



# Passive House (Passivhaus) as applied to Heritage Buildings

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Ruth Redden

George Alexander Foundation Fellowship, 2024

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Report by Ruth Redden

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Cover image: Glover House, fully certified Passive House retrofit of a Californian Bungalow by Dieppe Design. Source: Dieppe Design, 2022

**The International Specialised Skills Institute**

1/189 Faraday St,  
Carlton VIC 3053  
info@issinstitute.org.au  
+61 03 9347 4583

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# 01

## Acknowledgements

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### The Awarding Bodies

The Fellow sincerely thanks the George Alexander Foundation for providing funding support for the ISS Institute and for this Fellowship.

The ISS Institute plays a pivotal role in creating value and opportunity, encouraging new thinking and early adoption of ideas and practice by investing in individuals. The overarching aim of the ISS Institute is to support the development of a 'Better Skilled Australia'. The Institute does this via the provision of Fellowships that allow Australians to undertake international skills development and applied research that will positively impact Australian industry and the broader community.

The ISS Institute was founded in 1991 by a small group of innovators, including Sir James Gobbo AC, CVO, QC, and former Governor of Victoria, who had a vision of building a community of industry specialists who would lead the up skilling of the Australian workforce.

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over 580 Fellows to undertake skill and knowledge enhancement across a wide range of sectors which has led to positive change, the adoption of best practice approaches and new ways of working in Australia.

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## Sponsor - The George Alexander Foundation

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The George Alexander Foundation (GAF) Scholarship Programs form the core of the foundation's work, operating in partnership with major tertiary institutions, while our Fellowships and other Education grants provide other enriching and challenging educational experiences.

George Alexander believed in the notion of 'planting seeds and hoping they grow into pretty big trees'. The programs supported by the Foundation endeavour to support this ideal and as GAF Fellowship recipients go on to contribute to the community, George's legacy and spirit lives on through their achievements.

## Fellow's Acknowledgements

The Fellow acknowledges the Traditional Owners of the land on which the research for this fellowship was undertaken. Stretching from Wurundjeri Country in southeastern Victoria, Australia, to the lands of First Nations people in the northwest American region. The Fellow pays her respects to elders past and present and acknowledges the importance of traditional knowledge, particularly in caring for Country.

The George Alexander Foundation (GAF) has been supporting young people, particularly from rural and remote communities, to access education for over 50 years. GAF's aim is to help overcome barriers and make it possible for talented students to achieve their potential and go on to contribute to the Australian community.

The Fellow extends their thanks and deep appreciation to GAF for the support and funding of their Fellowship. This is the second Fellowship that the Fellow has undertaken with GAF's support, demonstrating the organisation's deep commitment to heritage and sustainability, a passion that the Fellow gained growing up on Arrernte Country in Mparntwe/Alice Springs. Having grown up in a rural area the Fellow is acutely aware of the positive impact that support such as fellowships can make on people's lives and careers, especially if there are limited opportunities otherwise.

## Organisations



NBR Architects for providing the Fellow with the time and support to complete the Fellowship research, and for supporting and actively encouraging opportunities to disseminate findings. NBR is an integrated design practice: Architecture, Heritage, Interior Design, and Landscape Architecture with expertise in Education, Wellness, Community, and Secure Spaces. Led by regenerative practitioners, NBR's insight-driven team seeks value-led sustainable outcomes that create joyful places for life.



Passivhaus Institute (PHI) for the training opportunities provided to understand Passive House as applied to heritage places.

## People



Peter Cox, managing director of Carrig Conservation in Ireland, and heritage and sustainability expert. The Fellow thanks Cox for meeting to discuss the Fellowship topic, for Cox's continued support post interview and for kindly introducing the Fellow to people in their extended network.



Susan Ross, Associate Professor at Carleton University, Canada for meeting with the Fellow to discuss the fellowship topic, and for reminding the Fellow of the human element amongst the technical aspects.



Eugene Byrne, director of Byrne Building Projects - Passive House building designer and builder. For sharing their expertise, providing a case study for the research and presenting publicly with the Fellow on the topic.



Emilia Iacovino, sustainability consultant and electrical engineer at Detail Green and fellow ISSI Fellow, for their professional and peer support in completing the Fellowship and willingness to work together professionally post our Fellowship experiences.

Importantly, the Fellow wishes to acknowledge her wife, Katherine Doyle, for her infinite support. Undertaking the Fellowship alongside the responsibilities of work and raising young children (the youngest of whom was born during the fellowship) wouldn't be possible without Katherine and the Fellow is eternally grateful for her support and inspiration.

# 02

## Executive summary

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The Intergovernmental Panel on Climate Change (IPCC) reports that current energy use in residential and non-residential buildings contributes 50% and 32% respectively to global building CO<sub>2</sub> emissions. Therefore, adapting existing buildings and decarbonising them so they operate more efficiently is essential in the race to slow global warming and the associated impacts of climate change. New buildings in Australia only account for approximately 2% of construction in any given year and in Victoria alone over 180,000 existing buildings are included in a heritage overlay. Accordingly, heritage protected places have a significant role to play in addressing the reduction of Australia's CO<sub>2</sub> emissions.

However, the environmental performance of historic buildings is not well understood or recognised globally. Many sustainability rating schemes fail to undertake a Life Cycle Analysis and review factors such as the embodied energy of an existing building, or the resources already consumed to construct the building, compared to the environmental impact of constructing a new 'green' building.

In the search for a sustainability framework that acknowledges the environmental benefits of conserving historic buildings, and one that complements best practice building conservation techniques, the Fellow identified the potential of the Passive House standard which includes a framework for retrofitting existing buildings. As a relatively new framework to the Australian market, the Fellow looked to Europe and North America for Passive House training, where the uptake of the standard has been so popular that some European and North

American planning regulators are adopting Passive House certification as a statutory requirement.

