National Energy Efficient Building Project (NEEBP)

Phase 2 Project 3

Improving Compliance and Consistency in the Application of the National Construction Code Energy Performance Requirements to Class 1 and 10 Additions and Alterations

The NEEBP is led by the Government of South Australia's Department of State Development and is co-funded by all Australian states and territories through the Council of Australian Governments (COAG) Energy Council.

Date: March 2016

Disclaimers

The findings of this report do not represent the views of the Commonwealth Government, State and Territory jurisdictions nor the South Australian government as Project Manager. Rather they represent the views of independent consultants Sustainability House based on evidence collected throughout the course of this study.

The material in this document is made available for information only and on the understanding that the Commonwealth and the state and territory governments (the Participating Bodies) are not providing professional advice, nor indicating a commitment by the Participating Bodies to a particular course of action. While reasonable efforts have been made to ensure the information is accurate, correct and reliable, the Participating Bodies, and all persons acting on behalf of the Participating Bodies preparing this publication, accept no liability for the accuracy of, or inferences from, the material contained in this publication, and expressly disclaim liability for any person's loss arising directly or indirectly from the use of, inferences drawn, deductions made, or acts on in reliance on this document. The material in this document may include the views or recommendations of third parties, which do not necessarily reflect the views of the Participating Bodies, or indicate their commitment to a particular course of action.

Glossary of terms and acronyms

Addition	Extension of a dwelling's existing floor area that involves new building work subject to a building application and is approved by a building certifier.
Alteration	A change to the external building fabric of an existing dwelling that is subject to a building application and is approved by a building certifier. For the purpose of this report, it does not include minor alterations (i.e. That do not require a building application such as general repairs or maintenance to the existing dwelling).
BAB	Building Appeals Board (VIC)
BASIX	Building Sustainability Index (NSW)
BCA	Building Code of Australia
Class 1	NCC building classification for one or more building which in association constitute; ● Class 1a - single dwelling being i) a detached house, or ii) one of a group of two or more attached dwelling, each being a building, separated by a fire-resisting wall, including a row house, terrace house, town house or villa unit; or ● Class 1b - a boarding house, guest house, hostel or the like with a total floor area not exceeding 300 m² in which no more than 12 persons would ordinarily be resident. ● Class 10 - NCC definition for Class 10 buildings and structures covers; - Class 10a - a private garage, carport, shed or the like, - Class 10b - a structure such as a fence, mast, antenna, retaining wall, swimming pool, or the like, and - Class 10c - a private bushfire shelter. For the purpose of this review Class 10 only refers to Class 10a that is attached to a Class 1 dwelling.
COAG	Council of Australian Governments
CPD	Continuing Professional Development
DSD	Department of State Development
DtS	Deemed to Satisfy compliance methods (Elemental or Energy Rating)
NatHERS	Nationwide House Energy Rating Scheme
NEEBP	National Energy Efficient Buildings Project
NCC	National Construction Code
NT	Northern Territory
NSW	New South Wales
QLD	Queensland
Relocation	Moving an existing dwelling from one location to another
Renovation	Is used within this report to encompass an alteration, addition or relocation where new building work is subject to a building application and is approved by a building certifier.
SA	South Australia
SHGC	Solar Heat Gain Coefficient of glazing
TAS	Tasmania

U-value	Overall heat transfer coefficient of window systems (for glazing and its frame)
VIC	Victoria
WA	Western Australia

Contents

Executive Summary

This report provides a pathway forward to improving the energy performance of Australian housing when buildings undergo renovations. Improvements to the energy performance of the existing building during building upgrade can be a cost efficient method to raise the energy performance of the Australian housing stock.

Sustainability House surveyed stakeholders and confirmed that levels of confusion exist in the application of the National Construction Code (NCC) and state and territory regulations. The survey also confirmed that discretion applied by building certifiers undermines industry certainty and consistency.

Two case studies, a large extension in relation to the existing building and a small extension, were used to demonstrate that improving the energy performance of the existing building at the time of renovation can provide a long term benefit for the householder.

Background

The National Energy Efficient Building Project (NEEBP) seeks to improve the design and construction of energy efficient buildings. NEEBP Phase One research identified significant industry confusion with the delivery of energy efficient alterations and additions. An opportunity was identified to overcome confusion by reviewing compliance solutions in each State and Territory, with the intention of identifying a best practice model.

Objectives

As part of NEEBP Phase Two projects, this project aims to investigate whether the current regulatory framework for the compliance of residential Class 1 and 10 alterations and additions is meeting the objectives of stakeholders including; the Australian Building Codes Board (ABCB), building certifiers, energy assessors, homeowners, builders and designers.

Approach

In order to identify ways to improve compliance and consistency in the application of the NCC energy performance requirements to alterations and additions, the study involved:

- A review of regulations and measures in each jurisdiction;
- Industry feedback through discussions with key stakeholders and online surveys of private and council certifiers and energy efficiency assessors;
- Reviews of example compliance documentation in each jurisdiction;
- Case studies assessed using the Elemental DtS and NatHERS software compliance pathways. Sustainability House's RoboRater tool was used to run 1.8 million Nationwide House Energy Rating Scheme (NatHERS) comparisons for different building upgrade works.
    - Two plans were assessed in each capital city over a range of specifications.
    - Construction costs were calculated for each specification.
    - Energy costs were estimated from the NatHERS software.
    - Possible outcomes; DtS Elemental, NatHERS 6 star, the Victorian and WA calculation methods and an improved DtS option where the existing building's ceiling was insulated and weather seals were applied, were compared.
- Recommendations for changes to the NCC and state jurisdictional requirements.

Findings

This study found there is confusion and inconsistency in how the energy efficiency requirements are applied. Key issues identified include:

- NCC requirements apply to all new building works but do not apply to the existing building.
- As the NCC requirement does not apply to the existing part of alteration and addition projects, each State and Territory has developed differing guidelines and/or regulations. In some jurisdictions retrofits to the existing building are required, in some they are encouraged, while in others no mandatory or voluntary improvements are required;
- Across all jurisdictions there is significant industry confusion on the definition of alteration and addition work, as well as the content and intention of requirements;
- In many jurisdictions certifiers have discretionary powers to determine on a case-by-case basis how energy performance requirements should apply, although they have limited understanding of what the energy performance requirements are, and the relative cost-benefits of their decisions;
- Some jurisdictions regulate assessment methods and compliance requirements based on the volume or area subject to alteration and addition works; and
- Energy assessors are making incorrect assumptions around the thermal performance of the existing part of the building. In some jurisdictions there are guidelines of how to assess the existing building.

The case study results indicate:

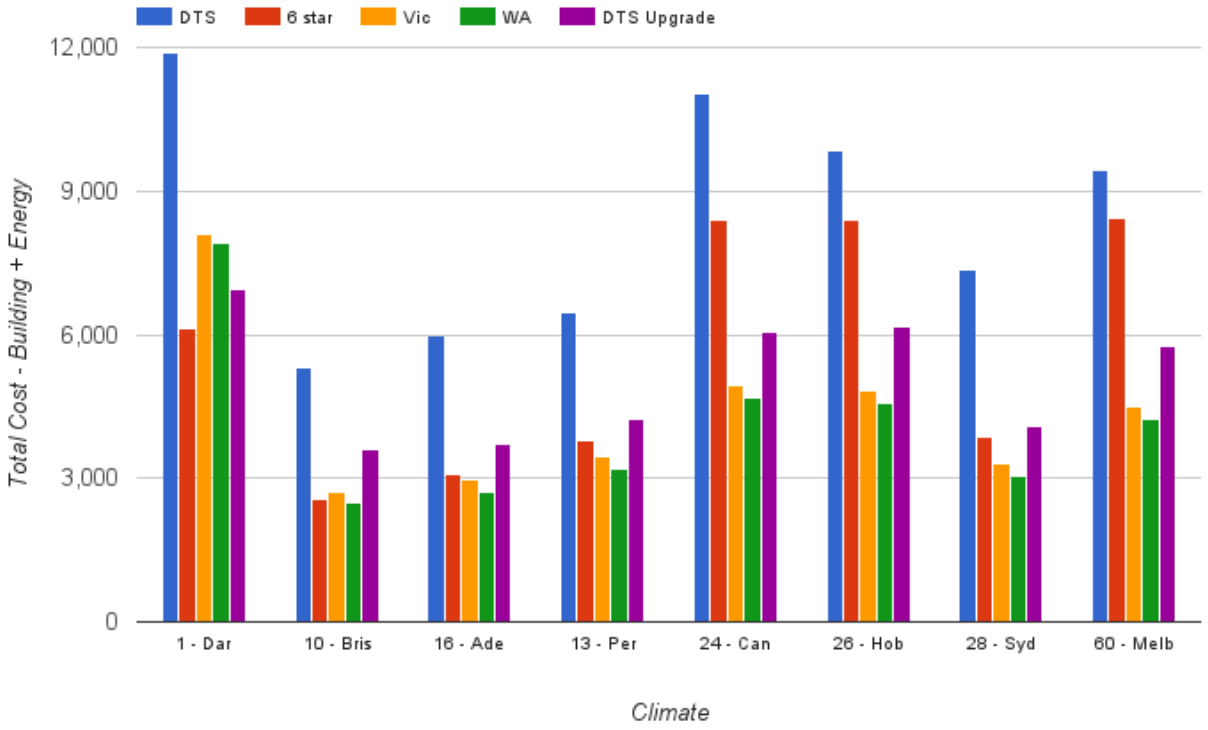
- The current methods of assessing alterations and additions have outcomes below the minimum acceptable construction standards set by the NCC; and
- Improving the thermal performance of the existing building has the potential to deliver a saving in energy costs which is greater than the construction cost. Additional insulation to the roof of the existing building was the most cost effective improvement.

As an example, the chart below shows the difference in total cost where the improvement costs are added to the heating and cooling electricity costs of one of the case studies over a 7 year period. The legend for the chart:

- DTS: The current standard practice, the existing building is left as is and the extension meets Elemental DTS
- 6 star: The least cost star rating greater than or equal to 6 stars.
- Vic: The least total cost star rating that achieved above the rating calculated using the Victorian method.
- WA: The least total cost star rating that achieved above the rating calculated using the Western Australian method.
- DTS Upgrade: The extension meets Elemental DTS and the existing part of the building meets Elemental DTS for; Roofs (3.12.1.2), and Building Sealing (3.12.3).

The chart indicates a saving in cost over the lifetime of the building for all methods compared with the addition only meeting the Elemental DTS.

Total cost - Building + Energy cost v Climate



Recommendations

The recommendation is to change the regulation to require altered and extended buildings to meet a cost effective standard of energy efficiency using methods which are: simple to apply, are similar to the methods used for new buildings, and provide both a clear Elemental DTS method and NatHERS (modelling) method.

The logical place for a national change is in the NCC. Removing the state and territory jurisdictional requirements and replacing them with NCC regulations would also further the ABCB programs of Variation Management and Code Consolidation, however as the recommendation is to improve the thermal performance of the existing building, the recommendation may need to be taken up by the states and territories.

It is proposed that:

- The Federal, State and Territory jurisdictions develop a definition of what constitutes alterations and additions work.

- An amendment is made to the Volume 2, Part 3.12 of the NCC, or to the state and territory requirements, that sets a minimum performance standard for the existing part of an alteration or addition. Particularly:
    - There is a requirement for the NCC Volume 2 Parts 3.12.1.2 Roofs, and 3.12.3 Building Sealing to apply to the existing parts of altered and extended buildings.

