHURI	Australian Housing and Urban Research Institute
CRHG	climate-ready housing guidelines
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTS	Cyclone Testing Station
DCCEEW	Department of Climate Change, Energy, the Environment and Water
LCC	Logan City Council
LMCC	Lake Macquarie City Council
LED	light emitting diode
MDF	medium-density fibreboard
NatHERS	Nationwide House Energy Rating Scheme
NCC	National Construction Code
PV	photovoltaics
QRA	Queensland Reconstruction Authority
RHC	Resilient Hills & Coasts
RMY	Reference Meteorological Years
SES	State Emergency Service
WHO	World Health Organization

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 Australia's changing climate

Homes are long-lasting structures. Many existing and new homes will remain in place for decades and will be exposed to future climate conditions (BoM and CSIRO 2022: 4). They will also be inhabited by numerous households over time, with changing demographics and needs. Australia needs a housing stock that can withstand these changes and provide fit-for-purpose homes.

Climate change has already increased the severity and frequency of extreme weather events and slow-onset climate events in Australia, with impacts projected to worsen (BoM and CSIRO 2022). Australia's 2025 National Climate Risk Assessment identified 10 priority hazards for Australia under climate change:

- changes in temperature, including extremes
- drought and changes in aridity
- bushfires, grassfires and air pollution
- extratropical storms
- convective storms, including hail
- tropical cyclones
- riverine and flash flooding
- coastal and estuarine flooding
- coastal erosion and shoreline change
- ocean warming and acidification.

The impact of these changes on housing can be grouped into four categories (ECRC 2018):

- Gradual changes, such as increased average temperatures and rainfall, can accelerate structural deterioration.
- Changes such as sea level rise can cause property damage or destroy properties through inundation or coastal erosion.
- Extreme weather events can damage or destroy homes. For example, cyclones and bushfires can cause structural damage, while floods can lead to structural impacts, mould, and damage to internal features such as cabinetry and electrical systems.
- Increasingly extreme climate conditions can render housing inadequate to ensure residents' health and safety. Prolonged periods of extreme indoor heat pose significant health risks. Smoke ingress from bushfires and mould growth after flooding can also harm occupants' health.

This research is part of a broader AHURI Inquiry into achieving a climate-resilient housing stock by 2050. The Inquiry includes vulnerability mapping and identifying pathways for building resilience into the Australian housing system. It is supported by two projects: the current study and a complementary project (Moore et al. forthcoming) that applies the climate-ready housing guidelines (CRHG) identified in this report to assess the costs of retrofitting Australia's existing housing stock for climate resilience. This report contributes key inputs that inform the wider Inquiry.

The report synthesises extant recommendations for climate-resilient housing from academic and grey literature and uses these to develop draft guidelines for Australian housing that are then refined through:

1. assessment against three case studies of climate-resilient housing
2. feedback from specialist property, construction and climate change adaptation practitioners
3. examining how climate-exposed groups in Australia build resilience in their homes.

This report presents policy and practice opportunities for building climate resilience in Australian homes and households. These focus on five domains: increasing standards for new homes; scaling up the retrofitting of existing homes; supporting household, neighbourhood and community resilience; addressing emerging and compounding climate hazards; and creating a living evidence system for climate-resilient housing.

1.2 Existing policy and practice

1.2.1 Climate change adaptation policies

Climate change adaptation refers to the process of adjusting systems, communities and practices to minimise harm and capitalise on potential benefits arising from current or anticipated climate impacts. The Australian Government and all state and territory governments have introduced climate change adaptation strategies, or strategies that combine climate change mitigation and adaptation. Each of these strategies references the need to improve the climate resilience of buildings, although the level of detail and priority given to housing varies, and some make no direct commitments to improving the climate resilience of homes. A summary of housing actions in the adaptation plans for Australian jurisdictions is included as Appendix A.

1.2.2 Climate-related housing policies

The National Construction Code (NCC) sets the minimum required standards for the design, construction and performance of buildings across Australia. As is the case in many other countries, the NCC's standards are based on current climate conditions and do not include climate-resilience measures (GRD 2021). In 2024, federal, state and territory ministers with portfolio responsibilities for building standards added climate resilience as an objective for the Australian Building Codes Board (ABCB), which oversee updates to the NCC (Watt et al. 2024).

Although the NCC does not yet account for predicted future climate conditions, it does include some requirements that offer protection in weather events that will increase under climate change. For example:

- The NCC recognises that climate risks differ across Australia and includes specific standards for properties in areas at risk of flood, bushfire and cyclones (ABCB n.d.-a).
- The 2022 update requires a minimum energy efficiency rating of 7 stars under the Nationwide House Energy Rating Scheme (NatHERS) or equivalent. NatHERS assesses features such as orientation, double or triple glazing, shading, zoning and insulation (ABCB n.d.-b).
- The 7-star NatHERS standard has been criticised for falling short of zero net emissions targets and international best practice (Daniel et al. 2024; Moore and Holdsworth 2019). Although the NCC standards are set nationally, legislation is implemented by individual states and territories. The adoption of 7-star requirements has been inconsistent across Australia (Daniel et al. 2024).

Federal, state/territory and local governments all play a role in Australia's housing system. Overlapping responsibilities between different levels of government, alongside interactions with related policy domains (such as taxation) and private sector actors (e.g. banks, builders and landlords), contribute to a complex governance environment that can complicate the implementation of housing policy changes (Dodson et al. 2017).

The 2019 Addendum to the trajectory for low energy buildings outlined a plan to improve the energy performance of all new and existing commercial and residential buildings across Australia (DCCEEW 2019). In August 2025, the Energy and Climate Change Ministerial Council announced updates to the Trajectory for low energy buildings, including an added objective to 'keep people healthy, comfortable and safe from climate hazards' (DCCEEW 2025b). While the Trajectory is an important collaboration between state, territory and federal governments, it has yet to be translated into widespread regulatory reform.

One reform outlined in the Trajectory is the expansion of NatHERS to existing homes. Previously, NatHERS was used only for rating new homes or significant renovations. In 2025, NatHERS was expanded to include ratings for existing homes. A staged approach to implement this across the country has commenced; however, as yet, there is no minimum allowable rating for existing homes (DCCEEW 2025a).

In addition to NatHERS, several voluntary options exist for householders aiming for higher sustainability and climate-resilience standards than those required by regulation. For example, the Green Building Council's Green Star Homes rating tool assesses energy efficiency and climate resilience for Australian homes (GBCA 2021). The Resilient Building Council provides a self-guided resilience ratings app that generates action plans tailored to local conditions (RBC 2024).

Overall, homes built before the introduction of the NCC perform poorly in bushfires and floods compared to newer homes (Mason et al. 2012; Roberts 2022). Some older homes have been upgraded over time or were originally built with features that help them remain resilient, such as suitable orientation, building materials and good ventilation. However, there is little regulation to improve the comfort, environmental performance or robustness of existing homes during climate events. On average, older homes are in poorer condition than newer homes and have more problems, such as cracks and mould (Daniel et al. 2024).

Existing homes in the rental market pose a particular challenge. On average, rental properties have poorer energy and thermal efficiency than owner-occupied homes (Krishnamurthy and Kristrom 2015). Renters are more likely than owners to live in homes that are in poor or derelict condition, which negatively impacts mental and physical health (Baker et al. 2016). When governments incentivise energy and thermal efficiency improvements, such incentives are disproportionately accessed by owner-occupiers (Charlier 2015).

Regulations to improve conditions in existing buildings are minimal. The Australian Capital Territory requires insulation in rental homes (JCSD 2025). In 2025, Victoria announced a staged introduction of mandatory insulation, draught sealing, and efficient electric heating and cooling for rental homes (Moore et al. 2025).

1.2.3 Housing after climate disasters

Federal, state and local governments all play a role in disaster recovery. These responsibilities range from land use planning to minimise housing in high-risk areas, to providing short-term accommodation and supporting community rebuilding efforts. There are calls for governments to embrace a 'build back better' approach, which focuses on strengthening resilience to future disasters rather than simply restoring what was lost. However, build back better is not yet standard practice (Heffernan et al. 2025).[1]

1 For a comprehensive overview of the roles of different levels of government in disaster preparedness, see Sanderson et al. (2025).

2. Research design

2.1 Research approach

This research forms part of an AHURI Inquiry into achieving a climate-resilient housing stock by 2050. The Inquiry aims to establish a framework to accomplish this objective. It includes a stock vulnerability audit and identifies pathways to retrofitting the entire housing stock for resilience, including key actors, their roles and regulatory pathways. The Inquiry is supported by the current project and another research project (Moore et al. forthcoming) that maps the resiliency deficit across Australian housing stock and assesses the costs and benefits (financial and non-financial) of retrofitting by 2050. The current report delivers two key outputs that inform other components of the Inquiry:

1. A definition of climate-resilient housing (Section 3.4.6) that underpins the Inquiry-level research question: who is responsible for building climate resiliency into the housing stock?
2. A set of climate-ready housing guidelines (CRHG) that are used for deficit mapping and cost-benefit analysis in the broader Inquiry.

2.2 Research aims and questions

This project aims to answer two questions:

- What does best practice look like in designing and delivering climate-resilient homes?
- How do Australian households practise climate resilience today?

2.3 Research methods

This research adopts a qualitative, multiple methods approach, drawing on three main data collection methods:

- rapid review
- case studies and practitioner interviews
- householder focus groups and interviews.[2]

This chapter introduces each method and explains how the data from each were synthesised to create the CRHG.

2 Ethics approval for the focus groups was attained from Monash University (project ID 47848).

2.3.1 Rapid review

A wide range of literature review methods can be used to synthesise evidence. For example, a systematic review uses transparent, structured methods to identify, select, evaluate, extract and analyse data from relevant studies to provide a transparent and exhaustive overview of the literature. Rapid reviews follow a similar process to systematic reviews but with deliberate simplifications to reduce the review time, focusing, for example, on existing reviews rather than primary research—a method known as umbrella reviewing. Rapid reviews are increasingly used to balance the need for time-sensitive decision-making and methodological rigour (Garritty et al. 2024).

In this project, a rapid review method was used to survey the literature on a broad range of climate hazards within a reasonable timeframe. The review process included several simplifications, including capping the number of papers screened. The primary approach was an umbrella review, which focused on identifying existing review papers. However, because much of the research on climate-resilient housing is relatively recent and not yet captured by previous reviews, a supplementary review of academic literature was also undertaken. This supplementary review was abbreviated by searching a single database. In addition, because government and non-government organisations hold substantial knowledge on climate resilience, the academic review was complemented by a grey literature search.

Search strategy

The rapid review drew on academic literature sourced from Scopus, a large database with broad interdisciplinary coverage. As no single database provides complete coverage, searches in Scopus were supplemented with Google Scholar and grey literature sources.

The rapid review included three components:

- an umbrella review using Scopus and Google Scholar
- a rapid review of the academic literature using Scopus
- a review of the grey literature using Informit[3] and Google.

Each search was set so that the most relevant papers were listed first and searches were terminated once 50 consecutive items were screened with no new, relevant papers identified.

Pilot testing was conducted until consistency was achieved among screeners, after which each paper was screened by a single researcher. A review protocol was pre-registered on Open Science Framework (Lang et al. 2025) that included all eligibility criteria and search, screening and evidence extraction strategies. The eligible study types are shown in Table 2.

The Google Scholar search was conducted using Publish or Perish, a software program that retrieves and analyses academic citations from various data sources (Harzing 2007). Papers were screened and duplicates removed using Covidence (app.covidence.org).

3 The Informit search incorporated six grey literature databases: AGIS Plus Text, Australian Public Affairs Full text, APO abstracts database, Engineering Collection, Health Collection, Humanities & Social Sciences Collection.

Table 2: Inclusion and exclusion criteria: study type

Inclusions	Exclusions
Studies that examine climate-resilient housing	Studies examining climate change mitigation and housing (e.g. energy efficient housing), without specific reference to climate resilience or climate change adaptation
Studies that examine housing resilience for specific climate threats (e.g. flood resilience, bushfire resilience)	Studies dated before 2005
Reviews, case studies, primary research, policy documents	Articles on housing impacted by non-climatic hazards (e.g. earthquakes, tsunamis, volcanoes) unless also addressing climate-related risks
Studies focused on OECD countries	Purely technical studies (e.g. on building materials or insulation) without discussion of climate-resilience outcomes
	Studies that are in temperature and humidity zones that are not comparable to current zones in Australia, current or predicted under a changing climate

Source: Authors.

Search terms

The review searched for papers from 2005 to 2025, focusing on two concepts: climate resilience and housing.[4] The search terms are shown in Table 3.

Table 3: Rapid review search terms

Database	All searches: climate resilience	All searches: housing	Additional terms: review of reviews	Additional terms: grey literature
Scopus, Informit	'climate-resilient' 'climate resilient' 'climate-resilience' 'climate resilience' 'climate adaptation' flood bushfire wildfire heat 'extreme temperature' 'extreme weather' 'climate event' storm rain precipitation cyclone drought 'sea level rise'	housing house home 'residential building' retrofit	systematic review' 'scoping review' 'rapid review'	guideline OR framework OR standard pdf file type
Google, Google Scholar	'climate resilience' 'climate resilient' 'climate adaptation' heat flood fire storm	house housing	[not applicable]	framework guideline standard

Source: Authors.

4 Data collection was completed in May 2025.

Location-specific searches

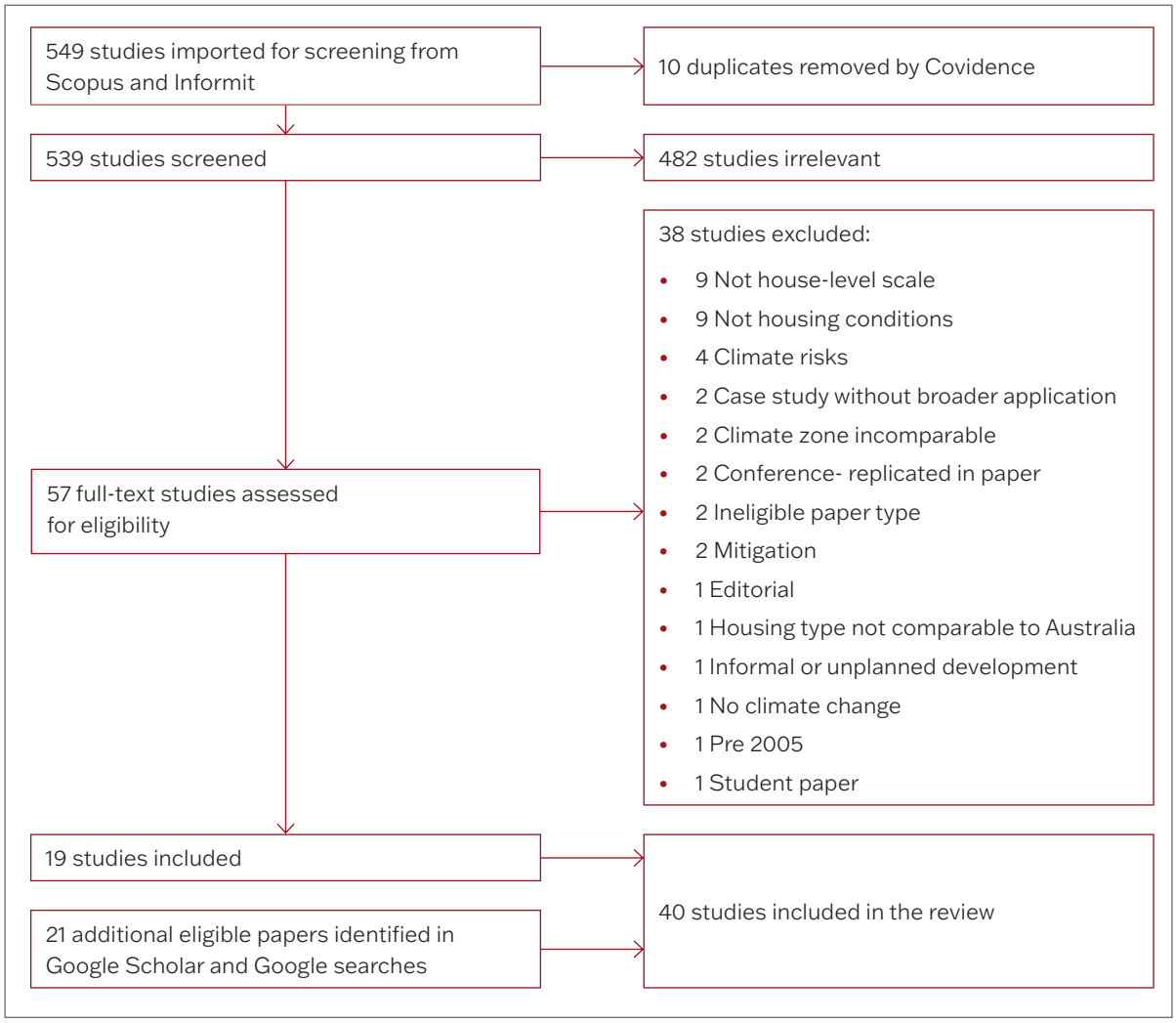
The rapid review was supplemented by targeted searches in Google and Google Scholar to identify relevant standards, guidelines and frameworks across all Australian federal, state and territory jurisdictions. Several international jurisdictions with high exposure to climate disasters and/or slow-onset climate events comparable to those experienced in Australia, and known to the research team as having introduced policies to address those climate threats, were also included:

- flood: the Netherlands
- bushfire: California, Greece
- extreme heat: Italy, Portugal, Spain
- cyclone (hurricane): United States.

Flowchart of the review process

Figure 1 shows the number of papers added and removed at each stage of the rapid review process for Scopus, Informit and Google Scholar searches, and the number of relevant papers identified in the Google search and location-specific Google searches.

Figure 1: Rapid review screening



Source: Authors.

Data extraction

The data extracted from eligible papers included:

- definition of climate-resilient housing
- criteria for inclusion in the CRHG
- document type (review, primary research, policy development document, policy document, guidelines/framework)
- jurisdiction
- research methods
- climate zone[5]
- specific housing attributes or design elements cited as contributing to climate resilience.

Limitations of the rapid review

The rapid review aimed for breadth, including a wide range of climate events, rather than depth. Therefore, there may be relevant findings in papers that were not picked up.

The rapid review did not include a systematic quality assessment process, as the CRHG and specific housing features presented in this report are intended as a starting point for considering climate resilience. Further evaluation by technical experts is required to assess the applicability of all recommendations in specific locations and across different housing typologies. The review was focused on building features and excluded items external to the home (e.g. vegetation) and planning considerations (e.g. disallowing homes in high-risk locations).

The review incorporated literature that included housing comparable to that in Australia. Some findings may not be applicable to the Australian housing context (e.g. findings related to housing designed for cold climates).

The Google search for grey literature returned most of the included grey literature. Although this was a global search, it was conducted in Australia and the results were predominantly from Australian jurisdictions.

Finally, the rapid review included both review articles and primary research, possibly resulting in the double counting of some studies.

2.3.2 Case studies and practitioner interviews

Three case studies of homes – Flores House, Eco-House and 10 Star House – that exemplify best practice climate-resilient housing were developed using desktop research. Publicly available information about the climate-resilient features of each property was collated. The case studies were used to assess the practical application of measures contained within the draft CRHG and to identify any additional resilience features not captured in the literature-derived guidelines.