In 2022 the Fellow was funded to undertake activities that would assist in learning more about Passive House as applied to existing and heritage protected buildings, and the relevance of Passive House in Australia. In completing the fellowship, the Fellow undertook:

- Training through the *Passive House Design and Construction Course* delivered by the Canadian Passive House Institute
- Training through the *Passive House Retrofits (Part 1) Course* through the Passive House Network (USA)
- Interviews with experts in Ireland and Canada on 'heritage and sustainability'
- Site visits to a Passive House building project in Naarm/Melbourne, Australia.

The Fellow learnt that the Passive House standard can be a sympathetic approach to decarbonising heritage places, particularly as the EnerPHit model acknowledges the challenges of working with existing buildings. The focus on passive design, high quality construction detailing, breathability, healthy indoor environments and the requirement for occupants to engage with the operation of buildings makes the Passive House standard appealing to building conservation practitioners. The Fellow was directed to numerous examples where Passive House had been successfully applied to existing, historic buildings, including to local case studies. In speaking to international conservation experts, the



Fellow learnt that in Europe, and unlike Australia, there is significant support and funding for research into the environmental benefits of adapting historic buildings, partly in response to statutory standards such as EN16883:2017 - Conservation of cultural heritage.

The Fellow was also reminded of the risks in applying the Passive House standard to historic buildings, which include maladaptation, and the importance of recognising that climate change is already affecting people and cultures. Assisting communities to adapt to a changed climate and identifying the impacts on cultural heritage is also an important aspect of the heritage and sustainability focus.

The impact of the fellowship has been deep and rewarding – on a personal, professional and sector level. On a personal level the Fellow was able to undertake professional development and continue international research on the important topic despite the challenges of Covid-19 border restrictions. Coupled with the financial costs associated with such targeted research, and the welcomed birth of the Fellow's second child in late 2022, the fellowship provided an opportunity for personal and career growth that would not have otherwise been available to the Fellow in the foreseeable future.

In mid-2023 the Fellow was offered a new position as Principal Heritage Consultant at NBR Architects, an organisation that values cultural heritage and sustainability. In support for continuing the learnings of the fellowship, NBR Architects have nominated the next ENVISION program – a paid internship program that NBR Architects has run for 13 years – to be on the topic of decarbonising existing buildings, with a focus on heritage places. As the lead designer of the program, the Fellow invited fellow ISSI Fellowship recipient Emilia Iacovino to be the Passive House expert reviewer on the project. NBR Architects are committed to supporting the ongoing development of research undertaken in the area of heritage and sustainability and in late 2023 provided the opportunity for the Fellow to present to the company nationally (VIC, NSW and QLD) on findings of the Fellowship. Other dissemination opportunities that the Fellow has embraced include:

- Assisting the Heritage Council of Victoria to produce 'heritage and climate change' resources.
- Presenting at the 2023 Local Government Heritage Forum on "Passive House as applied to Heritage Places" with Eugene Byrne whom the Fellow met through the Fellowship research.
- Assisting Peter Cox with public presentations during a visit to Australia (from Ireland) in 2023.
- Co-publishing an article in Sanctuary Magazine – a popular design magazine with a focus on sustainable homes – on the topic of adapting historic buildings for environmental sustainability.
- Presenting to Master of Urban and Cultural Heritage students at Melbourne University on the topic of 'heritage and sustainability'.
- Chairing a Melbourne Design Week 2024 panel discussion, sponsored by the Heritage Council of Victoria and National Trust, on the topic of 'The Fine Art of Traditional Trades' of which fellow 2019 ISSI Fellow Glen Rundell presented on the sustainability of traditional trades.

Recommendations from the findings of the Fellowship include:

- Continue to support research into the intersections between heritage and environmental sustainability, specifically:
  - Impacts of climate change on heritage places.
  - Risk preparedness for heritage places in the face of climate change.
  - Best practice methods for adapting historic places to meet the challenges of climate change.
  - Passive House design as applied to heritage places.
  - Building local data for Embodied Energy calculations, including data related to traditional materials.
- Implement statutory design, planning and construction standards that require a joint focus on improving the operational performance of historic buildings and best practice conservation. Such

requirements could lead to additional funding for research in the area, therefore upskilling Australian practitioners. As a requirement for any building project, the standard would create opportunities for people to identify issues and solutions to adapting historic buildings.

- Establish a professional working group that focuses specifically on Passive House as applied to heritage places. As a relatively new area with few Australian examples, it is important that knowledge about the application of Passive House to historic places is shared and peer reviewed.
- Train heritage architects and Passive House consultants to develop technical guidelines and specifications for detailing typical Australian heritage places to Passive House standards.
- Promote the environmental benefits of conserving historic places. These include but are not limited to: harnessing already expended embodied energy, reduced resource depletion, reduced waste and pollution, healthier indoor environments.
- Lobby governments to value the conservation of historic places over demolition for perceived benefits related to sustainability.

In adopting the above recommendations, the following should be considered:

Accept that there are some issues with historic places and the application of traditional trades that may need to adapt to meet contemporary requirements - particularly in the face of extreme weather events and changing climatic conditions due to climate change.

It will take time, resources and experimenting to develop much needed technical guidelines and specifications for detailing typical Australian heritage places to Passive House standards. However, this work is urgent and steps should be taken to begin.

## About the Fellow

Ruth Redden is a registered architect and heritage consultant with over 15 years' experience of providing heritage advice to private and public organisations. She was awarded an ISSI and George Alexander Fellowship in 2013 to research the topic of Greening Historic Buildings, an experience that kicked off her career as a recognised practitioner in heritage and sustainability. Ruth is an alternate member of the Heritage Council of Victoria and has participated in working groups for projects related to heritage and climate change. Ruth is a regular guest lecturer at Melbourne University where she presents to Master of Urban and Cultural Heritage students on the topic of 'heritage and sustainability'.