- A calculation method, similar to the one developed in WA, to be developed and used to calculate an amended minimum NatHERS star rating for the altered or extended part of the building. The calculation method should incorporate the age of the existing building and the relative percentage of the alteration or addition to the existing building. The amended star rating will be lower than the 6 star assessment for new buildings.

  In the case where the roof space is inaccessible the applicant can;
  - Use another method of compliance, such as verification against a reference building, or
  - Provide a cost benefit analysis to the building certifier as part of an application for a concession. As identified in NEEBP Phase One, concessions should be based on cost benefit rather than the building certifier's discretion.

- Clear and simple compliance checklists for alterations and additions to be developed and used for each stage of the compliance process.

- The state and territory jurisdictions alter their current requirements to refer to the NCC. Except in the cases of NSW and NT where similar changes are made to Building Sustainability Index (BASIX) and the NT Variation to Section 3.12.

- Energy performance requirements training to be developed and provided, particularly for certifiers and energy assessors, but also for other relevant stakeholders such as builders, architects, property owners and developers

Stakeholder benefits

Stakeholder benefits are identified for:

- ABCB - The introduction of these changes to the NCC will harmonise the treatment of alterations and additions nationally, a goal of the ABCB's Variation Management and Code Consolidation projects.
- Builders and designers - Clearer and simpler regulation potentially reducing approval times for projects.
- Building certifiers - Clearer and simpler regulation reducing approval times for projects and reducing their potential liability.
- Energy assessors - Clearer and simpler regulation and reduction of potential errors through making incorrect assessments.
- Homeowners - Potential energy saving and other benefits from increased thermal performance.

1. Introduction

1.1 Background

The National Energy Efficient Building Project (NEEBP) broadly seeks to improve compliance with the building energy efficiency requirements in the National Construction Code (NCC). NEEBP is led by the South Australian government Department of State Development (DSD) on behalf of the Commonwealth and all State and Territory governments.

Phase One of NEEBP sought extensive feedback through consultation with over 1000 industry stakeholders, regulators and policy makers across Australia to identify key systemic and process weaknesses, point of non-compliance and related issues. This initial project was delivered by Pitt&Sherry and Swinburne University of Technology, and incorporated a review of issues relating to new buildings, as well as alterations and additions.

The Phase One report provided a detailed review of issues specific to alteration and addition building projects, incorporating residential and commercial building types. Their findings relating to alterations and additions included that:

- There appears to be substantial confusion in the building industry about how and when the NCC energy efficiency requirements apply to alterations and additions;
- Responsibility for the application of the regulation devolves from the NCC to local authorities through clauses around practicality;
- The opportunity presented for energy efficiency improvements in existing buildings at the time of alterations and additions is not being realised; and
- There is a lack of industry confidence in the older versions of the energy rating tools and difficulties are experienced by energy assessors in applying rating tools to the assessment of alterations and additions.

Phase One identified that an opportunity exists to overcome confusion around the assessment of alterations and additions by reviewing compliance solutions undertaken in each state and territory and identifying a best practice model which could be adopted.

The NEEBP Phase One report provided several recommendations to improve clarity and consistency in the application of energy efficiency provisions for alteration and addition works:

- Triggers for the application of energy performance provisions to alteration and addition projects should be included in the NCC;
- The phrase ‘to the degree necessary’ is replaced with ‘to the degree cost-effective’ in the NCC;
- NCC energy performance requirements should apply to a ‘building or part thereof’;
- No area limitation to when the NCC requirements should apply to an alteration or addition project; and
- New building works is either 1) excluded from complying, 2) required to comply, or 3) required to comply, subject to a cost-effectiveness test.

1.2 What Are Alterations & Additions?

For the purpose of this review;

- 'Addition' projects are defined as new building works which extend the existing habitable floor area of an existing Class 1 and 10 buildings.

- 'Alteration' projects are changes to the external building fabric of an existing Class 1 and 10 that is subject to development approval. Between State and Territories, as well as at the local council level and individual certifiers, there is variation in what types of alteration works require development approval. This is discussed in further detail throughout this report.

1.3 The National Construction Code

The NCC sets minimum performance standards for new buildings. One of the primary goals of the NCC is to "enable achievement of nationally consistent, minimum necessary standards of relevant safety, health, amenity and sustainability objectives efficiently". The requirements are intended to provide net benefits, where the benefits to society are greater than the costs.

The NCC is structured in levels.

- Level 1, the overall Objective.
- Level 2, Functional statements setting out the requirements to meet the objective.
- Level 3, Performance requirements "outline a suitable level of performance which must be met by building materials, components, design factors, and construction methods in order for a building to meet the relevant Functional Statements and, in turn, the relevant Objectives.[1]"

The Performance Requirements of Part 2.6.1 state that "… a building must have, to the degree necessary, a level of thermal performance to facilitate the efficient use of energy for artificial heating and cooling…" In order to meet one of the core goals of the NCC, to provide a net benefit, energy efficiency requirements need to be balanced between costs and benefits.

NCC energy efficiency provisions apply to all new building works, whether construction of a whole house, or alteration, addition or relocation of an existing house as required by a jurisdictional building authority. The provisions do not apply to unaltered existing dwellings unless required by a jurisdictional building authority, such as through a change of use.

Variation Management and Code Consolidation

The NCC receives its regulatory backing through being implemented by the state and territory jurisdictions. When enacting the NCC the states and territories can and do make changes.
A nationally consistent code is an underlying principle of the ABCB Inter-governmental agreement[2].
Specific projects are:

- Variation Management, which aims to reduce state and territory variations, and

[1] http://www.abcb.gov.au/about-the-national-construction-code/the-building-code-of-australia/hierarchy-of-the-performance-based-bca.aspx
[2] http://www.abcb.gov.au/Initiatives/All/Variation-and-Harmonisation

- Code Consolidation, an intergovernmental agreement to take reasonable steps to consolidate mandatory provisions into the NCC.

Both initiatives are stated to improve industry and national productivity. This report assumes the benefits of the initiatives can be taken as read.

1.4 Renovations of the Existing Housing Stock

There is limited available data on the number and characteristics of dwellings that undergo renovations each year. The total value of work undertaken on renovations is estimated to account for about 12.5 percent of the total expenditure on residential building works (ABS 2015). HIA Economics forecast that the number of renovation projects as a proportion of new building projects will increase in the future.

The data that does exist on renovations only applies to projects that are required to undergo building development approval, as only these need to comply with NCC requirements. Development approval requirements vary between State and Territories, as well as at the council level.

Limited data also exists on the characteristics of existing housing stock and the nature of renovation projects in each State and Territory. Amongst the most comprehensive studies available was the study completed by the Victorian building regulator in metropolitan Melbourne (VBA 2013). Their findings identified that the average renovation project incorporated additions that increased the floor area by more than 60%, as well as alterations to 15% of the existing building at an average cost of $240,000. Renovation projects did not typically include sustainability features beyond NCC requirements.

In terms of greenhouse gas emissions, residential energy use accounts for about 12% of the total energy use in Australia. Of this approximately 40% of energy is used for space conditioning in homes (EES 2008). As the majority of Australian housing stock constitutes existing buildings constructed prior to the introduction of energy efficiency requirements, there are significant opportunities to reduce greenhouse gas emissions by improving the building shell performance of the existing housing stock.

1.5 Potential benefits beyond energy efficiency

The benefits of improving dwelling energy efficiency extend beyond reductions in energy use. Improved building sealing, for example, can not only improve energy efficiency but also occupant health and productivity by reducing the entry of dust, mould, toxins, moisture and pests into the home. One recent study finding, that 6.5 per cent of deaths in Australia are contributed to by exposure to cold weather, has been linked to the poor quality of Australian housing (Roberts 2015).

The NEEBP Phase One report identified that many industry stakeholders believe there is a missed opportunity in the NCC to upgrade existing buildings at the time of performing renovations, as this provides the best opportunity to regulate improvements to existing structures with an energy efficiency focus.

1.6 Research approach - Identifying the problem

This project aims to investigate whether the current regulatory framework for the compliance of residential Class 1 and 10 alterations and additions are meeting the objectives of the ABCB, including those set out in the NCC, and of other stakeholders. The research approach is to:

- Review the current building approval process for alterations and additions to Class 1 and attached Class 10 buildings in each jurisdiction, including identification of the circumstances when the energy efficiency requirements apply to alterations, additions and existing buildings.

- Obtain industry feedback from key stakeholders through conversations, online surveys and the examination of compliance reports.

- Address the issues identified by NEEBP Phase One research.

- Compare and discuss the current jurisdictional outcomes using case studies.

- If needed, write recommendations for a pathway to improve the regulatory framework to provide improved outcomes for stakeholders.

2. Review of Jurisdictional requirements and regulations

2.2 Energy Efficiency Requirements of the NCC

The NCC 2015 Volume 2 sets out construction standards for Class 1 and 10 buildings. Part 2.6 provides energy efficiency performance provisions. The Performance Requirements of Part 2.6 are satisfied by complying Part 3.12, which provides separate compliance pathways for Elemental DtS and Software DtS, using the NatHERS software.

New building work to Class 1 and 10 buildings, including alterations and additions, are required to demonstrate compliance as follows:

- Fabric, glazing & sealing - Class 1 and Class 10a buildings with a conditioned space
- Air movement - Class 1
- Services - Class 1, Class 10a and Class 10b swimming pool associated with a Class 1 or 10a building.

For the purpose of this review only treatment of Class 1 and enclosed, attached 10a buildings are required to demonstrate compliance with the energy performance requirements of the NCC. Requirements that apply to adding heating and/or pumping to an existing Class 10b swimming pool are not discussed in this report.

2.3 ABCB Supporting Information

Chapter 12 of the ABCB *Energy Efficiency Provisions for the BCA Volume Two Information Handbook 2015*, provides national guidance on the treatment of alterations and additions to an existing Class 1 and 10 buildings.

The ABCB *Energy Efficiency Glazing Provisions for BCA Volume Two* also provides some national guidance on the treatment of alteration and additions to existing Class 1 and 10 buildings. The guide advises that compliance requirements are at the discretion of the respective State and Territory Building Control Authorities, which may include consideration of existing building characteristics, as well as the type and extent of new building works.

The ABCB glazing guidelines recognise that in some climate zones and depending on the orientation of new glazing in an alteration or addition, it may be very costly or impossible to achieve compliance. Consequently an alternate method is detailed which may be acceptable in some jurisdictions. The guideline advises assessment of the new and existing dwelling as if new glazing were applied uniformly throughout.

2.3 Jurisdictional Treatment of Class 1 and 10 Renovations

Any provision of the NCC may be overridden or varied by State and Territory governments, and it is at their discretion how requirements are applied and enforced.

Each jurisdiction provides additional information on the treatment of new building works to existing buildings. In some jurisdictions regulatory requirements apply while in others guidance notes have been developed to assist in the interpretation and application of NCC requirements. Table 1 summarises the documentation that is available and whether regulatory or non-regulatory measures exist in each State and Territory.

Table 1. Regulatory and non-regulatory documents guiding the assessment of alterations and additions in each State and Territory.