The case studies were compared with the draft CRHG for climate-resilient housing to identify:

- how the principles in the draft CRHG are incorporated in these cases
- any features of the cases that are not reflected in the draft CRHG.

5 Climate zones based on Australian Government, Bureau of Meteorology, 'Climate classification maps', accessed 5 August 2026.

Case selection

The case studies were identified through desktop research using publicly available information. Members of the research team independently compiled potential cases, which were then reviewed collectively against a screening framework that considered housing typology, climatic region, hazard exposure, resilience characteristics, geographic representation and data availability. The team sought to capture a range of climate threats relevant to Australian housing, while ensuring diversity in resilience approaches and housing contexts. Three case studies that fulfilled the following criteria were selected for detailed analysis and comparison with the draft CRHG:

- built or retrofitted with the explicit aim of building climate resilience
- located in an area that experiences one or more of the severe weather conditions that are likely to occur in parts of Australia under a changing climate, such as drought, heat or heavy rainfall.

The research team hoped to identify properties that accommodated highly climate-vulnerable populations, such as those with chronic illness or low socio-economic status (Akerlof et al. 2015), but this was not possible. However, the sample includes a 10 star house that was specifically designed to provide affordability alongside climate resilience.

Limitations of case study research

Case study research has limitations. Notably, for this research, the findings may not apply to housing types that differ from the selected cases on measures such as tenure or dwelling type. The case studies in this research were based on secondary sources, limiting the ability to independently verify performance outcomes. Rather than critically evaluating the cases, the case studies were used to examine the usefulness of the CRHG. The case studies were not intended as a comparative evaluation of housing performance and no formal scoring or benchmarking framework was applied. The included case studies identified several extensions to the CRHG. This research considered only three cases. A more comprehensive review of climate-resilient properties may identify additional elements.

Practitioner interviews

In addition to the householder focus groups and interviews, six online interviews were held with people with professional experience relevant to climate resilience or housing. The participants were from the Northern Territory (1), Queensland (4) and South Australia (1), and worked in state and local government roles focused on building standards or climate resilience, insurance, architecture, Indigenous housing, trade and research.

The practitioner interviews included the same topics as the householder interviews and provided an opportunity for stakeholders to provide feedback on the draft CRHG.

Limitations of practitioner interviews

The practitioner interviews reflected a small, non-representative sample. Participants were recruited through the research team's networks and social media. Despite national outreach, most were based in Queensland. Therefore, the findings do not capture perspectives across all regions or housing-related professions, particularly tradespeople.

2.3.3 Householder focus groups and interviews

Focus groups allow people to share their experiences, build on each other's ideas and provide historical information. Focus groups are useful for gaining in-depth information about people's experiences (Creswell and Creswell 2017).

Five householder focus groups were held to examine the ways that households experience climate change, and the conditions that affect whether extreme climate events result in crisis at the household level. The focus groups aimed to answer the following questions:

1. What does climate resilience mean to participants?
2. How do the material conditions of the housing stock interact with social, economic, knowledge and community capabilities in shaping households' climate resilience or vulnerability?
3. Does the draft CRHG respond to the conditions that the focus groups identify as supporting climate resilience?

The focus groups did not include any participants from Western Australia. Therefore, two online, semi-structured interviews were conducted with people living in Western Australia. The interview participants were asked the same questions as those in the focus groups.

Most Australians have experienced some form of extreme weather and slow-onset climate events, and these events will become more prevalent and more extreme in the future. The target of the focus group recruitment was people with experience of extreme climate events, such as:

- people with medical conditions that make them vulnerable to extreme weather
- older people
- people who have migrated to Australia from regions with extreme weather conditions.

Across the five groups and two interviews, 35 people shared their experiences. Of these:

- 13 were aged over 65
- 7 had climate-affected medical conditions
- 16 had lived in another country with extreme weather conditions comparable to those projected for Australia under climate change.

Including the interviews, participants were drawn from all states and territories except the Australian Capital Territory, as no residents from there applied (Table 4).

Table 4: Householder participant locations

Location	Householder participants
ACT	0
NSW	2
NT	1
Qld	3
SA	14
Tas	1
Vic	12
WA	2

Source: Authors.

Focus group and interview data were analysed qualitatively using an asset-based community development (ABCD) approach, examining what already works for households and communities. Such an approach is useful for examining climate resilience because it focuses on tangible assets, such as property design, materials and landscaping, as well as intangible assets, such as social assets and shared narratives (Nunes 2018).

Limitations of focus groups and interviews

Focus groups and interviews capture the experiences of a limited number of participants and may not represent broader perspectives. In Australia, experiences of climate events vary substantially across different climate zones and levels of remoteness. To support participation from across the country, two focus groups were conducted online and scheduled in the evening (Australian Eastern Daylight Time) to avoid early morning participation in other time zones. The online focus groups were promoted in the north and west of Australia. Despite these efforts, most participants came from South Australia and Victoria. The participants reflected a mix of tenancy (e.g. renting, homeownership) and dwelling (e.g. houses, apartments) experiences, and came from a range of ages and socio-economic backgrounds. However, further research is needed to capture the full diversity of household experiences, particularly in relation to social housing. In addition, participants tended to be highly engaged with climate change issues, and their views may differ from those of less-engaged householders.

2.4 Climate-ready housing guidelines development

Each housing feature or design element extracted in the rapid review was classified based on its applicability to new and/or existing housing, and whether it is currently mandated by the NCC, to create the three-part climate-ready housing guidelines:

1. guidelines for new homes
2. guidelines for existing homes
3. climate-resilience features that are already required under the NCC and cannot be retrofitted (Appendix B).

The housing features and design elements were then categorised according to:

- degree of establishment in Australian housing
- confidence level for the recommendation
- resilience characteristics
- climate risk addressed
- climate risk potentially amplified (where applicable)
- NCC climate zone applicability.

While the rapid review provided the primary data for developing the CRHG, all research streams in this project contributed to the final guidelines. The contribution of each research stream is summarised in Table 5.

Table 5: Data synthesis into CRHG

Research method	Input to guidelines
Rapid review	Climate-resilient housing features and design elements were identified from the literature. Each feature or element was translated into an individual item in the CRHG.
Case studies	Additional housing features or design elements that support climate resilience, observed in case study properties but not captured in the rapid review, were incorporated into the CRHG. Features in the case studies also provided additional validation for items identified in the rapid review.
Householder focus groups and interviews	Climate-resilience features described by householders were incorporated into the CRHG and provided additional validation for items identified in the rapid review. Householders' experiences also identified gaps in the guidelines.
Practitioner interviews	Practitioners provided feedback on specific guideline elements, particularly regarding their applicability to local conditions. This informed the refinement of element definitions, climate zone relevance and potential risks. Practitioner insights also provided supporting evidence for items identified in the rapid review.

Source: Authors

3. Review findings and definition of climate-resilient housing

This chapter provides an overview of the literature identified in the rapid review and uses data extracted from that literature to build a definition of climate-resilient housing.

The review identified 40 recent publications, with most focused on:

- housing in Australia
- resilience to heat, flooding, bushfire and cyclones.

No evidence was found on drought resilient housing.

The new definition of climate resilient housing includes three resilience characteristics:

- robustness – structural integrity under a range of future climate conditions
- protection – occupant health, safety, and comfort in changing and extreme environments
- recovery – efficient and affordable recommissioning if damage occurs.

The resilience of households is shaped by the resilience of external services and infrastructure – for example, a reliable and resilient energy supply (see Chapter 6). However, these broader considerations are out of scope here. The definition developed in this chapter focuses specifically on the resilience of the home itself.

3.1 Climate resilience

The concept of resilience is used in fields such as public health, psychology and engineering. However, it has been criticised for its inconsistent definitions (Bryant and Aggleton 2025). In some contexts, resilience refers to the ability of families, communities or systems to withstand and adapt to challenges, while in others it describes an individual's capacity to recover from adversity (Sanson and Masten 2024). Critics argue that emphasising individual resilience can obscure the structural causes of adversity, placing the burden on individuals to adapt. A strength of the resilience concept is that it highlights strengths and capabilities rather than focusing solely on deficits (Bryant and Aggleton 2025).

The way that resilience is used in climate adaptation and disaster studies originated in ecology and refers explicitly to systems. The Intergovernmental Panel on Climate Change has adopted the following definition of resilience to climate change (Lavell et al. 2012:34):

> Resilience is defined as the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a potentially hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions.

Rather than aiming merely for a return to the previous state after a hazardous event, this definition includes the potential for improvement.

It is important to note that the climate resilience of a home is shaped not only by its own features but also by the surrounding neighbourhood and broader systems. For example, water-sensitive urban design at the neighbourhood level can reduce flood risk, while extensive impermeable surfaces can exacerbate that risk. Residents may also depend on community infrastructure for protection and comfort during extreme weather events, such as sheltering in cyclone-safe public buildings during a cyclone, or in air-conditioned libraries and shopping centres during a heatwave. However, this report focuses on the climate resilience of individual homes, including detached or semi-detached houses and apartments. The term 'home' is used instead of 'dwelling' or 'house' because it captures the diversity of residential property types and emphasises the lived experience and social value of the place where people reside, rather than viewing it solely as a physical structure.

Research on climate-resilient housing builds on ongoing efforts to ensure adequate housing for all, which has been enshrined as a human right since the 1948 Universal Declaration of Human Rights. For housing to be considered adequate, a number of conditions must be met, including habitability. Habitability is defined as guaranteeing physical safety, sufficient space and 'protection against the cold, damp, heat, rain, wind, other threats to health and structural hazards' (OHCHR n.d.:4). Climate resilience acknowledges that these threats to habitability are intensifying due to climate change.

Climate-resilient housing efforts also draw from the field of sustainable housing, which has gained prominence in research and policy in Australia since the 1990s (Yang and Yang 2015). Early work (2009–18) focused predominantly on energy efficiency and carbon mitigation through passive design and building performance optimisation, while recent literature (2019–25) emphasises comprehensive adaptation frameworks that integrate hazard-specific resilience strategies, technological innovations and socio-political considerations (Ma et al. 2025).

Despite increasing use in policy and planning, the concept of climate resilience for housing often suffers from vague definitions and a lack of standardised practices, especially in low-income or informal settlements where vulnerability is highest (Mansour et al. 2022).

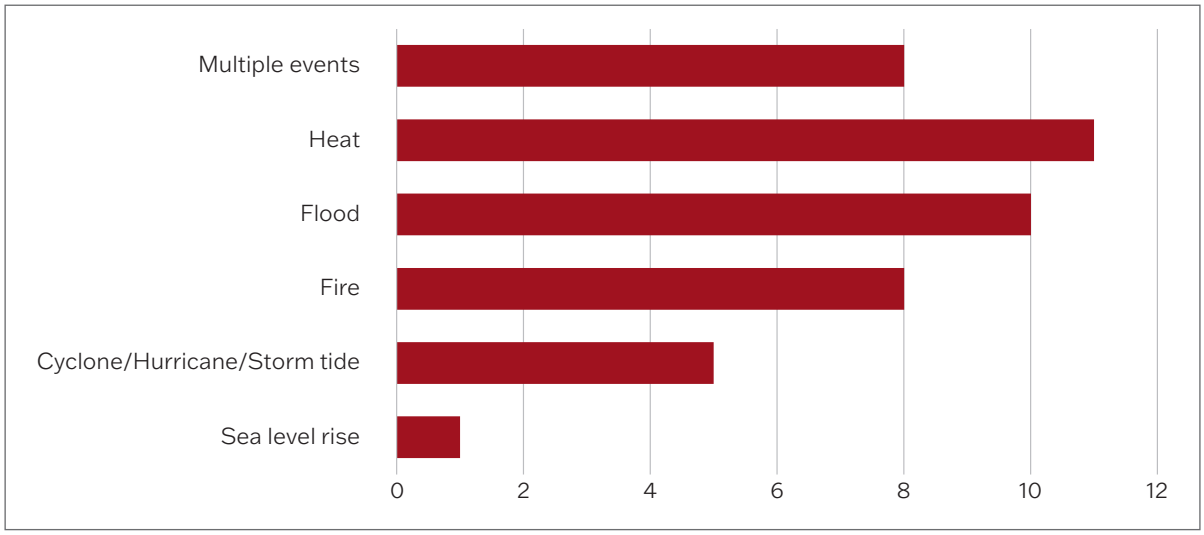
3.2 Literature profile

The review found 40 eligible papers, including:

- 5 formal reviews (systematic, scoping or scientometric)
- 19 academic papers and 21 grey literature documents (e.g. frameworks or guidance documents)
- 23 papers focused on Australia.

Eight papers addressed climate resilience in housing broadly (shown in Figure 2 as multiple events). The remainder examined resilience to specific extreme weather events that are expected to increase under climate change. Although drought was considered in the review, no data on housing drought resilience were found; therefore, drought is not included in the review findings or CRHG.

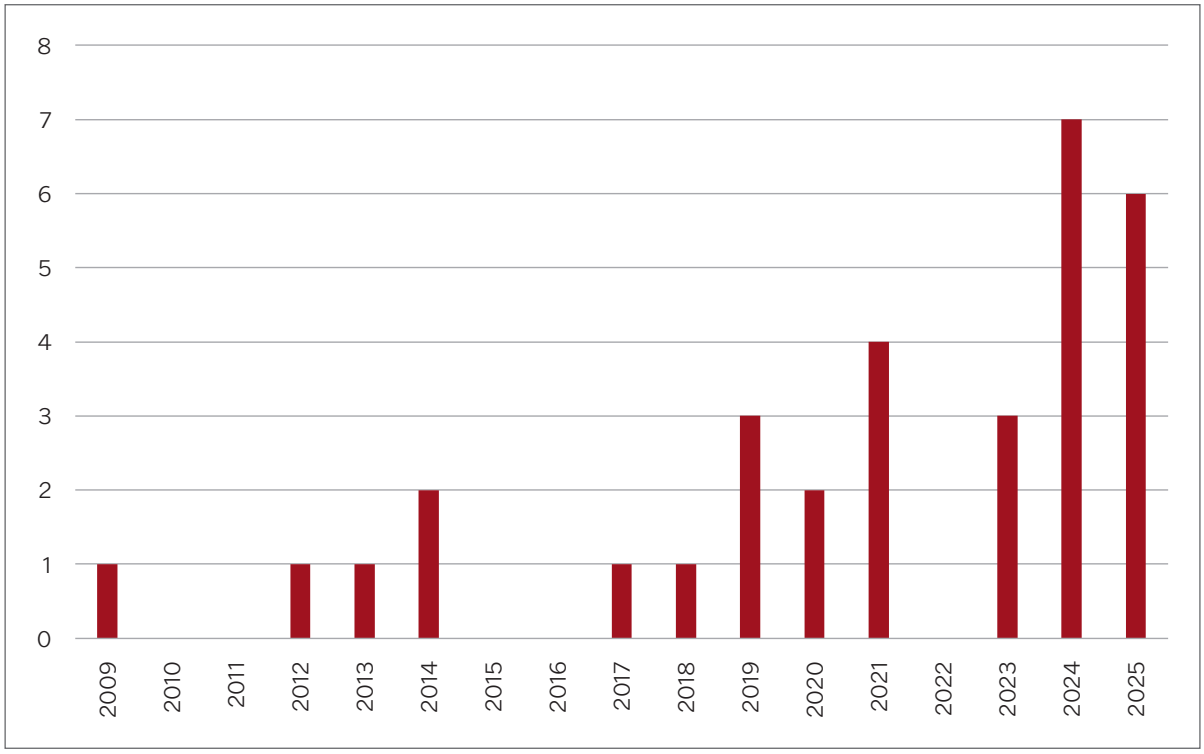
Figure 2: Climate events in included literature



Source: Authors.

The literature on climate-resilient housing is relatively recent. As shown in Figure 3, half of the included papers were published within the past five years. The highest number of publications occurred in 2024, followed by 2025, despite the review being conducted in May 2025.

Figure 3: Included papers: year of publication



Source: Authors.

3.3 Included papers

Tables 6 and 7 list all included academic and grey literature papers.

Table 6: Included papers: academic

#	Author(s)	Title	Year
1	Amini M and Memari AM	'Comparative review and assessment of various flood retrofit methods for low-rise residential buildings in coastal areas'	2021
2	Barrett K and Quarles SL	'Retrofitting homes: cost of mitigation strategies for improved wildfire resistance'	2024
3	Carratt A, Kokogiannakis G and Daly D	'Resilience testing in thermal retrofit optimisation: maximising the benefits of passive strategies across behavioural, climatic, and extreme weather scenarios'	2025
4	Cartwright A, Khalatbari-Soltani S and Zhang Y	'Housing conditions and the health and wellbeing impacts of climate change: a scoping review'	2025
5	Ghazwani K, Beach T and Rezgui Y	'Energy retrofitting using advanced building envelope materials for sustainable housing: a review'	2025
6	Golz S, Nikolowski J and Naumann T	'Energy saving and climate adaptation of buildings: a paradox?'	2019
7	Green-Mignacca S, Rostami M and Bucking S	'Towards codification of thermal resilience upgrades in midrise residential buildings: a Canadian archetype energy model approach'	2024
8	Henderson D, Boughton G, Falck D and McInnes S	'Design criteria for buildings to provide refuge from extreme weather'	2024
9	Hulathdoowage ND, Karunasena G, Udawatta N and Liu C	'Reviewing the contribution of retrofitting for climate resilience in residential buildings'	2024
10	Kalhor E and Valentin V	'Cost estimation framework for optimal retrofit planning to mitigate residential building vulnerability to wildfires'	2018
11	Kinnane O, Grey T and Dyer M	'Adaptable housing design for climate change adaptation'	2017
12	Leandro J, Chen K-F, Wood RR and Ludwig R	'A scalable flood-resilience-index for measuring climate change adaptation: Munich city'	2020
13	Rajagopalan P and Goodman N	'Improving the indoor air quality of residential buildings during bushfire smoke events'	2021
14	Rañeses MK, Chang-Richards A, Wang KIK and Dirks KN	'Housing for now and the future: A systematic review of climate-adaptive measures'	2021
15	Sen MK, Kabasi S, Dutta S and Ghosh S	'A practical framework for ensuring resilient housing infrastructure in flood-prone areas'	2025
16	Touchette J, Lethiecq-Normand M and Riahinezhad M	'Scientometric analysis on climate resilient retrofit of residential buildings'	2025
17	Wang X, Khoo YB and Wang CH	'Risk assessment and decision-making for residential housing adapting to increasing storm-tide inundation due to sea-level rise in South East Queensland, Australia'	2014
18	Wei M, Jia W, Fu Y, Yang Z and O'Neill Z	'Energy management and control system for a PV-battery system to improve residential building resiliency under extreme weather conditions'	2023
19	Wijesuriya S, Kishore R A, Bianchi MVA and Booten C	Enhancing thermal resilience of US residential homes in hot humid climates during extreme temperature events'	2024

Source: Authors.