# 03

## Fellowship background

### Fellowship context

Climate change has impacted all aspects of society, including building conservation practice. In addition to the physical impacts of extreme weather events and changing environmental conditions, mitigation measures such as new energy codes and the uptake of Environmentally Sustainable Design (ESD) have impacted the way that existing buildings are retrofitted. For the past decade, existing buildings have accounted for approximately 98% of building stock in Australia,<sup>1</sup> a trend that has been identified globally in most developed countries. According to the leading authority on climate change issues, the Intergovernmental Panel on Climate Change (IPCC), current energy use in residential and non-residential buildings contributes 50% and 32% respectively to global building CO2 emissions.<sup>2</sup> In order to mitigate the adverse impacts of climate change, existing building stock across the globe needs to be decarbonised. Decarbonisation can be described as significantly reducing the reliance on fossil fuels, switching to renewable energy sources and reducing the amount of energy produced.

In Victoria (Australia) alone, over 180,000 existing buildings are included in a heritage overlay<sup>3</sup> and therefore have some form of heritage protection. Heritage places have a significant role to play in the global effort to decarbonise existing buildings.

In 2013, as a recently registered architect, the Fellow completed an ISSI and George Alexander Fellowship titled 'Greening Historic Buildings'. The opportunity took the Fellow to New York City to participate in the Association for Preservation Technology Institute's annual conference and workshops, where they began engaging with international experts on the topic of 'heritage and environmental sustainability'. The Fellow identified knowledge gaps in the international and Australian conservation and building practice sectors, including the issue of sustainability rating schemes as applied to heritage places. Sustainability rating schemes, in the context of buildings, can be defined as methods or frameworks for recording and improving sustainability measures of a site. Sustainability measures can be solely focussed on operational performance and energy efficiency – or can be broadened as far as sustainability as

1 'Building and Construction' Australian Bureau of Statistics [website] <<https://www.abs.gov.au/statistics/industry/building-and-construction>> accessed 2024

2 'IPCC Sixth Assessment Report. Working Group III: Mitigation of Climate Change', Chapter 9: Buildings (IPCC, 2022) <<https://www.ipcc.ch/report/ar6/wg3/chapter/chapter-9/>> accessed 2024.

3 'The State of Heritage Review: Local Heritage' Heritage Council of Victoria [website] <<https://heritagecouncil.vic.gov.au/research-projects/the-state-of-heritage-review-local-heritage/>> accessed 2024

defined by the UNESCO Sustainable Development Goals (SDGs) which include focus areas such as education, poverty and gender equity.<sup>4</sup> Accordingly, the range of available sustainability rating schemes, the individual approaches and therefore impacts on heritage places is broad. However, one major issue that the Fellow identified was the lack of sustainability rating schemes that, at the time, considered embodied energy or low-impact interventions – instead prioritising the uptake of new technologies and extensive demolition under the guise of ‘sustainability’ or ‘green design’.

Between 2017 and 2019 the Fellow continued research as a PhD candidate at Melbourne University, researching the ‘environmental performance of historic buildings’.<sup>5</sup> Through this research the Fellow identified that existing sustainability rating schemes in Australia were generally inappropriate as applied to heritage places. However, there was promising evidence that a German framework, Passive House (Passivhaus), could be one of the few ESD frameworks that could complement building conservation, whilst improving the energy performance of existing buildings. A big limitation, however, was that whilst well established and widely implemented in Europe and North America, Passive House was relatively new to the Australian market. Not only was there little knowledge about the application of Passive House to new builds, but there was even less experience of applying Passive House to existing buildings – let alone to heritage protected ones.

In 2021, during the Covid-19 pandemic, the Fellow applied for a second ISSI and George Alexander Foundation Fellowship to investigate Passive House as applied to heritage places. The experience and findings of this fellowship are the focus of this report.

## Fellowship methodology

Due to travel restrictions during the Covid-19 pandemic, the Fellow proposed to undertake international research online from Australia. In response to the worldwide impact of lockdowns and border restrictions, many courses became available online and people became more comfortable with conducting conversations online. The Fellow identified this as an opportunity to undertake the fellowship research immediately without having to wait for borders to open.

To better understand Passive House concepts, the Fellow enrolled in the Passive House Design and Construction online training course, delivered by the Canadian Passive House Institute. The online course consisted of 13 online modules and learning goals delivered through over 100 pre-recorded videos and 8 exams. The online course was the equivalent of six in person classroom days, or 40 teaching hours and covered the topics of:

- Passive House Design Criteria
- Building Envelope Construction Options
- Thermal Bridge-Free Construction
- Airtightness – Theory and Practice
- Ventilation Requirements & System Design
- PHPP Design Software
- Window Design, Selection and Energy Balance
- Passive House Economics and Incremental Costs
- Heat Loss Calculations for building assemblies
- Building Science for Passive House – hygrothermic assessment.

4 UNESCO, ‘The 17 Goals – Sustainable Development [website] < <https://sdgs.un.org/goals> > accessed 2024

5 Redden, Ruth, and Robert H. Crawford. “Valuing the environmental performance of historic buildings.” *Australasian Journal of Environmental Management* 28, no. 1 (2021): 59-71. Available: <https://static1.squarespace.com/static/583b5a3c2e69cfc61c69d194/t/64adef2d8d6761234f2ec83c/1689120562603/Valuing+the+environmental+performance+of+historic+buildings.pdf>

After completing the Passive House Design and Construction course, the Fellow completed the Passive House Retrofits (PHR) online course through the Passive House Network, North America. The PHR course focussed specifically on EnerPHit, the Passive House sustainability framework designed for existing buildings. The PHR course consisted of eight modules delivered live over five hours.

To learn about international experiences and perceptions of Passive House as applied to historic buildings, and international thought leadership on the topic of heritage and sustainability, the Fellow interviewed two conservation experts:

- Peter Cox, managing director and head of energy at Carrig Conservation, Ireland; and
- Susan Ross, Associate Professor at Carleton University School of Indigenous and Canadian Studies, Canada.