Jurisdiction	Regulatory or non-regulatory	Documents
Federal	Non-regulatory	ABCB Energy Efficiency Provisions for BCA 2010 – Volume Two Information Handbook ABCB Energy Efficiency Glazing Provisions for BCA 2010 – Volume Two Information Handbook
ACT	Regulatory	Building (General) Regulation 2008 SL2008-3 Republication No. 27 Building Act 2004 A2004-11, Republication No 32
NSW	Regulatory	• BASIX Tool • BASIX Guide: Using Simulation for Alterations and Additions Version 0.4, 2 October 2013
NT	Non-regulatory	Building Advisory Services Branch Building Note Edition Number 68
QLD	Regulatory	Queensland Development Code Mandatory Part 4.1 - Sustainable Buildings and supporting Guideline
SA	Non-regulatory	Building Advisory Notice 03/12
TAS	Non-regulatory	Building Regulation Advisory Note BRAN No.4 of 2013, issued 23-12-2013, revised and updated 14-1-2015
VIC	Regulatory and Non-regulatory	• Building Regulations 2006 Regulation 608 • Practice Note 2014-55 Issued July 2014
WA	Non-regulatory	WA Alterations & Additions Protocol for Energy Efficiency in Class 1 or attached Class 10 buildings

2.4 Jurisdictional Treatment of Alterations

Many alterations don't require development approval and so are not assessed for NCC compliance. Where compliance is required most jurisdictions provide some exemptions to energy efficiency regulation for alterations to existing buildings, these are detailed in Table 2. Typically alterations are exempt if they involve minor changes to the external building fabric, such as maintenance, repair, replacing cladding or changing a window.

Jurisdictional guidance documents generally only discuss building fabric and glazing, without any reference to the other sections; building sealing, air movement and services.

Table 2. Treatment of alterations in each State and Territory.

Jurisdiction	Treatment of Alterations
Federal	All new building works must comply
ACT	Alterations must comply with NCC provisions.
NSW	Under the NSW Environmental Planning and Assessment (EP&A) Regulation 2000, developments that involve the alteration, enlargement or extension of a BASIX affected building (that is, a building that contains one or more dwellings, excluding hotel or motel), where the estimated construction cost of development is $50,000 or more, need to meet the BASIX requirements. Development for the purpose of swimming pool and/or spa with a combined size of 40,000L or more is also BASIX-affected (as Alterations and Additions). The trigger for BASIX requirements for Alterations and Additions is not directly related to type of work required (such as new framing members for walls or removal of linings).
NT	NCC energy efficiency provisions should be applied to alterations where practical and appropriate. Examples of when it is not required include when replacing or changing a window or roof cladding.
QLD	Alterations must comply with QDC 4.1 “as much as practical” where the proposed building work is subject to a building application.
SA	If the alteration is to the external fabric then where reasonable DtS should apply. If the modifications are deemed minor, such as repairing or painting of a ceiling or roof, DtS requirements do not need to be met. A modification would need to meet DtS requirements where the roof cladding or ceiling linings are removed to the whole house. The energy efficiency with alterations should not be less than the energy efficiency without alterations.
TAS	New works must comply with NCC provisions.
VIC	Alterations must comply with Performance Requirements P2.6.1 (building) and P2.6.2 (services) of the BCA Volume Two if constructed prior to the 5 star standard introduction on 1 July 2004. For Class 1 buildings constructed to the 5 or 6 star standard post 1 July 2004 alterations must ensure that the energy efficiency standard of the existing building is maintained.
WA	All new building works to Class 1 and 10 buildings to comply with NCC provisions.

2.5 Jurisdictional Treatment of Additions

The treatment of additions also varies between each jurisdiction, as detailed in Table 3. Compared to alterations, jurisdictions provide clearer recommendations that all new building works should comply with NCC requirements. However some states provide flexibility by using phrases like “as much as practical” or “at the discretion of building surveyors”.

Table 3. Treatment of additions in each State and Territory.

Jurisdiction	Treatment of Additions
ACT	Additions must comply with NCC requirements.
NSW	Under the NSW Environmental Planning and Assessment (EP&A) Regulation 2000, developments that involve the alteration, enlargement or extension of a BASIX affected building (that is, a building that contains one or more dwellings, excluding hotel or motel), where the estimated construction cost of development is $50,000 or more, need to meet the BASIX requirements. Development for the purpose of swimming pool and/or spa with a combined size of 40,000L or more is also BASIX-affected (as Alterations and Additions). The trigger for BASIX requirements for Alterations and Additions is not directly related to type of work required (such as new framing members for walls or removal of linings).
NT	Additions of partial or complete habitable rooms are required to comply with all measures for the new work. Only services are required to comply for non-habitable additions.
QLD	Additions must comply with QDC 4.1 “as much as practical” where the proposed building work is subject to a building application.
SA	Any added habitable rooms or extended portions thereof must comply with DtS provisions for the building fabric. Non-habitable rooms do not need to comply unless they are incorporated with additional habitable rooms. The energy efficiency of the addition should be not less than the energy efficiency of the building before the addition.
TAS	New works must comply with NCC requirements.
VIC	As detailed for alterations; and Extension works may only require partial compliance, at the discretion of building surveyors, if the extension is not greater than the lesser of either 25% of the floor area of the existing building or 1000m².
WA	As detailed for alterations.

2.6 Jurisdictional Treatment of Existing Parts of Altered Dwellings

The treatment of existing Class 1, as detailed in Table 4, varies between jurisdictions, from jurisdictions with no retrofit requirements to jurisdictions requiring upgrades where the alteration and addition works represents more than 50% of the existing floor area. In many jurisdictions energy efficiency requirements apply when a structure is changing to a Class 1 or being relocated.

Table 4. Treatment of existing dwellings in each State and Territory.

Jurisdiction	Treatment of Existing Dwellings
Federal	The existing building is not required to comply unless it is subject to new building works.
ACT	If substantial alterations are made to the existing building then the whole building must comply with NCC energy efficiency requirements. Substantial alterations are defined as more than 50% of the volume of the original building, including alterations made during the previous 3 years immediately before the day the application for building approval. The unaltered walls/ roof/ suspended floors of a substantially altered building need not comply if complying would require removal of more than 10% of walls/ roof/ suspended floors, or there is insufficient cavity space to accommodate insulation to achieve the R-value requirement. External glazing to the existing building is required to comply if it is not isolated from the addition. For example, where a living zone is extended onto a kitchen and forms part of the same zone, without doors to separate the zones, the existing kitchen glazing must comply with the Building Code Volume 2, Part 3.12.2.
NSW	The EP&A Regulation does not have any reference to “Major alterations and/or additions”. “Major alterations and/or additions” can be understood as > 50% volume of the original building (as per ACT and VIC). However, the definition of BASIX-affected Alterations and additions based on construction value can apply even if the volume of work is < 50%. With a 4-bedroom house of say 250m2 for example, the addition of another room (say 10% of the original volume) can trigger BASIX requirements when the cost of construction >= $50k.
NT	No modifications are required for the existing part of a dwelling unless changing from a Class 10 to a Class 1, in which case compliance is required with all energy efficiency provisions.
QLD	Where the proposed building work represents more than 50 percent of the existing dwelling’s volume, the building certifier has discretion to apply current building assessment provisions. This discretion can be used when

	applying relevant energy efficiency requirements under QDC 4.1 for an alteration, addition or relocation.
SA	Depending on modifications and compliance method used upgrades to the existing building may be advised.
TAS	Existing buildings are not required to be upgraded at the time of alteration and addition works.
VIC	Upgrades are not required to the existing building unless the volume of the any new works completed within the previous 3 years represents more than 50 per cent of the volume of the original building, then both the existing and alterations work should comply with the requirements. Where there is access to the roof space ceiling insulation should be installed to the existing building. Similarly, where sealing to the existing building is practical and achievable it should be undertaken.
WA	All new building works to comply with NCC requirements. The existing building is required to comply with the NCC if changing building classification (e.g. Class 10 to Class 1).

2.7 Jurisdictional Treatment of Class 10

Table 5. Treatment of enclosed and attached Class 10 buildings in each State and Territory.

Jurisdiction	Treatment of Class 10 Building
ACT	Class 10 buildings are required to comply with NCC provisions
NSW	Class 10 buildings are required to comply with NCC provisions
NT	Class 10 building with a conditioned space should comply with new building works requirements as detailed for alterations and additions.
QLD	Enclosed and attached garage to a Class 1 building is required to meet QDC 4.1.
SA	The addition of an attached Class 10 building requires insulation to the ceiling/ roof if the roof area is not separated from the existing building. Conservatories/ sunrooms are not required to comply with energy efficiency provisions provided the thermal performance of the existing building is not compromised.
TAS	Requirements for new building works apply to non-habitable outbuilding with a conditioned space.
VIC	Class 10a buildings with a conditioned space should comply with NCC provisions.
WA	All new building works to Class 10 buildings to comply with NCC provisions.

3. Energy Efficiency compliance methods

Documentation demonstrating compliance with the energy efficiency requirements is completed before construction commences. The building authority, the council or private certifier, determines whether the information presented is accepted as demonstrating compliance with the NCC or jurisdictional requirements.

Completing the energy efficiency requirements is done by a number of industry professionals or their staff, including; accredited and non-accreted energy assessors, builders, building designers, architects, homeowners, building product manufactures and building surveyors.

To date the majority of energy efficiency assessments have been done from information supplied in the form of written documentation. Generally the people creating the documentation do not visit the site.

The Certificate IV in NatHERS assessment is in the process of becoming a requirement for accredited energy assessors using the NatHERS software to issue star rating assessments. The Cert IV includes sections on site visits and methods of drawing up existing building in preparation for entry into the NatHERS software.

In the discussion of compliance methods below it is assumed that the provider of the documentation and building authority can correctly identify the requirements. Additionally it is assumed that the correct information is provided.

3.1 NCC compliance methods

The NCC applies to all new building work unless a dispensation has been given by the building authority. Changes to the existing building are determined by its jurisdiction.

Assessment tools, principally the NCC glazing calculator and the NatHERS software, require a whole building or whole floor to be assessed, blurring the division between new and existing work.

There are a number of ways a building, new or altered, can show compliance with the NCC Vol 2 Performance requirement P2.6.

The available methods include:

- **Deemed to Satisfy** - ***Elemental***
- **Deemed to Satisfy - *Energy Rating (software)***:
- **Alternative Solutions:**
    - ***Verification using a reference building (V2.6.2.2)***
    - ***Other Verification Methods***
    - ***Expert Judgement***

3.1.1 Deemed to Satisfy - Elemental

Compliance is demonstrated by meeting the minimum insulation levels and external glazing compliance is demonstrated by meeting the glazing calculator. Requirements also apply to building sealing, air movement and services.

This method is inflexible as each aspect, the roof, walls, floors and glazing needs to meet a minimum performance requirement. There is no option to trade performance above the minimum in one aspect of the building with another aspect which is lower than the minimum.

The most recent increase in stringency was introduced in BCA 2010. Buildings constructed before this can have trouble meeting the minimum performance levels in a cost effective manner.

Generally the building industry has decided it is not cost effective to increase the performance of:

- Walls, where adding insulation is not possible, as in cavity masonry construction, or the perceived cost of the removal and replacement of cladding or internal linings.
- Ceiling and roofs, where adding insulation is not possible due to lack of space.
- Glazing where the removal and replacement is required.

<u>Glazing</u>
After roof insulation, glazing is the most influential single aspect influencing building thermal performance.

The NCC sets minimum levels for glazing insulation and solar heat gain for glazing using a complex calculation formula. A glazing calculator spreadsheet is supplied to simplify the process.