Table 7: Included papers: grey literature

#	Author(s)	Title	Year
20	Blue R and Agar B	*Healthy buildings in a changing climate: improving health with multi-unit residential building retrofits*	2024
21	BCQ (Building Codes Queensland)	*Guideline for the construction of buildings in flood hazard areas*	2012
22	Bushfire Planning Group and Tasmania Fire Service	*Guidelines for development in bushfire prone areas of Tasmania*	not stated
23	Clarke D	*'Double benefit: designing for both bushfire resistance and thermal performance'*	2021
24	Cohen O, McTarnaghan S and Junod A	*Preserving, protecting, and building climate-resilient affordable housing*	2024
25	CTS (Cyclone Testing Station)	*A homeowner's guide: is your house ready?*	2009
26	DCCEEW (Department of Climate Change, Energy, the Environment and Water)	*Your home: adapting to climate change*	2023
27	Delafoulhouze M and Armstrong G	*Defining zero carbon homes for a climate resilient future*	2023
28	González R	*Community-driven climate resilience planning*	not stated
29	Jarzabkowski P	*Resilient housing policies: a framework for evaluation*	2024
30	LMCC (Lake Macquarie City Council)	*Flood resilient housing guidelines*	2014
31	LCC (Logan City Council)	*Flood resilient home design guidelines for the city of Logan*	not stated
32	Melbourne Water	*Flood resilient guide to retrofitting your home*	2025
33	NSW RFS (NSW Rural Fire Service)	*Building on bushfire prone land – NSW Rural Fire Service*	not stated
34	QRA (Queensland Reconstruction Authority)	*Storm tide resilient building guidance for Queensland homes*	2019
35	QRA, Brisbane City Council, Ipswich City Council, Lockyer Valley Regional Council, Somerset Regional Council and Seqwater	*Flood resilient building guidance for Queensland homes*	2019a
36	QRA, Brisbane City Council, Ipswich City Council, Lockyer Valley Regional Council, Somerset Regional Council	*Improving the flood resilience of Queensland homes*	2019b
37	QRA and CSIRO	*Adapting Queensland homes to be bushfire and heat resilient*	not stated
38	QRA, CTS, Bushfire & Natural Hazards Co-operative Research Centre and James Cook University	*Cyclone and storm tide resilient building guidance for Queensland homes: fact sheet*	not stated
39	RHC (Resilient Hills & Coasts) and Edge Environment	*Building climate ready homes: climate ready home specification*	not stated
40	Saman W, Boland J, Pullen S, de Dear R, Soebarto V, Miller W and Deuble M	*A framework for adaptation of Australian households to heat waves*	2013

Source: Authors.

3.4 Defining climate-resilient housing

Climate-resilient housing is resilient to overall higher temperatures and to specific climate events. Different definitions of resilience focus on the resilience of structures or the ability of those structures to protect human health and safety. This section synthesises definitions from the included literature to develop a new definition of climate-resilient housing.

3.4.1 Thermal resilience

Thermal comfort can be assessed using several frameworks, including the predicted mean vote model, which is static; the adaptive comfort approach, which is more dynamic; self-reported temperature perceptions; and other indicators that describe how temperature feels to occupants.

Wei et al. (2023) identify 13 metrics for thermal resilience, most of which define an acceptable temperature range to indicate tolerable levels of heat and, in some cases, cold. Two other elements are commonly added: effect on occupants and duration of the heat event.

Effect on occupants is captured in a variety of ways, primarily through:

- health concepts such as survivability, habitability or liveability of temperatures outside of the acceptable range
- comfort concepts such as self-reported temperature perceptions, thermal comfort criteria or indicators for how the temperature feels.

Duration refers to the time outside of an acceptable temperature range. This can be defined as the total time above or below acceptable temperatures or the time taken to reach an unacceptable temperature. It may also include the time that a building maintains acceptable temperatures using only passive measures or during a power outage.

Hulathdoowage et al. (2024) define three key dimensions of a thermally resilient home:

1. Robustness: the home maintains a relatively stable interior temperature despite gradual, long-term increases in outdoor temperatures.
2. Withstanding: the home continues to function in extreme heat conditions.
3. Recovery: the home quickly returns to acceptable levels of functioning after a disruption.

3.4.2 Flood, bushfire and cyclone resilience

In addition to protecting the health and safety of occupants, resilience to floods, bushfires and cyclones also requires that the building stays structurally sound during climate events. Many definitions of resilience focus on structural integrity. For example, LCC (n.d.:1) defines flood-resilient building design as the 'use of materials, construction systems and house design types that can withstand substantial and multiple inundations … to mitigate the effects and reduce consequences of flooding'. Other definitions focus on the consequences of flooding, bushfire or cyclones. For example, Leandro et al. (2020) include both structural integrity and protection of people living in the home. They argue that flood resilience has three dimensions: physical, social and economic.

- Physical resilience is the ability to withstand the impact of climate events, including multiple events in succession. Ideally, a resilient building will continue to function during climate events. However, resilience does not mean that the property will necessarily remain unscathed; rather, it implies that any damage will be relatively quick and inexpensive to repair – for example, a resilient building will maintain structural integrity despite inundation at ground level during flooding, and will retain its roof even if its windows and doors suffer in a cyclone (QRA 2019).
- Social resilience considers the capacity of the household to withstand climate events and recover to its original state. The social dimension focuses on the people living in the home rather than the building itself.
- Economic resilience takes into consideration the socio-economic position of affected households and the cost of repairing or rebuilding after climate events.

3.4.3 Resilience to multiple climate events

As average temperatures rise and climate events become more frequent, homes must be resilient both in the short and long term (Green-Mignacca et al. 2024). Resilience goes beyond one-off climate events and includes the ability to withstand and recover from:

- chronic changes (e.g. long-term increases in average temperatures or drought)
- repeated events (e.g. frequent flooding)
- compounding events (e.g. flooding followed by extreme heat).

3.4.4 Resilience during and after climate events

Climate resilience encompasses the performance of a home during a climate event and the time and quality of post-event recovery. During a climate event, resilience can take two forms:

- The home maintains structural integrity (e.g. withstanding a bushfire)
- The home protects occupants (e.g. indoor air temperatures stay within a healthy range).

After a climate event, resilience relates to how quickly and easily the home can be returned to usual function without ongoing effects. For example, in a resilient home, standard features would include the removal of water and mud and ventilation to avoid mould after a flooding event.

3.4.5 Environmental sustainability

While climate resilience is a climate adaptation response rather than a climate mitigation response, definitions of climate resilience include environmental protection and energy efficiency. Energy efficiency is particularly relevant for maintaining thermal resilience during power outages. For example, in defining zero carbon homes, Delafoulhouze and Armstrong (2023:2) emphasise the importance of designing to 'maximise a building's longevity and long-term safety for occupants, including prioritising resilience (i.e. ability to withstand or quickly recover from power outages and extreme weather events such as prolonged heatwaves, bushfire, cyclones, droughts, floods)'.

Climate-resilient retrofitting

While building standards generally focus on new homes, retrofitting can improve the resilience of the existing housing stock. This report follows the definition of climate-resilient retrofitting from Touchette et al. (2025: 2):

> Resilient residential retrofitting is the concept of upgrading existing buildings to decrease the building's vulnerabilities to physical climate risks. Resilient retrofits include structural hardening (for example, wind-resistant roofs and windows), resource conservation (for example, enhanced insulation), and energy supply (for example, backup generation). The climate risks can be acute (for example, hurricanes) or chronic (for example, extreme heat).

3.4.6 Proposed definition of a climate-resilient home

The definition used in this report draws on key elements from the existing definitions discussed above, including:

- resilience characteristics (e.g. robustness, protection of occupants, recovery)
- structural integrity and occupants' wellbeing
- environmental protection (e.g. efficient use of energy to minimise carbon emissions)
- a broad range of hazards and multiple hazards.

Accordingly, this report uses the following definition of a climate-resilient home:

> A climate-resilient home is built or retrofitted to be robust under projected climate changes – including extreme weather events, long-term shifts in climate and multiple successive climate events –while minimising energy use and/or environmental impacts. It maintains structural integrity and continues to protect the health, safety, and comfort of occupants during extreme weather and higher average temperatures. Post-event recovery is efficient and affordable, allowing the home to return to its original state or an improved state with minimal delay.

This definition can be usefully distilled into three essential resilience characteristics (Table 8).

Table 8: Resilience characteristic definitions

Resilience characteristic	Description
Robustness	The home maintains structural integrity through climate events and long-term, higher-than-average temperatures.
Protection	The home continues to function and protects the health, safety and comfort of occupants through climate events and long-term, higher-than-average temperatures.
Recovery	The home can be efficiently and affordably returned to acceptable levels of functioning after an extreme weather event, without long-term impacts.

Source: Authors.

3.5 Implications

The chapter demonstrates that research on climate resilient housing is both maturing and expanding rapidly. However, although the evidence base is growing, it remains uneven across climate hazards. This highlights the need for ongoing review and synthesis of emerging findings. Regularly updated evidence hubs or 'living reviews' supported by governments or peak bodies would help to consolidate knowledge and ensure that policy decisions draw on the most up to date research. International recommendations, such as the World Health Organization's Housing and health guidelines, illustrate the value of structured, iterative evidence reviews, and provide a potential model for the ongoing development of climate resilient housing guidance.

A second implication of the review presented in this chapter relates to the dominance of research focused on single climate events. Most studies examine resilience to heatwaves, floods or fires in isolation, even though climate change will increasingly expose households to multiple, cascading or back to back hazards. Future research and housing policy frameworks should therefore adopt a multi hazard lens, integrating a holistic understanding of climate resilience across long-term development strategies rather than treating hazards individually.

The chapter also shows wide variation in how climate resilient housing is defined. Some approaches focus narrowly, for example, addressing only extreme heat, while others incorporate a broad range of climate threats to homes and occupants. Given the diverse climate challenges Australia faces, governments and regulatory bodies should adopt a comprehensive definition of climate resilience, such as the one presented in this chapter, that includes structural robustness, occupant protection, and capacity for rapid recovery and reoccupation.

Finally, and perhaps most significantly, resilience is not only physical but also social and economic. Climate policies that focus solely on building performance risk overlooking questions of affordability, equity and fairness. Low-income households, renters and marginalised communities face high exposure to climate hazards and fewer resources to adapt than other households. Most technical studies make assumptions about household and community aspirations, capabilities, relations and roles that are not well founded. Consequently, policy based on these assumptions will be ineffective. To avoid deepening existing inequalities, policy measures should:

- take a social process, 'bottom-up' approach to understanding the complexities of human-hazard relations
- embed principles of climate resilience within social housing and rental regulations
- target financial and technical support to low-income and highly exposed households.

4. Climate-resilient housing and retrofitting

This chapter begins by outlining the current state of knowledge about approaches to improving resilience to different climate hazards. It then builds on this foundation by presenting findings from the rapid review on strategies for heat, fire, flood and cyclone resilience, including associated co-benefits and trade-offs. The remainder of the chapter describes specific climate-resilience measures for a home, organised according to where each measure applies, focusing on:

- wall, floor and roof systems
- doors and windows
- energy systems and technology
- external structures
- other design measures.

Section 4.1 provides a high-level overview of the principal approaches used to improve resilience to different climate hazards. These are intended to illustrate the range of available adaptation pathways rather than provide a detailed assessment of individual measures. Specific resilience measures identified in the literature, including their benefits, limitations and potential trade-offs, are discussed in Section 4.2. These findings are complemented by findings from householders, practitioners and case studies.

4.1 Climate resilience for new housing and retrofitting

Australia's climate is shifting rapidly, including increased warming, decreased rainfall in key regions and more frequent extremes. At 3°C of global warming, ecosystems may be irreversibly damaged, biodiversity will collapse, and forests will face widespread fire and pest threats (AAS 2021).

4.1.1 Regions within Australia will need different approaches

Temperatures and heatwaves are increasing across the country. However, Australia's diverse regions are experiencing climate change in different ways, and each will require distinct approaches to strengthen resilience (AAS 2021). For example, northern areas face intensifying and increasing cyclones, extreme heat and shifting disease patterns. Heavy rainfall is expected to intensify in the north-west, while south-eastern and south-western areas face worsening droughts and bushfire threats. Southern and south-western regions are subject to significant rainfall decline, placing pressure on water, agriculture and ecosystems. Rangelands are increasingly challenged by heat and drying trends, and coastal areas are exposed to sea level rise and flooding (AAS 2021).

4.1.2 National Construction Code zones may need to change

The National Construction Code (NCC) sets minimum requirements for safety, durability and energy performance. These vary across different climate zones. However, as climate risks intensify, the existing zoning within the NCC may no longer reflect the reality of where hazards are most likely to occur. Regions previously considered outside cyclone, bushfire or flood-prone zones increasingly experience these events (CCA 2025). This raises important questions about whether current NCC zones are adequate to protect future housing stock and existing communities.

4.1.3 Approaches to improving thermal resilience

Hot days and heatwaves are increasing across Australia and this trend is projected to accelerate (Coates et al. 2022). Many homes lack insulation and passive design features, making them highly dependent on auxiliary heating and cooling (ECRC 2018). As winters warm and summers intensify, managing thermal comfort requires integrating passive and active measures to reduce energy demand and enhance resilience (SV 2025).

Passive measures, such as insulation and cross-ventilation, form the foundation of thermal comfort by reducing indoor heat loads and minimising reliance on mechanical systems. Active measures, such as fans or reverse cycle air conditioning, are essential during severe heatwaves and periods in homes where passive strategies alone are insufficient.

Together, passive and active approaches form a pathway towards greater thermal resilience. By prioritising passive design and using active systems efficiently, Australian homes can better withstand hotter summers, reduce energy costs and support long-term climate adaptation.

4.1.4 Approaches to improving flood resilience

Flooding in Australia takes multiple forms, each with distinct drivers and intensification characteristics under climate change. For example:

- Surface flooding (or flash flooding) arises from intense, short-duration rainfall overrunning urban drainage and soils; such extreme rainfall events are becoming more intense with warming, stressing stormwater systems and leading to more frequent flash floods (Wasko et al. 2024).
- Riverine flooding occurs when sustained rainfall raises river levels above banks. With heavier storms and longer flood periods, large catchments experience more severe and extended inundation (ICA 2022).
- In coastal regions, storm surge flooding driven by stronger storms and rising sea levels increases the baseline flood risk, making rare events more frequent (Hague et al. 2024).

Improving flood resilience can be achieved through a range of strategies that either limit water entry, reduce its impact or allow excess water to be absorbed into the surrounding environment. There are four key approaches to improving flood resilience (Melbourne Water 2025) as described below.

1. Wet proofing:
    - allows controlled water ingress during flooding
    - employs water-resistant materials and structural detailing to permit water flow through the building without compromising its integrity or causing significant damage.
2. Dry proofing:
    - seals the building envelope using barriers, coatings or flood doors to prevent water entry
    - effective for low-depth flooding but less reliable during prolonged or high-level events
    - can push water onto neighbouring properties if not carefully designed.

3. Elevation:
    - raises habitable floor levels and/or critical services above the predicted flood level
    - reduces the likelihood of structural damage and service disruption during flood events.
4. Absorption:
    - uses permeable surfaces, bio-retention systems and landscape features to slow, infiltrate and temporarily store water on site
    - decreases overland flow volumes and reduces flood risk to buildings and neighbouring sites.

Together, these four approaches provide options for reducing flood impacts. While they are generally complementary, wet-proofing and dry-proofing measures may conflict and combining them without careful planning can compromise the effectiveness of each.

4.1.5 Approaches to improving bushfire resilience

Bushfires are increasing in both frequency and intensity as Australia's climate continues to warm. Rising temperatures, reduced rainfall in some regions and more extreme heatwaves create conditions that make vegetation drier and more flammable for longer periods of the year. Fire seasons are starting earlier, lasting longer and affecting areas not historically considered at high risk (Luo et al. 2024).

Ember attack is the primary cause of house loss during bushfires, often igniting roofs, gutters and subfloors. Minimising entry points reduces the risk of ember attack (Parida et al. 2025).

Openings and external features are also vulnerable. Windows and doors can be protected with stronger glazing, metal mesh screens or external shutters (BPG and TFS n.d.). Timber decks, pergolas and screens can be treated or separated to limit fire spread. Ember guards, gutter guards and, where appropriate, external sprinkler systems can provide additional defence. Careful siting of the home and landscape design can further minimise risk (e.g. building protection zones, low-flammability plant species, and strategically located driveways, water tanks and outbuildings).

Approaches to improving bushfire resilience involve a careful balance of building design, land management and community planning. A central priority is housing design, which must actively reduce ember intrusion, minimise flammable surfaces and improve the fire resistance of materials (QRA and CSIRO n.d.).

4.1.6 Approaches to improving cyclone resilience

Tropical cyclones are projected to become fewer in number but are becoming more destructive under climate change. Warmer sea surface temperatures, now extending further into subtropical regions, provide greater energy for cyclones to intensify when they do form. As a result, events are stronger, wetter and capable of causing greater damage (Climate Council n.d.). In addition, higher sea levels amplify storm surge impacts, increasing the risk of coastal inundation. The following approaches can improve cyclone resilience:

- structural reinforcement through robust tie downs and cyclone-proof design and materials
- protection of openings using reinforced doors and impact-resistant glazing or cyclone shutters/screens for windows and glass doors (Penberthy 2016)
- secured renewable energy systems and design landscaping, fencing and outbuildings to minimise debris and wind loads (QRA et al. 2019b).

In sum, a resilient home in a cyclone region is one where structural reinforcement, secure connections, impact-resistant elements and considered siting work together to resist wind, rain, debris and uplift.

4.2 Rapid review findings: climate-resilience measures

Climate-resilience measures identified in the review operate through two interconnected pathways: structural resilience and building envelope performance. Structural resilience refers to the ability of a home to maintain its integrity during hazards such as bushfire, flood and cyclone events. Building envelope performance refers to the capacity of walls, roofs, floors, windows and doors to regulate heat, moisture, air movement and other environmental conditions that affect occupant safety and comfort. Many housing components contribute to both functions; therefore, our findings are organised by building element rather than by resilience pathway to avoid duplication and better reflect housing design and retrofit practice.

4.2.1 Wall systems

Wall systems contribute to climate resilience through both structural and thermal functions. Depending on the hazard context, walls may help maintain habitable indoor temperatures, resist water ingress, reduce bushfire vulnerability or improve the capacity of homes to withstand extreme weather events.

Heat

Thermal envelope upgrades are foundational for climate resilience. External wall insulation is generally effective for improving thermal comfort in cold weather. However, the results are mixed for hot weather, with findings including:

- Wall insulation performs well in both heat and cold, particularly in cold and temperate climates (Carratt et al. 2025; Hulathdoowage et al. 2024).
- Wall insulation is ineffective in extreme heat, especially prolonged heat, or worsens overheating (Cartwright et al. 2025; Green-Mignacca et al. 2024; Kinnane et al. 2017).
- Additional wall insulation is minimally effective unless installed in conjunction with air sealing (Wijesuriya et al. 2024).
- External wall insulation improves thermal performance, but internal wall insulation worsens overheating (Touchette et al. 2025).
- External wall insulation can increase damage and repair costs after a flood (Golz et al. 2019).

Similarly, increasing the thermal mass of walls (and floors) may improve thermal comfort in heatwaves because it reduces temperature fluctuations by storing heat (Blue and Agar 2024). However, thermal mass can worsen overheating during protracted heatwaves and may need to be paired with significant ventilation or air conditioning as temperatures increase (Kinnane et al. 2017; Saman et al. 2013).

