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Ensuring quality control and safety in insulation installation

A research report to support an industry-led roadmap for healthy, comfortable buildings

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The membership of the Steering Committee included:

- Insulation Australasia
- Insulation Council of Australia and New Zealand
- New South Wales Department of Planning, Industry and Environment
- Victorian Department of Environment, Land, Water and Planning

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The Project Team considered the views of a large number of individuals and organisations in the development of this report. While we carefully considered statements and submissions received during consultation, and many stakeholders made supportive statements during the process, we do not assume that any of the individuals or organisations that we consulted either partly or fully supports the recommendations set out in this report.

While much of the invaluable input that we received was from individuals, in order to preserve their privacy, we have only listed the organisations that these individuals worked for. Accordingly, we reiterate that while we engaged with individuals from the following organisations, we do not assume that these organisations support the findings of this report:

- Acustrcut Builders
- All Weather Insulation
- Australian Building Codes Board (ABCB)
- Australian Institute of Architects
- Australian Institute of Building Surveyors (AIBS)
- Building Designers Association of Australia (BDAA)
- Buildspect
- Community Housing Industry Association
- Commonwealth Dept of Industry, Science, Energy and Resources
- CSR Bradford Insulation
- Design Matters
- Development Victoria
- Energy Makeovers
- Fletcher Insulation
- German-Australian Chamber of Commerce
- German Industry Initiative for Energy Efficiency (DENEFF)
- Insulfix
- Kingspan Insulation
- Leneeva Homes
- Mazzei Homes
- National Insulation Association Ireland
- National Insulation Association UK
- Nationwide House Energy Rating Scheme (NatHERS)
- New Zealand Energy Efficiency and Conservation Authority
- Positive Footprints

- Premium Showers and Robes
- Pro Clima
- Queensland Government
- South Australian Government
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- TS Constructions
- Thrive Research Hub, University of Melbourne
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- Victorian Building Authority
- Vinyl Council of Australia
- Western Australia Government
- WorkSafe Victoria

About the Energy Efficiency Council

The Energy Efficiency Council is Australia's industry association for energy management, energy efficiency and demand response. The Energy Efficiency Council is a not-for-profit membership association for businesses, universities, governments and NGOs.

Founded in 2009, the Energy Efficiency Council's members are diverse, but are united by a common cause: building a sophisticated market for energy management products and services that delivers:

- Healthy, comfortable buildings;
- Productive, competitive businesses; and
- An affordable, reliable and sustainable energy system for Australia.

Learn more at **eec.org.au**

About the Australian Sustainable Built Environment Council

The Australian Sustainable Built Environment Council (ASBEC) is the peak body of key organisations committed to a sustainable built environment in Australia. ASBEC members consist of industry and professional associations, non-government organisations and government and academic observers who are involved in the planning, design, delivery and operation of Australia's built environment.

ASBEC provides a collaborative forum for organisations who champion a vision of sustainable, productive and resilient buildings, communities and cities in Australia.

Contents

1 Executive summary

The Government of New South Wales, Government of Victoria, Insulation Australasia (IA) and the Insulation Council of Australia and New Zealand (ICANZ) have engaged a Project Team to support the development of an industry-led roadmap to ensure that insulation is installed in Australia in a manner that is safe and delivers quality outcomes. The Project Team consists of the Energy Efficiency Council (EEC) and the Australian Sustainable Built Environment Council (ASBEC).

The aim of the industry-led insulation roadmap is to facilitate actions from industry, government and the community that will ensure that insulation is installed following appropriate quality-control and safety processes. An industry-led approach will ensure that the roadmap is supported by the best available information and will ensure that each party (industry, government and community) plays the role that they are best suited to undertake.

This Final Report sets out the findings and recommendations of the Project Team to ensure that insulation is installed following appropriate quality-control and safety processes. These recommendations take into account considerable input from experts in a broad range of fields, including policy makers, insulation manufacturers, insulation installers, the construction industry and experts in building design and sustainability. The Project Team is solely responsible for the content of this paper, and the recommendations in this report do not necessarily represent the views of the project funders.

The Final Report will be used to inform the development of a short *'Industry-led Insulation Roadmap'* which will be signed off by a number of key industry organisations, and include a number of commitments and recommendations.

1.1 Summary of findings

A wide range of products are used to insulate buildings, including batts, panels, loose-fill, sprays, structural insulated panels and reflective building membranes. Ensuring that new and existing buildings have adequately specified and installed insulation can deliver major benefits to the Australian community, including:

- Improved comfort, health and wellbeing for building occupants;
- Reduced energy bills;
- Reduced greenhouse gas emissions; and
- Improved productivity, job creation and economic growth.

Installing insulation has lower risks compared to many other construction activities, but appropriate measures must be taken to manage risks that include:

- Working in an enclosed space;
- Working at heights;
- Contact with hazardous materials; and
- Electrical safety, particularly when retrofitting insulation in roof cavities.

Australian jurisdictions have quite significant regulations and processes in place to manage health and safety on construction sites, which affects insulation installation in new builds and renovations. However, there are fewer processes in place in relation to insulation retrofits.

Enhancing quality control processes for insulation installation could deliver significant benefits for both new builds, renovations and retrofits. Insulation products need to be correctly installed to maximise their benefits and reduce risks for building occupants, including:

- Minimising unnecessary gaps in the coverage of insulation;
- Leaving space around heat-generating equipment (e.g. heating fans and downlights); and
- Basic moisture management, such as ensuring that ceiling insulation batts don't touch the underside of the roof or sarking.

To identify options to improve the safety and quality of insulation installation, the Project Team examined international case studies, specifically Germany, Ireland, the United Kingdom, the United States and New Zealand (Section 7). A number of themes emerged from these case studies, including:

- All countries set clear requirements for insulation in their building code;
- Several governments have fostered quality control in insulation installation by making access to incentives contingent on quality control processes;
- Several countries required either companies or appropriately accredited people to sign-off and confirm that insulation installations met the relevant standards; and
- Countries were increasingly looking beyond simply ensuring quality control processes in insulation installation and encouraging the development of a workforce that can deliver integrated energy efficiency retrofits.

Based on these findings and extensive interviews with stakeholders, we have drafted a number of recommendations to improve the safety and quality of insulation installation. These are summarised in Section 2 and explained fully in Section 8.

The potential solutions firmly focus on ensuring safety and quality control in the installation of insulation. However, we were cognisant of broader issues when we developed these potential solutions, and recommend that further work be undertaken to improve integrated building design and construction and retrofit. While ensuring that insulation is safely and correctly installed will deliver multiple benefits, the full benefits of insulation can only be delivered through integrated design that considers the whole thermal envelope (including glazing and minimising thermal bridging), air tightness and systems for heating, cooling and ventilation.

1.2 Next steps

This Final Report will inform the development of a short *Industry-led roadmap for ensuring quality control and safety in insulation installation*. This Roadmap will be developed and signed off in the second half of the 2021 financial year (FY2021)

If you are interested in being a signatory to the Roadmap please email: rob.murray-leach@eec.org.au

2 Summary of recommendations

The Project Team has developed number of recommendations that would improve the safety and quality of insulation installations. This section summarises the recommendations in order to provide context and help readers navigate this document. We strongly recommend that people also read Section 8 of this report, which sets out the recommendations in more detail.

2.1 Context for recommendations

Before setting out a summary of the Project Team's recommendations, it is necessary to set out the Project Team's views on a number of matters.

First, these recommendations are solely the view of the Project Team, and do not currently represent of the views of either industry or governments, including the Project Funders. However, the Project Team hopes that these recommendations will help to inform the thinking of various organisations, and will support the development of an *'Industry-led roadmap for ensuring quality control and safety in insulation installation'*, which is intended for release in the second half of FY2021.

Second, the Project Team was commissioned to solely focus on recommendations relating to the installation of insulation in new and existing buildings. By focusing on this manageable task, the Project Team was able to develop clear advice that could be rapidly implemented. However, the Project Team recognises that maximising the benefits of insulation and delivering efficient, thermally comfortable and healthy buildings requires building construction and retrofit processes that incorporate both design and installation and also the integration of insulation, air tightness, ventilation and heating and cooling.

Therefore, the Project Team considered these broader issues in developing its advice on insulation installation and we recommend that various parties collaborate on a subsequent report to look at integrated building design, construction, renovation and retrofit.

Third, the Project Team has developed a set of recommendations that are designed to work together – in other words the recommendations are complements rather than alternatives. Multiple policies were determined to be essential. For example, even if industry and governments develop world-class training programs for insulation installation, insulation will not be delivered with quality if there are insufficient drivers for installers to undergo training, or strong incentives for installers to cut corners. These recommendations are set out in four broad streams:

- Training and accreditation;
- Retrofits (no building permit required);
- New buildings and major renovations (building permit required); and
- Moving beyond an insulation-only approach.

Fourth, the Project Team recommends that the industry roadmap develop a clear timeframe for delivering the various recommendations in this report. Some actions, such as finalising training programs can, and should, be implemented within two years. Other actions will either take longer to implement or need to be built on previous actions. For example, industry and governments will need to finalise the design of accreditation programs before governments could consider making accreditation mandatory.

2.2 Recommendations on training and accreditation

Recommendation 1:
Review and refine entry-level training and accreditation for installers

Insulation installers should undergo basic training relating to the safe and effective installation of insulation before they undertake any installation work. Industry should review and potentially refine existing formal training units and accreditation systems over the next 12 to 24 months to ensure that they provide a solid foundation for someone starting out in insulation installation. Governments should be involved in this review as these qualifications will need to address the quality and safety concerns of governments as consumers of insulation installation services (e.g. installation of insulation in public housing retrofits).

Recommendation 2:
Develop additional training units for installing particular types of insulation

Industry and governments should collaborate to develop additional formal or informal training units that could be completed by installers once they have completed the basic insulation installation training. These units would cover specific types or aspects of insulation, such as pumped insulation and structural insulated panels.

Recommendation 3:
Develop a competency-based 'Insulation Professional' certification

Industry and governments should collaborate on a competency-based certification for people who oversee the installation of insulation. This certification could potentially be based on an on-line test and/or practical demonstration of existing knowledge, rather than requiring experienced installers to undertake training.

Recommendation 4:
Integrate basic information on insulation in the training and Continued Professional Development (CPD) of selected trades

A number of trades and professions interact with insulation before and after it is installed. Basic information on insulation should be integrated into the training and CPD of these trades.

2.3 Installation of insulation in building retrofits

Recommendation 5:
Develop national guidelines and documents for insulation retrofits

In order to reduce costs and support national harmonisation, governments and industry should work together to develop a national set of simple model guidelines and documents to support insulation installation. These guidelines and documents would be a voluntary resource for the private sector but would have a mandatory component for the retrofits that are supported by governments (see Recommendation 7).

Recommendation 6:
Industry to maintain a list of products that have been verified to meet the current version of *AS/NZS 4859.1 Materials for the thermal insulation of buildings*

Industry, with the support of government, should develop and maintain a list of products that have been verified to meet AS/NSZ 4859.1. This list would be a voluntary resource for the private sector but would be mandatory for the public sector (see Recommendation 7).

Recommendation 7:
Public programs to require the use of quality installers, processes and products

Governments should commit that, where they commission or support retrofitting of insulation (e.g. retrofitting insulation into public housing or providing support through grant programs), they will require:

- All insulation installers to have undergone basic installer training and hold the relevant qualification or accreditation proposed under *Recommendation 1*.
- All insulation upgrades to be overseen and signed off by a certified Insulation Professional, in line with *Recommendation 3*;
- The use of best-practice processes set out in *Recommendation 5*;
- All products should be verified to meet the current version of AS/NZS 4859.1, as per *Recommendation 6*.

Noting that these systems will take some time to put in place, in the meantime governments should work with industry to use existing or easily-developed resources to deliver good practice in insulation installation. For example, in advance of the review of current installer training programs, governments could require that insulation installers that work on public housing upgrades have secured insulation installer accreditation from the Clean Energy Council.

Recommendation 8:
Public programs to require the use of companies that are pre-approved to install insulation

While skills are held by individuals, processes are typically committed to and implemented by companies. Where government programs support the installation of insulation, they should only use insulation installation companies that have been pre-approved as meeting a number of criteria, including using best-practice processes set out in *Recommendation 5*.

Recommendation 9:
Commission independent audits of insulation installations completed under government programs

Where government programs support the installation of insulation, they should undertake or contract independent providers to conduct spot-audits on a sample of installations (e.g. 5 per cent). These spot audits should involve thermal imaging and physical inspection.

Recommendation 10:
Governments consider issues associated with 'do-it-yourself' (DIY) insulation once appropriate systems are in place for professional installers

It will be difficult to consider and resolve any issues associated with DIY insulation until systems for the installation industry are in place. Once appropriate systems are in place for ensuring quality and safety with commercial insulation installation, governments should consider issues associated with DIY insulation.

2.4 Installation of insulation in new buildings and major renovations

Recommendation 11:
Improve general compliance and enforcement systems for the building and construction industry across Australia

The Shergold-Weir *Building Confidence* Report identified significant shortcoming in the overall compliance and enforcement systems for the building and construction industry across Australia. The *Building Confidence* recommendations should be implemented in a nationally harmonised form, led by Australia's Building Ministers.

Recommendation 12:
Improve internal quality assurance by requiring a certified Insulation Professional to sight visual evidence in order to sign a building's 'Certificate of Insulation'

Governments should make 'Certificates of Insulation' a mandatory piece of evidence for building surveyors to consider in their assessments, and governments should require that these certificates are signed off by a certified Insulation Professional (the new qualification set out in *Recommendation 3*), and that Insulation Professionals should certify that they have examined the installation either in person or via digital images.

Recommendation 13:
Improve independent assessment of insulation installation

As a complement to internal quality assurance, governments should consider a range of measures to improve the independent assessment of insulation installation, including:

- Requiring builders to provide time- and location-stamped photos of insulation installations to the building assessor;
- Conducting a cost-benefit study on whether building surveyors should be required to use thermal imaging equipment to determine whether insulation has been installed correctly; and
- Conducting a cost-benefit study on whether building surveyors should carry out remote or in-person inspections of a building at an earlier stage of its construction (e.g. prior to plasterboard being installed) in order to help them assess whether insulation has been installed correctly.

Recommendation 14:
Provide additional training to building surveyors on determining the quality of insulation installation

The insulation industry, in partnership with building surveyors organisations and governments, should provide additional training to building surveyors to help them determine the quality of insulation installations.

Recommendation 15:
Drive the uptake of basic insulation installer training

The insulation industry, in partnership with governments, should drive the uptake of basic insulation installer training in the construction industry (in line with *Recommendation 1*). As a no-regrets measure, insulation manufacturers, distributors and installers should work with builder associations (HIA, MBA) and major builders to voluntarily commit that all insulation installations will be conducted by people that have minimum insulation installer training. In addition to this voluntary measure, governments should conduct a cost-benefit study on requiring anyone installing insulation on a building site to have insulation installer training.