Finally, to help the Fellow understand the practical issues of Passive House as applied to heritage buildings in Australia, the Fellow interviewed two Passive House practitioners: architect Edward Dieppe of Dieppe Design (NSW), and Eugene Byrne from Byrne Building Projects (VIC). The Fellow visited a heritage protected house in renovation by Byrne Building Projects in Naarm, Melbourne.

## Fellowship period

The fellowship research was undertaken between October and November 2022. Focussed dissemination was delivered between 2022 and 2024.

## Fellow biography

Ruth Redden is a registered architect and heritage consultant at NBR Architects. NBR is a multidisciplinary studio of architects, interior designers, heritage consultants and landscape architects based in Victoria, New South Wales and Queensland. With over 55 years' experience of delivering community and people centred architecture, NBR is a champion of sustainability as defined by the UNESCO Sustainable Development Goals. Lead by Samantha Polkinghorne (Director, Head of Heritage and Chairwoman of the Board) the heritage studio at NBR knows that "the greenest building in one that is already built".<sup>6</sup> Ruth is a principal in the Melbourne office where she assists private clients and public organisations with the sustainable management of their historic assets.

Ruth is the alternate Architectural conservation/ Architectural history Member of the Heritage Council of Victoria. In her role at the Heritage Council Ruth has had the opportunity to contribute to important heritage and sustainability projects including 'Heritage and Climate Change'<sup>7</sup> and the Heritage Council's 'Climate Action Plan'.

Ruth is a regular guest lecturer at Melbourne University where she presents to Master of Urban and Cultural Heritage students on the topic of 'heritage and sustainability'.

In her private life, Ruth enjoys spending time with her wife, two young children and their cocker spaniel along the Merri Creek on Wurundjeri country near Naarm (Melbourne), Victoria.

6 Elefante, Carl, 'The greenest building...is the one that is already built' [website] (n.d.) < <https://carlelefante.com/insights/the-greenest-building-is/> > accessed 2024

7 'Heritage and Climate Change' Heritage Council of Victoria [website] (19 Jul. 2021) < <https://heritagecouncil.vic.gov.au/heritage-protection/heritage-and-climate-change/> > accessed 2024.



## Acronyms

<b>EPD</b>	Environmental Product Declaration
<b>ESD</b>	Environmentally Sustainable Design
<b>HRV</b>	Heat Recovery System
<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>LCA</b>	Life Cycle Assessment
<b>PHPP</b>	Passive House Planning Package
<b>PHR</b>	Passive House Retrofits
<b>SDGs</b>	Sustainable Development Goals

## Definitions

**Cultural significance:** Aesthetic, historic, scientific, social or spiritual value for past, present or future generations. Cultural significance is embodied in the place itself, its fabric, setting, use, associations, meanings, records, related places and related objects. Places may have a range of values for different individuals or groups (Burra Charter, 2013).

**Decarbonisation:** Human actions to reduce carbon dioxide emissions from human activities (IPCC AR6, 2023)

**Embodied Energy:** The total emissions [water use, land use] generated [used] in the production of goods and services regardless of the location and timing of those emissions [water use, land use] in the production process. This includes emissions [water use, land use] within the country used to produce goods or services for the country's own use, but also includes the emissions [water use, land use] related to the production of such goods or services in other countries that are then consumed in another country through imports. Such emissions [water, land] are termed 'embodied' or 'embedded' emissions, or in some cases, (particularly with water) as 'virtual water use' (Davis and Caldeira, 2010; Allan, 2005; MacDonald et al., 2015).

**Place:** Place means a geographically defined area. It may include elements, objects, spaces and views. Place may have tangible and intangible dimensions (Burra Charter, 2013).

**Maladaptation:** Adapting a place with products/ systems that detrimentally harm fabric and cultural heritage significance (Cox, P. 2023)

# 04

## Fellowship learnings

### Passive House (Passivhaus)

Passive House is a design standard that was developed in Germany in the 1990s, growing from the principles of passive design. The standard focuses on construction that prioritises thermal comfort with minimal mechanical heating or cooling, and high-quality indoor air quality through air exchange and material quality. To achieve these standards the Passive House Institute administers a certification scheme that only allows certification when rigorous performance standards can be demonstrated. Whilst the Passive House Institute certifies materials and building components to help designers maintain high quality construction,<sup>8</sup> it does not dictate how performance standards should be met, thereby allowing the framework to be applicable to any building site.

To obtain Passive House certification a building must meet the following criteria:

- Thermal comfort must be achieved during winter (20°C minimum) as well as in summer (this can be adjusted in extreme climates), with not more than 10% of the hours in a given year over 25°C.
- Heating demand 15kWh/m<sup>2</sup>/yr or heating load 10W/m<sup>2</sup>.

- Cooling demand 15kWh/m<sup>2</sup>/yr (in humid climates this allowance increases to allow for dehumidification) or cooling load 10W/m<sup>2</sup> (if installed)
- Humidity must not exceed 12g/kg for more than 20% of the year (~60%RH at 25°C).
- Airtightness must be 0.6ACH50 or lower and be verified on site.
- Overall energy use (Primary energy renewable must not exceed 60kwh/m<sup>2</sup>/yr. When calculating overall energy use, Passive House includes whole-of-building energy; this includes heating and cooling, hot water, lighting, fixed appliances and an allowance for consumer electronics.<sup>9</sup>

Passive House can be applied to any building, be it a small-scale domestic dwelling, or a large-scale office building or warehouse.

There are three levels of Passive House certification available: classic, plus, and premium. The level of certification relates to how much energy a building demands and how much renewable energy the building produces.

<sup>8</sup> 'Passive House Portal Component Database' [website] (n.d.) Passivhaus Institute < <https://database.passivehouse.com/en/components/> > accessed 2024.