Light-coloured wall surfaces help to reflect solar radiation, providing minor but valuable reductions in indoor heat gain for tropical and arid regions. Cool paints provide significant cooling benefits, but their effectiveness degrades quickly. Other radiative coatings are more durable (Ghazwani et al. 2025). In temperate and cold climate zones, the benefits of light colours, cool paints and radiative coatings are offset by increased heating requirements in cold conditions and this is projected to continue under climate change (Ghazwani et al. 2025; Hulathdoowage et al. 2024). Smart skins adjust building systems based on outdoor conditions, improving energy efficiency and comfort (Rañeses et al. 2021).

Shading prevents overheating by stopping the sun from hitting the home. This is particularly important for windows. Although shading can worsen thermal performance in cold weather in cooler climates, this can be avoided with movable shading that can be adjusted to allow sun to hit the home in cold weather (Hulathdoowage et al. 2024).

Phase change materials, integrated into walls, absorb and release latent heat, thereby reducing internal temperature fluctuations. These materials help to maintain warmth during cold snaps and cool buildings during heat events, especially if they are pre-cooled (Ghazwani et al. 2025; Wijesuriya et al. 2024). Similarly, aerogels and vacuum insulation panels embedded in wall systems offer high insulation performance. Although these may be less durable, their thermal resistance benefits are well documented (Ghazwani et al. 2025).

Fire

One of the most effective bushfire-resistant strategies is to construct external walls from non-combustible materials, such as brick, metal and stone, that are not only durable but resist ignition during exposure to radiant heat or ember attack (Kalhor and Valentin 2018). These materials act as physical barriers, preventing flame penetration withstanding high temperatures without degradation.

An additional layer of protection is non-combustible cladding or flashing at vulnerable junctions, such as wall–roof intersections. These locations are susceptible to ember accumulation and upgrading them with fire-resistant materials helps to prevent structural ignition (Barrett and Quarles 2024).

Flood

Dry-proofing measures for walls aim to minimise the ways that water can enter a home. This varies depending on the type of wall. For porous bricks, a cementitious render can be applied to stop water from soaking through. For walls with external cladding, adding flood-resilient fibre cement substrate and a waterproof membrane improves flood resilience.

Wet proofing takes a different approach by designing internal walls without cavities where water and mould can accumulate. It also involves constructing walls that resist water absorption, using water-resistant materials such as epoxy coatings, cement board or tiles. Additional measures include incorporating flood-resilient framing and using rigid insulation instead of loose-fitting types (Melbourne Water 2025; QRA et al. 2019c).

Fibre reinforced polymers use a reinforced render that is economical to install and has the potential to strengthen and repair deterioration in buildings to help them resist natural disasters such as floods (Touchette et al. 2025).

Cyclone

Evidence from hurricanes indicates that breakaway walls installed below the elevation that floodwaters are expected to reach can reduce damage by breaking off to allow water to run through, reducing load on the structure and foundations so that the structural integrity of the property is maintained (wet proofing) (Amini and Memari 2021).

Storm shutters installed over windows, and sometimes doors, shield them from damage during severe weather events such as cyclones. Similarly, impact cladding uses materials that are strong enough to protect walls, especially from flying debris (CTS 2009).

Co-benefits and trade-offs

While wall insulation has some thermal benefits (see above), it can increase the scale and cost of repairing flood damage (Golz et al. 2019).

4.2.2 Floor systems

Floor systems play an important role in climate resilience by influencing both structural performance and indoor environmental conditions. The review identified measures that reduce vulnerability to hazards such as flooding and heat, while also contributing to occupant comfort and post-event recovery.

Heat

Thermal properties of flooring did not come up in this search, likely because thermally resilient flooring is typically associated with resilience to cold rather than to heat.

Fire

Enclosed foundations using non-combustible materials, such as concrete, metal sheeting or adobe, can prevent flames and embers from reaching underfloor cavities (Kalhor and Valentin 2018). Open foundations invite ember intrusion, especially if vegetation is nearby, increasing the ignition risk.

Flood: dry proofing

Flood vents prevent water entry and allow water to escape subfloor spaces. Vents can be used in conjunction with concrete hobs that prevent water entering the subfloor space (Amini and Memari 2021; Melbourne Water 2025). A concrete blinding layer (a thin, non-structural layer of concrete) in the subfloor area of a home with suspended timber floors reduces flood damage because it is easier to clean (Melbourne Water 2025).

Flood: wet proofing

Flood-tolerant materials, such as concrete, tile and marine ply, resist water damage (CTS 2009).

Flood: elevation

Elevating the floor height by using a crawl space, an elevated slab or a regular slab is effective for reducing flooding risk (Amini and Memari 2021; CTS 2009). Research examining storm tides found that elevation is cost-effective for new homes only (Wang et al. 2014).

Cyclone

Flooring measures for cyclone resilience are related to water ingress and are included above.

4.2.3 Roof systems

Roofs are among the most exposed components of a dwelling and therefore make a significant contribution to climate resilience. The literature highlights their role in managing heat gain, resisting extreme weather impacts and supporting broader resilience objectives through water, energy and thermal management strategies.

Heat

Roofs are directly exposed to solar radiation and play a critical role in indoor climate control.

Similar to wall insulation, ceiling insulation is highly effective for thermal comfort in cold weather, but findings are mixed for hot weather performance. For example:

- Ceiling insulation performs well in both heat and cold (Carratt et al. 2025; Hulathdoowage et al. 2024; Touchette et al. 2025).
- Where ceiling insulation exists, the benefits of additional insulation are minimal or worsen overheating (Carratt et al. 2025; Green-Mignacca et al. 2024).
- Insulation is minimally effective unless installed in conjunction with air sealing (Wijesuriya et al. 2024).

Light-coloured roofs have cooling benefits (Rañeses et al. 2021). This has net benefits for tropical and arid regions. In temperate and cold climate zones, the benefits are offset by increased heating requirements (Hulathdoowage et al. 2024).

Cool roofs, featuring reflective or light-coloured coatings, reduce surface and internal temperatures; however, their effectiveness diminishes after several years if not properly maintained, due to material ageing (Ghazwani et al. 2025; Rañeses et al. 2021).

Fire

Roofs are among the most vulnerable parts of a home during bushfires. They are especially prone to embers, which can enter through vents or ignite debris lodged in roof valleys. To counter this, it is vital to use non-combustible roofing materials (e.g. tiles or metal sheeting) (NSW RFS n.d.). Additionally, roof vents and whirlybirds should be covered with metal mesh or ember-resistant screens to prevent ember entry (Kalhor and Valentin 2018).

Fire-resistant roofing membranes or underlays can also prevent flame penetration if the external surface is compromised. Ensuring that the entire roofing system, including flashings and intersections, is sealed and resistant to embers is critical (NSW RFS n.d.).

Flood

Blue roofs (i.e. water storage on the roof) reduce flooding at lower cost than green roofs (vegetation on the roof) (Touchette et al. 2025).

Cyclone

No additional items for cyclones.

Co-benefits and trade-offs

Green roofs with vegetation and soil layers provide insulation benefits and moderate rooftop temperatures. They perform well in both summer and winter, although they require careful waterproofing and structural consideration (Rañeses et al. 2021). Green roofs also filter stormwater to improve water quality of runoff (Touchette et al. 2025).

Whirlybirds and roof vents are simple yet effective passive cooling solutions. They expel hot air trapped under the roof, enhancing thermal comfort during hot periods. These can also help dry out interiors post-flooding (CTS 2009).

4.2.4 Doors and windows

Doors and windows are critical interfaces between the indoor and outdoor environment. Evidence from the review highlights their importance across multiple hazards, influencing thermal performance, ventilation, bushfire protection, flood resistance and occupant safety during extreme weather events.

Heat

High-performance glazing, such as double-glazed or low-emissivity (low-e) coated windows, significantly improves thermal performance in both hot and cold climates (Carratt et al. 2025; Hulathdoowage et al. 2024). These systems reduce heat gain in summer and heat loss in winter. Smart windows, capable of changing transparency based on heat or light levels, offer dynamic control over indoor environments (Rañeses et al. 2021).

Fire

Windows and doors are common entry points for embers during bushfires. Fire-resistant windows, typically made from thick toughened glass, are less likely to fracture from heat, preventing embers from entering (Clarke 2021). Standard glass can shatter under radiant heat, exposing interiors to flames and flying embers.

Window and door frames should be made from non-combustible materials such as aluminium or steel (Barrett and Quarles 2024).

Flood

Dry proofing includes, where possible, elevating windows above predicted flood levels, thereby preventing water from entering the home. Flood doors that seal tight when water pushes from outside can prevent water entering via the door during a lower-level flood event (Melbourne Water 2025)

Wet-proofing options for doors and windows (Melbourne Water 2025) include:

- large ground floor doors and windows that have a smooth base for easy cleaning, allow airflow during and after flood events, and allow water to flow out of the home
- doors and windows made from corrosion resistant materials
- solid doors with no cavity for damp or mould
- permeable garage doors that allow water to flow through.

Cyclone

No additional items for cyclones.

Co-benefits and trade-offs

Smart windows have thermal benefits and can be designed to close in strong winds, providing cyclone resilience (Touchette et al. 2025).

4.2.5 Energy systems and technology

The preceding sections focus primarily on the physical building envelope; however, climate resilience also depends on the capacity of homes to maintain essential services during extreme conditions. Energy systems and associated technologies can enhance both the day-to-day performance of homes and their ability to function during climate-related disruptions.

Heat

Ceiling fans provide air movement, helping to reduce heat-related health risks (Cartwright et al. 2025; Saman et al. 2013).

Air conditioning (AC) offers rapid cooling during heat events and can improve health outcomes. However, it also comes with drawbacks, including high running costs and greenhouse gas emissions (Cartwright et al. 2025). Some studies have found that high-efficiency inverter ACs and zoned systems are more effective (Saman et al. 2013). Others find that whole-of-home or central AC systems are more effective at reducing heat-related health risks (Cartwright et al. 2025). AC's reliance on grid power makes it vulnerable during blackouts unless paired with solar PV and battery systems (Cohen et al. 2024).

Smart energy systems use algorithms to optimise building controls for energy efficiency and thermal comfort. In combination with onsite renewables, smart energy systems maintain healthy indoor temperatures during power outages (Wei et al. 2023).

Solar-integrated cooling systems and solar chimneys that enhance natural ventilation are effective low-energy alternatives in hot climates (Rañeses et al. 2021). Meanwhile, air source and ground source heat pumps provide efficient heating during winter and cooling during summer, making them versatile all-season solutions (Hulathdoowage et al. 2024).

Fire

Air filters, such as high-efficiency particulate air filters, reduce indoor particulate matter from fires (Cartwright et al. 2025; Rajagopalan and Goodman 2021). Some filters also remove toxins in bushfire smoke (Rajagopalan and Goodman 2021). However, filters may not be effective in buildings that are not well sealed (Rajagopalan and Goodman 2021).

Flood and cyclone

See below for the flood-resilience benefits of ventilation and the cyclone resilience benefits of onsite power generation.

Co-benefits and trade-offs

Ventilation uses outdoor air to lower the indoor air temperature when external temperatures drop, for example, overnight. Ventilation also aids in drying and reduces the risk of mould after a flood (Melbourne Water 2025). Ventilation has benefits for indoor air quality as well (Cartwright et al. 2025).

Backup power systems, such as batteries or generators, allow occupants to maintain essential operations like lighting, water pumps and communication during grid outages (Cohen et al. 2024). Solar PV systems with battery storage ensure continuity of cooling, fire monitoring or communications. These systems are especially important in rural areas, where bushfire or cyclone threats can isolate communities (Cohen et al. 2024; Hulathdoowage et al. 2024).

Many studies have shown the benefits of renewable energy systems, such as solar PV or wind turbines with battery storage, for maintaining indoor air temperatures that support health and comfort during extreme heat and blackouts (Cohen et al. 2024; Green-Mignacca et al. 2024; Hulathdoowage et al. 2024; Saman et al. 2013).

Combining measures, such as an efficient thermal shell with pre-cooling of phase change materials, zoned air conditioning and onsite renewable energy, can produce thermal comfort while minimising carbon emissions (Delafoulhouze and Armstrong 2023).

4.2.6 External structures

Climate resilience extends beyond the primary building envelope to include external structures and spaces that shape how homes perform during extreme weather events. Landscaping design and maintenance are important for increasing resilience to flood, heat and bushfires; however, these measures are beyond the scope of this review. This review considers several other external measures that may help to prevent flood damage by reducing hazard exposure, supporting recovery and enhancing the overall resilience of residential properties.

Flood

Rainwater tanks lower the risk of flooding during heavy rainfall (Leandro et al. 2020). Smart rainwater tanks can release water prior to heavy rainfall to increase capacity (Melbourne Water 2025). Tanks should be fixed to a concrete slab to avoid damage caused by flood water carrying the tank to neighbouring properties (Melbourne Water 2025). Flood gates – barriers that can be manually or automatically activated to create a barrier to prevent water from reaching the home – are also an option (Leandro et al. 2020).

4.2.7 Other design measures

In addition to individual building components, the review identified broader design strategies that influence resilience at the whole-of-home scale. These measures often operate across multiple building elements and hazards, reinforcing the importance of integrated design approaches.

Heat

The overall housing condition and quality are often more impactful for residents' health than individual upgrades (Cartwright et al. 2025). If improving the thermal performance of the whole home is not feasible, there is evidence that designated rooms – 'cool retreats' – are beneficial. Cool retreats are specially designed internal rooms with superior insulation and minimal glazing that offer protective environments during heatwaves. Their integration is especially relevant for older and health-vulnerable households (DCCEEW 2023; Saman et al. 2013).

Fire

Metal mesh screens on all openings, including vents, underfloor spaces and eaves, are essential to prevent ember intrusion (Barrett and Quarles 2024). Embers entering through small gaps can ignite interior materials or furnishings even without direct flame contact.

Flood

Pumps and tanks remove floodwater from the home (Leandro et al. 2020; Melbourne Water 2025).

Elevation can be used to lift the whole home above flood levels (see Section 4.2.2 for elevation of floor level). Homes designed with an undercroft allow water to flow through the ground floor while other rooms are above flood levels (LMCC 2014). Open designs allow floodwater to flow through and away from the home (Melbourne Water 2025). Amphibious homes – designed to sit at ground level normally and float during a flood event – have been found to be more cost-effective than elevated homes (Touchette et al. 2025).

Specific items, such as power points, electrical appliances, cabinetry and storage can be installed higher than flood levels to allow continued functioning during a flood, as well as reduced costs and recovery time after a flood. Similarly, separate electrical circuits can be installed upstairs and downstairs so that upper levels have continuous power if flooding damages power to lower levels (Melbourne Water 2025).

Cabinetry is commonly a high-cost replacement item after a flood. Removable kickboards and flood-resilient materials (e.g. marine grade ply) can minimise replacement costs (Melbourne Water 2025).

Stairs can be made from flood-resilient materials (e.g. hardwood) and use an open design to avoid cavities where damp and mould can form (Melbourne Water 2025).

Cyclone

Safe rooms or internal shelter-in-place rooms offer protection during cyclones (Henderson et al. 2024). Safe rooms are designed with:

- reinforced internal cladding
- inward opening, debris-rated doors
- structural ceilings anchored to the tops of walls and independent roof support systems
- protected windows
- no windows or external openings.

Cyclone tie-down systems and structural bracing systems resist wind uplift and prevent roof loss (CTS 2009).

Co-benefits and trade-offs

Air sealing is effective for retaining heat in winter, but the research presents mixed findings for overheating: some papers highlight benefits in cooler climates when paired with controlled ventilation (Carratt et al. 2025; Wijesuriya et al. 2024), while others report increased overheating risks (Carratt et al. 2025; Cartwright et al. 2025; Green-Mignacca et al. 2024; Kinnane et al. 2017). Others advocate for air tightness (as part of a thermal shell) to improve thermal performance in hot and cold conditions (Delafoulhouze and Armstrong 2023).

Air sealing plays a role in flood resilience by preventing water ingress (dry proofing). However, maintaining breathability is crucial for drying out and preventing mould after flooding (wet proofing) (Melbourne Water 2025). There are concerns that air sealing may worsen mould, damp and the accumulation of indoor air pollutants (Cartwright et al. 2025). However, during bushfires, air sealing improves indoor air quality (Rajagopalan and Goodman 2021).

Certain architectural design principles enhance bushfire protection. A crucial design strategy is the avoidance of architectural attachments and recesses, such as decks, overhanging eaves, trellises and foundation indents. These features create ember traps where hot debris can accumulate and ignite (Kalhor and Valentin 2018). Simplified building envelopes with minimal external features are more fire resilient. This conflicts with the recommendation to use external shading to reduce overheating, although installations such as fire-rated shutters can provide shade and fire protection (Clarke 2021; Touchette et al. 2025).

Soft building design means that homes are designed to be adaptable to make it easier to retrofit future climate adaptations: for example, the building envelope is designed to accommodate additional insulation or cladding, and electrical systems are configured to allow for the future installation of renewable energy.

4.3 Implications

This chapter demonstrates that much of the available climate-resilient housing guidance builds on earlier, established work on energy efficient and sustainable design strategies.

For example, passive design is critical for maintaining thermal resilience during power outages. Homes without adequate passive design features (such as insulation and shading) become heavily reliant on energy-intensive cooling systems, which stop functioning when power is lost. Improving passive design reduces dependence on mechanical systems and enhances safety during climate hazards.

This has implications for the measurement and regulation of thermal performance, including:

- strengthening building codes to require passive design features and efficient active systems that minimise energy demand and protect health during heatwaves
- integrating renewable energy and battery storage into housing policy so households can maintain essential cooling and communication during outages (e.g. backup power capability, such as batteries with emergency supply functions, could be incorporated into NatHERS Whole of Home ratings, particularly for homes in climate-exposed zones)
- embedding future climate conditions in NatHERS modelling to ensure ratings reflect projected heat extremes.

Heat mitigation is increasingly important for both new and existing homes. Two overarching strategies – passive cooling and active cooling – operate differently and carry distinct risks under extreme conditions.

Passive cooling reduces heat gain and encourages natural airflow through insulation, shading, cross-ventilation and reflective surfaces. However, during prolonged or severe heat, passive systems alone can be insufficient, leading to overheating in homes without mechanical backup.

Active cooling systems, such as air conditioning and fans, require energy and are typically paired with airtight building envelopes. Although effective under normal conditions, homes designed primarily for active cooling are vulnerable during grid failures or interruptions to onsite renewable energy.

Passive and active measures can complement each other if well integrated. However, poorly combined retrofits can reduce overall effectiveness. This has important implications for supporting thermal measures. Our findings highlight the importance of:

- providing research and guidance on how to integrate active and passive cooling so that they reinforce, rather than undermine, each other, particularly during extended heat events
- encouraging flexible design, such as passively cooled homes that include an actively cooled refuge room for use during extreme heat or bushfire smoke events
- refining maximum safe indoor temperature ranges, especially for vulnerable groups, and offering guidance or assistance for managing the combined risks of heat and air pollution during compound events
- developing localised housing archetypes that combine suitable design elements for regional climate risks and common housing types
- ensuring measures do not compromise winter performance, particularly in southern states where winter warming requirements will continue, even under overall higher temperature scenarios.

Flood resilience also requires tailored responses, as different flood types and depths present varying risks. This has implications for effective planning, which relies on robust hazard projections and strong coordination across agencies.