2.5 Moving beyond an insulation-only approach

Recommendation 16:
Undertake further analysis on options for integrated building envelopes

Maximising the benefits of insulation in both new builds and retrofits will need insulation to be integrated with other elements of a building's thermal envelope, air tightness and ventilation systems. Governments should work with industry to:

- Draft a report on options to foster a market for more integrated buildings and develop an industry that is capable of delivering building retrofits at scale; and
- Communicate the need for, and benefits of, integrated building upgrades.

3 The function and benefits of insulation

The comfort and functionality of a building involves a number of factors, including:

- Temperature;
- Air movement and quality (e.g. carbon dioxide levels); and
- Relative humidity levels.

Insulating materials play a key function in maintaining a safe and comfortable indoor temperature, but can also influence air movement, air quality, moisture and the presence and absence of mould. Insulation should remain in place for the entire lifespan of a building, therefore proper installation is critical.

3.1 Thermal properties of insulation

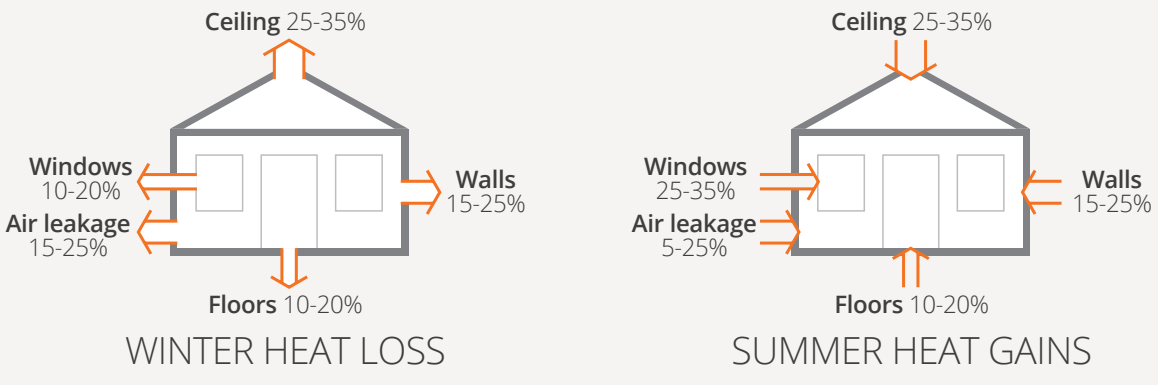
In terms of temperature, typical representations of uninsulated homes suggest that around 30 per cent of heat is lost or gained through ceilings, 20 per cent through walls, 20 per cent through floors and about 20 per cent through air leakage (Figure 1). However, precise figures will vary, and in particular heat loss and gain through air leakage can be much higher than 20 per cent.

Insulating materials work by reducing the flow of heat through a material. This is typically referred to as either:

- R-value – a measure of how much an insulation structure will resist the flow of thermal energy over a two-dimensional surface. Insulation products are typically rated based on their R-Value.
- U-value – a measure of how much an insulation structure will conduct heat, the inverse of R-value.

Most insulating materials function by trapping small pockets of air in relatively non-conductive material. A variety of materials are used for insulating buildings in Australia, which are set out in Table 1.

Figure 1 Typical heat losses and gains from an uninsulated house



Source: Sustainability Victoria 2016 *Cavity Wall Insulation Retrofit Trial*, Sustainability Victoria, Melbourne.

Table 1. Common insulating materials in Australia

	Type of insulation	Description	Function
Fibrous Insulation	Glasswool – Batts and blankets	Fibres of glass are formed into batts. Non-combustible.	Ceiling Underfloor Wall – new or reno
	Glasswool – Granulated	Fibreglass is granulated into a loose fill that can be blown or pumped into a space.	Wall – retrofit Ceiling
	Mineralwool – Batt	Fibres of minerals formed into batts.	Ceiling Underfloor Wall – new or reno
	Polyester – Batt	Polyethylene terephthalate (PET) fibres are spun and formed into batts.	Underfloor Ceiling Wall – new or reno
	Cellulose – blown	A type of blown insulation made from recycled paper and treated with fire retardants and pest-resistant materials.	Ceiling Wall – retrofit
Thermoplastic Foam Insulation	Expanded Polystyrene (EPS) panel (open cell)	Polystyrene is expanded and then cut into rigid boards. EPS is often coated with foil to increase its R-value.	Ceiling Underfloor Wall – new or reno
	EPS beads	Small EPS balls are coated with a binding agent and pumped into a wall, forming a semi rigid space. No longer in use due to low melting point.	Wall – retrofit Ceiling
	Extruded Polystyrene (XPS) panel (closed cell)	Polystyrene is extruded and then cut into a rigid board.	
Thermoset Foam Insulation	PIR board	A rigid insulation board made of closed cell, rigid foam.	Wall Ceiling Underfloor
	Phenolic board stock	Rigid insulation boards made of closed cell phenolic resin with a surface acting agent. Provides protection against moisture.	Wall – new or reno Ceiling – new or reno Underfloor – new or reno
Spray Foam Insulation	Open cell polyurethane foam	Cells are filled with air, creating a lower-density foam.	Wall – retrofit Underfloor Draught sealing
	Closed cell polyurethane foam	High-density cells are formed around a gas, creating a dense foam.	Wall – retrofit Underfloor Draught sealing
	Urea Formaldehyde	A resin and hardener are pumped into a space (e.g. wall cavity) and expand to form a rigid foam. Has been phased out for use in buildings.	Wall – retrofit Underfloor Draught sealing

	Type of insulation	Description	Function
Composite Panel Insulation	Structural Insulated Panels (SIPs)	Prefabricated insulated panels made from foam insulation sandwiched between structural board which comprise a structural element to the home.	Wall – new or reno Ceiling– new or reno Underfloor– new or reno
	External Insulated Façade Systems (EIFS)	Prefabricated insulated panels with external coating or barrier. Acts as both air sealing and insulation.	Wall – new or reno Roof
Reflective Building Membranes	Reflective Foil Laminates (RFL)	Foil insulation is typically a highly reflective material (e.g. aluminium) combined with other materials. It works by reflecting radiant heat.	The use of RFL is changing significantly, but can be used under roofs, in walls or underfloor.

Common insulation forms

In addition to being categorised by its materials, insulation can be categorised by its form.

Blankets and batts

Insulation batts are pre-cut to a specific size to suit wall, floor or ceiling stud/joist spacing for ease of installation. Blanket insulation includes fiberglass and mineralwool rolls that are laid out over a space, such as roof cavities, and underfloor spaces. Blanket and batt insulation need to be laid in contact with the surface that is being insulated.

Foam board

Foam board can be used in any application in a home (walls, underneath roofs, floors and underneath foundations), although it is typically not used for ceiling insulation or retrofitting enclosed spaces (e.g. wall cavities). When installed continuously with gaps sealed with spray foam, foam boards can also provide draught sealing.

Loose-fill

Loose-fill insulation includes cellulose, fiberglass and rockwool that has been granulated and can be blown into place. This type of insulation can be blown into an open space much like blanket insulation, but it is also suitable for filling enclosed spaces, including existing (uninsulated) wall cavities, sealed attic spaces and other hard-to-reach places.

Spray foam

Spray foam acts as both an insulation and an air and moisture barrier, and is sometimes used simply for draught sealing. Foams can be sprayed in place, injected, or poured, which makes it suitable for new and already enclosed walls cavities and underfloor installations.

Structural Insulated Panels (SIPs)

SIPs are composite panels that provide both insulation and structural components in homes, and can be used in cavities, ceilings and floors.

Reflective building membranes

Reflective building membranes can be either used on their own (e.g. in sarking) or integrated into products such as foam boards. Unintegrated foil products have electrical safety risks and are very rarely used in building retrofits.

3.2 The thermal interaction of insulation with other building elements

Insulating materials are a critical component of a system to keep a building comfortable. However, insulating materials are only one part of a structure (e.g. a wall), and the overall thermal property of a structure is affected by multiple factors. For example:

Gaps in insulation materials

In most buildings insulation doesn't form a continuous surface, and is interrupted by materials such as wooden joists. Wooden joists are not very thermally conductive in themselves, however if there are significant gaps in insulation (e.g. insulation hasn't been installed up to the edges of joists) it can significantly reduce the overall R-value of a structure.

Thermal bridging

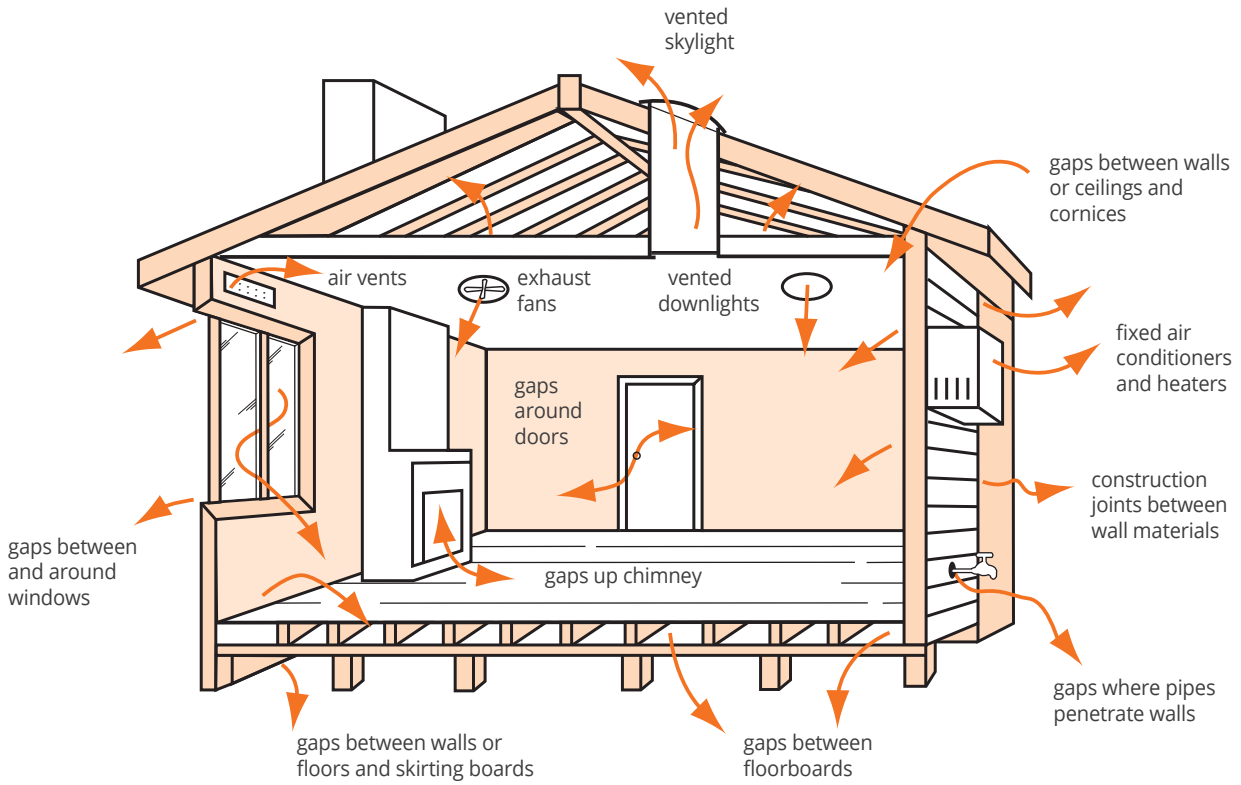
As noted above, in most buildings insulation doesn't form a continuous surface, and is often broken by materials such as wooden studs. Some level of thermal bridging is normal, and while wood results in thermal bridging that reduces the overall R value of a structure, it is a relatively poor conductor of heat. However, if an insulated surface is pierced by very thermally conductive materials, such as steel, it can dramatically reduce the R-value of the surface.

Air leaks

Even if a room is surrounded by a good insulating layer on all surfaces, if air can easily move in or out of the space it undermines the impact of insulation. Sources of air leakage can also enable vapour and moisture to enter a home which can then cause issues such as mould and mildew. Common sources of air leakage in a home are shown in figure 2.

In effect, a whole building is a thermal structure that includes ceilings, walls, floors, windows, doors and ventilation systems. The performance of a building depends on every element in the system – even if a ceiling is well insulated, a building can be very cold in winter and hot in summer if its walls and floors are uninsulated, it has single-glazed windows, and/or has a high rate of air leakage. Building renovations and retrofits are therefore viewed as a holistic system in terms of a 'building envelope', which can be defined as the barrier where the thermal and air barriers of a building meet.

Figure 2 Common sources of air leakage in a home



Source: YourHome: *Sealing your home*. https://www.yourhome.gov.au/passive-design/sealing-your-home

3.3 Air tightness, ventilation and moisture control

As noted above, the impact of insulation can be undermined by unintended air leaks. However, excessive air tightness can result in poor air quality, including high levels of carbon dioxide. Modern building practices combine minimising unintended air leaks with designing effective ventilation systems, such as mechanical fans in bathrooms, to ensure an appropriate level of airflow through a building. This approach can be strengthened by using heat-recovery ventilation systems that extract heat from outgoing air and use it to heat incoming air, or extract heat from incoming air to reduce the indoor temperature. This approach is often referred to as:

Seal it tight, ventilate right

Ventilation strategies also have a critical impact on moisture control. Moisture build-up on surfaces in buildings (e.g. on drywall) can lead to mould problems which both damage the building and have health impacts. However, moisture build up on surfaces is also affected by the thermal envelope of a building. Warm air can carry quite high levels of moisture. When warm moist air comes into contact with colder surfaces, it results in condensation.

Correctly designed and installed insulation measures can help to reduce condensation. For example, in cold climates installing insulation in walls can help reduce the build-up of moisture on drywall. However, installing insulation materials without addressing other elements of a building's design can also exacerbate condensation issues. For example, installing thick ceiling insulation can lower the temperature of a roof, increasing condensation in the roof cavity if it is tightly sealed. This can, in turn, cause insulation to become wet, rendering it less effective.[1] In this instance, installing insulation in a ceiling should be combined with strategies to ensure that moisture can exit the roof space.

This means that good integrated design and construction are important to maximise the benefits of insulation, for both thermal performance, air quality and building longevity, whether this is part of a new build, major renovation or retrofit.

3.4 The benefits of insulation

Insulation is an essential component of a healthy, comfortable building. In both commercial and residential buildings, ensuring an adequate level of insulation can result in lower heating and cooling bills, reduced prevalence of illness and death, and increased thermal comfort. The benefits of insulation extend far beyond the individual household, providing benefits for regional electricity grids, local pollution and greenhouse gas emissions.

Studies indicate that insulation levels in both new and existing buildings in Australia are significantly below the ideal cost-benefit level. An ABS survey from 2011 suggested that 14 per cent of homes had no ceiling insulation and the presence of insulation was unknown in a further 17 per cent of households.[2] The proportion of homes lacking insulation in their walls and underfloor is likely significantly higher.