<sup>9</sup> 'Passive House' Your Home [website] (n.d.) Australian Government < <https://www.yourhome.gov.au/passive-design/passive-house> > accessed 2024.

The Passive House design standard can be applied to existing buildings and Passive House EnerPHit certification was developed to account for the intricacies of existing buildings, including those which are heritage protected.

For a detailed explanation of Passive House and its applicability to the Australia building and construction sector, readers are encouraged to read Emilia Iacovino's ISSI and Italian Australian Foundation 2023 fellowship report titled "Passivhaus Building Certification: ensuring ultra energy efficient, comfortable, healthy, quality homes".<sup>10</sup>

In completing the Passive House Design and Construction Course, and the Passive House Retrofits course, the Fellow learnt that there are several key aspects of Passive House design that make the standard sympathetic to traditional building conservation.

### **Attention to detail and quality construction**

Passive House certification is typically undertaken in three stages: a pre-construction check of documentation and modelling, evidence of construction during the build, and a post-construction blower door test. To demonstrate compliance with certification requirements, modelling is undertaken during the design phase by certified Passive House designers, using the Passive House Planning Package (PHPP) software. Multiple scenarios can be developed to model building performance and financial metrics, requiring designers to scrutinise every aspect and component of a building area that seeks to be Passive House certified. When working with a historic property, this approach allows for a rigorous review of proposed interventions, allowing designers to "do as little as possible and as much as necessary" which is an important conservation principle of the Burra Charter,<sup>11</sup> the leading guide on heritage best practice in Australia and internationally.

During construction builders are required to keep records of materials used and construction details undertaken, ensuring a high level of transparency and again, attention to detail. Not too dissimilar to the pride that traditional trades people take in the care and execution of their work, Passive House builders take pride in the fact that what they construct goes above and beyond typical and often substandard construction details.

To ensure a project is on track to meet Passive House certification, it is not uncommon for testing to be undertaken several times throughout a project to benchmark air exchanges and the performance of a building – again ensuring quality performance.

### **Hygroscopic materials, ventilation and healthy indoor environments**

Passive House buildings are highly insulated and designed to prevent uncontrolled air flow. Therefore, a high level of scrutiny is placed on the specification of hygroscopic and breathable materials, and construction details that avoid moisture build up, condensation and mould growth. Whilst a problem with standard contemporary construction methods, traditional building conservation on the other hand is founded on the knowledge that historic buildings need to breathe to avoid issues of rising damp, salt attack, mould and fabric damage. This line of thinking is rebirthed with the application of Passive House standards.

Creating healthy and high-quality indoor environments is one of the most important principles of Passive House design. With a focus on natural, renewable and low carbon materials, many traditional products – such as lime wash, low-cement render, oil and wax coatings – are appealing to Passive House designers.

Whilst high levels of insulation are an important aspect of Passive House design, so is ventilation and

10 Iacovino, Emilia, Passivhaus Building Certification: Ensuring Ultra Energy Efficient, Comfortable, Healthy, Quality Homes ISSI and the Italian Australian Foundation. 2023 < [https://www.issinstitute.org.au/\\_files/ugd/51e950\\_8812f7e3bbbd4a23afe2d09ca1f63cce.pdf](https://www.issinstitute.org.au/_files/ugd/51e950_8812f7e3bbbd4a23afe2d09ca1f63cce.pdf) > accessed 2024.

11 The Burra Charter 2013, ICOMOS Australia. 2013 < <https://australia.icomos.org/wp-content/uploads/The-Burra-Charter-2013-Adopted-31.10.2013.pdf> > accessed 2024, 1.

air quality. Accordingly, a Passive House building may be highly insulated, but it might also have a large number of windows or door openings – it is up to the designer to ensure that those openings are thermally efficient and up to the building occupant to know how and when to open windows and doors to ensure the efficient operation of a building. Similarly, prior to the introduction of mechanical heating and cooling in the mid-20th century, building occupants understood the passive design principles of traditional buildings. Due to various Victorian-era diseases people were acutely aware of maintaining a healthy level of indoor air quality. Unbeknownst to many people today, buildings of the 19th century were often designed with highly sophisticated mechanisms for ventilation, heating and cooling, often disguised in decorative features such as ceiling roses and wall mounted ornaments, or concealed in wall cavities and sometimes underground tunnels.<sup>12</sup> Whilst highly technical and sophisticated, both Passive House designed buildings, and historic buildings rely on an interaction, understanding and dialogue between occupants and the building, thereby requiring people to engage with their environment and consider the impacts of their choices while occupying a space.

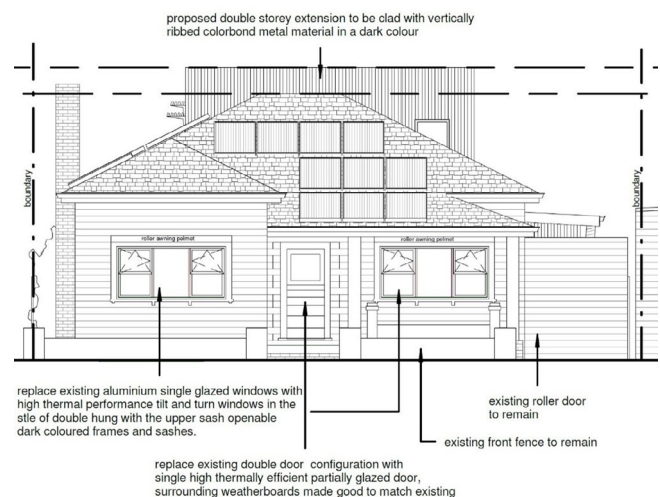
## Case study

To gain a better understanding of Passive House principles and particularly in the context of heritage places, the Fellow visited a heritage protected home that was being renovated to full Passive House standards by Passive House building designer Eugene Byrne.