Policy approaches to bolster flood resilience include:

- using updated flood projections to determine the appropriate approach or combination of approaches (e.g. wet proofing, dry proofing, elevation and/or absorption) based on local flood characteristics
- linking housing resilience requirements to land use planning, including limiting development intensification in high-risk flood areas
- strengthening collaboration across state bodies (e.g. transport, water authorities) and local governments to ensure that the latest flood modelling is fully integrated into planning schemes.

5. Case studies and stakeholder perspectives

Previous chapters examined the evidence base for climate resilient housing. This chapter examines how climate resilient housing is understood and applied in real world contexts, drawing on case studies and specialist practitioner interviews.

The case studies demonstrate how multiple design strategies are combined to address heat, flooding, bushfire and cyclone events, and highlight innovations and typology specific responses that extend beyond individual features.

The practitioner interviews provide complementary insights into the usability of the draft climate-ready housing guidelines (CRHG), areas of ambiguity, and differing approaches to thermal and flood resilience.

5.1 Learning from innovative properties

Regulatory approaches to building standards are effective in setting minimum standards that create homes that are safe to live in. However, they have been less successful in responding to the complex challenges of climate change mitigation and urban resilience. Regulatory change is slow and requires significant regulatory capacity (van der Heijden 2017).

Innovative housing developments often test solutions that go beyond minimum regulatory requirements, providing valuable insight into what works in practice and what does not. These include small scale dwellings, shared living models, inclusionary planning mechanisms and the adaptive reuse of underutilised infrastructure (Kraatz, 2018).

Recent, innovative housing approaches that build climate resilience include those that:

- use guiding principles, established technologies and learning by doing to scale up sustainable housing (Moore and Doyon 2018)
- prioritise alternative water and energy supplies and durable materials (Ruíz and Mack-Vergara 2023)
- trial novel collaborations to create niche housing solutions, such as pop-up accommodation for young people (Pablo and London 2022)
- combine prefabrication, reclaimed and biomaterials, and deep retrofit (Energiesprong n.d.).

This chapter draws on case studies of three innovative climate-resilient housing developments and interviews with six specialist practitioners. These inputs are compared with the rapid review findings to inform the development of the CRHG.

Overview of case studies

The three case studies were selected to illustrate how innovative housing responds to different climatic conditions and hazards. They include one international example and two Australian examples, spanning tropical, warm temperate and cool temperate climates. Rather than representing a single model of 'best practice', the cases demonstrate how climate-responsive and resilient design strategies are shaped by local environmental conditions, regulatory settings and risk exposures. Each project goes beyond baseline compliance, using integrated passive design, material choices and multi-functional systems to address site-specific challenges.

The case studies were selected as illustrative examples of climate-resilient housing and were used to test the practical applicability of the draft CRHG. We did not seek to assess the properties themselves or evaluate or rank the performance of individual homes; rather, the case studies were used to identify gaps in the review findings that could be addressed during the development of the CRHG, and examine how resilience measures identified in the literature were combined and applied in real-world projects.

Each case study examined below presents the local climate context followed by a summary of the property's climate-resilience features. Overall, the case studies include many elements that align with the review findings presented in Chapter 4.

Most of the resilience measures identified in the draft CRHG are represented in the case studies; however, their application varies according to local climate conditions, site characteristics and design priorities. The case studies reinforce the importance of combining multiple resilience measures rather than relying on individual interventions.

Since the primary aim of the case studies is to identify gaps, the summaries focus on the resilience measures found in the case studies that were either not captured or only minimally reflected in the review findings. Resilience measures from the case studies are incorporated into the CRHG (Chapter 7).

5.2 Case study 1: Flores House (Casa Flores) by FUSTER + Architects



Source: ArchDaily.

Located in a tropical coastal climate exposed to hurricanes, Flores House (Casa Flores) by FUSTER + Architects is a 2020-built, single-family home in Naguabo on Puerto Rico's south-eastern coast. The stated design intent was to withstand tropical storms while limiting reliance on mechanical cooling through passive means (ArchDaily 2026). It illustrates how architectural form, envelope systems and operable elements can be integrated to reduce reliance on mechanical systems while maintaining resilience in a high-risk tropical setting.

Flores House uses 'hot air chimneys' that double as skylights and are opened opposite prevailing winds to create a suction effect for continuous ventilation and daylighting. It also deploys hurricane-resistant, canvas-like screens/shutters that retract like curtains, admitting diffuse light. These features were explicitly integrated as part of the architectural expression rather than as an afterthought (ArchDaily 2026; Fuster Architects 2026; McKnight 2021).

The envelope strategy is also climate explicit, comprising an insulated concrete system with high R-value and a structural mortar/plaster layer containing continuous insulation. The polished exposed concrete floor is described as the only uninsulated structural element because floor insulation is 'not needed in this climate' (ArchDaily 2026; McKnight 2021). Finally, the house includes multi-function strategies to efficiently use water and space. These include a terrace pool that doubles as a water cistern and a compact floor plan that is expanded through the use of a terrace. These 'stacked' functions provide resilience levers and add day-to-day functionality to the home.

The case study complements several of the review findings for heat and cyclone protection, including solar chimney ventilation and storm shutters. Casa Flores shows that designing resilience features for specific properties not only improves everyday liveability but also provides protection during extreme events.

5.3 Case study 2: Eco-House Leura by Marra + Yeh Architects



Source: Australian Institute of Architects. Photographer: Brett Boardman.

Set within a cool temperate climate characterised by mild-to-warm summers and cold winters, Eco-House Leura (by Marra + Yeh Architects) is a 2020-built, climate-responsive home in Leura, New South Wales, Australia. The home is located within the World Heritage–listed Greater Blue Mountains Area. The case demonstrates how climate-resilient housing remains a relatively new and evolving concept, with the project team explicitly acknowledging the complexity of delivering a resilient dwelling in a landscape shaped by intersecting constraints (Sustainability Awards 2025).

These constraints include high bushfire risk, increasing heatwave intensity, strong and variable winds, and heavy rainfall events, alongside strict planning controls, ecological protection requirements, limited site disturbance allowances and the need to maintain natural hydrological flows within a sensitive catchment area.

Eco-House incorporates measures identified in the review, such as non-combustible materials, an enclosed subfloor area and dedicated firefighting water storage, that exceed minimum regulatory requirements. Its passive solar design, cross-ventilation and onsite renewable energy generation ensure year-round thermal comfort with low operational energy use.

The project includes a number of measures not captured in the review, for example:

- A rooftop sprinkler system for fire protection also enables evaporative cooling during heatwaves. The roof is described as shaping water capture so it can be reused continuously to supply sprinklers, linking roof form, water storage and fire defence in a closed operational loop (Sustainability Awards 2025).
- Appliance thermal zoning (e.g. placing the freezer in the coldest zone): the case describes locating cold-storage appliances strategically within the home's cooler zones (e.g. mudroom) to reduce energy demand (Moon 2024).
- The Eco-House is positioned to maximise protection from prevailing winds and to create defensible spaces during a bushfire event (Marra + Yeh Architects 2026).

5.4 Case study 3: 10 Star House by SUHO



Source: F2Design.

The 10 Star House, designed by F2 and built by SUHO, is a high-performance dwelling developed in South Australia (Adelaide/Woodforde) – a warm temperate climate characterised by warm-to-hot summers and cool winters. Designed as a demonstrator project, it integrates high-performance fabric, airtightness, advanced glazing, mechanical ventilation with heat recovery and onsite renewable energy. Importantly, the home showcases resilience not only as a design outcome but also as a replicable delivery model, linking standardisation, affordability and whole-home performance to broader housing scalability.

The 10 Star House was designed and built to demonstrate climate resilience and ultra-low-energy performance, achieving a 10-star NatHERS rating through:

- airtight construction
- high-performance insulation
- heat-recovery ventilation
- onsite solar PV
- window sizing/placement for beneficial solar gain and clerestory windows that bring north light deep into the first floor
- real-time home automation to manage heat and energy demand (Sustainability Awards 2025; Woolcock Group 2026).

In addition, the 10 Star House introduces efficiency measures such as solar hot water, low-energy lighting and greywater diversion as standard inclusions, rather than as optional upgrades.

This case study demonstrates that climate resilience can be delivered at scale: the project was designed to be easy to replicate at low cost. The standardised modular 8 × 8 metre, two storey cube design can be adapted to a range of housing formats. Affordability is achieved through high material efficiency, supported by an efficient layout and carefully planned building fabric (F2Design 2026).

5.5 Practitioner perspectives on the draft CRHG

Overall, the specialist stakeholders were supportive of the draft CRHG and saw value in:

- combining a broad range of climate threats into an integrated CRHG
- explicitly addressing resilience features that can be retrofitted.

Stakeholders identified how the CRHG could be used within their respective sectors. For example, it is anticipated that:

- Project managers in the property and construction industry would use the CRHG to guide decision-making, particularly if supplemented with practical examples or product specifications.
- Local government would have a role in identifying the relevance to their local climate risks and making this information accessible to residents.
- The CRHG could be used in advocating for enhanced requirements in housing and building policies, such as the NCC, residential tenancies acts and social housing.

Stakeholders with experience in public, social and Aboriginal housing highlighted the need for homes that are:

- robust, as higher up-front costs can be offset by long-term savings
- culturally appropriate.

Specialist stakeholders provided detailed feedback and clarification on specific measures identified in the rapid review. This feedback has been incorporated into the CRHG (Chapter 7).

The discussion focused on items that were less clear cut, where decisions were not based on individual housing features but on alternative approaches to addressing a problem. This mostly related to strategies for managing flooding and heat, discussed in more depth in the following sections.

5.5.1 Perspectives on flooding and cyclones: wet proofing is increasingly important

Specialist stakeholders argued that, for cyclone resilience, structural failure is no longer the dominant focus because existing requirements within the NCC are now sufficient to address structural performance during cyclones. Instead, managing flooding impacts and pre-cyclone preparation to secure outdoor items has become more important.

Stakeholders in the north of Australia identified mould as a major threat where flooding and heat occur together, highlighting the importance of effective wet proofing. Ventilation also reduces the risk of mould (Section 5.5.2).

In addition to mould prevention, mud removal is important for flood recovery. Mud removal is also supported by wet proofing. One stakeholder explained the importance of easy cleaning after flood events: ‘The worst thing about a flood is the mud. And the water, but the mud just gets into everything.’

One design element supported by several stakeholders for both cyclone resilience and wet proofing was Besser block wall construction. One stakeholder described the recovery advantages of this approach, explaining that if flooding occurs, 'you just get a pressure cleaner, clean it, repaint it, that's it'. Besser block construction was also described as highly durable and resistant to weather and wind.

5.5.2 Perspectives on thermal resilience: passive and active approaches have advantages and disadvantages

Consistent with the mixed findings in the literature regarding optimal approaches to thermal resilience, specialist stakeholders also expressed differing views on whether the primary focus should be on keeping heat out of the home through measures such as insulation and well sealed building envelopes, or on flushing heat out using strategies such as louvres, ceiling fans and designs that capture cool evening breezes.

Perspectives on heating and cooling varied across climate zones:

- In the south of Australia, heat is increasingly the focus, although houses still need to protect against cold.
- In northern regions, heat is an ongoing focus, particularly humidity and prolonged periods of unbroken heat.

Ventilation was highlighted as critical for mould prevention in warm, humid climates and following flood events. One stakeholder explained the benefits for mould prevention and comfort:

> The mould is always going to be an issue and the only thing that can save you is ventilation and things being able to dry out … Up here, we're looking much more towards flowthrough ventilation. And that's the old Queenslander … that style of house starts to come into its own … you can't beat a velvety, cool summer breeze over your face in your bedroom.

Another stakeholder noted that, while the north of Australia is characterised by heat, cold does occur and climate change exacerbates cold snaps. He highlighted the importance of residents' control over ventilation:

> there are lots of people who've only got the louvre windows and they don't seal. So, they can close them or open them and you get great cooling. But when it does get cold, you can't fully close them, there's always a cold breeze going through the house.

This highlighted the need for adaptable systems that allow occupants to regulate airflow in response to changing conditions.

Stakeholders proposed cool rooms to balance ventilation-based and sealing-based approaches to thermal comfort. A cool room is a single, well sealed and well insulated space equipped with mechanical air conditioning. This option supports low-cost thermal comfort because the house operates passively to provide comfortable conditions during benign conditions, and enables efficient and cost-effective mechanical cooling (or heating) when required. In many contexts, the energy required for mechanical cooling can be offset by renewable technology, for example, solar panels. However, stakeholders emphasised the need to ensure equitable access to renewable energy, noting that groups such as social-housing tenants often cannot benefit directly from solar generation.

5.6 Implications

The case studies and practitioner perspectives show that, while mandatory standards help lift the minimum performance of housing, innovation is needed to test and demonstrate the value of ambitious climate resilience measures. Across the case studies, resilience strategies fall along a spectrum, from basic measures already required by minimum standards, to established measures that are increasingly common, to innovative approaches that have yet to be widely adopted. This has implications for developing policy responses that target specific points on this spectrum. For example:

- Basic and established measures should be included in mandatory minimum standards.
- Innovative measures can be supported through policies that foster experimentation, such as:
    - programs that encourage builders and developers to voluntarily adopt emerging resilience features, including recognition or incentive schemes
    - measuring the as built performance of innovative housing to verify new approaches across climate contexts and build an evidence base for future inclusion in mandatory standards.

Evidence from the 10 Star House case study indicates that many resilience features can be delivered at relatively low cost. This reinforces the importance of identifying cost-effective climate resilience measures to incorporate in NCC updates and other mandatory policy instruments (e.g. residential tenancy acts).

Practitioner perspectives highlighted substantial regional variation in climate risks, housing stock characteristics and approaches to hazards such as flooding and extreme heat. These differences suggest that a single national approach cannot fully address local needs, reinforcing the value of state-based implementation of NCC standards and the use of climate risk zones to target specific measures. Policy and practice implications include the need for:

- performance-based requirements that respond to diverse conditions, are progressively strengthened to meet current climate conditions and are in line with climate projections
- investment in local technical expertise to support building designers and practitioners to accurately interpret and apply performance-based provisions and assist households wishing to exceed mandated resilience standards
- localised guidance.

Given the variation in climate risks and building typologies, local governments need to play a more significant role in providing context-specific advice and support.

Finally, the findings that relate to public and remote housing emphasise the long-term value of investing up-front in robust construction and design features. Participants noted that resilience measures can reduce maintenance demands, improve health outcomes and improve robustness to climate hazards. These insights point to the importance of placing greater emphasis on lifecycle costs in cost-benefit analyses, rather than focusing solely on initial capital expenditure.

6. Households and climate resilience

Resilience outcomes depend not only on the physical features of a home and its surrounds but also on the characteristics and behaviour of its occupants. Household size, caring needs, health, wellbeing, resources and skills all impact resilience. Additionally, the diverse responsibilities carried out in the home, such as caregiving, schooling and work, further affect how well households can adapt and cope.

This chapter explores how people use their homes during extreme weather and gradual climate change using data from focus group discussions and interviews with people who have experienced extreme weather events. It focuses on factors that affect vulnerability, such as ageing and climate-affected health issues, and on aspects of adaptive capacity, including knowledge gained from past climate events and cultural practices for living in harsh climates.

The chapter begins with an overview of the asset-based community development (ABCD) framework, followed by a summary of the existing literature on households' climate resilience. The results of the focus groups and interviews are then presented in two parts: the first provides a general overview of householders' experiences of extreme weather, and the second maps climate resilience strengths against the ABCD framework. The chapter concludes with a discussion of the implications for housing policy.

6.1 Asset-based community development framework

We used an ABCD framework to structure the focus group discussions and subsequent analysis of data. This approach recognises that communities hold assets that allow them to survive and thrive through disasters and ongoing challenges (Nunes 2018). The ABCD framework used in this research categorises those assets as follows:

- **individual:** each person's own skills and interests
- **community:** associations, such as local sports clubs, or informal networks of neighbours
- **formal institutions:** large corporations, government or non-government organisations
- **physical assets:** buildings, natural assets, public amenities
- **local economy and exchange:** locally based businesses and non-financial exchanges of goods or skills
- **shared narratives:** stories shared within and between communities that allow for the development of all of the other assets.

6.2 What we know about household climate resilience

Vulnerability describes the degree to which people are exposed to and susceptible to harm shaped by physical, social and economic factors. Adaptive capacity is the capability to adjust, learn and implement strategies that reduce risk and enhance resilience. Together, these concepts explain why some households require more support than others to meet the challenges of climate change (Gaskin et al. 2017). Households with greater vulnerability or lower adaptive capacity need homes with stronger resilience features to cope effectively with climate change. Factors that increase climate vulnerability for individuals or households include (Li et al. 2023):

- age: especially older people and children
- socio-economic vulnerability: unemployment or underemployment, low household income and low socio-economic neighbourhoods
- health: disability or pre-existing health conditions
- livelihood: reliance on physical labour
- housing insecurity: housing precarity (e.g. informal tenancy, couch surfing)
- service access: poor access to services and facilities like the State Emergency Service, hospitals, private vehicles or public transport
- social isolation: social exclusion and living alone.

Factors that increase a household's capacity to withstand or recover from a climate event include (Li et al. 2023):

- knowledge: awareness and experience of climate events
- social connection: social support, local connection, civic participation, social cohesion and volunteering
- access: health services, essential services and communication technology
- physical environment: access to green space, shading and thermally comfortable public spaces.

People actively manage their homes before, during and after climate events to minimise impacts on their health, homes, dependents and communities (Snel et al. 2020). Residents can take individual harm-minimising actions, such as installing rainwater harvesting to minimise flooding. People can also take community action, such as sandbagging shared spaces or assisting vulnerable neighbours (Jurgilevich et al. 2023).

6.3 Householder experiences of extreme weather

6.3.1 Lived experiences shape understanding of climate resilience

Householders' most salient ideas about climate resilience focused on extreme weather events they had experienced directly or learned about through friends and family. Householders described climate resilience in the home as the capacity to:

- survive extreme climate events, such as bushfires, floods, or cyclones
- maintain physical and mental health during extreme weather events and under sustained higher temperatures
- minimise damage to the dwelling, surrounding grounds and personal belongings, including vehicles.

Householders spoke about a wide range of climate threats, including those identified in the rapid review (heat, flood, bushfire, cyclone, drought). While drought was included in the rapid review search strategy, it did not yield drought specific findings. In contrast, householders identified drought as contributing to structural problems, particularly in stone houses, although they reported limited awareness of effective measures to improve drought resilience. Householders' experiences of climate change in their homes also included four climate threats not explicitly included in the rapid review:

- hail – caused damage to solar PVs, skylights and vehicles, as well as physical injury such as bruising
- dust storms – reduced indoor air quality and caused property damage, including damage to vehicle paintwork
- water scarcity – made it difficult to maintain gardens that provide cooling and mental health benefits
- energy insecurity (power outages) – caused food spoilage, loss of air conditioning and the inability to operate essential medical equipment.

6.3.2 People manage their homes to improve resilience

Householders described managing their homes to improve climate resilience in three main ways:

- retrofitting or rebuilding to improve thermal performance and/or resilience to specific climate threats
- taking action before, during or after extreme weather events to reduce impacts without making permanent changes to the home
- modifying the external environment around the home (e.g. landscaping).