Given that almost all buildings constructed after 2011 include insulation, the proportion of partially- or fully-uninsulated houses is likely to have declined but still remain significant.

Health and Social benefits

Hayes et al conclude that *"housing, health, and energy efficiency are closely intertwined"*, and that improving household energy efficiency can deliver significant improvements in occupant health outcomes, with particularly significant benefits in reducing asthma, respiratory illness, and cardiovascular disease.[3]

It is estimated that around 3,000 Australians die during periods of hot and cold weather each year, and Melbourne, Sydney and Brisbane have cold-associated mortality rates that are far higher than Stockholm in Sweden.[4] As Australians spend much of their lives indoors, the poor thermal quality of our homes is considered a critical factor in Australia's high temperature-related mortality rates.[5] In one health district in Melbourne, 78 per cent of elderly patients presenting with hypothermia had developed it indoors.[6]

Improving the insulation of our buildings wouldn't just reduce cold-associated morbidity and mortality – Morshed et al estimate that bringing the entire building stock of Melbourne up to a minimum of 5.4-star NatHERS rating would reduce deaths in heatwaves by 90 per cent.[7] With climate projections suggesting increased periods of hot weather, ensuring that buildings can maintain safe and comfortable temperatures during heatwaves will be critical.

1 Building Standards and Occupational Licencing. (n.d.) *Condensation in buildings: Tasmanian designer's guide*. Tasmanian Department of Justice.

2 ABS. (2011). Dwelling characteristics and insulation. https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/4602.0.55.001Main+Features3Mar+2011

3 Hayes, S., Kubes, C., & Gerbode, C. (2020). *Making health count: Monetizing the health benefits of in-home services delivered by energy efficiency programs*. American Council for an Energy Efficient Economy: Washington, DC. Page iv.

4 Gasparrini, A., Guo, Y., & Hashizume, M. (2015). Mortality risk attributable to high and low ambient temperature: a multicountry observational study. *The Lancet*, 386(1), 369–375. https://doi.org/10.1016/S0140-6736(14)62114-0

5 Australian Department of Agriculture, Water and the Environment. (n.d.). *Indoor air*. https://www.environment.gov.au/protection/air-quality/indoor-air

6 Forcey, D., Fitzgerald, M., Burggraf, M., Nagalingam, V. and Ananda-Rajah, M.2020 " 'Cold and lonely': emergency presentations of patients with hypothermia to a large Australian health network", *Internal Medicine Journal*, 50, pp54-60

7 Morshed, A. Sanjayan, J., Zou, P. Srewart, M. and Wilson, J. 2016 "Modelling the correlation between building energy ratings and heat-related mortality and morbidity," *Sustainable Cities and Society*, 22, pp29-39

A 2011 review of the Warm Up New Zealand: HeatSmart program found the largest benefits to participants to be derived from insulation activities. These benefits were realised largely in health terms,[8] including:

- Hospitalisation and pharmaceutical cost savings;
- Reduced medical visits;
- Reduced days off school or work; and
- Associated reductions in caregiver costs.

Annual health-related savings from insulation improvements through the HeatSmart program were found to be valued at NZ$636 per participant, and NZ$854 for low-income participants. Total health benefits over the lifetime of insulation improvements (30 years) were valued at NZ$1.27 billion.

Australia's healthcare system setup as a single-payer system means that a large proportion of health savings from insulation retrofits would be realised by governments. This is especially relevant for insulation interventions in low-income homes due to their reliance on the public health system.

In addition to health benefits, insulation upgrades also deliver emotional and social benefits. Studies of insulation retrofits in social housing in the UK found that tenants reported improved thermal comfort, health and wellbeing, including improved mental health, social interaction, family relations and nutrition.[9,10] Studies in New Zealand have found that insulation retrofits delivered significant improvements in self-reported heath measures, reduced general practitioner visits, hospitalisations and days missed from work or school.[11,12]

Environmental benefits

Improving the levels of insulation in new and existing building in Australia would deliver significant greenhouse gas emissions reductions through the reduction in energy use and fossil-fuel extraction and combustion, with one study estimating that insulation could reduce Australia's emissions by 7.1 million tonnes of CO_2e.[13,14] The impact of insulation on reduced energy demand can also impact on local air pollution. Reductions in the extraction and combustion of coal and gas reduce particulate matter, sulphur dioxide, nitrogen oxides and mercury pollution as well as greenhouse gas emissions associated with coal mining and fossil fuel-generated electricity.[15]

8 Grimes, A., Denne, T., Howden-Chapman, P., Arnold, R., Telfar-Bernard, L., Preval, N., & Young, C. (2011). *Cost benefit analysis of the Warm Up New Zealand: Heat Smart Programme.*

9 Lilley, S., Davidson, G., & Alwan, Z. (2017). ExternalWall Insulation (EWI): Engaging social tenants in energy efficiency retrofitting in the North East of England. *Buildings*, 7(4). https://doi.org/10.3390/buildings7040102

10 Gilbertson, J., Stevens, M., Stiell, B., & Thorogood, N. (2006). Home is where the hearth is: Grant recipients' views of England's Home Energy Efficiency Scheme (Warm Front). *Social Science and Medicine*, 63(4), 946–956. https://doi.org/10.1016/j.socscimed.2006.02.021. Page 946.

11 Chapman, R., Howden-Chapman, P., Viggers, H., O'Dea, D., & Kennedy, M. (2009). Retrofitting houses with insulation: A cost-benefit analysis of a randomised community trial. *Journal of Epidemiology and Community Health*, 63(4), 271–277. https://doi.org/10.1136/jech.2007.070037.

12 Howden-Chapman, P., Matheson, A., Crane, J., Viggers, H., Cunningham, M., Blakely, T., Cunningham, C., Woodward, A., Saville-Smith, K., O'Dea, D., Kennedy, M., Baker, M., Waipara, N., Chapman, R., & Davie, G. (2007). Effect of insulating existing houses on health inequality: Cluster randomised study in the community. *British Medical Journal*, 334(7591), 460–464. https://doi.org/10.1136/bmj.39070.573032.80. Page 460.

13 ASBEC & ClimateWorks Australia. (2018). The bottom line: The household impacts of delaying improved energy requirements in the Building Code. In *Building Code Energy Performance Trajectory Project*.

14 Energy Efficient Strategies (2012). *The value of insulation based residential energy savings measures in Australia*. http://icanz.org.au/wp-content/uploads/2013/04/The-Value-of-Insulation-Based-Residential-Energy-Savings-Measures.pdf

15 Nishioka, Y., Levy, J. I., Norris, G. A., Wilson, A., Hofstetter, P., & Spengler, J. D. (2002). Integrating risk assessment and life cycle assessment: A case study of insulation. *Risk Analysis*, 22(5), 1003–1017. https://doi.org/10.1111/1539-6924.00266

Economic benefits

The total economic benefit of insulation is a combination of their health, social and productivity benefits.

The most obvious economic and social benefit of insulation in buildings is reduced energy bills. A study of insulation retrofits in New Zealand found that homes with upgraded insulation had energy bills that were 13.2 per cent lower than the control group.[16]

However, multiple studies suggest that the health and social benefits of insulation are far larger than the bill-savings. Returning to the insulation retrofit study from New Zealand, the authors estimated that total discounted benefits of insulation retrofits due to reduced general practitioner visits, hospitalisations and days missed from work or school resulted in financial savings in the order of "one and a half to two times the magnitude of the cost".[17]

A second study from New Zealand suggested that each dollar that had been spent on their insulation retrofit program delivered a benefit-cost ratio of 3.6 to 1 for retrofits to the homes of the general population, and a ratio of 7 to 1 for retrofits to the homes of low-income households.[18,19]

Extending beyond the household, insulation also delivers benefit to electricity networks by reducing peak demand and therefore reducing the need for expenditure on networks.[20,21]

Finally, insulation installation is jobs-rich. The International Energy Agency estimates that energy efficiency upgrades to buildings deliver approximately 6.5 to 15 jobs per million USD of expenditure, making public investment in energy efficiency retrofits well suited to stimulus programs.[22]

16 Chapman, R., Howden-Chapman, P., Viggers, H., O'Dea, D., & Kennedy, M. (2009). Retrofitting houses with insulation: A cost-benefit analysis of a randomised community trial. *Journal of Epidemiology and Community Health*, 63(4), 271–277. https://doi.org/10.1136/jech.2007.070037. P271.

17 Chapman *et al*. (2009). Retrofitting houses with insulation: A cost-benefit analysis of a randomised community trial.

18 Preval, N., Keall, M., Telfar-barnard, L., Grimes, A., & Howden-chapman, P. (2017). Impact of improved insulation and heating on mortality risk of older cohort members with prior cardiovascular or respiratory hospitalisations. *British Medical Journal*, 7(1), 1–8. https://doi.org/10.1136/bmjopen-2017-018079

19 Grimes, A., Denne, T., Howden-chapman, P., Arnold, R., Telfar-barnard, L., Preval, N., & Young, C. (2012). *Cost Benefit Analysis of the Warm Up New Zealand : Heat Smart Programme Ministry of Economic Development. June*.

20 ASBEC, & ClimateWorks Australia. (2018). The bottom line: The household impacts of delaying improved energy requirements in the Building Code. In *Building Code Energy Performance Trajectory Project*.

21 Energy Efficient Strategies. (2012). *The value of insulation based residential energy savings measures in Austral*. http://icanz.org.au/wp-content/uploads/2013/04/The-Value-of-Insulation-Based-Residential-Energy-Savings-Measures.pdf

22 International Energy Agency 2020 *Sustainable Recovery*, IEA Paris.

4 The insulation process and industry

The supply chain for insulation involves the following steps:

- Manufacturing insulation products;
- Distribution and sales of the insulation product via the manufacturer, specialist distributor and/or retailer; and
- Installation of product into a building via one of four broad routes:
  - Construction of new buildings;
  - Renovation of an existing building (requires building permit);
  - Retrofit of an existing building (no permit required); and
  - Do-it-yourself (DIY) installation. While many households undertake DIY installation, this issue is not covered in this report.

4.1 Construction of new buildings

New buildings are designed and constructed via a relatively regulated process. This process is described in more detail in Section 5, but involves:

- A building is designed by an architect, building designer or experienced builder. While many buildings use model plans rather than bespoke design, these model plans were originally designed by one or more experts. These plans either use design features to achieve energy efficiency outcomes, or their energy performance is modelled using software;
- A building surveyor or other party reviews the plans and either approves them or seeks amendments to ensure that they line up with the requirements of the National Construction Code (NCC);
- A builder or site supervisor oversees the construction of the building and coordinates the multiple trades involved in its construction, including licensed carpenters, licensed roof plumbers, licensed plumbers and general labourers; and
- A building surveyor or similar verifies that the building has been constructed to code. In some jurisdictions regulators also undertake spot-checks.

Insulation is generally installed in new buildings by one of two broad groups:

- **Insulation specialists**
  There are a number of companies that specialise in insulation installation – these companies are hired by builders to install insulation on the developments. Some insulation specialists are independent of any other company, and some are associated with large insulation manufacturing companies or insulation distributors; and
- **Workers that don't specialise in insulation**
  On the remainder of construction sites, especially those run by smaller construction firms, insulation is installed by a person who is undertaking multiple tasks, such as both plastering and insulation. Interviewees suggested that these non-specialist installers of insulation come from a variety of trades, including plasterers, carpenters and general labourers. While some of these people are well-trained in insulation installation, this is not guaranteed due to their diversity of backgrounds.

ICANZ estimates that there are around 700-1,500 people working as insulation specialists in Australia, and potentially around 2,500 to 3,500 non-specialists that install insulation on a part-time basis.[23] The Australian Government estimates that there are around 4,200 workers employed as 'building insulation installers', noting that this occupation code (ANZSCO ID 821411) is wider than just insulation, and also includes window films.[24]

Interviewees suggested that insulation specialists likely installed insulation in over 50 per cent of new homes in Australia, particularly homes constructed by volume builders, with non-specialists likely to install insulation in significantly less than 50 per cent of homes. However, this proportion appears to vary by state.

Installing insulation in new buildings is typically more straightforward and has lower safety risks than installing insulation in a renovation or retrofit, as:

- The absence of plasterboard can make it relatively straightforward to install insulation in walls, ceilings and under floors;
- Ceiling insulation is often (but not always) installed from underneath and underfloor insulation is often (but not always) installed from above, reducing the risks associated with working at heights and working in an enclosed space; and
- Wiring in the building is typically not live when insulation is installed.

However, the situations can vary significantly between sites, and there are still complexities and safety issues associated with installing insulation on a construction site.

4.2 Major renovations

Major renovations that require a building permit are similar to the construction of new buildings, in that the process involves:

- Design of the renovation by a specialist that can consider the overall performance of a building;
- Review of the design by specialists;
- Construction by a multi-disciplinary team;
- Independent review of the completed renovation; and
- Obligation to meet energy efficiency requirements as per the National Construction Code, noting that the requirements for renovations and new builds are different.

However, there are a number of differences between new builds and renovations that are relevant for insulation. These include:

- A new building is a 'blank slate' and the construction firm can control a large number of features of the building. In contrast, in a renovation a number of existing features of the building may be difficult or expensive to change. For example, when an extension is added to a building it is relatively simple to ensure that any new walls are properly insulated, but it is more complicated to install insulation in existing walls. Elements that are difficult or expensive to retrofit include:
  - Installing insulation into walls;
  - Installing airtight and vapour permeable barriers; and
  - Optimising multiple features of a house to achieve good air-tightness and effective ventilation at modest cost;

23 Dennis D'Arcy. (2020). Personal communication.

24 Australian Government Job Outlook. (n.d.) *Building Insulation Installers*. https://joboutlook.gov.au/occupations/building-insulation-installers?occupationCode=821411

- From a safety perspective, renovating a building can involve more hazards such as wiring that is not compliant with the latest safety standards, or needing to access restricted spaces; and
- Renovations tend to be undertaken by smaller construction teams, including workers that don't specialise in insulation.

There are no estimates of the mix of insulation specialists and non-specialists in building renovations, although the bespoke nature of renovations means that non-specialists are more likely to be involved than in new buildings.

4.3 Retrofits

'Retrofits' of existing buildings are upgrades that don't require a building permit. Currently in Australia, upgrades of building's thermal shell, air tightness and ventilation systems tend to be undertaken as a series of separate actions that aren't coordinated by a building expert. Typically, a building's owner or manager will engage a number of separate companies to undertake projects which could include some or all of the following:

- Installing or topping up ceiling insulation, often but not always by a company that specialises in insulation;
- Installing underfloor insulation;
- Retrofitting wall insulation (which can involve pumping rockwool glasswool or polyurethane foam into a wall cavity, installing insulated panels or removing parts of the wall to install batts or panels);
- Retrofitting more efficient glazing;
- Draught-sealing (can be one or more projects); and
- Improving ventilation (can be one or more projects).