The glazing calculator is intended to be applied to a “whole storey” of a house. The ABCB guidance notes (ABCB 2015) advise that the glazing of the existing dwelling is assessed “as if the new glazing were uniformly applied to the whole storey, but to require complying glazing to be installed only in the alteration or addition”.

This approach allows a complying glazing specification to be applied for the whole storey of the dwelling in the compliance documentation, but only installed to the addition. The cost of removing and replacing existing glazing is generally considered to be unfeasible. However the final building thermal performance will be below the minimum standard set by the NCC.

In addition, where no north facing glazing is included in the calculation it may be difficult to achieve compliance as heavy favourable weighting is given to the presence of northern glazing. In these cases the building either needs to get a concession from the building authority or use another method to show compliance.

<u>Air-leakage and services</u>
Other aspects of building energy efficiency beyond the structure are required for new buildings to comply with the DTS requirements. These include:

- Building sealing: stopping unwanted air-leakage from doors, windows, exhaust fans and other penetrations.

- Air movement: ensuring sufficient ventilation is available. This is also covered in NCC Vol2, Section 3.8.5 Ventilation.
- Services: including lighting, insulation of ductwork and hot-water heating.

3.1.2 Deemed to Satisfy - Energy Rating Method

The Nationwide House Energy Rating Scheme (NatHERS) uses predictive modelling software to meet or exceed whole-of-house annual energy usage targets. The software takes building design and specification inputs, and calculates a star rating using a climate file, estimated comfortable temperature ranges, usage patterns and starbands. The star rating is from 0 to 10 stars with a 10 star building expected to be comfortable all year with no external heating or cooling.

For dwellings that comply using this method, the whole house, including new building works and the existing structure, must be assessed using accredited NatHERS star rating software.

Software assessment is more flexible than the Elemental DTS method, as the software assesses the whole building rather than the constituent parts

The NCC sets a minimum star rating requirement of 6 Stars in most jurisdictions. In some climate zones and jurisdictions, such as Climate Zones 1 and 2 under the NCC, and in QLD, optional credits can be used towards meeting the energy equivalence requirement (via a compliant outdoor living area and/or a photovoltaic (solar) energy system).

The state and territory jurisdictions encourage the building surveyors to only accept NatHERS certificates from accredited energy assessors. Accredited assessors are professionals who are accredited by an Accrediting Assessor Organisation. Training for accredited assessors is in the process of being changed to require a Certificate IV in NatHERS assessment (Cert IV). The Cert IV includes a requirement for skills in investigating and drawing existing buildings.

Energy ratings on alterations and additions are problematic. Issues can include:

- Assessments from un-trained or non-accredited assessors
- Existing building can perform poorly, reducing the overall efficiency, particularly if constructed before energy efficiency requirements were part of the NCC.
- Costs involved with upgrading existing buildings.
- Incorrect assumptions of construction and materials of existing buildings. This can include factors such as missing, old or removed insulation, shading from adjacent buildings and incorrect assumption of air-leakage. For accredited assessors these assumptions should be reduced where an accredited assessment is requested after the introduction of the Cert IV.
- Where older buildings are being altered or extended one common requirement of homeowners is increased glazing for light and ventilation. This can lead to large glazing areas in relation to the floor area of for the alteration or addition leading to poor thermal performance and low star rating.

It is possible to correct each of these issues, but they can meet resistance by differing from client intentions or are deemed to be too expensive.

A NatHERS software assessment is done on a whole building. Where the building does not meet the mandatory minimum changes need to be made to the design or specification to increase the buildings thermal performance to meet the minimum. With an altered or extended building the design of the existing part of the building is fixed and the specification exists. Changes to improve the specification of the extension may not improve the thermal performance of the whole building sufficiently to meet the mandatory minimum.

There has been industry acceptance that it is not reasonable to ask the homeowner to renovate the existing building to meet the thermal performance requirement. Such renovations could involve removing and replacing existing windows or adding insulation to solid walls.

There have been two methods put forward to address this issue;

- In SA and TAS it is possible to conduct the NatHERS assessment with materials which have improved thermal performance to the whole building, but only require the improved thermal performance materials to be used in the extension or alteration leaving the existing building as is.

  The issue with this method is that the house receives a 6 star assessment for a building which performs below the 6 star level. This could be a serious issue in the future if disclosure of the energy performance of the building becomes a national requirement. In that case the owner of the upgraded building would assume their building is at 6 star whereas the actual performance may be much lower.

- In Vic and WA where methods have been devised to give the altered building an adjusted star rating for the completed building. Both methods use the age of the existing building and the relative size of the alteration in the calculation.

3.1.2.1 NatHERS Modelling Protocols

In addition to the training accredited assessors receive, the NatHERS administrator publishes Technical Notes which provide some guidance on how to model alteration and addition projects. The information advises that:

- Accredited NatHERS software assessors should use the software in regulatory mode for assessing buildings.
- NatHERS software tools must assess a whole building, not a part of a building, and
- State and territory jurisdictions have alternative modelling methods

3.1.2.2 NatHERS Modelling Assumptions

The absence of complete or reliable information has presented a major issue for assessors attempting to model the existing building.

Based on a review of example compliance reports from each jurisdiction and discussions with assessors across the country, a range of assumptions are currently made about the existing building specifications when using NatHERS modelling software. In some jurisdictions, assessors do not make any assumption, as they are advised to model the whole building as if glazing and insulation requirements were applied uniformly throughout irrespective of the existing building specifications. In other jurisdictions, such as NSW, no advice is provided but assessor's record their

assumptions and submit them with the compliance report. A review of example compliance reports identified inconsistency between information reported and assessment approaches.

The introduction of the Certificate IV in NatHERS assessment requires assessors to be able to investigate and assess additions and alterations has addressed this issue through there will also need to be a change in how energy ratings are conducted for assessors to visit site.

3.1.3 Alternative solutions

3.1.3.1 Verification against a reference building

An NCC prescribed method, V2.6.2.2 is intended to apply to whole Class 1 buildings and to an enclosed Class 10a building attached to a Class 1 building. Predictive modelling software is used to compare the proposed building with a reference building. The reference building is modelled as designed except using the DtS Elemental Provisions of Part 3.12 in accordance with 3.12(a)(ii).

This is one of the most poorly understood of the assessment methods. Survey feedback indicated that more than 80% of assessors never use this compliance method for the assessment of alterations and additions, although it provides more achievable energy performance standards than the Energy Rating method and is not restrictive for certain designs or construction types like the Elemental method. V2.6.2.2 provides a flexible modelling approach which can be readily applied to the assessment of alteration and addition projects.

Using software to model the reference and proposed building can lead to the same issues with assumptions and incorrect data outline in section 3.1.2.2 above.

3.1.3.2 Other verification methods

In theory, any building construction or specification that can meet the NCC performance requirement and can be documented to show compliance is acceptable. In practice the building certifiers can be reluctant to take responsibility for new, innovative methods especially if there is no clear chain of responsibility. The NCC is moving towards a performance based code and new verification methods may be introduced in the future

3.1.3.3 Expert Judgement

Judgement by an expert who has the qualifications and experience to determine whether a Building Solution complies with the Performance Requirements. Survey feedback from certifiers in WA, QLD, SA, NSW and Vic indicated that expert judgement is used at least some of the time in these jurisdictions. No example reports were obtained to demonstrate the application of this compliance method to an alteration and addition project.

3.2 State and Territory compliance methods

In most jurisdictions all of the NCC compliance methods can be used, although the guidance documentation often creates confusion around this by referencing some and not others. A summary of recommended energy performance compliance methods by State and Territory Regulators is provided in Table 6.

To address the issues of applying the NCC Energy Rating method to alteration and addition projects, several jurisdictions provided guidance documentation:

- SA and TAS recommend that the whole building is assessed as if glazing and insulation requirements were applied uniformly throughout, but the building constructed with performance measures to the addition only. Consequently while the building has been rated to 6 stars for compliance, it does not actually achieve this performance standard. This may cause issues for the current or future owners who may expect that the building performs at a 6 star level.

- QLD regulators recommend that when using NatHERS software to assess energy efficiency, the proposed alterations and additions are modelled including the kitchen area as a reference point (Queensland Development Code, 5.3.4 Alterations to an existing house or townhouse).

In QLD and NT when applying the expert judgement method expert consultants are nominated-from the Queensland Peer Review Panel. The appointed expert appraises available information about the proposed alterations and additions and determines whether or not a building complies.

The NSW Building Sustainability Index (BASIX) energy efficiency compliance methods for alterations and additions are similar to NCC requirements. In the majority of cases compliance is achieved using the DIY method which is designed to be approximately equivalent to DtS Elemental using BCA 2009 insulation and glazing requirements for new building works.

In some instances BASIX administrators can approve the use of the Simulation Method which is equivalent to the NCC Verification using a Reference Building (V2.6.2.2) approach. Projects can apply to use the Simulation method where there are practical or legal constraints preventing full compliance with the BASIX requirements, including heritage considerations, structural limitations, or strata restrictions in unit buildings.

The NCC methods allows alternative solutions to be developed as a compliance verification method. Two states have opted to develop alternate solutions under the verification methods: VIC and WA. These approaches are reviewed in further details below in Sections 3.4 and 3.5.

Table 6. Energy performance compliance approach by State and Territory Regulators.

Jurisdiction	Elemental	Energy Rating	V2.6.2.2	Expert Judgement/ Other Alternative Solution	State-Specific Verification Method
ACT	Yes	Yes	Yes	Yes	-
NSW	Yes - BASIX DIY	-	Yes - BASIX Simulation	-	-
NT	Yes	Yes	Yes	Yes	-
QLD	Yes	Yes	Yes	Yes	-
SA	Yes	Yes	Yes	Yes	-
TAS	Yes	Yes	Yes	Yes	-
VIC	Yes	Yes	Yes	Yes	Yes
WA	Yes	Yes	Yes	Yes	Yes

3.4 Victorian compliance method

Alterations and additions to Class 1 and 10a buildings with conditioned spaces constructed prior to 1 July 2004 can be assessed using one of several different compliance methods. These include DtS Elemental and Energy Rating, as well as Alternative Solutions, including v2.6.2.2. Buildings constructed to the 5 or 6 star standard post 1 July 2004 must ensure the energy efficiency of the existing building is maintained.

When using the Elemental method to achieve compliance, building additions are required to comply with the NCC fabric provisions for the extended portion, although partial compliance may be permitted by the building certifier if the addition is only small (25% of floor area or 1000m², whichever is less). For alteration works that include replacement of existing elements, such as roof or wall cladding or wall lining then the new works should also comply with the BCA fabric provisions.

When assessing compliance of the extension glazing using the glazing calculator, a recommended approach is to apply the glazing type for the extension uniformly to the whole storey, but only require the complying glazing to the extension. This principle can be applied when using either of the DtS methods: Elemental and Energy Rating.

Where the Energy Rating method is used to assess a building the whole building must be rated, but only the new building works are subject to requirements unless the extension represents 50% or more of the existing floor area, in which case the whole building should comply.

The Victorian Method

Where the building was constructed before 2004 and the floor area is less than 50% of the total area, two assessments are required: one to establish a star rating for the existing building and another to demonstrate that the alteration meets the minimum required overall star rating calculated using an approach unique to Victoria. The calculation method is detailed below and uses the proportional volumes of the existing building and extension to determine the overall star rating requirement.