The house was an interwar weatherboard bungalow located in a locally listed heritage overlay area. Under the planning provisions there were only external controls on the house. The proposal included a ground and second floor addition, and a deep renovation to achieve Passive House standards for both the existing and new parts of the dwelling. For the existing part of the house this was achieved by measures including but not limited to:

- replacing existing (non-original) aluminium windows with new high performing sash windows with a traditional appearance
- replacing the existing doors with thermally high performing doors
- removing all internal linings to install continuous, high performing insulation in the floors, walls and roof; and
- installing a Heat Recovery System (HRV).

In terms of original built fabric, the house was able to maintain its traditional appearance as seen from the public realm with its terracotta tiled roofed, façade-faced chimney, horizontal weatherboard cladding and porch with brick balustrade.



PROPOSED WEST ELEVATION AND STREETSCAPE

Figure 1. Proposed west elevation of case study building showing proposed changes. Source: Byrne Building Design, 2023

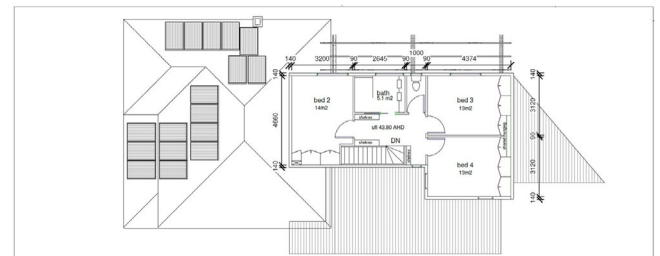


Figure 2. Proposed Level 1 plan of case study building showing existing building to the left and proposed additions to the right. Source: Byrne Building Design, 2023

<sup>12</sup> Lerum, Vidar. Sustainable building design: Learning from nineteenth-century innovations. Routledge, 2015; Redden, Ruth, and Robert H. Crawford. "Valuing the environmental performance of historic buildings." *Australasian Journal of Environmental Management* 28, no. 1 (2021): 59-71.

Challenges that the existing building faced in terms of meeting Passive House standards included:

- an east-west orientation, making passive solar gain more difficult
- a chimney located on the side of the building, requiring conscious detailing to achieve an unbroken thermal barrier.

According to Byrne, despite being an existing dwelling with heritage restrictions, blower tests undertaken throughout the construction process showed early results above those seen on other new build Passive House projects. Accordingly, the project easily achieved full Passive House certification and did not need to apply EnerPHit standards to the existing, heritage portion of the dwelling.

Visiting the case study building and speaking to Byrne on a number of occasions provided the Fellow with a practical understanding of the topics learned in the online courses and demonstrated that Passive House could be successfully applied to a heritage building without compromising important historic features or best practice building conservation methods.

For further information on the case study project, refer to slides in Appendix A from a joint presentation that the Fellow delivered with Byrne at the 2023 Victorian Local Government Heritage Forum.

The Fellow also interviewed Edward Dieppe of Dieppe Design in NSW who has worked on numerous existing buildings and upgraded them to Passive House standards.<sup>13</sup> Dieppe confirmed that whilst existing and heritage protected buildings have individual challenges, the challenges are not insurmountable and heritage places can be upgraded to Passive House standards.

## International perspectives

### Peter Cox, Ireland

The Fellow spoke with Peter Cox, managing director of Carrig International, an internationally recognised heritage consultancy firm based in Ireland. Cox, who is also Head of Energy at Carrig, was President of the ICOMOS National Scientific Committee on Energy Sustainability and Climate Change (NSCES+CC) from 2013 to 2020. In their conversation Cox highlighted concerns with Passive House which stemmed from sealing a building so tightly that condensation and mould growth is a high risk, and the embodied energy involved in adding extra materials to a place – particularly if the materials are not sustainably sourced, renewable or have a limited life span. Cox noted that whilst the operational carbon of a building is reduced after being deeply retrofitted, the embodied carbon emissions can steeply rise if the materials used in the retrofit are not measured, and low carbon materials utilised.

Cox also highlighted that once insulation is installed in a Passive House building, and sealed to the extent required to achieve certification, it makes it very hard to inspect the materials for maintenance purposes in the future.

Cox shared with the Fellow a long list of initiatives that the European government and private sector European organisations are undertaking around heritage and environmental sustainability. Partly in response to the introduction of the European standard *EN 16883:2017 Conservation of cultural heritage*, a significant amount of work is being carried out in Europe to improve the energy performance of historic buildings. Cox was able to identify a significant number of studies that seek to measure the performance of retrofitted historic buildings, identify issues related with deep retrofitting, and opportunities for sustaining traditional trades as part of the deep renovation process. Many of the studies shared by Cox are included in the bibliography of this report.

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13 See Dieppe Design website for information on Passive House projects: <https://dieppedesign.com/>



Cox highlighted that one of the largest gaps in sustainable building conservation in Europe is the lack of reliable data available to undertake Life Cycle Assessments (LCA), which assist to review the embodied energy associated with building projects. Cox identified a current push in Europe to develop statutory requirements for every product in the construction industry to have an Environmental Product Declaration (EPD) – a move that would eventually make embodied energy data and LCA modelling more reliable.

Many of the studies shared by Cox with the Fellow are relevant to the Australian context in that they highlight the opportunities and constraints in decarbonising historic buildings. Many of the issues identified, such as impacts on significant fabric and important areas of focus are the same for the Australian context, however other aspects are very different – such as the amount of insulation required to keep a building comfortable in a European winter compared to an Australian winter. Accordingly, Australia could benefit from the significant number of research projects being funded in Europe by undertaking a literature review of the best practice projects, adopting relevant findings, and direct limited available funding to areas that require adaptation for the Australian context – such as developing local embodied energy databases for Australian LCAs, and identifying the most important focus areas of retrofitting an existing building.