While single-technology retrofits can deliver significant benefits to homes, the lack of expert integration between various upgrades can significantly undermine their effectiveness, and cause significant problems which are discussed in Section 5.

Insulation retrofits generally consist of at least two visits to a building:

- An individual with more experience in insulation visits the property to assess the site and develop a quotation for the insulation upgrade. This individual sometimes assesses a range of features of the site, including safety issues; and
- If the quote is accepted, a team of installers visit the site with the specified insulation materials and conduct the installation.

Currently, insulation retrofits in Australia are rarely performed in an integrated manner with other parts of a building shell, such as air tightness, ventilation and heating and cooling systems.

4.4 Do-It-Yourself Installation

Although anecdotal evidence suggests that there is a significant number of Do-It-Yourself (DIY) insulation installations occurring in Australia, this is outside the scope of this report.

5 Key challenges for insulation

5.1 Risks for insulation performance and building occupants

To maximise the benefits of insulation, it needs to be part of an integrated design for a building, and it also needs to be installed correctly. Some of the risks associated with insulation performance and impacts on building occupants include:

Insufficient insulation

Building designers can specify insufficient insulation levels in building plans. Almost all homes in Australia that were built prior to the introduction of minimum insulation standards have insufficient insulation, which has a major impact on occupant health and wellbeing.

Gaps in insulation

Insulation needs to form as continuous a barrier as possible to be fully effective. Excessive gaps can emerge at three stages:

- **Design and overall construction** – designers and builders can create buildings with areas that are either uninsulated (e.g. skylights), or extremely difficult to insulate (e.g. the corners of some wall frames);
- **Incorrect installation** – installers can fail to correctly install insulation and leave unnecessary gaps (e.g. not putting insulation between joists in ceilings); and
- **Disturbing insulation** – trades such as electricians and plumbers often move insulation in order to undertake their work, and if it isn't put back correctly this can create gaps. They may also crawl on top of ceiling insulation while doing work in the roof space, which can disturb and compress insulation, rendering it less effective.

Thermal bridging

Thermal bridging is typically caused by poor decisions at the design phase of a building (e.g. using metal frames that touch both internal and external surfaces of external walls), although it can be introduced in the installation phase if installers use metal fastenings that fully penetrate the insulation material. In addition to undermining the thermal benefits of insulation, thermal bridging can cause significant moisture issues by introducing condensation on small parts of a surface (e.g. where metal studs meet plasterboard).

Condensation

As part of an appropriate sealing and ventilation strategy, insulation can help to reduce condensation and associated issues with mould and air quality. For example, retrofitting cavity wall insulation can significantly reduce the build-up of condensation on drywall.

However, in some situations the installation of insulation can exacerbate condensation and mould issues unless it is combined with ventilation strategies. For example, increasing the thickness of ceiling insulation can lower the temperature in a roof cavity, and in tightly sealed roof cavities this can increase the build-up of moisture.

Fire risks

Many insulation products are extremely resilient to heat (e.g. rockwool) or are safe if they are properly designed and integrated into a building's structure. However, some insulation products (e.g. polystyrene) are combustible if they are used in the wrong context. Proper selection of products and proper integration of products into building design can eliminate the risks associated with combustible insulation products.

However, even non-combustible insulation products can create fire risks if they trap heat from equipment such as luminaires and fans, which can then ignite materials such as joists in ceilings. This risk can be mitigated by leaving appropriate gaps between insulation and high temperature equipment, such as fans and downlights.

Electrical issues

Most insulation products are non-conductive and do not impact on the electrical safety of building occupants. However, issues can be created by two types of insulation product:

- EPS beads and adhesives can lead to the degradation of some forms of wiring if they are in contact; and
- Foils, sarking and staples are conductive and can create electrical hazards if they come into contact with exposed electrical wires.

Other issues outside the scope of this report

Interviewees identified a number of other risks that are associated with insulation, including the embodied carbon and energy costs of manufacturing and distributing insulation products and the safe disposal of insulation products at end of life. These issues fall outside the scope of this project.

5.2 Role of installers

Some of the issues identified in section 5.1 are largely caused by errors in building or retrofit design, and installers are rarely in a position to correct design errors. In particular:

- Insufficient insulation in a building is generally a problem in the design phase;
- Some gaps in insulation are caused at the design phase;
- Thermal bridging is largely caused by poor decisions in design; and
- Condensation issues are largely caused by poor decisions in the design of a building's construction, renovation or retrofit.

However, insulation installers can influence the following:

- **Gaps in insulation:** Installers can influence whether insulation covers as much of a surface as possible;
- **Installing the incorrect product:** Installers may use insulation of an insufficient R-value or low-quality insulation products, due to either not following the insulation specifications or lacking the correct product on site;
- **Compression:** Installers can compress insulation during installation, which reduces the amount of air in it and undermines its effectiveness;
- **Thermal bridging:** While installers are rarely responsible for the most egregious forms of thermal bridging, some fasteners used in insulation can create thermal bridges;
- **Fire risks:** Installers are responsible for minimising fire risks by creating appropriate spaces around lights, fans and other equipment;
- **Some condensation issues:** Installers need to ensure that batts are not in contact with the underside of sarking or other roofing materials; and
- **Some ventilation issues:** Installers of air-tight insulation materials (e.g. foams) need to have the appropriate skills to avoid creating condensation issues.

5.3 Risks during the installation of insulation

The process of installing insulation products is relatively safe compared to many other construction activities, as insulation materials are relatively light, non-toxic and can be cut and installed without the use of power tools. However, like any activity, there are safety issues associated with installing insulation. These include:

Working at heights

Installers potentially risk injuries from falls if they are working at heights, which is especially an issue when installing ceiling insulation. In retrofits, ceiling insulation is generally installed by installers entering the roof space from either inside the home or by removing part of the roofing, and installers often need to balance on joists. In new construction, ceiling insulation is generally installed from underneath, which may somewhat reduce the height that workers are operating from, but it is sometimes installed from above.

Working in restricted spaces

Insulation installers often need to work in restricted spaces, such as roof cavities and the crawlspace under houses. This presents safety issues, including difficulties in quickly exiting an area if there are problems. This is especially an issue for retrofitting underfloor insulation and ceiling insulation.

Overheating

The temperature in a roof cavity can easily exceed 40 degrees on a hot day, which presents significant health hazards. Overheating is a particular risk for retrofitting ceiling insulation, although it is a risk that can be easily mitigated by not working in roof cavities during hot weather.

Hazardous materials

Roof cavities and crawlspaces under houses can contain a variety of potentially hazardous materials, including mould and, in some cases, asbestos.

Electrical safety

Installers can come into contact with live wires, especially if they are retrofitting insulation into a roof cavity. Generally, wiring in a new construction is compliant with modern safety standards, is not live and presents a low safety risk. Electrical safety issues are significantly higher for renovations and retrofits because:

- Wiring may have been installed prior to the introduction of modern safety standards and features such as Residual Current Devices;
- Wiring may have degraded or been tampered with by unqualified people; and
- Even if the electricity is switched off at the mains, lives wires from the electricity network or onsite solar PV can enter the house through the roof cavity.

Reflective building membranes (i.e. foil insulation) present a particularly significant safety risk if appropriate installation processes are not followed. Two of the four deaths associated with the Australian Government's Home Insulation Program were due to inexperienced installers using conductive fasteners while working with foil insulation. Accordingly, the Royal Commission into the Home insulation Program includes a recommendation (14.15.7) that foil insulation should be banned from being retrofitted over ceiling joists in roof cavities, and the Project Team notes that none of the insulation installers interviewed in this project reported using reflective building membranes in retrofits.[25]

25 Hanger, I. 2014 *Report of the Royal Commission into the home Insulation Program*, Commonwealth of Australia.

6 Current Australian policy and programs

There are currently a range of policies and programs in Australia that encourage the safe and quality installation of insulation.

- General rules that are not specific to insulation:
  - Workplace health and safety laws and electrical safety laws; and
  - Commonwealth, state and territory consumer protection laws.
- Voluntary standards:
  - Voluntary standards for insulation materials; and
  - Voluntary standards for the process of installing bulk insulation.
- A range of training and accreditation programs for insulation installers;
- The National Construction Code (NCC) and associated state and territory regulations and compliance mechanisms; and
- State and territory energy efficiency schemes that incentivise insulation installation.

6.1 Workplace health and safety laws and electrical safety laws

State and territory workplace health and safety laws require employers to provide safe workplaces and require employees to follow safe work practices. Relevant acts include:

- *Work Health and Safety Act 2011* (NSW);
- *Occupational Health and Safety Act 2004* (Vic); and
- *Workplace Health and Safety Act 1995* (Qld).

States and territories also have legislation that set out specific requirements around electrical safety, such as the *Electrical Safety Act 2002* (Qld). It is notable that the three companies that employed insulation installers that were electrocuted during the Australian Home Insulation Program were fined at least $100,000 each for failing to meet their duties under the *Electrical Safety Act 2002* (Qld), with one also fined for breach of the *Workplace Health and Safety Act 1995* (Qld).

This means that the employers of insulation installers are already required to provide safe workplaces, particularly in regards to electrical safety. However, the level of explicit guidance as to *what constitutes a safe workplace or work-practice* varies between sectors.

In addition to general requirements, individuals that work on construction sites (new build or renovation) are required to undergo basic safety training to obtain a 'white card'. However, these safety trainings are quite basic and may not cover all the issues that insulation installers face, particularly in a retrofit context.

Some jurisdictions have introduced specific regulations and guidelines around retrofit work, including:

- In Western Australia safety regulations require mains electricity to be switched off before entering a ceiling space;
- In NSW, the 'electrical hazards when working in ceiling spaces' safety alert reminds workers entering ceiling spaces of the risk of electric shock and identifies a series of steps to ensure safe entry into ceiling spaces; and
- In Victoria WorkSafe has issued guidelines for the level of knowledge and actions should be taken in regards to certain hazards, such as electrical wiring.

6.2 Fair trading and consumer protection laws

Commonwealth, state and territory laws, such as Australian Consumer Law and Fair Trading Act 2012, provide a framework that places some requirements on companies to deliver fair services. Amongst other requirements, these laws require the provision of clear and fair contracts and a requirement to deliver the services that were quoted or provide a refund. This legislation does provide some protection for consumers, but since many consumers lack sufficient knowledge of insulation installation, they may not understand or demand their rights in this matter.

6.3 Standards for products

Standards Australia has developed a standard for insulation materials - *AS/NZS 4859.1– Materials for the thermal insulation of buildings*. AS/NZS 4859.1 sets out quite comprehensive details on the desired features for insulation. The National Construction Code requires products to be in accordance with *AS/NZS 4859.1* but there are no requirements in relation to materials used in retrofits.

6.4 Standard for Bulk Thermal Insulation - Installation

Standards Australia has developed a standard for the installation of bulk thermal insulation - *AS 3999*. This standard has been upgraded three times since the Royal Commission in the Home Insulation Program to take account of the lessons from recent insulation programs and new technology developments.

AS 3999 set outs the process for the safe and effective installation of bulk insulation, and is relatively comprehensive, running at 118 pages.

Recommendations in the standard include:

- Before bulk insulation is installed in a dwelling, there should be a pre-installation inspection. This inspection should include actions such as:
  - Assess electrical safety;
  - Assess the presence of electrical elements (e.g. wires and luminaires) to minimise heat build-up;
  - Assess impediments to installing insulation;
  - Assess potential condensation issues, including potential contact between bulk insulation and existing building membranes; and
  - Specify the works that will be carried out on the site, including the installation of insulation, the need for special equipment such as barriers around luminaires and measures to address condensation.
- During insulation, care should be made to address issues such as:
  - Minimising gaps between insulation;
  - Ensuring that insulation isn't compressed; and
  - Leaving space between insulation and external walls, to allow external walls to breath.
- Installers should address safety issues through measures such as:
  - Carrying out an assessment of the electrical risks on a site prior to installation; and
  - Switching off power to the work area where possible.

However, compliance with the standard is currently entirely voluntary in insulation retrofits, and interviewees expressed the view that a large number of insulation installations, especially retrofits, are not carried out in accordance with the standard. The cost of obtaining a copy of the standard may also be an impediment to people reading and understanding it, although the ICANZ Insulation Handbook, which references the standard, can be freely downloaded.

6.5 Training and accreditation for installers

Several organisations have developed formal and informal training around insulation products and installation processes, including:

- Some insulation installer companies;
- The manufacturers of insulation products; and
- Industry associations.

Batt insulation training

There is also a series of relevant formal training units that cover the installation of batt insulation products:

- CPCCOHS2001A Apply OHS requirements policies and procedures in the construction industry;
- CPCCCM1015A Carry out Measurements and Calculations;
- CPCCCM2010B Work Safely at Heights;
- CPCCPB3014 Install bulk insulation and pliable membrane products; and
- CPCCPB3027 Install ceiling insulation.

These units could theoretically be delivered by any Registered Training Organisation (RTO) that has the capacity to deliver it. However, in practice the only organisation that currently delivers this training is the Association of Wall and Ceiling Industries Australia and New Zealand (AWCI). The training is delivered over two days through in-person training in small groups (15-25), which provides a high level of guidance. However, there are only a few courses run each year as the requirements for attending in person and minimum numbers of attendees per course creates significant barriers for potential attendees, including costs, travel and time away from work. AWCI estimate that around 200 people have completed the training over the past eight years.

Batt insulation accreditation

The Clean Energy Council (CEC) runs an accreditation program for batt insulation installers that is built off the training units currently delivered by AWCI. To gain provisional accreditation, an installer has to submit:

- Statement of Attainment from the course provider;
- Certificate of Currency for Public Liability Insurance of at least $5 million;
- Current Working at Heights certification; and
- Current White Card (construction induction).

Once the installer has provisional accreditation, they can secure full accreditation by undertaking seven insulation installations and submitting evidence of their work, specifically 3 wall batt installations, 3 ceiling batt insulations and 1 floor batt installation. This evidence is currently reviewed by AWCI. To maintain accreditation, installers must pay $150 and submit three practical assessments each year.

Very few people have completed or maintained CEC Insulation Installer accreditation. Only 73 individuals have applied for provisional accreditation, and of these only 27 have gone on to secure full accreditation. The vast majority of people have let their provisional and full accreditations expire – only two people have ever renewed their accreditation. Accordingly, on 1 September 2020 there were only 16 people with current full accreditation.

With ICANZ estimating that each year between 3,200 and 5,000 people undertake paid insulation work on either a part-time or full-time basis, this means that less than 0.5 per cent of installers have current CEC Insulation Installer accreditation.

The number of people obtaining and maintaining accreditation could potentially be increased by improving the convenience and lowering the costs of training and accreditation. However, the largest barrier to the uptake of this accreditation is likely to be the limited drivers for individuals to gain accreditation. While some insulation installer companies put their staff through the CEC Insulation Accreditation program as a way of differentiating their services, accreditation does not appear to be essential to operate in the market.