For an addition(s)/extension(s) that impact less than 50% of the floor area in the past 3 years, the formula is:
(Ve x SRe) + (Vn x SRn) = SRr (Ve + Vn)

Where:
Ve = Existing internal dwelling volume,
Vn = New work internal volume remaining after work completed,
SRe = Existing house star rating,
SRn = New house star rating,
SRr = Required overall star rating.

For example, if Ve = 203.7 m^3 Vn = 20.8m^3 SRe = 3.2 stars SRn = 6.0 stars.
The required overall star rating (excluding any volume of new internal work (Vni)):
SRr = (203.7 x 3.2) + (20.8 x 6.0) (203.7 + 20.8) = 3.5 star requirement.

For alterations to an existing dwelling including internal works, the formula becomes:
[(Ve – Vni) x SRe] + [(Vn + Vni) x SRn] = SRr (Ve + Vn)

Calculation including internal works in existing building:
Ve = 203.7 m^3 Vn = 20.8m^3 Vni= 35.6m^3 SRe = 3.2 stars SRn = 6.0 stars

The required overall star rating (incl. the Vni):
SRr = ((203.7 - 35.6)x 3.2) + ((20.8 + 35.6)x 6.0) (203.7 + 20.8) = 3.9 star requirement.

The adjusted minimum performance requirement should give an indication of the thermal performance of the altered building. While the adjusted star rating is lower than the 6 star minimum performance requirement set by the NCC, it doesn't raise expectations of performance for the homeowner or subsequent purchaser as is the case is the case with the SA & TAS method.

3.5 Western Australian compliance method

Alterations and addition projects in WA can choose to comply under alternate methods set out in the Protocol, or another alternative solution or the DtS provisions. The three methods described in the Protocol are:

1. Elemental Provisions option - applies targets to provide reasonable allowances for the likely performance of the existing building; and
2. NatHERS option - an alternate star rating method using NatHERS software that reduces the total star rating requirement from 6 stars. This approach allows the whole-of-house star rating method to be applied when it may not be cost-effective or feasible to improve the existing building to achieve 6 stars.

3. Services option – applies targets to BCA Part 3.12.5 that make reasonable allowances for the likely performance of existing services.

The NatHERS option of the Protocol sets out an alternative calculation method that makes reasonable allowances for the likely performance of the existing building when undertaking alterations and/or additions of Class 1 and 10 buildings.

In an approach similar to the Victorian method, for the NatHERS option an area weighted adjustment factor is used to calculate a proportional star rating which considers the total areas of the existing building and new works. The area weighting adjustment star rating for the existing building varies according to building age:

- Existing area approved before 1 May 2004 - 2 stars;
- Existing area approved before 1 May 2006 - 3 stars;
- Existing area approved before 1 May 2012 - 4 stars.

The area weighted adjustment factor only applies to dwellings when the alteration or addition is greater than 10% and no more than 80% of the dwelling. When the affected proportion exceeds 80% the whole building is required to achieve a star rating no greater than that equivalent to requirements of BCA 3.12.0.1. When the affected proportion is less than 10% the target star rating for the whole building is reduced to 2, 3 or 4 stars depending on the existing area was approved, in accordance with dates outlined above.

By applying a minimum performance requirement to the existing building, the WA approach encourages energy performance improvements to the existing building. This is also a simplified approach when compared with the Vic method as the required star rating can be calculated easily, without relying on the initial star rating to determine the required rating.

4. Discretionary powers of Building Certifiers

In all State and Territories it is the responsibility of building certifiers to provide building approval, inspections and certification. In some states certifiers are also permitted to produce energy efficiency compliance reports and other compliance documentation, in addition to the approval.

In some jurisdictions certifiers are employed by councils, in some jurisdictions certifiers are privately employed, while in others regulators permit both private and council certifiers to operate.

Most jurisdictions permit some level of discretionary powers for certifiers to determine the appropriate level of compliance for the new works and/or existing structures, as summarised below in Table 7.

In some jurisdictions, certifiers are recommended to exercise their professional judgement and consider factors such as cost-benefit, technical impracticability and difficulty in applying their discretion. Certifiers are recommended to prioritise health and safety, while given greater flexibility to interpret and apply sustainability requirements so as to not provide an unreasonable requirement where the benefit is outweighed by the cost.

Table 7. A summary of the degree of discretionary powers of certifiers in each State and Territory

Jurisdiction	Discretionary Power of Certifiers
ACT	None
NSW	Limited discretionary powers
NT	Flexibility to interpret and apply NCC requirements for new works
QLD	Is determined on a case-by-case basis, particularly the extent to which the existing structure needs to comply with QDC 4.1.
SA	“Appropriate level of compliance” determined by certifier in accordance with SA guidelines
TAS	Unclear from guidance documents
VIC	Regulation 608 provides certifiers with powers to permit partial compliance, which can be applied to both the new and existing structures
WA	Limited discretionary powers

Survey feedback from certifiers indicated that they exercise these powers in a number of circumstances including:

- heritage buildings where requirements cannot be implemented;
- for minor alterations such as internal changes to one window;
- when the requirement seems unreasonable; and
- where jurisdictional regulations and guidelines allow them to, which may extend to all aspects of the new building works and existing structure.

The benefits of this approach are suggested to include flexibility for applicants to achieve realistic energy efficiency performance outcomes which consider individual variations in existing dwellings and renovations projects, as well as conflicting requirement such as heritage listing. Nearly three-quarters of certifiers reported that they consider design and construction limitations in older dwellings when considering energy efficiency compliance requirements for alterations and additions.

Industry concerns have also been raised throughout Australia in allowing flexibility in the application of regulatory requirements. The Phase One NEEBP report suggested that “discretion creates uncertainty, and potentially scope for pressure to be brought to bear upon parties to exercise discretion in a particular direction”. In many jurisdictions building applicants can nominate a private certifier who may risk future work opportunities if applicants perceive that the certifier is not lenient enough. Ten per cent of survey respondents, spanning VIC, ACT, QLD and NT, reported that they consider relationship maintenance when applying discretionary powers to determine energy efficiency compliance requirements for alteration and addition projects.

Flexibility for certifiers to determine compliance requirements on a case-by-case basis also raises questions about how closely outcomes align with NCC performance requirements and optimise cost-benefit outcomes. Industry feedback indicates that most certifiers have received limited training, if any, in the relative energy performance impact of building design features and their costs to understand the ramifications of their decisions. Survey feedback indicated that certifiers often seek advice from energy efficiency assessors about regulatory requirements; however industry feedback indicates that seldom do certifiers seek advice on relative performance benefits when applying their discretionary powers.

In addition to discretionary powers of certifiers, in Victoria the Building Appeals Board (BAB), an independent statutory body established under the Building Act, has the power to waive, modify or vary the provisions of the Regulations and the NCC on a case-by-case basis, including those relating to energy efficiency. If the certifier does not grant application for partial compliance, review by BAB can be requested by the applicant.

5. Educational material and advisory services

Survey feedback from energy assessors and certifiers - the two stakeholder groups with the greatest responsibilities to understand and apply energy efficiency requirements to Class 1 and 10 buildings, indicated that there is significant confusion about requirements and measures. Half of certifier e-survey respondents reported that they find energy efficiency requirements and measures complex and difficult to understand. This perception was also shared by more than half of energy assessors, despite their high level of experience as assessors with more than 80% of e-survey respondents having worked in their profession for five or more years.

Certifiers reported that they most commonly seek clarification on energy efficiency compliance requirements for alterations and additions from the following sources;

- NCC (86%),
- Jurisdictional regulations and measures (58%),
- Energy efficiency consultants (58%),
- ABCB guide notes (30%),
- Work colleagues (30%),

- Internet (20%), and
- NatHERS Technical Notes (20%).

Energy assessors reported that they seek clarification from;

- NatHERS Technical Notes (76%),
- NCC (75%),
- Jurisdictional regulations and measures (63%),
- ABCB guide notes (46%),
- Internet (30%),
- Work colleagues (19%), and
- Local council (17%).

It is interesting to note that while more than half of energy assessors reported that they find regulations and measures complex and confusing, certifiers regularly seek clarification on requirements from them. This highlights the need for improved clarification and education material to guide on energy efficiency regulations and measures for renovations.

Energy assessors are trained in the use of NatHERS software, but in the past have not received the same level of training in the NCC or state or territory requirements.

In some jurisdictions advisory services are available to certifiers, applicants and the broader construction industry. In SA certifiers can seek an expert opinion from the Building Rules Assessment Commission about the application of regulations for a fee of $461. In NSW a free BASIX helpdesk service is made available via phone, email and post to advise on the appropriate application of the Simulation method and answer other queries.

The response from the surveys can be seen in Appendix D.

6. Upgrades to Existing Buildings

Although existing building upgrades are not required in most jurisdictions when undergoing alterations and additions, some jurisdictions suggest voluntary changes are adopted. In Victoria guidelines encourage ceiling insulation and building sealing improvements where practical and achievable. In Tasmania ceiling and floor insulation upgrades are advised where accessible, particularly adjacent to new building works.

Addition projects often increase the volume of buildings that are subject to space conditioning and therefore the amount of energy required for heating and cooling. Unless retrofit improvements are made to increase energy efficiency of the existing building shell, then it is likely that the outcome will be increased building energy use irrespective of energy performance requirements for the new building works. This is one reason to consider adopting retrofit requirements for the existing building in future NCC or jurisdictional requirements.

There are a range of retrofit options that could feasibly be applied to the existing building to improve energy efficiency and reduce greenhouse gas emissions, including:

- Measures to improve building shell performance, such as insulation (roof space and where feasible, external walls), shading and improving air tightness;
- Upgrading services by replacing inefficient lighting, space conditioners, hot water systems; and
- Installation of solar PV or other improved energy supply options.

Survey feedback from assessors and certifiers as to what upgrades to the existing building they considered to be reasonable to require as part of the building approval for Class 1 dwellings varied significantly between assessors and certifiers. While assessors provided strong support for a range of retrofits, certifiers indicated limited support for potential retrofit requirements to the existing dwelling.

Assessors provided strongest support for existing building retrofits which add ceiling insulation and improve building sealing and air tightness, including sealing wall vents and other cracks and gaps, self-sealing exhaust fans and sealing around windows and doors.

Of the proposed upgrade options, certifiers provided the strongest support for adding ceiling insulation, with more than 90% indicating that they believed it should be added in at least some instances.

A common reason cited by building certifiers to avoid energy efficiency requirements for the existing building was costs and difficulties in applying retrofits to the existing building.

There is also a danger in adopting more stringent regulations for alterations and additions which discourage renovations or applicants to demolish and rebuild rather than retain the existing structure and materials.

One certifier highlighted that reuse of existing building materials should be encouraged and “at no stage should legislation require the removal and replacement of existing building materials in order to achieve energy efficiency measures”. Replacing existing materials can detrimentally increase

greenhouse gas emissions produced in the manufacture and transportation of new building materials. However as the current energy efficiency regulations do not consider embodied energy, this should also be considered in determining cost-benefit outcomes of regulations.

Industry stakeholders identified a range of scenarios where ceiling insulation retrofits to the existing building can be onerous, particularly raked ceilings with no roof space access. However improvements to building sealing, and retrofitting of ceiling or roof insulation where the roof space is accessible, represent relatively cost-effective compliance solutions to achieve significant improvements in energy performance.

A 2011 report *The Value of Ceiling Insulation: Impacts of Retrofitting Ceiling Insulation to Residential Dwellings in Australia* found that the payback period was five or less years across most jurisdictions, although contemporary payback periods are likely to be shorter due to energy price increases since this report was published.