### **Susan Ross, Canada**

The Fellow spoke with Susan Ross, Associate Professor at Carleton University School of Indigenous and Canadian Studies, Canada. Ross is a registered architect and former heritage consultant who now researches in the areas of sustainable heritage conservation, and landscapes history and conservation. Ross also shared with the Fellow multiple resources related to heritage and climate change, with a particular focus on the social justice aspects of climate change impacts on cultural heritage. Some of the resources shared by Ross are included in the bibliography of this report.

Ross acknowledged that decarbonising existing buildings plays an important role in climate mitigation, but that cultural heritage managers also need to consider adaptation to an already changed climate, and what that means for communities impacted. For example, there are many communities across the globe that have already been forcibly relocated due to rising sea levels, disastrous bush fires or hurricanes. Ross probes us to question, what are some of the impacts that moving could have on a community if people are no longer living on traditional lands and dispersed from other community members? Ross highlighted several research projects being undertaken by students which investigate these issues and other themes, such as embodied energy associated with decarbonising historic buildings.

Finally, Ross highlighted the importance of risk preparedness for heritage places and landscapes. If the conservation community doesn't prepare for the extreme weather events and other climate change impacts predicted (if not already occurring), then an energy proficient historic building is not very sustainable if it doesn't survive the impacts of climate change.

The information and research shared by Ross is directly applicable to the Australian context in that disaster preparedness for heritage places is an emerging field with only a handful of heritage experts qualified to consult in this area. As a relatively new field globally, Australia would benefit from continued conversations with practitioners internationally to develop best practice vulnerability assessments and risk plans for heritage places. Furthermore, the impacts of climate change are similar across the globe and there are First Nations and non-Aboriginal cultural groups affected by climate change in Australia every day. By continuing conversations globally, Australia could knowledge exchange with other countries about managing the impacts of climate change on cultural groups.

# 05

## Personal, professional, and sectoral impact

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### Personally

The fellowship has provided personal opportunities for the Fellow to undertake professional development and higher learning in a capacity that would not have been possible through a formal education program, such as university. Financially the fellowship covered significant costs associated with professional Passive House courses where learning outcomes could be applied immediately, and the fellowship assisted with the costs of taking unpaid leave to undertake Fellowship research. Undertaking the professional development associated with the Fellowship has undoubtedly contributed to the Fellow gaining employment as Principal – Heritage at NBRS Architecture, where the Fellow was supported to complete this report, and is actively encouraged and supported to continue research and advocacy for heritage and sustainability.

Throughout the course of the Fellowship the Fellow made personal and professional relationships with other Fellows who understood the responsibility of undertaking the Fellowship amongst other life commitments and the potential offered by the opportunity.

### Professionally

The Fellow is aware of the long-term professional impacts associated with the opportunity to do a fellowship, having completed an ISSI and George

Alexander fellowship in 2013. In completing this latest fellowship, the Fellow has built upon specialised skills first undertaken in 2013 and honed upon over the past 11 years.

With a renewed interest and updated skills related to the management of heritage places and the intersections with environmental sustainability, the Fellow actively sought employment with an architecture practice with demonstrable commitments to heritage and sustainability. Since starting the fellowship the Fellow closed their consulting business and accepted a Principal Heritage Consultant role with NBRS Architects. Through this appointment the Fellow is expected to collaborate with other NBRS architects and sustainable design consultants to engage, promote and professionally consult in heritage and sustainability.

### Organisationally

Having the Fellow employed at NBRS Architects means that there is a dedicated person advocating for, and spearheading heritage and sustainability, and the sector requirements as identified in this fellowship report. NBRS has actively supported this work since the Fellow's employment.

For over 13 years NBRS has run the ENVISION program – a 10 week paid internship program where students or early career graduates are employed by NBRS to research a topic of interest to the company.

In 2024 the Fellow was invited by NBRIS to lead the ENVISION program under the research topic of “Decarbonising Existing Buildings” with a focus on heritage places. In developing the program, the Fellow engaged associate ISSI fellowship recipient Emilia Iacovino to be a program mentor, alongside National Trust of Victoria and other NBRIS mentors. The plan for ENVISION is to use case study buildings and test some of the principles and ideas identified through the fellowship research.

## Broader sector

Despite a small number of professionals working in this space internationally, research into heritage and sustainability continues to be an emerging field in Australia. The climate change crisis has mandated interest in the area over the past ten years or so, however there are few heritage professionals in Australia who have targeted expertise in heritage and sustainability. The ISSI and George Alexander Foundation continue to be one of the largest supporters of heritage, sustainability and traditional trade research in Australia, helping to give Australian researchers such as the Fellow a place to significantly impact the sector by identifying gaps and important findings from Australia and abroad.

Upskilling in the area has enabled the Fellow to confidently advocate for and lead heritage and sustainability related projects. In her role at the Heritage Council of Victoria, the Fellow has contributed to Heritage and Climate Change projects,<sup>14</sup> including internal strategic projects due for completion in mid-2024.

As adaptive re-use and decarbonisation remain pressing issues in the built environment, the Fellow continues to advocate for the adaptive re-use and improved energy performance of historic buildings.

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14 'Heritage and Climate Change' Heritage Council of Victoria [website] (19 Jul. 2021) < <https://heritagecouncil.vic.gov.au/heritage-protection/heritage-and-climate-change/> > accessed 2024.

# 06

## Recommendations and considerations

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As a result of the research and subsequent experience gained by the Fellow during the Fellowship experience, the following recommendations are made for the Australian heritage management (private and government) and design sectors:

- Continue to support research into the intersections between heritage and environmental sustainability, specifically:
  - Impacts of climate change on heritage places.
  - Risk preparedness for heritage places in the face of climate change.
  - Best practice methods for adapting historic places to meet the challenges of climate change.
  - Passive House design as applied to heritage places.
  - Building local data for Embodied Energy calculations, including data related to traditional materials.
- Implement statutory design, planning and construction standards that require a joint focus on improving the operational performance of historic buildings and best practice conservation. Such requirements could lead to additional funding for research in the area, therefore upskilling Australian practitioners. As a requirement for any

building project, the standard would spearhead opportunities for people to identify issues and solutions to adapting historic buildings.