It appears likely that a significant proportion of insulation installers will only be driven to take up accreditation if:

- Accreditation is mandatory for insulation installation (either just retrofit, or both retrofit and new build); or
- Governments provide incentives for insulation retrofits and make access to that incentive contingent on using trained installers. To be effective at driving the uptake of accreditation, insulation incentives will need to be significant and in place for several years. Experience in Australia and overseas shows that short-term insulation programs that require accreditation will not drive significant uptake of accreditation.

Spray insulation and pumped insulation

Training for batt insulation will not provide people with the relevant skills for either spray insulation (i.e. expanding foams) or pumping insulation into walls. While one organisation previously provided training in foam insulation in Australia, this is no longer available.

Pumped and spray insulation are the most cost-effective way to retrofit insulation into many walls in Australia. A training program specifically for spray and pumped insulation could be considered, noting that additional training would be required for specific insulation products and installation systems.

6.6 Licensing for insulation installation in South Australia

In South Australia, the lead contractor for insulation installation must have a building work contractor licence which includes 'insulation' within its scope of activities. To obtain this license, they must have undertaken either the 'CPCCPB3027A Install ceiling insulation' training unit or a series of training units, specifically:

- CPCCCM1006A Work safely at heights;
- CPCCOHS2001A Apply OHS requirements, policies and procedures in the construction industry; and
- CPCCPB3014A Install batt insulation products.

6.7 National Construction Code and compliance with the Code

The National Construction Code (NCC) is a set of technical provisions for the design, construction and performance of buildings and plumbing and drainage systems throughout Australia. The NCC is developed by the Australian Building Codes Board (ABCB), a standard-writing body which is an initiative of all three levels of government in Australia.

The NCC is given legal effect by relevant legislation in each State and Territory. As a result, different jurisdictions may have different versions of the NCC in operation. In NSW, the energy efficiency requirements for residential buildings in the NCC are replaced with requirements set out under the Building Sustainability Index (BASIX) (see section 6.8).

The NCC sets out requirements for insulation, ventilation and air tightness for most classes of buildings in Australia. The requirements vary between different types of buildings, including commercial buildings, apartment buildings and single dwellings. However, there are some common requirements for thermal insulation in most classes of building.

Table 2. Thermal insulation requirements in the NCC

Building class	Type of building	Thermal insulation requirements
Class 1	Single family homes	• Must comply with AS/NZS 4859.1; • Must abut or overlap adjoining insulation; • Must form a continuous barrier; and • Must not affect the safe or effective operation of a domestic service or fitting.
Class 2	Individual apartment units	
Classes 2-9	Various types of commercial buildings	

The NCC requires insulation products used in the construction of a new building to meet the *AS/NZS* 4859.1 standard. However, there is currently no labelling requirement that shows product compliance with the *AS/NZS* 4859.1 standard. The CodeMark Australia Certification Scheme exists as a national, independent process for demonstrating product suitability for applications under the NCC. This is a voluntary certification scheme for building products that could potentially be utilised to indicate quality and effectiveness in insulation products for new builds, major renovations, and retrofits.

The NCC also specifies that insulation should not be compressed and recommends the minimising of thermal bridging. However, while the NCC specifies the end result of insulation installation (e.g. the formation of a continuous insulating barrier) it does not specify the insulation process, and does not call up AS 3999, the standard that specifies how insulation should be installed.

The ABCB is currently considering significant enhancements to the NCC in relation to residential energy efficiency, ventilation and moisture control. While improvements and clarifications to the NCC can play a valuable role in improving insulation installation, changes to the NCC will need to be complemented by improved compliance mechanisms to ensure insulation is installed in accordance with the NCC.

Compliance

The Performance Requirements set out in the NCC are mandatory minimum requirements that must be met by buildings and building elements. The requirements become law once a jurisdiction has implemented them, and each jurisdiction is responsible for enforcing compliance.

A building can be shown to be compliant with Performance Requirements through one of two pathways:

- The 'Performance Solution' pathway, which is unique to each building site, with assessment methods within the NCC used to address Performance Requirements; or
- The 'Deemed to Satisfy' Solution pathway, which sets out a step-by-step 'recipe' for materials, components, design factors and construction methods that, when followed, are used to address the Performance Requirements.

To demonstrate compliance with the NCC:

- The design of a building is documented and, in some cases, its energy performance is modelled in software to produce a performance rating such as the Nationwide Home Energy Rating Scheme (NatHERS). This design has to be reviewed and approved by building surveyors and or other parties; and
- An independent surveyor or building assessor examines the building at several stages, typically including after the foundation is laid and after construction is completed.

This means that, while the building assessor has a responsibility to assess if a building is insulated in accordance with the NCC, in practice it can be difficult for them to determine this. By the time that a final building inspection takes place, insulation is often hidden behind material such as plasterboard. As a result, many building assessors rely on signed statements from builders that insulation has been installed as specified in the plan. However, the 'Certificate of Insulation' that is often used as evidence that insulation has been installed correctly can currently be signed off by anyone, regardless of their expertise in insulation.

Requirements for demonstrating compliance with the NCC are left up to individual jurisdictions, and vary considerably between jurisdictions.[26] The Shergold-Weir *Building Confidence* Report includes recommendations for improving compliance with the NCC.[27]

In November 2020, Building Ministers agreed to release a National Model Code of Conduct for Building Surveyors[28] in response to recommendations set out by the *Building Confidence* report. The model code includes 16 obligations for building surveyors, which are grouped into four categories:

- Comply with the law and act in the public interest;
- Professionalism;
- Honesty and integrity; and
- Transparency and accountability.

This new model code of conduct will establish a degree of separation between the building process and certification of works, and is intended to improve compliance outcomes with the NCC.

6.8 Building Sustainability Index (BASIX)

In New South Wales, BASIX operates in place of the energy efficiency requirements of the NCC. The requirements apply to all new homes and renovations of over $50,000. All proposed developments must be assessed using the online BASIX tool, which generates a BASIX certificate to be submitted with the development application.

The BASIX certificate lists the 'sustainability commitments' within the design, which includes insulation. Insulation requirements within BASIX are based on the NCC. Insulation within a building design can be assessed via one of two methods:

- The DIY method, which correlates to the NCC Deemed-to-Satisfy method and can be used for buildings that meet certain requirements; or
- The Simulation method, which requires an accredited assessor to simulate the building with an approved software tool.

Once all the relevant commitments of a proposed development are certified, an Occupation Certificate (OC) is issued by the principal certifying authority (PCA). The PCA confirms the commitments have been met before issuing an OC by:

- Taking advice from other professionals, generally including the builder or someone who has witnessed the development during its construction;
- Reviewing invoices and other documentation; or
- Requesting a Part 4A Compliance Certificate.

26 Miller, Wendy, Zedan, Sherif, & Kirsch, Ernestine (2020) *Electronic Building Passport: The role of an Electronic Building Passport for energy efficiency compliance and quality assurance in residential buildings: NEEBP Phase 4 Project 1*. South Australian Department of Energy and Mining, Australia. https://eprints.qut.edu.au/205841/

27 Shergold, Peter & Weir, Bronwyn (2018) *Building Confidence: Improving the effectiveness of compliance and enforcement systems for the building and construction industry within Australia*.

28 Commonwealth of Australia and States and Territories of Australia. (2020). *National Model Code of Conduct for Building Surveyors*. Canberra: Australian Building Codes Board. https://www.abcb.gov.au/Resources/Publications/Corporate/National-Model-Code-of-Conduct-for-Building-Surveyors

The PCA then generates a 'completion receipt', which alerts the Department of Planning, Industry and Environment that the building has been constructed and occupied. Only accredited PCAs and councils can generate completion receipts.

No inspections are required for compliance with BASIX and there are no other compliance requirements. This means that the PCA must take builders on their word that insulation has been installed in a quality manner and up to specification. As the *Building Confidence* report notes, lack of independence between various parties involved in the building and sign-off process may lead to concerns around ensuring quality of insulation installation.

6.9 South Australian Retailer Energy Efficiency Scheme

The Retailer Energy Efficiency Scheme (REES) is a South Australian energy efficiency scheme that incentivises energy savings for households and businesses. As a result of REES, some energy retailers and their contractors have offered households discounted installation of insulation.

A number of requirements are in place to ensure safety and quality of insulation installs under REES.[29] These include:

- Compliance of insulation products with *AS/NZS 4859.1*;
- Installation of products in accordance with *AS 3999*, particularly the safety, pre-inspection and risk assessment procedures, electrical safety provision, and provisions for limiting moisture; and
- Insulation installation must not compromise the condensation management of the building.

Documentation of installations must include time- and location-stamped photographs of the space before and after installation. This documentation enables some level of post-installation audit even if insulated areas are inaccessible after installation.

The Retailer Energy Productivity Scheme (REPS) replaced REES on 1 January 2021 and will not initially include incentives for insulation.

29 South Australia Department of Energy and Mining. Installation of Insulation in an Uninsulated Ceiling Space; Residential Only. Activity No. BS1A. https://www.energymining.sa.gov.au/__data/assets/pdf_file/0003/315507/REES-specification-BS1A.pdf

6.10 ACT Energy Efficiency Improvement Scheme

The Energy Efficiency Improvement Scheme (EEIS) is an energy efficiency retrofit scheme for households and small-to-medium businesses in the Australian Capital Territory (ACT). As of 2020, incentives are available for installation of ceiling and underfloor insulation.

For insulation installations to receive incentives through EEIS, the following requirements need to be met:

- An authorised, licenced electrician must perform a pre-installation electrical safety check and issue an electrical safety report before insulation installation proceeds;
- Insulation needs to be installed by an insulation Installer who has been accredited by the Clean Energy Council; and
- The site needs to be physically inspected by an independent 'insulation installation auditor'.[30]

Insulation installation auditors need to:

- Undertake the training that is required to meet the CEC Insulation Installer accreditation, though they do not need to meet the practical requirements of the course or hold accreditation;
- Demonstrate their competency in turning off mains power to the building being insulated and interpretation of the electrical safety report; and
- Have at least one year of experience as an insulation auditor, insulation installer, building surveyor, or licenced electrician.

Insulation installation under the EEIS also requires documentation of installation and retainment of documentation. This documentation includes:

- The pre-installation electrical safety report;
- A copy of the Certificate of Electrical Safety (CES) for any electrical remediation completed;
- A term of responsibility signed by the householder, confirming they have been informed of works completed;
- Time- and location-stamped photographs of works completed;
- CodeMark certificate or report issued by an Accredited Testing Laboratory that confirms insulating products meet *AS/NZS 4859*; and
- Evidence of compliance with the requirements of *AS 3999*.

30 Australian Capital Territory. Energy Efficiency (Cost of Living) Improvement (Eligible Activities) Code of Practice 2020. https://www.legislation.act.gov.au/ni/2020-199/

7 International case studies

Australia will need to design an approach to insulation that considers our specific circumstances, including the structure and capabilities of our construction industry, the types of buildings in Australia, our regulatory systems and our governance structures.

However, Australia can learn a great deal from other countries. Rather than conduct a shallow survey of many countries, the Project Team conducted in-depth analysis of four countries – Germany, Ireland, New Zealand and the United States of America. These countries were selected based on recommendations from global experts, similarities to Australia and availability of key information in English.

Each country we studied had a unique approach to insulation installation, which built on that country's culture, traditions, construction systems, regulatory frameworks and experience with insulation. Nevertheless, there are a number of key themes that emerged from all case-studies:

- Governments in every country considered insulation a critical part of healthy homes and had taken policy measures to address this. All countries had both:
  - Minimum insulation standards for new homes; and
  - Generous grants for insulation retrofits, even in countries with a strong public acceptance of the benefits of well-insulated homes (e.g. Germany).
- While every case-study country was taking strong action to drive insulation retrofits, they also saw the challenge of improving existing buildings as a long-term commitment. This is a significant contrast to Australia's problematic Home Insulation Program (HIP), which had attempted to deliver an extraordinary number of insulation upgrades in a few years;
- The generosity of insulation grants in these countries meant that a large proportion of insulation retrofits were channelled through grant programs. These grant programs all involved much greater controls on safety and quality than the requirements on unsubsidised retrofits, and typically included:
  1. Requirements for companies and/or installers to have accreditation. Accreditation for processes should generally be targeted at companies, and accreditation for skills should generally be targeted at individuals;
  2. Requirements for installers to use approved products and processes; and
  3. Risk-based auditing of a sample of retrofits.
- Germany, Ireland and the US all went through a phase of encouraging insulation without properly taking into account ventilation and moisture control, which resulted in significant problems with condensation and indoor air quality. These countries have subsequently developed a more integrated approach to improving the thermal properties and air quality of buildings.

Many buildings in Australia currently suffer significant condensation and air quality problems because they lack sufficient insulation. In learning from Germany, Ireland and the US, Australia can move directly to taking an integrated approach to buildings that considers insulation, air tightness and ventilation.

7.1 Germany

Germany has a long tradition of skilled craftspeople that were historically associated with guilds. Craftspeople in a particular discipline (e.g. carpentry) rise through the ranks of apprentice (*Lehrling*), journeyman (*Geselle*) and, eventually, mastercraftsman (*Meister*). Some types of businesses, such as construction companies, need to employ at one least *Meister* in the relevant discipline.

While there are clear parallels between German 'crafts' and Australians 'trades', there are significant cultural and practical differences, including longer training periods. The designation of *Meister* is highly valued and the risk of losing this designation is taken very seriously. Accordingly, much of the German building regulatory system is based around *Meister* and other accredited people personally signing off that building elements meet the relevant standards, in conjunction with a relatively low rate of independent audits.

The relevant signatories for new buildings and external cladding are *Meister* builders. For cavity wall insulation, installation and signoff is generally carried out by an 'industrial installer' who has received accredited training, often from a manufacturer.

New construction and major renovation

Building codes in Germany are set by the 16 state governments (*Länder*) and vary between states. However, the German government, in consultation with the 16 states, sets national rules for the energy efficiency of homes in every state through the national Building Energy Act 2020 (*Gebäudeenergiegesetz 2020*).

State governments manage compliance with their building codes, including reviewing the plans for each new development to see if they meet the requirements of the Building Energy Act. Unlike Australia, where every building needs to be assessed during and after completion by private building surveyors, German state governments send independent public surveyors to assess potentially as few as one per cent of new constructions.

The German Government also offers attractive loans and grants through the KfW (state-owned bank) to encourage new buildings and renovations to go significantly beyond the requirements in the Energy Code, and there are additional compliance mechanisms in place to ensure that public funds are well spent.

To secure these incentives, developers must provide their retrofit plans to the KfW. These plans need to be signed off by an Energy Rater (*Energieberater*). An *Energieberater* is not a particular profession – rather it is a *Meister*, architect, engineer, craftsperson or similar who has undertaken additional training in energy and been registered on a central government platform as an *Energieberater*. The KfW also undertakes independent inspections of less than one per cent of projects to assess if they have complied with their submitted designs.