7. Case studies

To better understand what impact these methods have on energy performance outcomes, two case studies were reviewed in each capital city to compare outcomes under several compliance methods and potential approaches.

7.1 Methodology

7.1.1 Building plans

The plans were chosen as representative examples of typical building designs and standard practice in extensions.

The size of the extension in relation to the existing building can impact the comparative change in energy use between the extended and existing buildings. There is a change in the requirements in some jurisdictions with respect to the size of the extension in relation to the existing building.

- Case study 1 is a large extension in relation to the existing building.
- Case study 2 is a small extension in relation to the existing building.

The case studies were assessed in the FirstRate5 software.

Floor plans can be seen in Appendix A.

7.1.2 Specification choices

The existing and extended building for both scenarios was assessed using FirstRate5 software. The climates used to assess the case studies are listed in Table 8.

Table 8: NatHERS Climate Files and postcodes

Proposed Climate Files	
Location, Postcode	**NatHERS CZ**
Darwin, 800	Climate – 01
Brisbane, 4000	Climate – 10
Perth, 6000	Climate – 13
Adelaide, 5000	Climate – 16
Richmond(NSW), 2753	Climate – 28
Tullamarine, 3043	Climate – 60
Canberra, 2600	Climate – 24
Hobart, 7000	Climate – 26

Both buildings were specified as brick veneer, with a metal clad pitched roof and a concrete slab on ground floor. It was assumed that:

- the extended part of the building was sealed as required by the NCC; and
- the roof space of the existing building was accessible for the installation of insulation.

A range of building specification options was run using RoboRater. Independently developed by Sustainability House, RoboRater is an innovative software tool which automates building thermal simulation to test the effect of design changes. RoboRater is compatible with files from NatHERS approved software (AccuRate, FirstRate5 and BERS Pro). It rapidly assesses how a dwelling will perform with a range of construction and specification types.

More than 1.8 million results were assessed. The range of specification choices can be seen in tables 9 - 16.

Table 9 - Existing ceiling insulation options - Pitched steel roof

	Option 1	Option 2	Option 3	Option 4	Option 5
Building: Existing					
Insulation	None	R2.5	R4	R5	R6
Roof colour	Light	Medium	Dark		

(Reflective foil under the roof was not modelled)

Table 10 - Existing sealing options & ceiling fans

	Option 1	Option 2
Building: Existing		
Draft & window seals	Unsealed	sealed
Ceiling fans	None	Living areas and bedrooms

Table 11 - Existing Glazing

	Option 1	Option 2	Option 3	Option 4	Option 5
Building: Existing					
Reference	alstd	low e	al tint	al dg low e	al cp
Frame	Aluminium	Aluminium	Aluminium	Aluminium	Aluminium
Glass	Single clear	Low emission	Single tinted	Double clear/low E	Comfort plus
U-Value	6.5	4.37	6.2	3.8	4.5
SHGC	0.75	0.63	0.55	0.55	0.45

Table 12 - Extension wall options - Brick veneer

	Option 1	Option 2
Building: Existing		
Insulation	R2	R2.5

Table 13 - Extension ceiling insulation options - Pitched steel roof

	Option 1	Option 2	Option 3	Option 4
Building: Existing				
Insulation	R2.5	R4	R5	R6
Roof colour	Light	Medium	Dark	

Table 14 - Extension Glazing

	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Building: Extension						
Reference	alstd	low e	al tint	al dg low e	al cp	tim dg low e
Frame	Aluminium	Aluminium	Aluminium	Aluminium	Aluminium	Timber
Glass	Single clear	Low emission	Single tinted	Double clear/low E	Comfort plus	Double tint/low E
U-Value	6.5	4.37	6.2	3.8	4.5	1.79
SHGC	0.75	0.63	0.55	0.55	0.45	0.45

Table15 - Extension ceiling fans

	Option 1	Option 2
Building: Extension		
Ceiling fans	None	Living areas and bedrooms

Table 16 - Extension floors - Concrete slab on ground

	Option 1	Option 2
Building: Extension		
Floor insulation	None	R1 underfloor insulation

7.1.3 Material costing

Construction costs were sourced from various organisations including: Rawlinsons, Plus Spec, Kingspan, Fletchers Insulation, Fairhaven Homes, Hotondo Homes, No Gap Insulation, Technoform, Bradnams.

Painted plasterboard linings and single clear glazed aluminium framed windows have been assumed to have been installed as part of standard construction. Costs are expressed as the cost of: adding insulation, improving windows, adding ceiling fans or applying seals to the building.

While efforts were made to determine reasonable costs, feedback from previous studies has shown there is a large amount of price difference in the market. It is suggested that the costs given show the relative difference in costs of materials rather than an exact estimate.

It was assumed that the existing buildings were constructed before 2004.

Construction costs are listed in Appendix B.

Removal, improvement and restoration costs for the existing building

There is an assumption that the cost of removing internal linings to install insulation and replacing windows would impose a prohibitive cost on the project. This is the reason that building certifiers are given discretion to allow partial compliance.

In an attempt to test this assumption in the case studies it has been assumed:

- Flat ceilings with pitched roofs in the existing building allow access to install insulation.
- There will be trades on site capable of:
    - Removing, replacing and making good windows.
    - Removing, and replacing painted plasterboard to the external walls.

The additional cost estimate of the removal and replacement for:

- Plasterboard to the external walls is $49.5 /m2.
- Windows is $120 /m2.

7.1.4 Energy costs

NatHERS star ratings are indications of the potential for a building to be used in an energy efficient manner. NatHERS software predicts heating and cooling loads based on a set of comfortable temperature bands and an occupancy pattern. While it is unlikely that a real household would use exactly the same energy for heating and cooling as predicted, energy costs have been calculated and are subject to the following assumptions:

- Assumptions used in the NatHERS software. These include: Typical Meteorological Year (TMY), number of occupants and times of occupation, comfortable temperature ranges, air leakage, operability of window openings and shading.
- Accuracy of assessment of existing buildings, particularly the assumptions made regarding the existing building as indicated by the surveys conducted for this report.
- NatHERS software does assume a Coefficient of Performance (COP) of the heating and cooling plant. An all electric split air-conditioning system has been assumed with a constant COP of 3.1. This is a conservative figure, as there are more efficient units in the market.

- A flat national average retail energy price of $0.284, obtained by averaging electricity prices from the energyrating.gov.au website.
    - No attempt has been made to increase the price with CPI or to predict the future price of energy.
    - The cost of electricity for heating and cooling is assumed to be the same, where in practice cooling energy may be of higher cost due to charges for peak summer use.
- Correct installation of insulation.
- The total load has been used to calculate the energy cost over a 7 year period. 7 years was chosen as a reasonable time that a house would be lived in after renovation and before sale.

The NatHERS starbands change with climate zone, A 6 star house in Darwin has a much higher total heating or cooling load than the same 6 star house in Brisbane. NatHERS starbands are set by the NatHERS Steering Committee. This change in heating and cooling leads to changes in energy costs vary between the example climates.

7.1.5 Assessment costs

Assessing the building for compliance with energy incurs a cost. NatHERS assessments have been costed at $250 each. In the case of the Vic method there are two NatHERS assessments.

DtS assessments have been costed at $50. While consultants may charge more than $50 to assess an extension many DtS assessments are done for free by the staff of one of the industry professionals involved in the project such as the builder, designer or building surveyor. $50 has been chosen to reflect the internal cost of providing a DtS assessment of a small extension.

7.1.6 Result selection

The two main areas of interest are the:

- Overall energy efficiency of the building as represented by the star rating, reflecting the NCC Performance requirement of the efficient use of energy.
- Total cost over the building lifetime, including both construction and energy used costs, as an indication of the practicality of any proposed change.

A number of possible scenarios will be examined for comparison:

- Existing: The star rating for the existing building before the extension.
- DtS: The general current practice, where the extension meets Elemental DtS and there is no requirement to change the existing building.
- Victorian method: Calculation of the minimum star rating required in Victoria as outlined in Part 3.4 of this study.
- Western Australian method, the rating calculated using the Western Australian method, as outlined in Part 3.5 of this study.
- DTS Upgrade: A possible change to the Elemental DTS requirements where the extension meets Elemental DtS and the existing part of the building meets Elemental DtS for Roofs NCC, Vol 2 Part 3.12.1.2, by adding ceiling insulation ceiling and Vol 2 Part 3.12.3 Building sealing by adding weather seals.

7.2 Results

Results for the two case studies are presented in Charts 1 - 4, and detailed results are provided in Appendix C.

7.2.1 Case Study Results, Energy Use

Charts 1 & 2 show the star ratings for the different assessment methods for case studies 1 & 2. The legend for the charts 1 & 2 is as follows:

- Existing: The star rating for the existing building before the extension.
- DtS: The general current practice, where the existing building is left as is and the extension meets Elemental DTS.
- Vic Calc: The minimum star rating calculated using the Victorian method, as outlined in Part 3.4 of this study.
- Vic Least cost: The least total cost star rating that achieved above the rating calculated using the Victorian method.
- WA Calc: The minimum star rating calculated using the Western Australian method.
- WA Least cost: The least total cost star rating that achieved above the rating calculated using the Western Australian method.
- DtS Upgrade: The extension meets Elemental DtS and the existing building has added ceiling insulation and weather seals.

In Charts 1 & 2 it can be seen that the DtS option has a very similar star rating to the existing building. Only in Climate 10 - Brisbane for Case Study 1 does the extended building have a lower star rating than the existing building. All of the other options are a substantial improvement. The star rating for Darwin in Chart 2 is zero stars and so doesn't register on the chart.

Generally the improvement is due to the addition of ceiling insulation to the existing ceiling. For all climates but 1 - Darwin. In the NatHERS software hot climates such as Darwin perform better with reflective insulation rather than bulk insulation. Reflective insulation was not considered in the study.

There were few results in the 2.5 to 4 star range, the jump being caused by the application of ceiling insulation.

Both the WA and Vic calculation methods set a lower star rating minimum than adding insulation to the existing ceiling provides. The Vic & WA Least Cost options are the building specifications which achieved greater than or equal to the calculated star rating at the minimum construction cost.