- Establish a professional working group that focuses specifically on Passive House as applied to heritage places. As a relatively new area with few Australian examples, it is important that knowledge about the application of Passive House to historic places is shared and peer reviewed.
- Train heritage architects and Passive House consultants to develop technical guidelines and specifications for detailing typical Australian heritage places to Passive House standards.
- Promote the environmental benefits of conserving historic places. These include but are not limited to: harnessing already expended embodied energy, reduced resource depletion, reduced waste and pollution, healthier indoor environments.
- Lobby governments to value the conservation of historic places over demolition for perceived benefits related to sustainability.

In adopting the above recommendations, the following should be considered:

Accept that there are some issues with historic places and the application of traditional trades,

that may need to adapt to meet contemporary requirements - particularly in the face of extreme weather events and changing climatic conditions due to climate change.

It will take time, resources and experimenting to develop much needed technical guidelines and specifications for detailing typical Australian heritage places to Passive House standards. However, this work is urgent and steps should be taken to begin immediately.



# 07

## Dissemination and stakeholder engagement

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Since being awarded the Fellowship the Fellow has:

- Been appointed as the Architectural History/ Conservation Alternate member for the Heritage Council of Victoria and participated in multiple working groups for projects related to heritage and climate change. The Fellow assisted the Heritage Council of Victoria to produce 'heritage and climate change' resources, and is currently chair of the Heritage Council of Victoria's Climate Action Plan working group.
- Presented at the Local Government Heritage Forum, held in Melbourne 2023, on "Passive House as applied to Heritage Places" with Eugene Byrne whom the Fellow met through the Fellowship research.
- Assisted Peter Cox with public presentations during his visit to Australia (from Ireland) in 2023.
- Co-published an article in Sanctuary Magazine – a popular design magazine with a focus on sustainable homes – on the topic of adapting historic buildings for environmental sustainability.<sup>15</sup>
- Presented to all **NBRS Architects** studios (VIC, NSW and QLD) on the topic of "Heritage and Sustainability" with a focus on Passive House as applied to heritage places.

- Developed a student internship program at **NBRS Architects** based on Heritage and Sustainability, of which Emilia Iacovino, associate ISSI Fellow, has agreed to be a mentor.
- Chaired a Melbourne Design Week 2024 panel discussion, sponsored by the Heritage Council of Victoria and National Trust, on the topic of 'The Fine Art of Traditional Trades' of which associate 2019 ISSI fellow Glen Rundell presented on the sustainability of traditional trades.

The Fellow intends to:

- Prepare a submission (due June 2024) for the Parliament of Victoria on the Inquiry into Climate Resilience, with a focus on built heritage.
- Participate in a Passive House EnerPHit taskforce organised by the Passive House Institute of Australia.

Finally, since being awarded the Fellowship, the Fellow has consulted on dozens of heritage related projects; networked with a wide range of industry professionals including architects, engineers and planners; and participated in events where the Fellow always takes the opportunity to promote the ISSI and George Alexander Foundation, and the fellowship research and findings.

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<sup>15</sup> Martin, L., Redden, R. and Travers, I., 'HANDLING HISTORY: Opportunities and challenges for upgrading heritage homes', Sanctuary: Modern Green Homes (Issue 63) < <https://static1.squarespace.com/static/583b5a3c2e69cfc61c69d194/t/64709d5a45092b5179c05db4/1685101918947/S63-Handling+history-Upgrading+heritage+homes.pdf> > accessed 2024, 66-69.

The Fellow is committed to maintaining existing relationships with Local, State and Commonwealth departments and agencies by actively contributing to the work of the Heritage Council of Victoria and engaging with governments from all levels on the issue of heritage and sustainability. The Fellow will actively work with industry professionals and the Passive House Institute of Australia – of which she became a member during the Fellowship process – to ensure the findings of this report are disseminated and built upon.

# 08

## Conclusion

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Climate change is impacting historic buildings right now. Humans need to reduce CO2 emissions immediately and retrofitting existing buildings, many of which are heritage protected, is one of the most impactful ways to do this.

Passive House appears to be a promising sustainability framework that can help to decarbonise heritage buildings, without compromising best practice building conservation techniques. Careful attention would need to be placed on materials and detailing specified, but given the popular uptake of the standard in regions such as Europe and America, there are numerous examples of where the Passive House standard has been applied to existing buildings and where the buildings have continued to perform well. Due to the level of scrutiny required to achieve Passive House certification, heritage places are at a lower risk of maladaptation compared to a standard retrofit that seeks to meet base minimum standards.

Europe has introduced standards that regulate the decarbonisation of culturally significant places. As a result, a significant amount of funding has been invested into research and development for the sustainable management of heritage protected buildings. Europe and America are building a significant knowledge base around heritage and sustainability, and creating opportunities to maintain traditional skills and trades whilst ensuring heritage places remain contemporary.

Managers, conservationists and regulators of heritage places in Australia should review the findings, resources and recommendations of this report and work together to ensure Australia is well placed to manage heritage places in the face of climate change impacts, or face losing important cultural heritage fabric and associated knowledge.

# 09

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# 10

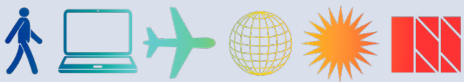
## Appendices

**Appendix 1:** Course Certificate – Passive House Design and Construction Online Course, Canadian Passive House Institute, 2022

**Appendix 2:** Course Certificate – Passive House Retrofits: Part 1, The Passive House Network, 2022

**Appendix 3:** Redden, R. And Byrne, E., 'Passive House adaptation of a contributory place in HO' [power point slides] Heritage Council Local Government Heritage Forum 2023. Melbourne





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