Retrofits

The German Government also offers attractive incentives for upgrading the thermal shell of buildings. As with incentives for new buildings, to be eligible for these incentives, plans need to be signed off by an *Energieberater*.

In addition to incentives for specific upgrade measures, the German government provides subsidies for holistic home retrofit designs, also known as a 'building retrofit passport'. A building energy passport is far more than just an energy efficiency rating – instead an *Energieberater* provides detailed specifications for an integrated energy efficiency retrofit that considers insulation, air tightness, ventilation, heating, cooling and hot water. This plan is detailed and actionable, providing quite specific details on what should be installed (e.g. the type and thickness of insulation) and the sequencing of measures.

To give an indication of the level of thoroughness of a building energy passport, the full unsubsidised cost of a passport would be around AUD 2,500, although the German government covers up to 80 per cent of the cost of a building retrofit passport.

Implications for Australia

Some German measures would be hard to rapidly introduce in Australia due to their reliance on highly-trained tradespeople and professionals. However, there are three take-away measures:

- Testing and certification of products will become increasingly important as buildings move towards pre-fabricated components;
- More training and accreditation are critical as we move towards high-performance buildings, including for the installation of insulation; and
- Australia will need highly skilled individuals to design and deliver integrated building retrofits, whether those skills are held by builders, architects or dedicated energy professionals similar to the *Energieberater*. As one interviewee noted *"Homeowners may only upgrade their homes once in their life, why would we expect them to become experts in retrofitting if they are only doing it once?"*

7.2 Republic of Ireland

Ireland's system for quality control of insulation is built around three elements:

- Certification for insulation products, and associated certification for the companies that install these products;
- Standards for new buildings and renovations; and
- Generous grants for insulation retrofits that are accompanied by requirements to use certified products and installers and undertake a home energy efficiency rating.

Accreditation for products, companies and experts

The National Standards Authority of Ireland (www.nsai.ie) has a branch (*NSAI Agrément*) that oversees standards for 'new and innovative' building products and processes, including thermal insulation, wall membranes and window systems. *NSAI Agrément* standards for products also set out the standards for the installation of those specific products to ensure that they remain certified, including how to address ventilation issues.

In relation to insulation, *NSAI Agrément* certifies:

- Cavity wall insulation – generally pumped insulation;
- External insulation – pre-fabricated panels of multiple materials fitted to the outside of buildings; and
- Installers of specific products – e.g. some installers are specifically certified to use the Korefill Cavity Wall Insulation system. Interviewees indicated that manufacturers of these products will provide training for installers to provide quality control.

NSAI Agrément also certifies:

- Air tightness testers (testing is required for new construction);
- Thermal modellers (modelling is required for new construction); and
- People that can validate that ventilation systems have been appropriately installed, balanced and commissioned (validation is required for new construction).

In addition, the Sustainable Energy Authority of Ireland (SEAI) trains and accredits Building Energy Raters (BER) that develop energy ratings for buildings.

New construction and major renovation

The design and construction of buildings is regulated under the *Building Control Acts* 1990 to 2014. As part of this system, buildings need to meet specific energy efficiency requirements, including the use of appropriately certified products. As noted above, new buildings and major renovations are also tested, including tests for air tightness and ventilation systems.

Retrofits

NSAI and SAI Global have developed a *'Code practice for the energy efficient retrofit of dwellings'* (Standard Recommendation SR 54:2014&A1:2019) which sets out comprehensive advice for the retrofit of dwellings including insulation, air tightness, ventilation, heating, hot-water systems and lighting. This document provides technical guidance on energy efficiency retrofits, and is intended for 'designers, specifiers, installers and property managers working on energy efficient retrofit projects for dwellings'. This code of practice is entirely voluntary unless projects are supported by government grants.

The Sustainable Energy Authority of Ireland (SEAI – www.seai.ie) offers a range of generous grants to encourage and support people to undertake energy retrofits. The Better Energy Home (BEH) grants include:

- Attic insulation – grants of €400 (approximately AUD 650);
- Cavity wall insulation – grants of €400 (approx. AUD 650);
- External wall insulation in a detached house – grants of €6,000 (approx. AUD 9,800); and
- Heat Pump for space heating (air to air) – grants of €600 (approx. AUD 980).

If homeowners complete three upgrades, they get an additional grant of €300, and if they complete four upgrades their grant will be increase by a further €100. If homeowners are on social security, they can be eligible for completely free upgrades.

Due to the generosity of these grants, a large proportion of insulation retrofits in Ireland take advantage of these grants, which enables the Irish Government to put additional controls on the quality of installation. These additional conditions include:

- Requirements to use appropriately certified materials. For example, cavity wall insulation must be *NSAI Agrément* certified cavity wall insulation;
- Requirements to use an SEAI Registered Contractor for the relevant work. For example, contractors carrying out cavity wall insulation must be on the directory for *NSAI Agrément* 'Registered Blow Cavity Wall Installation Companies';
- Contractors must comply with all relevant Health and Safety legislation, including the *Safety, Health and Welfare at Work Act 2005*. There are additional requirements around matters such as electrical works, where non-compliant 'earthing and bonding' must be rectified to the applicable National Rules for Electrical Installations 2008 before grant-funded works are started;
- The contractor must carry out a pre-works assessment before works commence, which includes an assessment of 'ventilation provision'. Depending on the current condition of the dwelling and the works that are planned, some upgrades to the ventilation systems may be required. One interviewee highlighted the importance of the pre-works assessment;
- Materials must be installed in accordance with specifications that are specific to that material (e.g. cavity wall insulation or ceiling insulation). These specifications are set out in SEIA 2019 *Domestic Technical Standards and Specifications*, SEAI, Dublin. In the case of cavity wall insulation, for example, the specification requires:
  - Walls must be surveyed before installation by a trained surveyor. Any defects recorded in the survey must be rectified before works can commence;
  - Cavity filling with EPS balls should not be undertaken where unprotected PVC-sheathed electrical cables are passing through the cavity; and
  - Cavity wall insulation must achieve a U-value of at least 0.35 W/m2K.

- Manufacturers, system suppliers and/or contractors must issue a guarantee to the customer;
- The impact of the upgrade must be assessed by a registered 'Building Energy Rating (BER) Assessor'. The assessment must be conducted in accordance with a range of guidelines, including the most pessimistic default settings in calculations unless the BER Assessor has been provided with relevant information and certificates for the products that have been used; and
- SEAI conducts random checks of insulation installation. Spot checks typically take place during the installation of insulation, rather than afterwards, due to the complexity of assessing the quality of cavity wall insulation after it is completed. While there are benefits in conducting an assessment during the installation process, it does make it significantly less effective at ensuring compliance, as installers will know which upgrades will be monitored and which will not.

Implications for Australia

- As with Germany, Irish programs suggest that testing and certification of products will become increasingly important as buildings move towards pre-fabricated components;
- As with Germany, Ireland has invested considerable efforts to create an industry that can deliver integrated energy efficiency retrofits;
- Australia could learn from the way that Ireland has used the relationships between insulation manufacturers and insulation installers to ensure that installers are trained in installing products and motivated to deliver quality outcomes; and
- Australian policy makers could examine the Better Energy Home grants documentation to develop requirements for insulation installers for local programs.

7.3 United Kingdom

In the UK there are strong standards for the construction of new buildings, including insulation.

In retrofits, there are requirements for installations that are associated with government programs. While there are limited requirements for retrofit installers outside of government schemes, the scale of government insulation schemes in the UK means that most installer companies have the relevant qualifications for government-funded work. In effect, the standards associated with government-funded upgrades have become the *de facto* standard for all retrofit work.

Publicly Available Specification (PAS)

Insulation installations supported by UK government programs are required to comply with the Publicly Available Specifications (PAS) for installing insulation. The previous version of this was known as PAS 2030:2017 *Specification for the Installation of Energy Efficiency Measures (EEM) in Buildings*. This PAS is currently moving towards version 2030:2019 which has stronger considerations around fire risks and condensations issues.

However, organisations are currently also developing PAS 2035, which will provide a more holistic approach to retrofits. PAS 2035 lays out retrofit steps and their order, encourages homeowners to have more than one upgrade measure installed at a time and enables incentives for these upgrades. PAS 2035 also sets out five new roles for individuals involved in retrofits:

- Retrofit Advisor;
- Retrofit Assessor;
- Retrofit Co-ordinator;
- Retrofit Designer; and
- Retrofit Evaluator.

ECO program

The Energy Company Obligation (ECO) scheme provides largely free retrofits of insulation to vulnerable homes. The ECO involved around expenditure of around £4.84 billion on energy efficiency upgrades between 2013 and 2020. To be eligible for work under ECO:

- Contractors must gain accreditation to the relevant PAS and register with Trustmark;
- Works must be carried out in accordance with the relevant PAS;
- Insulation products must be certified by the British Board of Agrement (BBA), Kiwa or similar; and
- Installers must have an insurance-backed guarantee, which is typically a 25-year guarantee supported by an independent body, with £20 from every install going into a guarantee fund. An example of an insurance-backed guarantee is the Cavity Insulation Guarantee Agency (CIGA), which covers defects in materials and workmanship related to cavity wall insulation.

Compliance under the ECO program is based on documentation and audits. There exists a paper trail for monitoring purposes, as well as random checks on retrofit works and monitoring of supplies. Reports are submitted by contractors to energy suppliers, who then supply data to Ofgem.

Green Home Grants

In July 2020, £3 billion was dedicated to the Green Home Grants scheme for insulation and other energy efficiency measures as part of the COVID-19 economic stimulus. Installers wishing to work within the scheme are required to obtain the new PAS2030/2035 accreditation, which has just recently come into force and as such, much of the workforce has not yet made the transition. With Green Home Grants funds only available until March 2021, there have been reports that installers are hesitant to go through with the time-consuming accreditation process, leaving many homeowners unable to find qualified installers for the scheme.

Implications for Australia

- The UK has used the scale of its government-funded retrofit programs to drive increased standards in both government-funded and non-funded retrofits. This approach has been highly effective under the ECO, due to the long running time and stability of the program. However, it has been far less successful under the Green Home Grants, due to the very short length of the program. This suggests that it would make sense for governments to commit to a set of standards that would apply to any program that they run around insulation, rather than developing very specific standards for various programs;
- The UK uses a centralised body for registering installers and holding work documentation, which is a useful model Australia could employ to avoid redundancy between states and territories; and
- The UK's new retrofit process takes a whole-of-house, 'deep retrofit' approach, which Australia should work towards as an important next phase.

7.4 United States of America

In the United States, state governments are responsible for many matters relating to buildings, including standards associated with new construction and programs to encourage retrofits. However, there is a level of national or regional coordination provided by various bodies.

New Buildings and major renovations

Building code requirements in the US vary by state and city but are generally based on model codes, primarily the International Building Code (IBC) which is developed by the International Code Council (ICC). While the IBC has been adopted by a small number of jurisdictions, including Abu Dhabi and Colombia, it is heavily driven by US requirements, and all eighteen of the ICC's directors are based in the US.[31]

US jurisdictions generally use a combination of two model codes to set their requirements for energy efficiency:

- The ICC's International Energy Conservation Code; and
- The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) *Standard 90.1 for the Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings* (i.e. commercial buildings and apartments).

Model codes are generally updated around every three years, but states and local governments are not required to adopt the latest version of a model code as soon as it is updated, and so there are a variety of vintages of model codes in operation around the US.

States and local governments are responsible for compliance with their building codes. As in Australia, building surveyors are required to assess that new buildings are compliant with the code. However, unlike Australia, most jurisdictions require a building inspection before drywall (plasterboard) is installed so that surveyors can properly assess electrical works, plumbing and insulation. Interviewees from the US noted that the requirement to have inspections prior to the installation of drywall was primarily to inspect electrical works, and that insulation was rarely assessed in detail. However, major defects in insulation would be far more likely to be picked up if buildings were inspected prior to drywall installation.

Retrofits

If building owners upgrade the insulation in their home without any grant from government or utilities, there are no specific training or process requirements that insulation installers are required to meet beyond general occupational health and safety and consumer protection requirements.

However, over several decades there have been a variety of national, state, utility and local programs to encourage energy efficiency retrofits in buildings. For example, following the Global Financial Crisis, the Obama Administration invested US$11 billion in stimulus for building upgrades between 2009 and 2011.[32] These programs have typically imposed a range of certification and quality requirements on insulation upgrades.

The Better Buildings Neighborhood Program (BBNP) was one such program, through which US$508 million was committed to whole building energy upgrades for cities, states and non-profits. Lasting 3 years and retrofitting 100,000 homes, the program kick-started the scale-up of the retrofit workforce and began driving demand for quality housing.

There are currently two main retrofit programs in the US:

- The Weatherization Assistance Program (WAP), which funds retrofits on low-income homes in each state and territory with funding based on population; and
- Home Performance with ENERGY STAR (HPwES), which is a voluntary program implemented by sponsors (i.e. utilities, states, municipalities, or non-profit organisations).

31 Confirmed on 28 August 2020.

32 International Energy Agency 2020, *Energy efficiency and economic stimulus*, IEA, Paris.

Weatherization Assistance Program

The WAP is funded by the US Department of Energy (DOE) to reduce energy costs and increase health and safety in low-income homes through energy efficiency. The program retrofits about 35,000 homes each year, supporting 8,500 jobs around the country.

Each US state and territory receives funding for retrofits under the WAP based on their population. As a federally-funded program, program administrators are given a high level of control over insulation installers and processes. As such, more robust requirements around training and certification exist for contractors, raters and specifiers[33] than exist under the voluntary Home Performance with ENERGY STAR program.

The WAP sets out specific roles for contractors performing assessments and retrofits. Separate roles exist for single-family homes and multifamily apartment buildings. For single-family homes, these roles include:

- Energy Auditor, who evaluates health and safety issues and energy use within a building and makes recommendations for improvements;
- Quality Control Inspector, who ensures quality of retrofit work by conducting inspections; and
- Crew Leader, who supervises and assists in retrofit installations and is responsible for quality control, documentation and final inspection of retrofit work.

Creating a hierarchy of roles related to retrofits creates a career trajectory for the workforce, which is a measure Australia may consider to drive interest in the industry. Broader training for insulation installers and those working in retrofits would increase individual skillsets and potentially reduce the frequency of installer turnover.

Job Task Analyses (JTAs) define each role and its relevant tasks, which enables training providers to develop coursework which is accredited by a third-party organisation. By following these specific roles and verified training programs, retrofits performed by certified installers through the WAP program can be assured to be of consistent quality.

Home Performance with ENERGY STAR

The US Department of Energy runs a national voluntary program called Home Performance with ENERGY STAR (https://www.energystar.gov/campaign/improvements) which encourages and supports households to have an integrated energy efficiency retrofit to their home. These integrated retrofits consider a broad range of issues such as insulation, air sealing, ventilation, windows, air conditioning, hot water and appliances. The program includes:

- Mandatory certification for some categories of expert;
- A process for a 'home performance assessment' which leads to a relatively comprehensive set of 'home improvement recommendations';
- A system for assurance quality of the installations performed by vetted contractors; and
- Standards around how upgrades are conducted.