Chart 1: Comparison of star ratings - Case Study 1 Large Extension

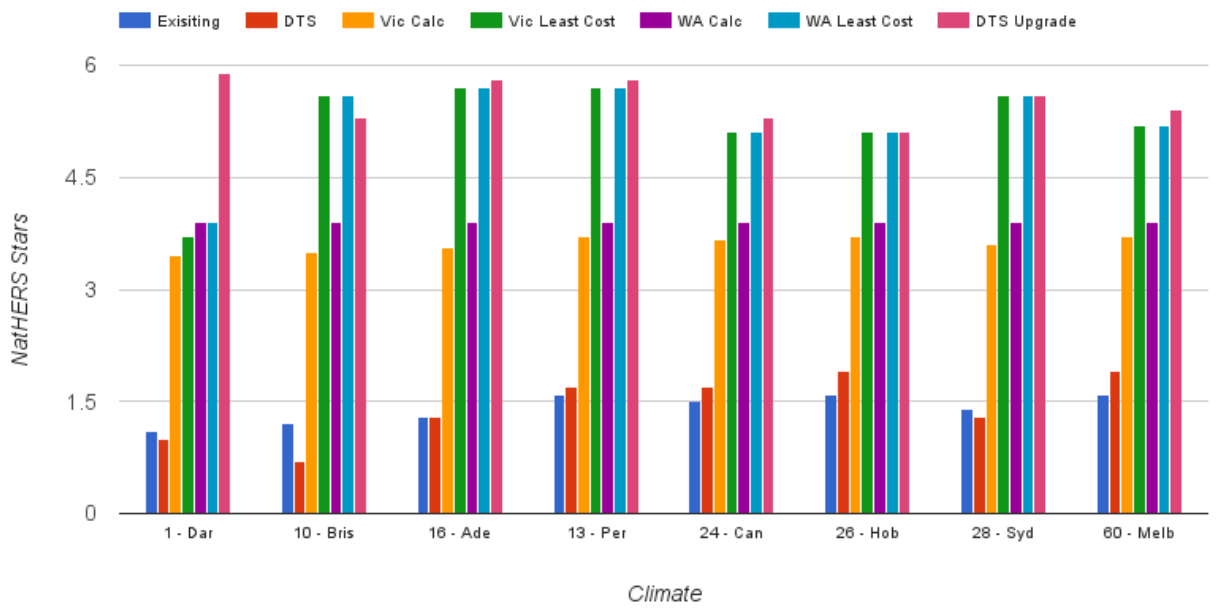
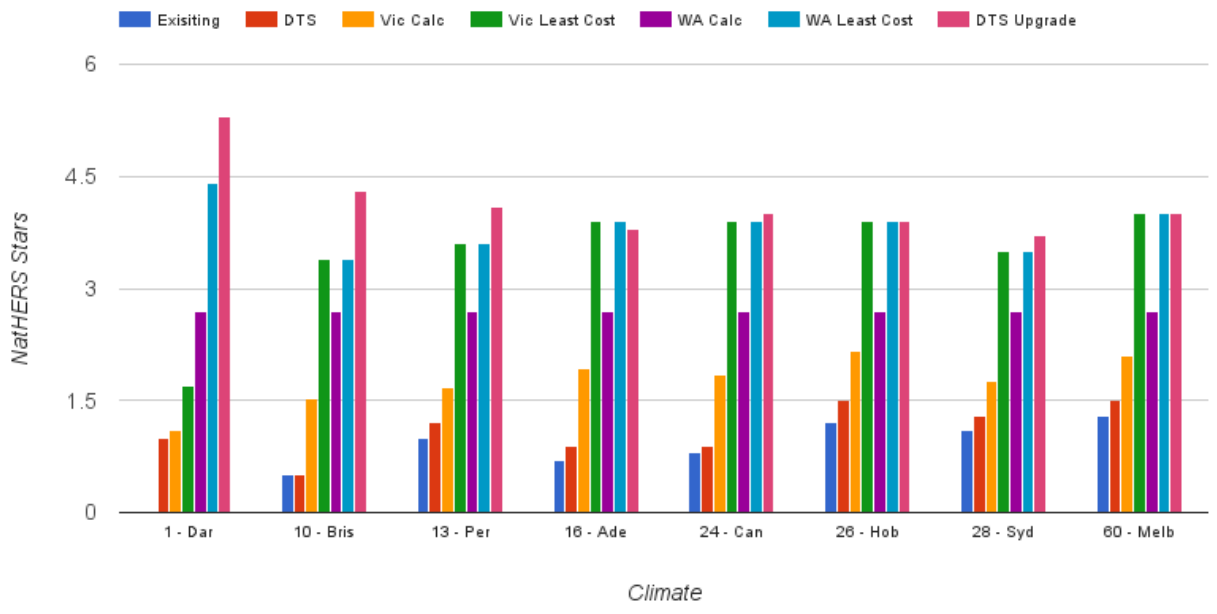


Chart 2: Comparison of star ratings - Case Study 2 Small Extension



The legend for the charts 3 & 4:

- DtS: The current base practice, the existing building is left as is and the extension meets Elemental DtS
- 6 star: The least cost star rating greater than or equal to 6 stars.
- Vic: The least total cost star rating that achieved above the rating calculated using the Victorian method.
- WA: The least total cost star rating that achieved above the rating calculated using the the Western Australian method.
- DtS: Upgrade: The extension meets Elemental DtS and the existing part of the building meets Elemental DtS in the ceiling and has weather seals.

Charts 3 & 4 show the total cost for each option and climate. Overall as seen in Charts 1 & 2, the addition of insulation to the ceiling of the existing house reduces the total cost significantly in comparison to the Elemental DtS option. The flexibility allowed by the NatHERS to change roof colour and add ceiling fans can be seen in the difference between the Vic and WA options and the DtS upgrade.

Case studies 1 & 2 were chosen for the difference in the size of the extension in relation to the existing building. In cold climates such as 24 - Canberra, 26 - Hobart and 60 – Melbourne, external wall insulation and window changes are often needed to get the building to 6 stars. When the extension is small in relation to the existing building, as in Case study 2, removing and replacing the windows and external wall lining can be cost prohibitive. This can be seen in the high total cost for 6 star ratings for cold climates in Chart 4.

In all the climates but one (Darwin), the WA and Vic methods achieve a significant saving on the total cost. The WA method uses one less NatHERS assessment which is the difference between the two.

Chart 3: Comparison of total cost - Case Study 1 Large Extension

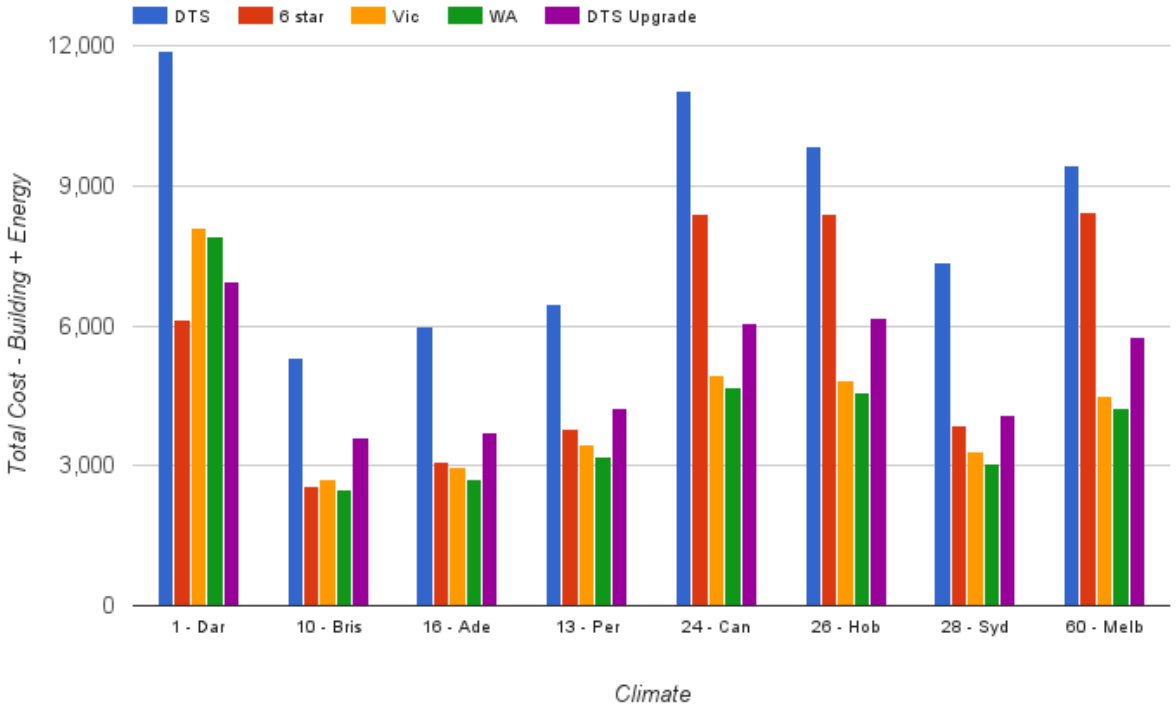
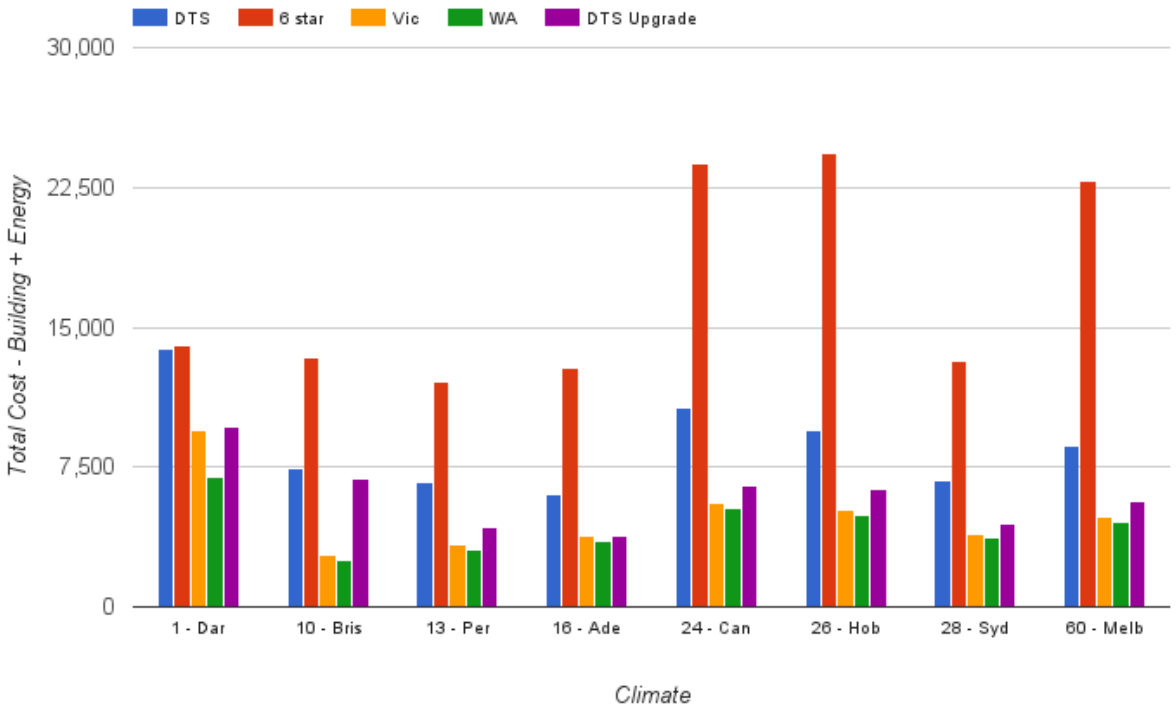


Chart 4: Comparison of total cost - Case Study 2 Small Extension



8. Proposal for change and alternatives

Based on the review and the case studies it is evident that:

- Alterations and additions are not meeting the NCC minimum performance standard.
- There is confusion in the building industry between where, when and how to apply the current regulations.

The intention is to provide a change to the regulation that ensures altered and extended buildings reach a reasonable standard of thermal performance using methods which are simple to apply, are similar to the methods used for new buildings, and there is both an Elemental DtS method and NatHERS method.

The logical place for national changes is in the NCC. However the NCC applies to new building work or those parts of the building being effected by the new building work. For work in relation the existing building the NCC defers to state and territory regulations.

It is proposed that an amendment is made to the Volume Part 3.12 of NCC or to state and territory regulation that sets a minimum performance standard for the existing part of a building undergoing an alteration or addition. Particularly:

- There is a requirement for the NCC Volume 2 Parts 3.12.1.2 Roofs and 3.12.3 Building sealing to apply to the existing parts of alterations and additions.
- The WA calculation method as is, or simplified, is used to calculate a NatHERS star rating to be applied to the altered or extended building.