Householders who had retrofitted or rebuilt their homes followed two broad pathways: 1) an initial focus on low carbon living that later expanded to include climate resilience considerations, most commonly focused on thermal comfort; 2) retrofitting undertaken in direct response to a specific climate event. Participants reported undertaking a range of retrofitting measures, including improved insulation, double glazing or window tinting, installation of solar PV systems and roller shutters.

Not all householders had undertaken major retrofits or rebuilds. More commonly, participants described managing their homes through practices undertaken before or during extreme weather events. One participant reflected on this active management, stating: 'you need to steer a house like you'd steer a ship'. Examples of climate resilient practices reported by householders included:

- placing wet towels along doors and windows to reduce dust ingress during dust storms
- closing curtains and blinds, adding temporary shade to gardens or windows, spraying water from a bottle into a fan, closing off rooms and living in cooler areas of the home, consuming cool food and drink, and shifting activities to nighttime on hot days
- using items such as bricks to redirect water away from the home or garage, and moving furniture to higher levels during flood events
- stocking up on canned food, filling bathtubs to ensure a freshwater supply and securing any outdoor items 'that might become a missile' during cyclones
- placing blankets over cars to reduce damage during hailstorms
- cleaning gutters and clearing branches and debris during bushfire events.

In some cases, householders reported mixed benefits of climate-resilience measures, for example:

- solar PV systems supported low cost cooling but increased potential repair costs following hail damage
- artificial turf reduced water use in areas experiencing severe water shortages but increased temperatures around the home
- trees provided cooling benefits and supported mental health, but increased the risk of flooding and bushfire due to blocked gutters.

6.4 Factors shaping household climate resilience

6.4.1 Individuals vary in vulnerability and capacity

Individuals' vulnerability to climate change varies, as does their capacity to adapt their home and provide support to others in their community due to factors such as ageing, pregnancy, disability and having caring responsibilities:

- Participants in the seniors' focus group reported being more affected by heat than when they were younger, particularly those who had developed health conditions. For some householders, investing in climate resilience, especially thermal resilience, was described as an essential part of ageing in place.
- Participants noted that during pregnancy they felt unable to carry out normal activities during periods of extreme heat.
- Disability-related needs created additional vulnerabilities, particularly where householders relied on electricity for essential supports. One participant described automatic doors that opened during a power outage caused by extreme weather and could not be securely locked when manually closed.
- Households with caring responsibilities for young children or adults affected by climate sensitive health conditions reported increased pressure to take additional precautions, particularly to maintain safe indoor temperatures.

Householders also differed in their capacity to adapt their homes to reduce climate impacts. Key sources of variation included:

- Knowledge: some householders described making design choices that they later regretted, such as placing large windows in a visually appealing location that received full sun and contributed to overheating. Others drew on knowledge gained through professional training, independent research or prior experience of living in the dwelling before undertaking upgrades. Householders also used specialised knowledge to prepare for specific climate events, such as stocking up on nutritious food before a cyclone.
- International experience: householders who had migrated from countries with more frequent or severe extreme weather events drew on this experience when managing their homes during extreme conditions. However, differences in housing types, construction standards and infrastructure meant that this knowledge was not always directly transferable to the Australian context.
- Housing tenure and resources: householders' ability to improve their homes also varied according to factors such as renting, apartment ownership and income.

6.4.2 Community assets and support

Local associations (e.g. sports clubs) provided evacuation points during extreme weather events. More commonly, community assets took the form of informal mutual aid, such as:

- assisting with recovery activities (e.g. removing debris or cutting up fallen trees)
- providing temporary accommodation or essential support to people whose homes were damaged or had lost power
- supplementing official emergency responses by:
  - directing people to evacuation points
  - going door to door to warn neighbours of an approaching cyclone
  - clearing roads and redirecting cars and pedestrians to safety
  - travelling between towns and interstate to assist recovery efforts in regions affected by fire or flooding.

Overall, community support was described positively and was highly valued by householders. However, some limitations were identified. One person noted the risks associated with community support failing, describing an event when vulnerable individuals were left alone without heating or food for several days. Another person reflected on sheltering in an apartment for five days during an extreme weather event and having no contact with other residents in the building. He remained unsure of whether apartment dwellers should have supported one another or if that violated the instruction to stay at home.

Householders who had previously lived in countries with lower levels of institutional support than Australia reflected on how communities often filled these gaps. Examples included neighbours delivering mail by canoe during floods or sharing resources with daily wage workers who were unable to attend work during extreme weather events.

6.4.3 Formal institutions

Building standards contribute to climate resilience. Householders were most aware of this in cyclone prone regions, where standards introduced after major events, such as Cyclone Tracy, made newer properties highly robust.

Building and real estate professionals were a source of specialist knowledge about how to improve climate resilience. However, knowledge levels were variable. In some cases, professionals were unable to provide guidance or provided misinformation.

Householders expressed concerns that planning schemes permitted development in highly climate vulnerable locations, excessive house sizes and insufficient incorporation of climate resilience features.

Water management policies affected the availability of water for household gardens, which could reduce householders' capacity to create shade.

Emergency services played a significant role in protecting homes during extreme climate events and post-event recovery.

Regulations governing rental and strata titled properties constrained householders' ability to adapt their homes, leaving residents with limited control over property conditions.

High housing costs limited buyers' ability to select climate resilient features, particularly for younger people and lower income households. Financial constraints also restricted retrofitting, with one householder stating that 'cost is the limiting factor'.

Aged care reforms had resulted in a loss of help from local councils, such as home handyman services to clean air conditioner filters and change smoke alarm batteries.

6.4.4 Physical assets

The focus of this study is the individual home as a key physical asset influencing climate resilience at the household level. Householders identified a range of property features that either protected them or increased their vulnerability during climate events, including building materials, orientation, shading, insulation and solar PV. Internal features such as blinds influenced thermal comfort and fire risk, while floor coverings affected flood recovery.

Physical assets on neighbouring properties or in public spaces also impacted the climate resilience of the home. For example, adjacent development on surrounding properties significantly influenced household impacts. Larger dwellings, increased densification, reduced garden space and greater use of impermeable surfaces (e.g. concrete) contributed to two key effects:

- urban heat island
- increased stormwater runoff.

One householder stated that 'all the water is being sent into our property'. These issues were exacerbated by stormwater systems that were insufficient for contemporary storm intensity.

Other physical assets that impacted the climate resilience of the home included the tree canopy, road design and proximity to water (e.g. rivers and lakes). According to householders:

- Trees on private and public land were highly valued for shade.
- Road design and infrastructure contributed to climate resilience where:
  - light coloured surfaces were used to reduce overheating
  - road grading directed water away from private properties.
- Water proximity was valued for amenity and natural beauty but increased flood risk to homes.

6.4.5 Goods and energy services

Local exchange became essential when communities were cut off from regular supply chains. Residents shared food and key resources, including camping equipment, to meet immediate needs. All groups emphasised the importance of maintaining a stable power supply. Energy security during extreme events varied significantly between households and neighbourhoods, depending on location, access to electricity and/or gas, backup generators or the presence of underground power lines. When blackouts occurred, those with continuing power shared energy services, such as food storage, device charging and access to cool indoor spaces.

6.4.6 Shared narratives shape climate-resilience decisions

Householders described significant mental health impacts from climate events, particularly major fires and floods. Distress was not limited to those directly affected, but extended to concerns for friends, family, the wider community and the natural environment. Stories about extreme events also influenced housing decisions. For example, one participant noted that 'Black Saturday changed the way we thought about moving to the country'.

Householders reported feeling both physically and mentally prepared for recurring climate events. Even when individuals had not previously experienced an event, shared knowledge about preparation and emergency responses, such as where to go and what to do, provided reassurance. In contrast, events that were rare in a location were associated with high levels of anxiety and low preparedness, both personally experienced and observed in others.

Community members were widely regarded as trusted sources of information about climate resilient home improvements. Knowledge was primarily shared through informal networks – although, in some cases, this peer to peer exchange was supported or formalised by community organisations, environmental groups or local government.

Householders also observed that shared cultural beliefs could hinder climate resilient adaptation. Examples included:

- the idea that brick construction is inherently superior, limiting uptake of innovative and thermally resilient timber designs
- cultural norms favouring large homes over well constructed, efficient dwellings
- preferences for European style houses and gardens poorly suited to Australian conditions, particularly under climate change.

6.5 Implications

This research confirms earlier findings that individuals and households differ markedly in their vulnerability and capacity to manage climate risks. Vulnerability and capacity are shaped by social, natural and built environments (Tapia et al. 2017). Factors such as lived experience, age and life stage, financial and material resources, education and tenure shape resilience outcomes. Housing typology and the level of control occupants have over their environment further influence their ability to prepare for, respond to and recover from extreme events. Resilience policy should reflect these variations. For example:

- Owner-occupiers, renters and strata residents require distinct regulatory, funding and support mechanisms.
- Resilience should not be assessed solely by a person's knowledge or whether they have completed specific preparedness actions, but by recognising the lived realities of how people experience extreme weather.
- Planning for ageing in place must explicitly address increasing needs for thermal comfort.

Experience with extreme weather events has both positive and negative implications for resilience. Those with limited experience reported feeling uncertain or fearful due to a lack of knowledge about how events unfold or what actions to take. Conversely, those with extensive experience felt confident and prepared; however, such people did not always seek the latest advice or prepare for variations, such as increased intensity or new hazard combinations. Support programs should be designed to address these variations, for example:

- Newcomers to areas with recurring extreme climate events should be introduced to local resilience issues, strategies and networks.
- Support for existing residents should build on existing knowledge and provide updated information reflecting evolving hazard profiles.

Energy security is critical for households because a stable energy supply enables the home to function safely during climate hazards, including maintaining a healthy indoor temperature. Renewable energy can either strengthen or diminish energy security, depending on system design and reliability. As Australia transitions to renewables, it will be essential to assess and manage energy security during extreme events and to provide support mechanisms that reduce risks while maximising resilience benefits.

Hail and dust storms are localised climate threats that householders in affected regions reported as significant hazards. Hail and dust resilience were not explicitly included in the rapid review for this study but should be incorporated into future climate-resilience evidence reviews and policy.

Formal institutions that shape the built environment and social services (health and care) have wide-ranging importance for resilience. While the home was the chief loci of climate resilience investigated here, discussions demonstrated the importance of the rest of the surrounding property and wider neighbourhood. Climate-resilient housing must consider the context of the home, its strengths and vulnerabilities. This means that climate resilience should be embedded across:

- building codes
- planning frameworks
- tenancy legislation
- aged care, education and childcare policies.

Housing standards are mandated at the level of an individual home, and this report also focuses on that scale. However, it is clear that housing resilience depends on neighbourhood and system-level factors. Communities learn from extreme weather events and share those learnings informally. Household capacity is shaped by tacit knowledge and social connections (Li et al. 2023). Neighbourhood networks, local associations and peer-to-peer knowledge sharing help residents to prepare for, respond to and recover from extreme events. These social connections also enable the collective sharing of essential goods and energy during crises. This has important implications for policy development, which needs to support these informal mechanisms. Specifically, policy should seek to:

- strengthen social and community assets, including peer-to-peer learning
- draw on community experiences and post-event lessons to inform ongoing housing standards and guidance
- complement, not replace, local knowledge and adaptive practices.

Integrated approaches should combine household-level measures with community infrastructure (e.g. water-sensitive urban design or cooling centres).

7. Developing climate-ready housing guidelines

This chapter synthesises the findings from the preceding chapters to develop our three-part climate-ready housing guidelines (CRHG):

- Part 1: Guidelines for new homes
- Part 2: Guidelines for retrofits
- Part 3: National Construction Code (NCC)–based requirements (measures that are already mandatory for new homes in Australia and cannot be retrofitted to existing properties, included as Appendix B).

7.1 Guidelines for climate-resilient housing

The NCC sets the minimum required standards for design, construction and performance of new buildings across Australia. Similar to standards in many countries, the standards in the NCC are based on current climate conditions and do not include climate-resilience measures for new or existing housing (GRD 2021). The energy efficiency performance of most new homes is assessed using the Nationwide House Energy Rating Scheme (NatHERS), which relies on Reference Meteorological Years (RMY) to represent typical weather for each climate zone. RMY use historical weather data and assumes a stationary climate. In the 2025 RMY update, NatHERS and CSIRO explore ways to incorporate climate trends or projections to better account for climate change (CSIRO 2025). Although the NCC does not (yet) use future climate scenarios, it does include requirements that address weather-related risks that are expected to worsen with climate change, such as heat, flooding and cyclones.

In addition to the building standards mandated through the NCC, there are guidelines and tools for designing and measuring buildings to higher standards of sustainability and thermal comfort. While these resources initially focused on mitigating climate change, many now also incorporate measures to enhance climate resilience, often with significant overlap between the two goals. For example:

- GreenStar Homes, created for volume builders, includes resilience considerations of water use, heat resilience and withstanding climate disasters such as bushfires and flooding (GBCA 2021).
- The Australian Government's Your home: adapting to climate change guide to sustainable homes now includes climate-resilience advice for heat, bushfires, storms, cyclones and strong winds, flooding, drought, sea level rise and storm surges (DCCEEW 2023).
- Passivhaus (or Passive House), a rigorous energy efficiency standard for buildings, minimises heating and cooling needs through airtight construction, high insulation and passive solar design. Passive houses are increasingly assessed against their ability to provide thermal comfort under the more extreme conditions of climate change (APA 2023).

For existing homes, both government and non-government organisations provide targeted voluntary guidance to improve resilience to specific climate hazards. For example, the Queensland Reconstruction Authority (QRA n.d.) provides guidance for increasing house resilience for floods, cyclones, storm tides and bushfires. The Queensland Government et al. (n.d.) also provides a screening tool to assess climate risk.

Some resources take a broader approach to climate resilience, offering region-specific guidance for typical housing types – for example, in Castlemaine, Victoria (Castlemaine Institute 2024), and in the Adelaide Hills and Fleurieu Peninsula, South Australia (RHC 2020).

In 2024, the Resilient Building Council launched a multi-hazard resilience rating tool. The tool encompasses resilience measures for bushfire, storm, flood, cyclone, heatwave, thermal comfort and energy efficiency (RBC 2024).

Currently there is no overarching guidance for climate resilience that applies to new and existing housing in Australia. Our CRHG seeks to fill that gap, outlining key principles for improving the resilience of all homes to climate-related impacts.

7.2 Categories in the climate-ready housing guidelines

The rapid review (discussed in Chapter 3) searched for multiple hazards; however, little research was available that addressed more than one hazard at a time. The CRHG does not cover all climate risks to housing – for example, measures to address sea level rise, cold snaps and hailstorms are not included. Instead, the CRHG focuses on four major climate-related threats that are expected to become more frequent or intense in Australia: heat, bushfires, floods and cyclones.

The climate-resilience measures identified in the rapid review span from basic, well-established measures to cutting-edge innovations. Not all measures are suitable for every Australian region, and some may inadvertently exacerbate certain climate impacts while mitigating others. To address this complexity, each measure is classified into several categories, including innovation level, climate events and resilience characteristics. Other climate risks that could be amplified because of the measures, climate zones relevant to the respective measures and the references for each measure are also included. These categories are discussed below.

7.2.1 Elements of a home interact

Each measure is presented separately in the CRHG, but, in reality, elements of a home interact. For example, while insulation and thermal mass delay the transfer of outside heat to interior spaces, they can also trap heat in the home. This is mitigated by installing them in combination with shading and ventilation. The best choices for any individual home should be based on a full performance assessment that considers how all elements interact.

7.2.2 Measure levels

Climate-resilience measures are classified as basic, established or innovative according to the following definitions:

- **basic** – common in the Australian housing stock, included in the NCC
- **established** – established but less common in the Australian housing stock; may be referenced in the NCC but not mandated
- **innovative** – uncommon in the Australian housing stock due to high cost or new technology.

7.2.3 Confidence levels

Confidence in each recommendation is classified as low, mid or high according to the following definitions:

- **low** – inconsistent findings across the included literature or only referenced in one source; may increase the risk of another climate-related hazard
- **mid** – referenced in two to three sources in the included literature with consistent findings or already referenced in the NCC
- **high** – referenced in more than three sources in the included literature with consistent findings or already referenced in the NCC.

7.2.4 Climate events and resilience characteristics

The CRHG includes measures to address a broad range of climate risks (heat, bushfires, floods and cyclones). The measures improve robustness or protect occupants during these events, or support recovery afterwards. The associated resilience characteristics are defined as follows:

- **Robustness:** the home maintains structural integrity through climate events and long-term, higher-than-average temperatures.
- **Protection:** the home continues to function and protects the health, safety and comfort of occupants through climate events and long-term, higher-than-average temperatures.
- **Recovery:** the home can be efficiently and affordably returned to acceptable levels of functioning after an extreme weather event, without long-term impacts.

The climate risks and resilience characteristics are summarised in Table 9.

Table 9: Climate risks and resilience characteristics

Climate hazard	Robustness measures	Protection measures	Recovery measures
Heat Includes long-term increased average temperatures and short-term heatwaves	Prevent degrading over time	Improve the home's capacity to maintain safe internal temperatures during extreme heat	Reduce time to return internal temperatures to safe levels after extreme heat
Bushfire Includes grassfires	Maintain structural integrity through a fire event	Prevent smoke ingress and extreme heat; protect occupants from fire	Flush out airborne pollutants after a fire
Flood Includes pluvial, riverine, storm surge and cyclone flooding	Maintain structural integrity through a flooding event; prevent water ingress	Maintain essential functions during a flooding event; maintain safety (e.g. electrical safety, prevention of potable water contamination)	Prevent mould and structural damage by enabling fast removal of water and mud after a flood
Cyclone Includes wind and debris	Maintain structural integrity through a cyclone	Protect occupants from debris and wind	–

Source: Authors.

7.2.5 Risks potentially amplified

Measures aimed at improving resilience to one type of climate event may inadvertently reduce resilience to another. For instance, measures that enhance cooling during heatwaves can make it harder to retain warmth in colder conditions. In some cases, a measure may even compromise resilience to the very event it targets. For example, sealing a home to prevent water ingress can be effective during minor flooding, but if floodwaters breach the seal, it may hinder drainage, mud removal and ventilation, potentially increasing the risk of mould and prolonging recovery.

Although measures to improve thermal performance in cold weather are excluded from this project, heat-related measures that have implications for thermal performance during cold weather are noted due to their potential to amplify other risks. Despite a projected decline in cold days, homes in climate zones 4–8, as defined by the NCC, still need to safeguard occupants from cold conditions. Similarly, although hailstorms were not included in the rapid review from which the CRHG is derived, householders identified hail as a common concern; therefore, it is included as a risk that may be amplified by several measures.

The existing literature offers limited insight into the interacting effects of climate measures and the complex requirements for enhancing resilience in properties exposed to multiple climate events simultaneously or in rapid succession. Although our understanding of these compounded or conflicting risks remains incomplete, their inclusion here is based on the available evidence from the rapid review, supplemented by the qualitative judgement of the research team. Further refinement is needed.

7.2.6 Climate zones

The recommendations are made for NCC climate zones, based on projected climate conditions in each zone to 2050. Risk zones for flooding, bushfire and cyclone are localised within each climate zone. Those risk zones are likely to expand as risks increase. However, the CRHG does not provide recommendations about the boundaries or definitions of these risk zones.