This program in effect establishes a bar for integrated energy efficiency retrofits, with HPwES setting out broad guidelines and each 'sponsor' effectively administering its own program within these guidelines. Sponsors can be utilities, states, municipalities, or non-profit organisations, and they may use program staff to perform in-home assessments or may hire contractors to complete assessments. Sponsors also provide funding for quality assurance and quality control, including ongoing oversight of contractors for HPwES and ongoing quality assurance processes that meet program standards.

Retrofits performed under HPwES are scoped by a 'consultant' or by a contractor who may also perform the work as agreed to by the homeowner. Some type of training is required for energy assessors and insulation installers working through the programs. One example of a certification body for installers is the Building Performance Institute (BPI), an organisation which also sets out health and safety standards for residential retrofit processes.

33 US Department of Energy, Guidelines for Home Energy Professionals Accredited Training, https://www.energy.gov/eere/wipo/guidelines-home-energy-professionals-accredited-training.

The Building Performance Institute (BPI) (www.bpi.org) has established a suite of training and accreditation programs for building performance specialists, which includes:

- Building Analysts, who can conduct whole-of-home energy audits and make tailored recommendations to improve buildings based on building physics;
- Crew Leaders, who have the ability to oversee energy efficiency upgrades; and
- Retrofit Installer Technicians, who can install insulation, air sealing, duct sealing, ventilation and other elements of a building upgrade.

The Building Analyst certification is competency-based, which means that while training may be valuable, it is not mandatory. Instead, certification is based on passing:

- An online examination that consists of 100 multiple-choice questions derived from the ANSI/BPI-1200-S-2017 Standard Practice for Basic Analysis of Buildings; and
- A field test that consists of health and safety inspections of equipment within the home, including carbon monoxide testing of gas-fuelled equipment, and administering a blower door test to measure air leakage within the home.

Although the Building Analyst accreditation is considered one of the BPI's entry-level accreditations, Building Analysts perform quite comprehensive audits that include:

1. A basic visual inspection of electrical systems within the home, especially electrical boxes and wiring within the roof space;
2. A visual inspection of any health and safety issues within or outside the home – existing or potential – including, but not limited to gutters and water diversion outside the home, cracks in walls or ceiling indicating compromised structural integrity, mould or mildew as a result of moisture issues or improper ventilation;
3. Testing gas lines inside and outside the home for gas leaks;
4. Testing ventilating fans, including ensuring they vent to outside the home and measuring their airflow;
5. Testing combustion (gas-fuelled) equipment (generally hot water heaters, ducted gas furnaces, and ovens) for carbon monoxide generation and proper venting;
6. Measuring ceiling, wall and underfloor insulation (where possible) to later prescribe recommendations for top-ups;
7. Visual inspection of the roof space to check for unsealed downlights and other bypasses for significant air leaks and unsafe insulation practices such as covering downlights or wires; and
8. Performing blower door tests to determine airflow throughout the home to later prescribe an appropriate level of air sealing.

After a Building Analyst assesses a home, they present their initial findings to the homeowner and then use a modelling software or deemed savings to come up with specific, cost-effective recommendations. Recommendations include specific insulation top-up amounts, levels of draught sealing, HVAC and lighting upgrades to present the homeowner with a holistic retrofit picture including costs. Certain levels of insulation and airflow reductions may need to be met within the home in order for the homeowner to qualify for rebates. Alternatively, they may opt for retrofit work that does not meet these requirements and not receive any financial incentives.

In some cases, the analyst may refer the homeowner to a specific company that is capable of completing the retrofit work, or they may be employed by a company that is capable of doing this work. Homeowners may then qualify for rebates on the retrofit work through the Home Performance with Energy Star program, which the company will assist with.

Implications for Australia

- Australian policy makers could consider how to give Australian building surveyors the same ability to assess the quality of buildings as their counterparts in the US. In the US building inspections are conducted before drywall (plasterboard) is installed, which enables US building inspectors to easily assess electrical works, plumbing and insulation. Options include changing the timing of building inspections in Australia or requiring builders to provide building surveyors with comprehensive photographs of buildings prior to the installation of plasterboard.
- The US Home Performance with ENERGY STAR demonstrates one potential approach for a national program to improve the quality of insulation installation and building retrofits, which includes:
  - National collaboration to develop standards and certification for building energy efficiency retrofits; and
  - State and local governments and utilities providing funds to roll out this approach at a local level.
- The Building Performance Institute does not have a single accreditation system, rather it has a range of accreditations in the design and installation of energy efficiency retrofit measures in homes. In Australia, a single insulation installer accreditation will deliver significant benefits, but the benefits would be significantly greater if insulation installer accreditation was split into several levels and accompanied by a range of other accreditation programs, particularly in the design of home energy retrofits.
- The insulation market in the US has taken years to develop its workforce and roll out nationally, having started with a relatively small retrofit program and built up over time. While Australia has the benefit of being able to take lessons from insulation markets overseas, training and building up the insulation workforce in Australia will take time.

7.5 New Zealand

Construction work in New Zealand is regulated under the *Building Act 2004*, whether it requires building consent or not. However, in practice the construction of new buildings and major renovations are regulated significantly more than maintenance and retrofits.

Like the US, New Zealand doesn't require training or accreditation for the retrofit of insulation unless it is supported by government funding. However, New Zealand has a major and very generous incentive program for retrofitting insulation into the homes of low-income and vulnerable households, currently called *'Warmer Kiwi Homes'*, which is associated with quite significant processes for quality control.

Warmer Kiwi Homes

Warmer Kiwi Homes is a retrofit program administered by the Energy Efficiency and Conservation Authority (EECA) in New Zealand. The program offers significant subsidies for the installation of insulation, moisture barriers and heating systems in low-income homes. Prior to the COVID-19 pandemic, the program was offering grants that covered an average of 67 per cent of the cost of upgrades. In response to COVID-19, grants have been increased and now cover around 90 per cent of the cost of a retrofit.

The precursor to Warmer Kiwi Homes started in 2009, and the program has been extended, refunded and rebranded several times. A recent evaluation found that the program's health, economic and manufacturing benefits resulted in a benefit-cost ratio of:

- 3.6 to 1 for the general population; and
- 6 to 1 for low-income households.[34,35]

34 Preval, N., Keall, M., Telfar-barnard, L., Grimes, A., & Howden-chapman, P. (2017). Impact of improved insulation and heating on mortality risk of older cohort members with prior cardiovascular or respiratory hospitalisations. *British Medical Journal*, 7(1), 1–8. https://doi.org/10.1136/bmjopen-2017-018079

35 Grimes, A., Denne, T., Howden-chapman, P., Arnold, R., Telfar-barnard, L., Preval, N., & Young, C. (2012). *Cost Benefit Analysis of the Warm Up New Zealand: Heat Smart Programme Ministry of Economic Development. June.*

The success of the program is likely in part attributable to the fact that it has been operating for over a decade, which has allowed EECA to iterate the program design. The program has well-established quality control process that includes:

- A panel of vetted installation companies;
- Requirements to use accredited insulation products;
- Requirements for companies to follow processes in insulation installation; and
- Independent audits of approximately 5 per cent of retrofits.

A key component of the Warmer Kiwi Homes program is that it has a pre-approved panel of insulation providers that service each region of New Zealand. In order to join the panel, installer companies need to show evidence of a history of insulation installation and their documented quality control processes. EECA expects installer companies to have health and safety processes in place in line with the general provisions of the New Zealand *Health and Safety at Work Act 2015*, and does not require specific certifications around health and safety.

EECA does not require individual installers to take particular training courses or become certified – instead it expects installer companies to appropriately train their staff. The stability and generosity of the Warmer Kiwi Homes program provides a strong incentive for insulation installer companies to ensure that they can continue to participate in the program. Accordingly, many installer companies have had a long relationship with the program.

The main component of EECA's quality assurance process is a set of quite specific processes that installer companies need to follow in order to receive payment. These processes are set in the EECA 2020 *Warmer Kiwi Homes Service Provider (Insulation) Program Guidelines – v3.0*, and include:

Pre-installation – the service provider must visit the property to:

- Complete a site-specific health and safety assessment, including the identification of any risks on the site. The service provider must keep a copy of the site-specific health and safety assessment; and
- Assess the site to determine whether it is eligible for the program, determine what energy efficiency measures to install and identify any specific issues for the site (e.g. the number of light fittings that will need to be worked around).

Installation – on the day of the installation the service provider must:

- Complete a 'pre-start assessment', where the staff involved in the installation must review risks and controls identified in the site-specific health and safety assessment, and discuss the method and sequence of work for install; and
- Install the insulation in line with a range of documents, including:
  - The Warmer Kiwi Homes quality and audit manual;
  - *NZS4246:2016 Energy efficiency – installing insulation in residential buildings;*
  - The New Zealand Building Code; and
  - Electrical (Safety) Regulations 2010.

Quality control and audit – there are two separate processes:

- The service provider company itself must carry out quality assurance processes on every installation, including signing and dating a post-installation audit that declares that the installation meets all the requirements. This is a critical step, as individual insulation installers may have a much weaker incentive for quality control than service provider companies that are seeking a long-term source of revenue.
- EECA has a long-term contract with an independent audit company, which carries out independent inspections on around 5 per cent of installations.

Implications for Australia

New Zealand's 'Warmer Kiwi Homes' sets out a model for quality control processes that Australian governments could use as the base for their quality control processes. Australian governments may want to consider additional safety measures, specifically requiring all insulation installers that participate in government-funded programs to have undergone basic health and safety training.

8 Recommendations to enhance insulation installation in Australia

The Project Team has developed a number of recommendations that would improve the safety and quality of insulation installations. These recommendations are solely the view of the Project Team, and have not been endorsed by any other organisation, including the Project Funders. However, the Project Team hopes that these recommendations will help to inform the thinking of various organisations and support the development *'Industry-led roadmap for ensuring quality control and safety in insulation installation'*, which is intended for release in the second half of FY2021.

8.1 Context for recommendations

Before setting out a summary of the Project Team's recommendations, it is necessary to set out the Project Team's views on a number of matters.

First, the Project Team was commissioned to solely focus on recommendations relating to the installation of insulation in new and existing buildings. By focusing on this manageable task, the Project Team was able to develop clear advice that could be rapidly implemented. However, the Project Team recognises that maximising the benefits of insulation and delivering efficient, thermally comfortable and healthy buildings requires building construction and retrofit processes that incorporate both design and installation of insulation and also the integration of insulation, air tightness, ventilation and heating and cooling.

The Project Team considered these broader issues in developing its advice on insulation installation and it is recommended that various parties collaborate on a subsequent report to look at integrated building design, construction, renovation and retrofit.

Second, the Project Team has developed a set of recommendations that are designed to work together – in other words the recommendations are complements, rather than alternatives. Multiple policies are essential in order to improve the quality of insulation installation. For example, even if industry and governments develop world-class training programs for insulation installation, installers will not undertake training unless there are drivers for installers to have completed training, such as requirements for accreditation in government programs.

Our complementary recommendations are set out in four broad streams:

- Training and accreditation;
- Retrofits (no building permit required);
- New buildings and major renovations (building permit required); and
- Moving beyond an insulation-only approach.

Third, the Project Team recommends the development of an industry roadmap with clear timeframes for various actions set out in this report. Some actions, such as finalising training programs can, and should, be implemented within 2 years. Other actions will take longer to implement, and some cannot be undertaken until other actions have been completed. For example, industry and governments will need to finalise the design of accreditation programs before governments could consider making accreditation mandatory.

8.2 Training and accreditation

Background to recommendations 1, 2, 3 and 4

The Project Team identified that there are potentially multiple forms of training that are required for excellence in insulation installation:

- Ideally, every person that installs insulation should have undergone basic training around safety and quality issues associated with insulation installation;
- Ideally, individuals that install more complex types of insulation, such as pumped insulation, would have additional training specific to that type of insulation; and
- Every insulation installation should be overseen and inspected by someone with a deep knowledge of insulation installation and the relevant standards to ensure that the installation is in line with those standards.

Splitting insulation installer training and accreditation into various levels would have a number of benefits. Many installers are only in the industry for a short period of time and, while they should undergo basic training, they will not need more extensive training in order to start installing insulation. Conversely, the people that specify insulation and lead installation teams will need to have much more extensive knowledge than entry-level installers, and recognising their knowledge through accreditation may encourage people to see a career path in insulation.

The Project Team recommends at least four types of training and accreditation.

Recommendation 1:
Review and refine entry-level training and accreditation for installers

Insulation installers should undergo basic training relating to the safe and effective installation of insulation before they undertake any installation work. The Royal Commission in the Home Insulation Program recommend that *"there should be a minimum standard of qualification which applies in all jurisdictions for any worker entering the roof cavity"* (14.15.9). [36]

There are currently a number of formal training units that could provide important skills relating to the safe and effective installation of insulation, including:

- - CPCCWHS2001 Apply WHS requirements policies and procedures in the construction industry;
- - CPCCCM2012 Work Safely at Heights;
- - CPCCOM1015 Carry out Measurements and Calculations;
- - CPCCPB3014 Install bulk insulation and pliable membrane products; and
- - CPCCPB3027 Install ceiling insulation.

Industry (ICANZ, IA, relevant trade associations and independent insulation companies) should collaborate with governments to select, review and potentially refine a number of existing formal training units over the next 12 to 24 months and agree to a set of units that would provide a solid foundation for someone starting out in insulation installation. Ideally, the outcome of this review would define what is nationally recognised as the minimum training required for safe and effective installation of insulation. This review should also consider whether part of this training could be delivered online in order that training can be delivered flexibly and at lower cost.

Ideally, several Registered Training Organisations could deliver these training units, which would provide a geographic diversity of training providers while ensuring that industry can be confident that any trained installer has the key skills for safe and effective installation.

36 Hangar, I. 2014 *Report of the Royal Commission into the Home Insulation Program*, Commonwealth of Australia, page 317.

Individuals that have completed this training should be accredited by one or more organisations, to make it easier for builders, governments and other parties to identify if an individual has the appropriate skills to install insulation. The Project Team notes that the Clean Energy Council currently accredits installers who have undergone training in insulation installation by the AWCI. Depending on the outcome of the review of insulation training units, a potentially updated version of the Clean Energy Council's accreditation system could provide value as one of a number of formally recognised accreditation systems.

Recommendation 2:
Develop additional training units for installing particular types of insulation

Industry (ICANZ, IA, relevant trade associations and independent insulation companies) and governments should collaborate to develop additional formal or informal training units that could be completed by installers once they have completed the basic insulation installation training. These units would cover specific types or aspects of insulation, such as pumped wall cavity insulation and structural insulated panels.