7.2.7 References

The references column shows where each measure was cited:

- Numbered citations correspond to the academic and grey literature sources listed in Tables 6 and 7.
- The three case studies introduced in Chapter 5 are listed as CS1 (Case Study 1 –Flores House), CS2 (Case Study 2 – Eco-House) and CS3 (Case Study 3 – 10 Star House).
- Specialist stakeholder data from practitioner interviews (Chapter 5) are listed as SS.
- Householders' data from focus groups or interviews (Chapter 6) are listed as HH.

7.3 Guidelines for new homes and retrofits

The CRHG is presented in three parts, each with a corresponding table of measures:

Part 1: Recommendations for new homes (Table 10), **i**ncludes measures that:

- may be referenced in the NCC but are not mandated or commonly used elements of the deemed-to-satisfy provisions
- cannot be retrofitted to existing homes.

Part 2: Recommendations for existing homes (Table 11), includes measures that:

- are already required under the NCC, either as standalone regulations or commonly used elements of the deemed-to-satisfy provisions
- can be retrofitted to existing homes.

Part 3: Pre-existing NCC requirements (Appendix B), includes measures that:

- are already required under the NCC (2022 update), either as standalone regulations or commonly used elements of the deemed-to-satisfy provisions
- cannot be retrofitted to existing homes.

These measures increase robustness in bushfire, flood or cyclone events. As no further recommendations are proposed for these measures, they are included for reference only.

Table 10: CRHG part 1: guidelines for new homes

Building element	Measure	Level	Confidence	Climate event addressed	Resilience characteristic	Risk potentially amplified	NCC zone	References
Walls	Single-skin walls (no cavity) and/or flood-resilient materials	Basic	Low	Flood	Recovery	Cold Heat	1, 2	32, SS
	Use of building materials with high thermal mass (e.g. concrete or brick) Benefits depend on other passive design features, such as location of the mass, orientation, shading, solar exposure and level of insulation Innovative alternatives include situating all/part of home underground in suitable climates	Basic	Low	Cold Heat Cyclone Flood (concrete)	Protection Protection Robustness Recovery	Heat	3, 4, 5, 6	11, 20, 27, 40, CS1, HH, SS
	External shading (e.g. louvres, overhang, external blinds/shutters)	Established	High	Heat	Protection	Bushfire Cold	All (5, 6, 7, 8 dynamic shading only)	3, 4, 9, 11, 14, 16, 27, 37, HH, SS
	Light-coloured or heat-reflective coatings (cool paints or radiative coatings) applied to walls (may lack durability)	Established	High	Heat	Protection	Cold	1, 2, 3, 4	5, 9, 20, 26, 27, 37, 40
	Water-resistant internal, external wall linings (e.g. rigid insulation, flood-resilient framing, fibre reinforced polymers)	Established	High	Flood	Robustness	Heat	All	28, 31, 32, 35, 36, 16
	External walls brick, stone or metal	Established	Mid	Bushfire	Robustness		All (bushfire prone)	10, 37
	Cementitious render to porous brick walls to minimise water entry and seal area under cladding to minimise the chance of water entry into the home (note – only appropriate for properties where dry proofing is sufficient)	Established	Low	Flood	Robustness	Flood (Recovery)	All	15, 32
	Integrate phase change materials into building envelope	Innovative	High	Heat	Protection	Bushfire	All	5, 14, 19
	Breakaway walls	Innovative	Mid	Cyclone Flood	Recovery		1, 2 (cyclone prone areas)	1, 38

Table 10 (continued): CRHG part 1: guidelines for new homes

Building element	Measure	Level	Confidence	Climate event addressed	Resilience characteristic	Risk potentially amplified	NCC zone	References
Walls	Innovative construction using vapour and air barrier	Innovative	Low	Cold Heat	Protection		All	14
	Strawbale walls	Innovative	Low	Cold Heat	Protection		All	HH
	Vacuum insulation panels in building envelope	Innovative	Low	Cold Heat	Protection		All	5
Roof	Whirlybirds/vents (ventilation is already required in NCC 6,7,8)	Basic	High	Heat Flood	Protection Recovery		All	32
	Heat-reflective or light-coloured coatings (cool paints or radiative coatings) applied to roofs	Established	High	Heat	Protection	Cold	1, 2, 3, 4	5, 9, 14, 20, 26, 27, 40
	Green roof	Innovative	High	Heat Flood	Protection Robustness		5, 6, 7, 8	14, 16
	Blue roof (water storage)	Innovative	Low	Flood Fire	Robustness Robustness		All (flood hazard areas)	16
	Rooftop sprinkler	Innovative	Low	Heat Fire	Protection Robustness		All	CS2
Doors / windows	Fire-resistant windows; thick, toughened glass	Basic	High	Bushfire	Robustness		All (bushfire prone)	23
	Frames made from non-combustible materials such as aluminium or steel, angled to prevent embers settling	Basic	High	Bushfire	Robustness		All (bushfire prone)	2, SS
	Windows treated to improve thermal performance (e.g. coated or multiple glazed)	Basic	High	Heat Cold	Protection		All	3, 14, 16, 27, CS2, HH
	Corrosion resistant door and window hardware, solid doors	Established	High	Flood	Robustness		All (flood hazard areas)	32

Table 10 (continued): CRHG part 1: guidelines for new homes

Building element	Measure	Level	Confidence	Climate event addressed	Resilience characteristic	Risk potentially amplified	NCC zone	References
Doors / windows	Flood door	Established	High	Flood	Recovery		All (flood hazard areas)	32
	Permeable garage door	Established	High	Flood	Recovery		All (flood hazard areas)	32
	Smooth bases on large ground floor doors and windows	Established	High	Flood	Recovery		All (flood hazard areas)	32
	Windows above predicted flood level	Established	High	Flood	Robustness		All (flood hazard areas)	32
	Smart windows that close for strong winds	Innovative	Mid	Cyclone	Robustness	Cyclone (risk of malfunction, power outage)	1, 2	16, SS
	Smart windows with electrochromism to switch between opaque and transparent	Innovative	Mid	Cold Heat	Protection	Risk of malfunction during power outage	All	14
Energy/ technology Ceiling fans	Ceiling fans	Basic	High	Heat	Protection		All	4, 40
	Air filters	Established	High	Bushfire	Protection		All (bushfire prone)	4, 13
	Backup power from generator or onsite renewables with battery	Established	High	Cold Cyclone Flood Heat	Protection	Hail (damage to solar PV)	All	7, 9, 24, 40, HH
	Ground source heat pump	Established	High	Heat	Protection		All	9
	Natural or mechanical ventilation[6]	Established	High	Heat Flood	Protection Recovery		All	3, 11, 9, 14, 26, 32, CS3, HH, SS
	Smart system in conjunction with solar PV and battery storage	Established	High	Heat Cold	Protection		All	18, 24, 40

6 For most homes, a combination of natural and mechanical ventilation is appropriate. Natural ventilation can be used for cooling and mould prevention; however, most houses need to be able to be sealed for efficient mechanical heating/cooling and when the external air is polluted (e.g., bushfire smoke). Mechanical heating and cooling should be efficient and appropriate to the climate (e.g. heat recovery systems, AC correctly sized and rated for operation in extreme heat).

Table 10 (continued): CRHG part 1: guidelines for new homes

Building element	Measure	Level	Confidence	Climate event addressed	Resilience characteristic	Risk potentially amplified	NCC zone	References
External structures	Secure external structures (e.g. rainwater tanks)	Basic	High	Flood	Robustness		All (flood hazard areas)	32
	Install rainwater tanks, underground water tanks or smart tanks	Basic	Mid	Flood	Robustness		All	16, 32
Other design measures	Raise electrical appliances (e.g. whitegoods, kitchen appliances), cabinetry and storage for valuable items above predicted flood levels	Established	High	Flood	Robustness		All (flood hazard areas)	32
	Removable components: bottom riser of stairs, cabinetry kickboards	Established	High	Flood	Recovery		All (flood hazard areas)	32
	Replace non-resilient cabinetry and kickboards with flood-resilient options	Established	High	Flood	Recovery		All (flood hazard areas)	32, SS
	Separate circuits on lower and upper levels in multistorey home	Established	High	Flood	Robustness		All (flood hazard areas)	32
	Solar chimney that regulates temperature and ventilation	Established	High	Cold Heat	Protection		All	14, CS1, CS3
	Cool retreats	Established	Mid	Heat	Protection		All	26, 40, CS2,
	Locate living areas above bedroom spaces (multistorey homes)	Established	Low	Heat	Protection		All	27
	Amphibious homes/amphibious retrofits	Innovative	Low	Flood	Robust		All (flood hazard areas)	16
	Cyclone-safe room/shed	Innovative	High	Cyclone	Protection		1, 2	8, 38, HH
	Flood gate	Innovative	Mid	Flood	Robustness		All (flood hazard areas)	12
	Soft building design (adaptable to future needs)	Innovative	Mid	All	Protect Recovery Robustness		All	11, 14

Note: Shading represents innovation levels: blue indicates basic, grey indicates established, orange indicates innovative.

Source: Authors.

Table 11: CRHG part 2: guidelines for existing homes

Building element	Measure	Level	Confidence	Climate event addressed	Resilience characteristic	Risk potentially amplified	NCC zone	References
Walls	Fire-rated shutters or screens	Basic	High	Bushfire Heat	Robustness Protection		All (bushfire prone)	23, 33
	Storm shutters and impact cladding	Basic	Mid	Cyclone	Robustness		NCC 1, 2 (wind regions C, D, possible B)	25, 26, 38, CS1
	Install insulation to facade or internal walls following performance-based assessment of property, considering projected future climate conditions[7]	Basic	High	Cold Heat	Protection	Flood	All	3, 4, 6, 7, 9, 11, 14, 16, 19, 26, 27, 29, 35, 36, CS3
	External shading (e.g. louvres, overhang, external blinds/shutters)	Established	High	Heat	Protection	Bushfire Cold	All (5, 6, 7, 8 dynamic shading only)	3, 4, 9, 11, 14, 16, 27, 37, HH, SS
	Light-coloured or heat-reflective coatings (cool paints or radiative coatings) applied to walls (may lack durability)	Established	High	Heat	Protection	Cold	1, 2, 3, 4	5, 9, 20, 26, 27, 37, 40
	Non-combustible materials for bottom section of external walls, fences and gates near home, and as cladding or flashing on intersections (e.g. wall–roof)	Established	High	Bushfire	Robustness		All (bushfire prone)	2, 22, 26, 33, 37, 39
	Cementitious render to porous brick walls to minimise water entry and seal area under cladding to minimise the chance of water entry into the home (note: only appropriate for properties where dry proofing is sufficient)	Established	Low	Flood	Robustness	Flood (Recovery)	All	15, 32

7 The benefit of this measure depends on the property's current insulation levels, with clear benefits for properties with no existing insulation and marginal benefits in properties with pre-existing insulation.

Table 11 (continued): CRHG part 2: guidelines for existing homes

Building element	Measure	Level	Confidence	Climate event addressed	Resilience characteristic	Risk potentially amplified	NCC zone	References
Roof	Install ceiling insulation following a performance-based assessment of the property, considering projected future climate conditions[8]	Basic	High	Cold Heat	Protection	Heat	All	3, 4, 7, 9, 11, 16, 19, 26, 27, 34, 35
	Whirlybirds/vents (ventilation already required in NCC 6, 7, 8)	Basic	High	Heat Flood	Protection Recovery		All	32
	Heat-reflective or light-coloured coatings (cool paints or radiative coatings) applied to roofs (conservative requirements already apply in NCC zones 1–5).	Established	High	Heat	Protection	Cold	All	5, 9, 14, 20, 26, 27, 40, HH, SS
	Green roof	Innovative	Mid	Heat	Protection	Heat (risk of damage to green roof)	5, 6, 7, 8	14, 16, SS
	Blue roof (water storage)	Innovative	Low	Flood Fire	Robustness Robustness		All (flood hazard areas)	16
Doors/windows	Fire-resistant windows; thick, toughened glass	Basic	High	Bushfire	Robustness		All (bushfire prone)	23
	Frames made from non-combustible materials such as aluminium or steel	Basic	High	Bushfire	Robustness		All (bushfire prone)	2
	Windows treated to improve thermal performance (e.g. coated or multiple glazed)	Basic	High	Heat Cold	Protection		All	3, 14, 16, 27, CS2, HH
	Corrosion resistant door and window hardware, solid doors	Established	High	Flood	Robustness		All (flood hazard areas)	32
	Flood door	Established	High	Flood	Recovery		All (flood hazard areas)	32
	Permeable garage door	Established	High	Flood	Recovery		All (flood hazard areas)	32
	Smooth bases on large ground floor doors and windows	Established	High	Flood	Recovery		All (flood hazard areas)	32

8 The benefit of this measure depends on the property's current insulation levels, with clear benefits for properties with no existing insulation and marginal benefits in properties with pre-existing insulation.

Table 11 (continued): CRHG part 2: guidelines for existing homes

Building element	Measure	Level	Confidence	Climate event addressed	Resilience characteristic	Risk potentially amplified	NCC zone	References
Doors/windows	Smart windows that close for strong winds	Innovative	Low	Cyclone	Robustness	Cyclone (risk of malfunction, power outage)	1, 2	16, SS
	Smart windows with electrochromism to switch between opaque and transparent	Innovative	Mid	Cold Heat	Protection	Risk of malfunction during power outage	All	14
Energy/ technologies	Air source heat pump	Basic	High	Cold Heat	Protection		All	9
	Efficient lighting	Basic	High	Cold Heat	Protection		All	9
	High-efficiency inverter or evaporative air conditioners with zoned cooling to reduce energy and heat risk Appliance models rated for performance in extreme heat and smoke ingress	Basic	High	Cold Heat	Protection		All	4, 9, 27, 40, HH
	Air filters	Established	High	Bushfire	Protection		All (bushfire prone)	4, 13
	Backup power from generator or onsite renewables with battery	Established	High	Cold Cyclone Flood Heat	Protection		All	7, 9, 24, 40
	Natural or mechanical ventilation[9]	Established	High	Heat Flood	Protection Recovery		All	3, 11, 9, 14, 26, 32, CS3, HH, SS
	Smart system in conjunction with solar PV and battery storage	Established	High	Heat Cold	Protection		All	18, 24, 40

9 For most homes, a combination of natural and mechanical ventilation is appropriate. Natural ventilation can be used for cooling and mould prevention; however, most houses need to be able to be sealed for efficient mechanical heating/cooling and when the external air is polluted (e.g. bushfire smoke). Mechanical heating and cooling should be efficient and appropriate to the climate (e.g. heat recovery systems, AC correctly sized and rated for operation in extreme heat).

Table 11 (continued): CRHG part 2: guidelines for existing homes

Building element	Measure	Level	Confidence	Climate event addressed	Resilience characteristic	Risk potentially amplified	NCC zone	References
External structures	Secure external structures (e.g. rainwater tanks)	Basic	High	Flood	Robustness		All (flood hazard areas)	32
	Install rainwater tanks, underground water tanks or smart tanks	Basic	Mid	Flood	Robustness		All	16, 32
	Flood gate	Innovative	Mid	Flood	Robustness		All (flood hazard areas)	12
Other design measures	Air sealing (e.g. repair or seal all possible gaps) following performance-based assessment of the property[10]	Basic	Mid	Cold Heat Flood	Protection Robustness	Heat Flood (Recovery)	All	3, 4, 7, 11, 13, 19, 27 32
	Elevate essential services (e.g. hot water unit, meter board) and pool/water tank pumps above predicted flood levels	Basic	High	Flood	Robustness		All (flood hazard areas)	32
	Vents/eaves/under deck/gutters enclosed with ember-resistant screens or metal mesh	Basic	High	Bushfire	Robustness		All (bushfire prone)	2, 10, 22, 26, 33
	Improving overall quality/condition of home	Basic	Low	Heat	Robustness		All	4
	Cool retreats	Established	Mid	Heat	Protection		All	26, 40
	Indoor tank with submersible pump to hold flood water	Established	High	Flood	Robustness	Flood (contamination risk)	All (flood hazard areas)	12, SS
	Raise electrical appliances (e.g. whitegoods, kitchen appliances), cabinetry, storage for valuable items above predicted flood levels	Established	High	Flood	Robustness		All (flood hazard areas)	32
	Removable components: bottom riser of stairs, cabinetry kickboards	Established	High	Flood	Recovery		All (flood hazard areas)	32

10 Air sealing is only recommended for properties that enable effective occupant control of ventilation, allowing for the safe release of heat, humidity and pollutants. Thermal modelling should take into account projected future climate conditions, including prolonged heat events, and consider how occupants are likely to manage ventilation.

Table 11 (continued): CRHG part 2: guidelines for existing homes

Building element	Measure	Level	Confidence	Climate event addressed	Resilience characteristic	Risk potentially amplified	NCC zone	References
Other design measures	Replace non-resilient cabinetry and kickboards with flood-resilient options	Established	High	Flood	Recovery		All (flood hazard areas)	32, SS
	Sump pump under floor	Established	High	Flood	Robustness		All (flood hazard areas)	32
	Solar chimney that regulates temperature and ventilation	Established	High	Cold Heat	Protection		All	14, CS1, CS3

Note: Shading represents innovation levels: blue indicates basic, grey indicates established, orange indicates innovative.

Source: Authors.

7.4 Implications

The above climate-ready housing guidelines are significant for the ongoing development of new home standards. They are particularly important for integrating emerging technologies, addressing climate risks, and setting priorities to encourage or mandate upgrades to existing homes.

For **new homes,** the priority should be to mandate basic and established measures with high confidence ratings (e.g. external shading, light-coloured roofs, air filters), where such measures are not already covered within NCC requirements. Measures should be progressively introduced to the NCC that align with the recent mandate of the Australian Building Codes Board to consider climate resilience.

Several factors need to be considered in the phasing in of mandatory measures. For example, it will be important to:

- set sufficiently ambitious targets so that a new standard of climate-resilient housing becomes accepted and embedded within the new housing market
- consider sector capacity for upskilling, noting that training will likely be required for property professionals, builders and trades
- provide clear signalling of expectations and timelines for the introduction of climate-resilience measures so that the sector can prepare.

Where measures are classified as 'innovative', it will be necessary to ensure that sufficient confidence can be given to their appropriateness for widespread adoption within the Australian housing stock prior to their introduction. It may be more appropriate that these measures remain voluntary until they reach sufficient maturity.

The CRHG for **existing homes** contains a large proportion of measures classified as 'basic' with high confidence ratings (e.g. fire rating shutters or screens, ceiling insulation, efficient air conditioning), indicating that existing housing stock is highly vulnerable to heat, flood, bushfire and cyclone risks. These retrofittable measures should be prioritised for existing homes. Practical assistance and/or incentives, such as rebates or low-interest loans, are likely required for homeowners and investors to undertake climate resilience improvements. Where occupants have limited control over dwelling condition and maintenance (e.g. private and social rental markets), basic measures should be mandated through minimum standards via residential tenancies acts and other legislative instruments.

The CRHG designates NCC climate zones for specific measures; however, these climate zones (including cyclone and bushfire designated areas) may not **reflect future hazard patterns** as risks shift geographically. Climate and 'risk' zones should be reviewed regularly to account for changing climate conditions, ensuring the application of appropriate climate-resilience measures. For example, housing policies should contain clear triggers that initiate a review of standards and zoning as climate modelling is progressively updated. Interim guidance should support designers and planners to exceed current NCC requirements in areas likely to experience emerging hazards.

Some measures within the CRHG improve resilience for one climate risk but have the potential to exacerbate another. Therefore, decisions about which measures to adopt must be based on up-to-date information about long-term climate changes, including the occurrence of multiple hazards. Guidance should be developed to direct the adoption of a suite of measures that maximise co-benefits and minimise unintended consequences. The interaction of different measures and multiple hazards requires further policy attention and research, for example, testing trade-offs and compounding risks.

A number of measures within the CRHG were rated as low-to-mid confidence, reflecting insufficient or contradictory evidence. There is a need to support research examining the benefits and potential risks of such measures for the Australian climate and housing stock.

8. Policy and practice opportunities

This report contributes to the growing body of work exploring how housing must adapt to cope with climate change. The preceding sections have sought to document how Australian households practise climate resilience today, and the implications for best practice guidance. Here we draw the research findings together, and present policy and practice opportunities for delivering climate-resilient homes.

Climate change is already affecting homes and households across Australia, with different regions exposed to different hazards. Policy and practice responses need to be designed with these variations in mind if they are to deliver climate-resilient housing. As the threats intensify, including heatwaves, flooding, bushfires and cyclones, so does the importance of suitable local and regional policy responses – geographically, socially and culturally.

Over time, building standards have added new measures to improve energy efficiency, maintain healthy indoor temperatures and ensure that homes remain safe and secure during extreme weather. However, some existing requirements are no longer sufficient. As climate events become more frequent and severe, current regulations will increasingly require modernisation in order to keep pace with climate change and protect housing and households. Currently, building standards mainly apply to new homes, leaving significant performance gaps across Australia's existing housing stock.

This concluding chapter summarises the research's key findings on household climate resilience (Section 8.1) and best practice in developing climate-resilient homes (Section 8.2). This is followed by a discussion of five key opportunities for policy and practice to enhance the climate resilience of Australian homes and households (Section 8.3).

8.1 Households and climate resilience

Australian households are active, resourceful and adaptive in response to climate hazards, but their resilience varies widely. The capability to cope with higher temperatures and more frequent extreme weather depends on a wide range of socio-economic factors, housing quality, local environmental conditions, and the availability of community and institutional support.

The research found that householders' understanding of climate resilience is shaped by their lived experience of extreme weather. Householders described resilience as the ability to:

- survive bushfires, floods, cyclones and other major events
- maintain (good) physical and mental health under extreme heat and long-term temperature increases
- protect their home, garden, vehicles and belongings from damage.

Householders improve resilience using three broad strategies:

- retrofitting or rebuilding, including thermal performance upgrades, hazard specific retrofits and installing renewable energy systems backed up with batteries
- modifying the surrounding environment (e.g. through landscaping to create shade, cooling and drainage)
- engaging in active management before, during or after extreme climate events, including:
  - blocking dust ingress with wet towels around doors and windows
  - using shade, blinds, room closure and mist/fan for cooling during heatwaves
  - elevating belongings during floods
  - securing outdoor items before cyclones
  - adding car protection during hail
  - clearing gutters for fire safety.

Households frequently navigate trade-offs between competing risks. Solar PV, for instance, can strengthen energy security but increase exposure to hail damage. Trees provide cooling and shade but can elevate fire or flood risk without ongoing management.

The research also found that many households play an active role in community resilience, sharing information and resources during extreme weather, and participating in preparation and recovery activities such as sandbagging and clearing fallen trees.

8.2 Best practice in developing climate-resilient homes

This project developed the **climate-ready housing guidelines (CRHG),** grouped into three parts:

1. measures for **new homes** (Table 10)
2. measures for **existing homes** (Table 11)
3. existing National Construction Code (NCC)–mandated measures that apply only to new builds and are already adequately addressed in current NCC requirements (Appendix B).

The development process highlighted several elements required for best practice climate-resilient housing. To assess the relevance and priority of each measure, we created a set of taxonomies that describe levels of innovation and confidence, resilience characteristics, risks that may be exacerbated, climate zone relevance and additional best practice considerations. These are elaborated below.

8.2.1 Levels of innovation and confidence

These categories indicate how widely each measure is currently used in Australia's housing stock and the strength and consistency of evidence supporting its effectiveness.

8.2.2 Resilience characteristics

Effective climate-resilient housing must incorporate measures that support:

- robustness – ensuring structural durability
- protection – maintaining safe, healthy indoor conditions
- recovery – enabling rapid and affordable restoration after an event.

8.2.3 Risks that may be exacerbated

Some measures reduce exposure to one hazard but increase vulnerability to another. This report identifies these potential trade-offs, although further research is required to better understand and manage them.

8.2.4 Climate zone relevance

Because climate risks differ significantly across Australia, the CRHG must be tailored to the conditions and hazards of each region. The CRHG assesses the relevance of each measure for different NCC climate zones, as well as localised cyclone, bushfire and flood-prone areas.

8.2.5 Additional best practice considerations

Climate-resilient housing research is an emerging and fast-evolving field. Guideline development must remain iterative so that new evidence, technologies and lessons can be incorporated over time. Findings from this research suggest the following considerations for future initiatives to support climate-resilient homes:

- Resilience is achieved through multiple features of a home working together, rather than through any single measure. This reinforces the value of the NCC's performance-based, whole-of-home approach.
- Homes are increasingly exposed to multiple concurrent or consecutive climate hazards. More research is needed to understand these multi-hazard interactions and how homes can be designed to withstand them.
- Feedback from householders and practitioners supports the National Risk Assessment's conclusion that hail is a major hazard (ACS 2025). Householders also identified dust, water scarcity and energy insecurity as compounding risks that intensify the impacts of extreme weather. Future guideline development should incorporate measures addressing hail and dust exposure, and strategies to reduce vulnerability to water and energy shortages.

8.3 Five policy and practice opportunities

This report draws on academic and grey literature, case studies, practitioner interviews and householder interviews and focus group discussions. Across this evidence base, there are five clear domains for policy and practice improvement opportunities:

- strengthen and modernise standards for new housing to reflect future climate realities
- rapidly scale up retrofitting as the most impactful national adaptation strategy
- invest in household, neighbourhood and community resilience, recognising that social and physical systems are interdependent
- build capacity to anticipate, cross-analyse and design for multi-hazard, future-focused planning that recognises emerging and compounding risks
- forge a dynamic national evidence system that can inform adaptive, iterative regulation and practice.

Together, these opportunities can embed proactive, equitable climate resilience within homes and households.

8.3.1 Strengthen and modernise standards for new housing

Current building standards do not yet adequately account for projected climate conditions. Homes built today will be occupied for 50 years or more, yet NCC requirements still largely respond to historical climate data rather than future hazards. Strengthening standards for new homes prevents the creation of a resilience deficit in future housing stock. It also reduces future retrofit costs and ensures that new Australian housing does not lock in future vulnerability.

There are opportunities for the NCC to build climate resilience in several ways:

- Basic and established climate-resilience measures (outlined in the CRHG) could be mandated for heat, bushfire, flood and cyclone risks (e.g. external shading, light-coloured roofs, non-combustible cladding, cyclone tie downs).
- Risk-based NCC hazard zones could be expanded to reflect projected future climate exposure, not only current conditions.
- There is the potential to set triggers for ongoing revisions, ensuring standards evolve with changing climate projections and refined technical expertise (e.g. construction technologies).
- Climate resilience could be integrated into NatHERS through:
  - use of future climate weather files
  - introduction of requirements for passive survivability during power outages (e.g. accounting for battery-backed energy security).

For the benefits of updated NCC standards to be realised nationally, consistent adoption across all states and territories would likely be required. This might consist of incentives (or penalties) for timely and complete adoption of updated NCC standard for states and territories. Updates to the NCC have typically been opposed by construction industry peak bodies (Daniel et al. 2024), who claim that too frequent changes impact their ability to deliver housing at scale. Therefore, the inclusion (and adoption) of climate-resilience objectives and requirements within the NCC would be significantly aided by support for the training and upskilling of the construction labour force, as well as increased oversight to ensure compliance.

8.3.2 Rapid scale up of retrofitting: Australian housing's greatest resilience gap

Most Australian homes that will exist in 2050 already exist today. Many older homes were built without consideration of future climate conditions. Retrofitting for climate resilience can directly improve household safety, reduce energy hardship and minimise disaster damage costs. There is an opportunity to increase retrofitting of existing homes using several mechanisms:

- National minimum resilience standards for rental properties could be introduced to ensure that all rented homes provide basic protection from climate hazards. Some states and territories have introduced, or are investigating the introduction of, minimum energy efficiency requirements to their residential tenancy acts (e.g. Victoria, New South Wales and the Australian Capital Territory). This existing pipeline of consultation and change should be broadened to incorporate climate-resilient housing measures.
- Targeted incentive programs can encourage voluntary retrofit activity, such as rebates for insulation, shading, air sealing and ventilation upgrades, rooftop solar and battery systems, and low-interest loans for structural retrofits.
- Tailored retrofit guidance delivered by local governments or at a local scale can provide an opportunity for householders to receive advice that is specific to both locality, climate zone and typology (e.g. for Queenslanders – brick veneer villas or apartments).
- Support directed to low-income and climate-vulnerable households, including renters, older people and regional communities disproportionately impacted by disasters, could assist households at greatest risk of climate change.
- Retrofit pathways could be embedded in recovery funding, shifting from rebuilding previous homes to building back better.

- The development of the NatHERS Disclosure Framework – Version 2 and subsequent pilot of voluntary disclosure in New South Wales represents a potential opportunity to support enhancement of climate resilience in existing homes. For instance, if disclosure at point of sale or lease is rolled out nationwide, homeowners and landlords of properties falling below a minimum level of energy efficiency will be informed. Support could be targeted at resilience uplift.
- Requirements for renovations to meet prescribed resilience standards could be introduced.
- The scaling up of climate-resilience retrofit activity would also require upskilling of the construction workforce, which would benefit from specific policy and investment. Nationally, the opportunity for scaled climate-resilience retrofit and strengthening of NCC standards could be included in subsequent versions of the Trajectory for low energy buildings and the National Adaptation Plan. There are also opportunities for states and territories to innovate and lead national action on climate resilience in housing through state legislation, voluntary programs and subsidies.

8.3.3 Invest in household, neighbourhood and community resilience

The resilience of individual homes is strongly shaped by the surrounding neighbourhood and vice versa. Household focus groups showed that community assets, such as shared knowledge, local facilities and social networks, play a crucial role in climate hazard preparedness, response and recovery. Informal, community-driven knowledge sharing is a critical asset for climate adaptation and could be strengthened through:

- support for peer-to-peer learning networks and neighbourhood-level information sharing
    - Local governments can play an active role in facilitating networks and sharing information. Many already support communities during extreme weather and engage in climate change adaptation at the local level. Some local governments explicitly encourage peer-to-peer learning. One innovative example is 'The Adaptation Game' – a facilitated, cooperative board game hosted by local government or community organisations that guides groups of local people to work together to explore personal and community climate adaptation options (YRC n.d.)
- initiatives encouraging informal information sharing to support community-level disaster preparedness
    - This is demonstrated by the Northern Territory Government's approach of including neighbour-to-neighbour check-ins during cyclone warnings (SecureNT 2025).
- practices that systematically integrate community insights into climate-resilience planning processes, particularly following climate events when lived experience is most salient.
    - This could include engaging communities in co-design of relevant policy across all three levels of government.

Local and state/territory governments are well placed to build on existing community assets that support the climate resilience of households by:

- extending street tree canopy expansion and public-space shade infrastructure to support neighbourhood cooling
- strengthening and scaling water-sensitive urban design initiatives to reduce flooding in public spaces and in homes
- expanding and upgrading existing resilience hubs (e.g. libraries, schools and community centres) to extend their ability to provide:
    - clean air during smoke events
    - safe cooling during heatwaves
    - reliable power and communication during outages.

8.3.4 Build capacity for multi-hazard, future-focused planning

Australian households are already encountering hazards not widely addressed in existing guidelines: hail, dust storms, energy insecurity and combinations of hazards that occur simultaneously or sequentially (e.g. floods followed by heatwaves). Climate risks are shifting geographically, requiring updated governance frameworks. Increasingly sophisticated climate risk projections provide several opportunities to foster resilience. These include:

- regularly updating hazard maps and planning controls to support the timely introduction of appropriate measures in areas facing emerging risks, such as:
  - new flood zones based on revised modelling
  - areas newly exposed to bushfire or extreme heat
  - projected cyclone boundary shifts
- incorporating multi-hazard and compounding-event scenarios into planning and regulation to support housing that is better equipped to withstand multiple, overlapping or successive extreme weather events
- targeted controls or incentives to limit the impact of large houses and impermeable outdoor surfaces on neighbourhood-level overheating and flooding.

Such incentives could be financial or non-financial: for example, fast-tracking approvals for applications that minimise impermeable surfaces or include cooling features, such as trees, shading and green space.

In addition to planning changes, resilience could be fostered by directly supporting households to maintain critical functions such as cooling, medical equipment and communications during extreme weather events. Household energy security could be further improved in at least two ways:

- at the individual household level, through backup power supply
- regionally, through the installation of underground power lines.

Previously overlooked hazards could be included in future guidelines to better equip householders and policymakers to prepare for a gamut of climate risks by supporting, for instance:

- hail resilience
- improvements to dust-proofing and indoor air quality
- measures to reduce drought-related structural risks.

Integrated guidance could assist householders in navigating trade-offs, such as:

- summer shading versus winter warmth
- airtightness versus mould risks
- solar PV benefits versus hail exposure
- wet proofing versus dry proofing.

8.3.5 Build a ‘living’ national evidence and guidance system

The evidence for climate-resilient housing is growing but remains uneven, with more research on flooding and thermal performance than on drought or the combined effects of multiple hazards. Much of the existing literature fails to comprehensively address projected future extremes. The risk is that resilience standards will be based on partial and scattered evidence and thus lag emerging climate realities in key areas. Without a national system for continuously synthesising new findings, policymakers and practitioners may be faced with gaps in evolving guidance.

A 'living' evidence model, used in health research, offers a template (University of Melbourne Library 2026). Living systematic reviews are updated as soon as new studies emerge, keeping recommendations current. For example, the Australian Living Evidence Collaboration provides regularly updated clinical guidelines for conditions such as stroke, kidney disease and arthritis, demonstrating that rigorous review methods, active evidence monitoring and responsiveness to practitioner questions can ensure that guidelines are up-to-date (ALEC 2026).

A living evidence model for climate-resilient housing could provide up-to-date evidence on:

- multi-hazard interactions and compounding risks
- the effectiveness of measures across households, communities, construction types and future climates
- the distribution of social, economic and environmental costs and benefits for households, including vulnerable households
- retrofit pathways that account for social processes and capabilities, and for challenging housing types (e.g. social housing, rentals, apartments)
- longitudinal real-world testing of innovative homes and technologies, using qualitative and quantitative measures of performance and social and community acceptance.

In addition to developing living guidelines, climate-resilient housing research could be strengthened by building the evidence base in areas that remain underexplored, including:

- how different risks interact and compound and how resilience to multiple climate hazards can be configured
- assessing the effectiveness of resilience measures across diverse construction types and projected future climate conditions
- evaluating the costs and benefits of resilience measures, with particular attention to households facing heightened vulnerability due to income, health, age or life stage
- identifying viable retrofit pathways for hard-to-retrofit housing, such as social housing, rental properties and apartments
- conducting longitudinal performance testing of real-world climate-resilient homes (e.g. the case studies in Chapter 5), and innovative measures, such as smart windows and phase-change materials.

These activities complement and extend existing work undertaken by the Climate Change Authority, various Australian Government departments and CSIRO. By addressing the challenges and opportunities facing resilient housing in Australia in a comprehensive and joined-up way, resilient housing can be seen as an up-front investment that provides benefits for future generations, reducing harms, damage and risks, and supporting prosperous Australian households.

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Appendix A: Housing actions in climate adaptation plans of Australian jurisdictions

Jurisdiction	Climate adaptation policy	Commitments for improving climate resilience of housing
Aust	*National climate resilience and adaptation strategy*	Highlights built environment as priority domain No specific actions
ACT	*ACT climate change adaptation strategy 2019–25*	Continue renewables support and trial deep retrofits for low-income Information, pilot projects for climate-wise homes Review planning regulations
NSW	*NSW climate change adaptation strategy and adaptation action plan 2025–2029*	Review land use planning frameworks
NT	*NT Climate resilience plan*	No specific actions
Qld	*Queensland climate adaptation strategy*	Includes a 'Built Environment and Infrastructure Sector Adaptation Plan' with priority actions
SA	*South Australian Government climate change resilience and adaptation actions*	Includes 'Built and Urban Environments' as a priority, with 10 actions
Tas	*Tasmania's climate change action plan 2023–25*	Energy efficiency and renewables support Develop a housing strategy, including responding to climate change impacts Incorporate climate modelling in planning
Vic	Adaptation plans for seven systems, including *Built environment adaptation action plan*	Includes actions for strategic planning, building standards and retrofits
WA	*Climate adaptation strategy*	Adaptation plan for the built environment flagged but no commitment

Source: Authors

Appendix B: CRHG part 3: measures already included in the NCC

Measures identified in the literature that are already required for new homes in Australia and not relevant for existing homes. No additional recommendations are provided for these items, except that states and territories should align with the NCC.

Building element	Measure	Level	Confidence	Climate event addressed	Resilience characteristic	Risk potentially amplified	NCC zone	References
Floor	Elevation of floor height using crawl space or elevated slab	Basic	High	Flood	Robustness		All (flood hazard areas)	1, 17, 25, 26, 34, 36
	Flood-tolerant materials, such as concrete, tile, marine ply, that resist water damage	Basic	High	Flood	Robustness		All (flood hazard areas)	25, 26, 34
	Concrete blinding layer in subfloor	Established	High	Flood	Robustness		All (flood hazard areas)	32
	Enclose subfloor area	Established	High	Fire	Robustness	Flood	All (bushfire prone)	CS2
Roof	Roof form used for wind deflection	Established	High	Cyclone	Robustness		1, 2 (cyclone risk zones)	CS2
External structures	Backflow prevention valves	Basic	High	Flood	Robustness		All (flood hazard areas)	16, 21, 26
Other design measures	Building design that avoids attachments (e.g. deck, trellis, eaves) and indents (e.g. window wells, foundation indents)	Basic	High	Bushfire	Robustness	Heat	All (bushfire prone)	10
	Cyclone tie-down systems/ structural bracing systems	Basic	High	Cyclone	Robustness		1, 2 (cyclone risk zones)	25, 38
	Raise power points above predicted flood levels	Established	High	Flood	Robustness		All (flood hazard areas)	32
	Spatial and window orientation to maximise thermal comfort and/or minimise bushfire risk	Basic	High	Heat Cold	Protection		All	CS2, CS3, HH
	Stairs with open design and flood-resilient materials	Basic	High	Flood	Recovery Robustness		All (flood hazard areas)	32

Note: Shading represents innovation levels: blue indicates basic, grey indicates established.

Source: Authors.



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