Recommendation 3:
Develop a competency-based 'Insulation Professional' certification

All insulation installers should have a basic level of knowledge before they start installing insulation. However, a much higher level of knowledge is required to ensure that insulation is installed with excellence in accordance with the directions of the latest versions of the NCC, BASIX and *Australian Standard (AS) 3999 - Thermal insulation of dwellings – bulk insulation – installation requirements*. All insulation installations should be overseen and signed-off by people with significant experience in insulation.

Industry and governments should collaborate on a competency-based certification for people who oversee the insulation of installation. This certification could potentially be based on an online test and/or practical demonstration of existing knowledge, rather than requiring experienced installers to undertake training. As long as they can demonstrate having the relevant knowledge, individuals from a range of trades and professions should be eligible to seek certification, including insulation installers, builders and building surveyors. This would enable the construction sector to use a variety of approaches for leading insulation installation.

Recommendation 4:
Integrate basic information on insulation in the training and Continued Professional Development (CPD) of selected trades

A number of trades and professions interact with insulation before and after it is installed. The Project Team received substantial advice that these trades often undermine the integrity of insulation after it has been installed, for example electricians removing insulation so that they can install wiring and then not properly reinstalling it afterwards. Basic information on insulation should be integrated into the training and continuing professional development of these trades, noting that this would need to be complemented by other measures that create incentives for workers to maintain the integrity of insulation (e.g. building assessors reviewing the quality of insulation in a building prior to signing its Certificate of Occupancy).

8.3 Installation of insulation in building retrofits

Background to recommendation 5

A variety of insulation programs around the world, such as New Zealand's Warmer Kiwi Homes, provide guidelines and documents to support insulation installation. Developing a set of national model guidelines and documents would support governments and industry to improve the safety and quality of insulation installation, regardless of whether these processes are adopted on a voluntary, incentivised or mandatory basis.

These documents could be built off existing documents, such as the current version of *AS 3999 Thermal insulation of dwellings – bulk insulation – installation requirements*. However, the version that is current as of writing this report, AS 3999-2015, is not a particularly accessible document. In addition to the recent video guides produced by ICANZ, key elements of the standard could be turned into simple user-friendly guides and documents.

Recommendation 5:
Develop national guidelines and documents for insulation retrofits

In order to reduce costs and support national harmonisation, governments and industry should work together to develop a national set of model guidelines and documents to support insulation installation. These guidelines and documents could be a voluntary resource for the private sector but following the guidelines should be mandatory for retrofits that are supported by governments (see Recommendation 7). The guidelines and documents would include:

- **'Pre-Installation Assessment' processes and documents**
  A Pre-Installation Assessment is where an Insulation Professional visits a site to assess the safety issues associated with the site and identify the suitable products for retrofit. The process guidelines should specify a number of matters, including that if an Insulation Professional identifies any potentially significant electrical issues at the site (e.g. the absence of a Residual Current Device), they should engage an electrician to remedy these issues prior to insulation installation;
- **'Pre-Start Checklist' processes and documents**
  On the day of the installation, all staff that will be involved in the installation process should complete a Pre-Start Checklist that includes checking off on any of the safety issues that were identified in the Pre-Installation Assessment;
- **Guidelines for insulation installation**
  Guidelines for installation should build off existing work, including the current version of *AS 3999 Thermal insulation of dwellings – bulk insulation – installation requirements*;
- **Methods for documenting completed installation**
  The guidelines should specify one or more options for rapidly documenting completed installation, including taking date- and location-stamped digital images of the installed insulation;
- **Quality assurance processes and documents**
  A relevant Insulation Professional should either visit the site or view photographs to confirm that the installation was undertaken in accordance with relevant standards.

Background to recommendation 6

There is an existing standard for insulation materials, *AS/NZS 4859.1:2018 – Materials for the thermal insulation of buildings*. The experience from overseas is that it is important to verify whether insulation products meet relevant standards, and this becomes significantly more important once complex composite products start to become common in the market, such as Structural Insulated Panels.

Recommendation 6:
Industry to maintain a list of products that have been verified to meet the current version of *AS/NZS 4859.1 Materials for the thermal insulation of buildings*

Industry, with the support of government, should develop and maintain a list of products that have been verified to meet AS NSZ 4859.1. This list would be a voluntary resource for the private sector, but governments should mandate the use of products from the list for retrofits that are supported by governments (see Recommendation 7).

Background to recommendations 7, 8 and 9

In Germany, Ireland, the UK, the US and New Zealand, government programs that provide grants for the retrofit of insulation all require insulation installers to conduct installations in accordance with clearly specified processes and they require the use of accredited individuals and/or companies. It is clearly in governments' interest to ensure good outcomes from any retrofit that they support but, equally importantly, this provides governments with an opportunity to support the development of a more effective insulation retrofit industry.

Individuals and companies will only adopt voluntary training and quality control processes if they see an incentive to do so. There are currently a number of high-quality insulation companies that have adopted training and quality-control processes as differentiators in the market, but wider uptake has, to date, been extremely low. For example, the Clean Energy Council's *Accredited Insulation Installer* program commenced in 2014, but less than 27 people have been fully accredited under this program over the last six years. While there are potentially options to lower the effort of obtaining and maintaining this accreditation, the main reason that so few people have obtained accreditation is that there is very limited demand for installers to have accreditation.

This approach of governments 'leading the way' by adopting good standards of quality control was seen in all the international case-studies that the Project Team examined.

Recommendation 7:
Public programs to require the use of quality installers, processes and products

Australian governments should commit that, where they commission or support retrofitting of insulation (e.g. retrofitting insulation into public housing or providing support through grant programs), they will require:

- All insulation installers to have undergone basic installer training and hold the relevant qualification or accreditation proposed under *Recommendations 1 and 2*;
- All insulation upgrades to be overseen and signed off by a certified Insulation Professional, in line with *Recommendation 3*;
- The use of best-practice processes set out in *Recommendation 5*; and
- All products should be verified to meet the current version of *AS/NZS 4859.1*, as per *Recommendation 6*.

Noting that these systems will take some time to put in place, in the meantime governments should work with industry to use existing or easily-developed resources to deliver good practice in insulation installation. For example, in advance of the review of current installer training programs, governments could require that insulation installers that work on public housing upgrades have secured insulation installer accreditation from the Clean Energy Council.

Recommendation 8:
Public programs to require the use of companies that are pre-approved to install insulation

While skills are held by individuals, processes are typically committed to and implemented by companies. Where government programs support the installation of insulation, they should only use insulation installation companies that have been pre-approved and commit to:

- Use trained and accredited installers and insulation professionals;
- Follow best-practice processes set out in *Recommendation 5*;
- Conduct an in-house quality assurance process; and
- Provide a guarantee of the quality of insulation materials and installation.

Recommendation 9:
Commission independent audits on insulation installations completed under government programs

Where government programs support the installation of insulation, they should undertake or contract independent providers to conduct spot-audits on a sample of installations (e.g. 5 per cent). These spot audits should involve thermal imaging and physical inspection.

Background to recommendation 10

There are a number of issues that need to be considered in relation to quality and safety in DIY retrofit insulation. However, it will be difficult to consider and resolve any issues associated with DIY insulation until systems for the installation industry are in place.

Recommendation 10:
Governments to consider issues associated with 'do-it-yourself' (DIY) insulation once appropriate systems are in place for professional installers

Once appropriate systems are in place for ensuring quality and safety in professional insulation installation, governments should consider issues associated with DIY insulation.

8.4 Installation of insulation in new buildings and major renovations

Background to recommendation 11

The Shergold-Weir *Building Confidence* report identified significant shortcomings in the compliance and enforcement systems for the building and construction industry across Australia. While the *Building Confidence* report does not explicitly mention insulation installation, rectifying deficiencies in the general compliance and enforcement systems for the building and construction industry will be critical to improving the quality of insulation installation.

Recommendation 11:
Improve general compliance and enforcement systems for the building and construction industry across Australia

The Shergold-Weir *Building Confidence* report identified significant shortcoming in the overall compliance and enforcement systems for the building and construction industry across Australia. The *Building Confidence* recommendations should be implemented in a nationally harmonised form, led by Australia's Building Ministers.

Background to recommendation 12

In some jurisdictions, the people overseeing insulation installation (which could be the builder, site supervisor, insulation installer or another individual) provide building surveyors with a 'certificate of insulation' that states that insulation was installed as per relevant regulations. The requirement for a certificate of insulation varies around the country, but the Project Team is not aware of any jurisdiction requiring individuals to have particular qualifications in order to sign certificates of insulation

While the requirement for providing certificates of insulation is often informal, several insulation installation companies require their experienced staff to sign these certificates as part of the quality assurance processes. These companies require the insulation installers that they employ to take digital time- and location-stamped photos of completed insulation installations. An experienced staff member uses these images and/or visits the site to assess the quality of the installation, and then signs the certificate of insulation.

This kind of quality assurance process is essential to support quality insulation installations, as it ensures that insulation installations are reviewed by an individual with:

- Sufficient knowledge to be able to determine whether an installation is compliant with relevant standards; and
- A strong motivation to ensure that an installation meets the relevant standards.

Recommendation 12:
Improve internal quality assurance by requiring a certified Insulation Professional to sight visual evidence in order to sign a building's 'Certificate of Insulation'

Every state and territory government should require building surveyors to sight Certificates of Insulation, and should require that these certificates are only be signed off by a certified Insulation Professional (the new qualification set out in Recommendation 3), and that Insulation Professionals should certify that they have sighted visual evidence of the insulation installation. Potentially, images of the installation could also be attached to the Certificate of Insulation, and provided to both the building assessor and building owner.

Background to recommendations 13 and 14

In addition to improving internal quality control, we also need to improve independent inspection of insulation installation. There is currently relatively limited independent assessment of the quality of insulation installation in new buildings and renovations. In addition to the general issues with building inspections that are identified in the *Building Confidence* report, many building surveyors find it difficult to determine whether insulation has been installed in line with the relevant regulations because insulation is often hidden (e.g. behind plasterboard).

Recommendation 13:
Improve independent assessment of insulation installation

Governments should consider a range of measures to improve the independent assessment of insulation installation. These measures are listed in order of their cost (low-to-high) and speed of implementation, but these measures are complementary, rather than alternatives. We recommend that:

- First, builders should be required to provide time- and location-stamped photos of insulation installations to the building assessor. Photos of specific areas may be required, such as insulation around downlights. These photos could be the same photos that are provided to the Insulation Professional (Recommendation 12). This measure could be introduced rapidly and would have limited cost implications as most mobile phones have the capability to take date- and location-stamped digital images;
- Second, governments should conduct a cost-benefit study on whether building surveyors should be required to use thermal imaging equipment to determine whether insulation has been installed correctly. While thermal imaging can provide unique insights about whether there are gaps in insulation coverage, the use of thermal imaging would need to be complemented by digital images recommended above in order to determine the type and R-value of insulation that has been installed. This cost-benefit study should also examine whether blower-door testing should form a mandatory part of building inspections due to the synergies between these techniques, noting that blower-door testing is used to determine the air tightness of a building rather than the quality of insulation installation. This cost-benefit study should also examine the potential for government employed-surveyors to conduct spot audits of buildings using thermal imaging and blower-door tests; and
- Third, governments should conduct a cost-benefit study on whether building surveyors should carry out remote or in-person inspections of a building at an earlier stage of its construction (e.g. prior to plasterboard being installed) in order to help them assess whether insulation has been installed corrected. As this option is likely to be the most expensive and may not be suitable for some insulation products (e.g. insulated plasterboard), and it is recommended that the first two options are implemented before this third option is considered.

Recommendation 14:
Provide additional training to building surveyors on determining the quality of insulation installation

The insulation industry, in partnership with building surveyor organisations and governments, should provide additional training to building surveyors to help them determine the quality of insulation installations. This training should cover relevant sections of building standards (the NCC, BASIX etc) along with techniques to determine installation quality.

Background to recommendation 15

Insulation installations in new buildings are undertaken by a mix of people that specialise in insulation installation and people that undertake other roles on building sites (e.g. carpenters and plasterers). The quality of basic training varies significantly between these individuals.

Recommendation 15:
Drive the uptake of basic insulation installer training

The insulation industry, in partnership with governments, should drive the uptake of basic insulation installer training in the construction industry (in line with Recommendation 1). As a no regrets measure, insulation manufacturers, distributors and installers should work with building associations (e.g. the Housing Industry Association, Master Builders Australia and the various state and territory organisations associated with these organisations) and major builders to voluntarily commit that all insulation installations will be conducted by people that have minimum insulation installer training.

In addition to this voluntary measure, governments should conduct a cost-benefit study on requiring anyone installing insulation on a building site to have basic insulation installer training. South Australia already requires the lead contractors for insulation installation to have undergone basic insulation installer training, and other jurisdictions could consider either copying the South Australian system or adopting a stronger requirement that all installers should have minimum installer training.

8.5 Moving beyond an insulation-only approach

Background to recommendation 16

To deliver truly safe and comfortable buildings, insulation materials need to be integrated with a range of other measures, including other thermal elements (e.g. windows), airtightness, and heating, cooling and ventilation systems.

Ensuring that insulation is installed safely and with quality will contribute towards high-performing buildings, but is only part of this process. Other critical steps in delivering high-performing buildings include:

- Developing an integrated design for a new, renovated or retrofitted building; and
- Project managing the construction, renovation or retrofit.

There are already a series of processes in place to integrate a range of elements in the construction of new buildings and renovation of existing building - enhancing these existing processes should be able to deliver high-performing buildings. For example:

- Buildings are currently designed by architects, building designers or similar experts, sometimes with input from energy specialists. This process could be enhanced through additional training for existing professions and injecting more support from experts in building physics into the design process; and
- There are already individuals that coordinate construction projects and independent building assessors examine the final building. This process could be enhanced through additional training for key parties and potentially more rigorous testing of building performance, such as through blower-door testing.

There are far greater challenges facing the retrofit of existing buildings. Generally, homeowners and building managers, most of whom lack expertise in building physics, coordinate retrofits themselves by engaging a series of disparate service providers. As a result of the lack of either an integrated design or integrated installation of multiple measures to improve the performance of building measures, retrofits are often partial and significantly less effective.

The Project Team interviewed experts in Germany, Ireland, the UK, the United States and and New Zealand and found that all five countries had made significant efforts over the last two decades to develop experts and industries that could deliver integrated building retrofits at scale. To ensure that all Australians live in safe, comfortable homes, governments and industry will need to work together to develop a strategy to deliver integrated building retrofits in this country.

Potential Solution 16:
Undertake further analysis on options for integrated building envelopes

Maximising the benefits of insulation in both new builds and retrofits will need insulation to be integrated with other elements of a building's thermal envelope, air tightness and ventilation systems. Governments and industry should work together to:

- Draft a report on options to foster a market for more integrated buildings and develop an industry that is capable of delivering building retrofits at scale; and
- Communicate the need for, and benefits of, integrated building upgrades.

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