In the case where the roof space is inaccessible the applicant can:

- Use another method of compliance, or
- Provide a cost benefit analysis to the building certifier as part of an application for a concession. As identified in NEEBP Phase One, concessions should be based on cost rather than the building certifiers discretion and an amendment to Part 2.6.1 is required to make this the case.

Clear and simple compliance checklists for alterations and additions should also be developed and used for each stage of the compliance process. These checklists should be automatically generated when using calculation software tools and designed to reduce errors and increase comparability of assessments. [3]

[3] There are International construction codes that already implement this process to assist with compliance at the planning, construction and completion phases, see https://www.energycodes.gov/sites/default/files/documents/BECP_Building%20Energy%20Codes%20Resource%20Guide%20Code%20Officials_October2010_v00.pdf

9. Stakeholders

Should the proposal for change be acted on, stakeholders likely to be affected are: building certifiers, accredited assessors, builders, designers and homeowners.

9.1 Building certifiers

Building certifiers carry the liability that a building they approve for construction meets the NCC. The results of the survey indicated that there is confusion regarding the application of the energy efficiency regulation to alterations and additions. The proposed change would provide clarity allowing the certifiers to be confident of which regulations apply and how the regulation would be applied.

9.2 Accredited assessors

Accredited assessors are similar to building certifiers in that there is confusion regarding the appropriate way to assess buildings. While it is hoped that the introduction of the Certificate IV in NatHERS assessment will improve the assessment of alterations and additions, they are currently making assumptions of the features of existing buildings. The WA calculation method provides a way of assessing an existing building dependant on age of the building, removing the need for the assessor to guess.

9.3 Builders and Designers

Builders are generally accepting of regulation if the regulation is clear, practical and applies equally to everyone. The current state of the regulation and the ability of building certifiers to provide discretion means the regulation is unclear and the final outcome can depend on the relationship between the builder and the certifier. The proposed changes should make the application of the regulation simpler and clearer.

9.4 Homeowners

The case studies show that adding insulation to the existing part of the building can provide a potential saving in heating and cooling bills. While a benefit to the homeowner, this is only one of the potential benefits of a home with greater levels of thermal performance.

9.5 ABCB

The ABCB applies only to new building work and relies on the state and territory jurisdictions for the application of the energy efficiency requirements to the existing building. Current ABCB initiatives are for Code consolidation, Variation management and for performance based measures. The proposed changes harmonise the regulations across Australia and provide a performance based measure in the calculation of the adjusted star rating for the extended building.

10. Proposed regulatory and jurisdictional change

The following changes to the jurisdictional regulations are suggested.

Table 4. Treatment of existing dwellings in each State and Territory.

Jurisdiction	Current Treatment of Existing Dwellings	Proposed Treatment of Existing Dwellings
Federal (NCC)	The existing building is not required to comply unless it is subject to new building works.	Make the changes to the NCC as suggested in Part 8 of this report.
ACT	If substantial alterations are made to the existing building then the whole building must comply with NCC energy efficiency requirements. Substantial alterations are defined as more than 50% of the volume of the original building, including alterations made during the previous 3 years immediately before the day the application for building approval. The unaltered walls/ roof/ suspended floors of a substantially altered building need not comply if complying would require removal of more than 10% of walls/ roof/ suspended floors, or there is insufficient cavity space to accommodate insulation to achieve the R-value requirement. External glazing to the existing building is required to comply if it is not isolated from the addition. For example, where a living zone is extended onto a kitchen and forms part of the same zone, without doors to separate the zones, the existing kitchen glazing must comply with the Building Code Volume 2, Part 3.12.2.	Remove state based requirement and refer to the NCC, or change state based regulation.
NSW	The EP&A Regulation does not have any reference to “Major alterations and/or additions”. “Major alterations and/or additions” can be understood as > 50% volume of the original building (as per ACT and VIC). However, the definition of BASIX-affected Alterations and additions based on	Provide an addition to BASIX requiring the upgrading of insulation to the ceilings and sealing to existing part of extended buildings. It is suggested that this be done in a similar method to the WA calculation and be based on the age of the existing building.

	construction value can apply even if the volume of work is < 50%. With a 4-bedroom house of say 250m2 for example, the addition of another room (say 10% of the original volume) can trigger BASIX requirements when the cost of construction >= $50k.	
NT	No modifications are required for the existing part of a dwelling unless changing from a Class 10 to a Class 1, in which case compliance is required with all energy efficiency provisions.	NT refers to BCA 2009. Write an amendment for the state and territory variation requiring BCA Volume 2 2009, 3.12.1.2 Roofs and 3.12.3 Building sealing to apply to existing buildings. Or change state based regulation
QLD	Where the proposed building work represents more than 50 percent of the existing dwelling's volume, the building certifier has discretion to apply current building assessment provisions. This discretion can be used when applying relevant energy efficiency requirements under QDC 4.1 for an alteration, addition or relocation.	Remove state based requirement and refer to the NCC, or change state based regulation.
SA	Depending on modifications and compliance method used upgrades to the existing building may be advised.	Remove state based requirement and refer to the NCC, or change state based regulation.
TAS	Existing buildings are not required to be upgraded at the time of alteration and addition works.	Remove state based requirement and refer to the NCC, or change state based regulation.
VIC	Upgrades are not required to the existing building unless the volume of the any new works completed within the previous 3 years represents more than 50 per cent of the volume of the original building, then both the existing and alterations work should comply with the requirements. Where there is access to the roof space ceiling insulation should be installed to the existing building. Similarly, where sealing to the existing building is practical and achievable it should be undertaken.	Remove state based requirement and refer to the NCC, or change state based regulation.
WA	All new building works to comply with NCC	Remove state based requirement

	requirements. The existing building is required to comply with the NCC if changing building classification (e.g. Class 10 to Class 1).	and refer to the NCC, or change state based regulation.

11. Good Regulatory Principles

The content and questions below have been taken from the ABCB publication "Guideline to preparing a Proposal for Change" which is available for download [link] from the ABCB website.

A key objective of the ABCB is to establish building codes and standards that are the minimum necessary to achieve relevant health, safety, amenity and sustainability efficiently. Good regulatory practice requires that any proposed change to the NCC must ensure that:

- *There is a rigorously tested rationale for the regulation;*

  Two case studies are not enough data as a basis for a change in regulation. It is recommended that further work is carried out to provide more evidence.

- *The regulation would generate benefits to society greater than the costs (that is, net benefits);*

  The current case studies show a monetary saving for homeowners which in most jurisdictions is a substantial saving over the current regulation. Using the output of NatHERS to calculate energy use is problematic for the reasons given in this study. Independent corroboration should be undertaken.

- *There is no regulatory or non-regulatory alternative (whether under the responsibility of the ABCB or not) that would generate higher net benefits;*

  Energy efficiency in Class 1 and Class 10 buildings forms part of the NCC. The proposed change adds a qualification of how existing parts of alterations and additions should be treated rather than being a new regulation.

  As suggested in the NEEBP Phase One report there is an opportunity at the time that a building is being altered or extended to improve the thermal performance. As with new buildings it would be beneficial to see the industry and homeowners take advantage of the long term benefits offered by improved thermal performance voluntarily. Regulation has been necessary to date.

- *The competitive effects of the regulation have been considered and the regulation is no more restrictive than necessary in the public interest.*

  The proposed change to the regulation is flexible, allowing participating parties to choose from a number of regulatory paths to achieve compliance.

12. Action Plan

Actions to be taken include:

- Industry consultation of the recommendations of this study, particularly around the assumed costs used in the case studies and generally around the practicality of changing the regulation.
- There is inconsistency between jurisdictions in what constitutes new building works and subsequently when the NCC requirements apply to alteration and addition works. In order to achieve national consistency in requirements, it is recommended that State and Territory governments work together to reach agreement on a nationally consistent administrative framework for building and plumbing regulations so that the application of the NCC requirements to new building works can be consistently applied.
- Examination of the WA calculation method to see if simplification of the method is possible and examination to make sure there are not climate specific issues which would negatively impact the outcomes for stakeholders.
- Further national case studies on a wider range of buildings and construction types to confirm the findings in this report. Attention should be paid to the glazing calculator and investigations made if changes specific to alterations and additions are required.
- Draft the actual wording of changes to the NCC and the jurisdictional regulations. Relevant other technical documents, such as the NatHERS technical note, be updated.
- Education information for the building industry to be drafted. Particularly continuing professional development (CPD) for Building Certifiers on changing from the practice of granting concessions based on assumption to concessions based on a requested cost analysis.

13. Conclusions

A review of the application of NCC energy efficiency requirements for alterations and additions to Class 1 and 10 buildings found that there is confusion and inconsistency in how requirements apply in each jurisdiction throughout Australia. Key issues include:

- The definition of what constitutes an alteration or addition subject to energy performance requirements differs between jurisdictions, from all new building work to numerous exemptions, particularly for an alteration.

- Jurisdictional variation in energy performance requirements centres on building fabric (Part 3.12.1) and glazing (Part 3.12.2), although there is industry confusion about all energy performance requirements.

- All jurisdictions provide additional guidance information and/ or regulatory requirements on the treatment of alterations and additions resulting in variation from the NCC requirements and each other. Some of the reasons that jurisdictions have developed additional information are due to the NCC not specifically addressing these types of projects and difficulties in applying the NCC requirements to assess alterations and additions projects. Guidance materials are also provided to support application of their own jurisdictional-based assessment methods and protocols.

- Some industry confusion is due to the fact that the jurisdictional guidelines provided by the states and territories do not always cover every aspect of the NCC in application. For

example, they may reference DtS (meaning Elemental) and Energy Rating, but not V2.6.2.2. While all NCC assessment methods apply in most jurisdictions, the industry is unaware and confused about these options.

- Across all jurisdictions there is significant industry confusion, including amongst those that are responsible for interpreting and applying them, about what the requirements are.

- In many jurisdictions certifiers have discretionary powers to determine on a case-by-case basis how energy performance requirements should apply, though they have limited understanding of the relative cost-benefits of their decisions.

- Some jurisdictions are requiring the building to be assessed to a 6 star standard but not requiring the existing part of the building to be altered, creating the potential for the homeowner to have an incorrect impression of the thermal performance of their home.

- Some jurisdictions regulate assessment methods and compliance requirements based on the building age, and the volume or floor area subject to alteration and addition works.

Case studies conducted to compare the differing compliance methods, show that the addition of ceiling insulation to existing buildings made the largest single improvement in the thermal performance of the building as predicted by NatHERS software. Additionally, cost estimates showed that there was a financial benefit over a 7 year period in insulating the ceiling of the existing building and providing weather stripping.

A current method that could be used to assess new buildings for compliance and to counter the identified issues is:

- Using the NatHERS software using the WA method, as is or with alterations, for providing a minimum energy rating which takes into account the age of the existing building and the relative size of the existing building to the alteration.
- Using the Elemental DtS method. It is recommended that the section NCC Vol 2, Part 3.12.1.2 Roofs and 3.12.2 Building Sealing be altered to apply to the existing parts of altered or extended buildings.
- Using clear and simple compliance checklists for alterations and additions that are automatically generated when using calculation software tools, and designed to reduce errors and increase comparability of assessments. These could be based on the Internationals standards[4]

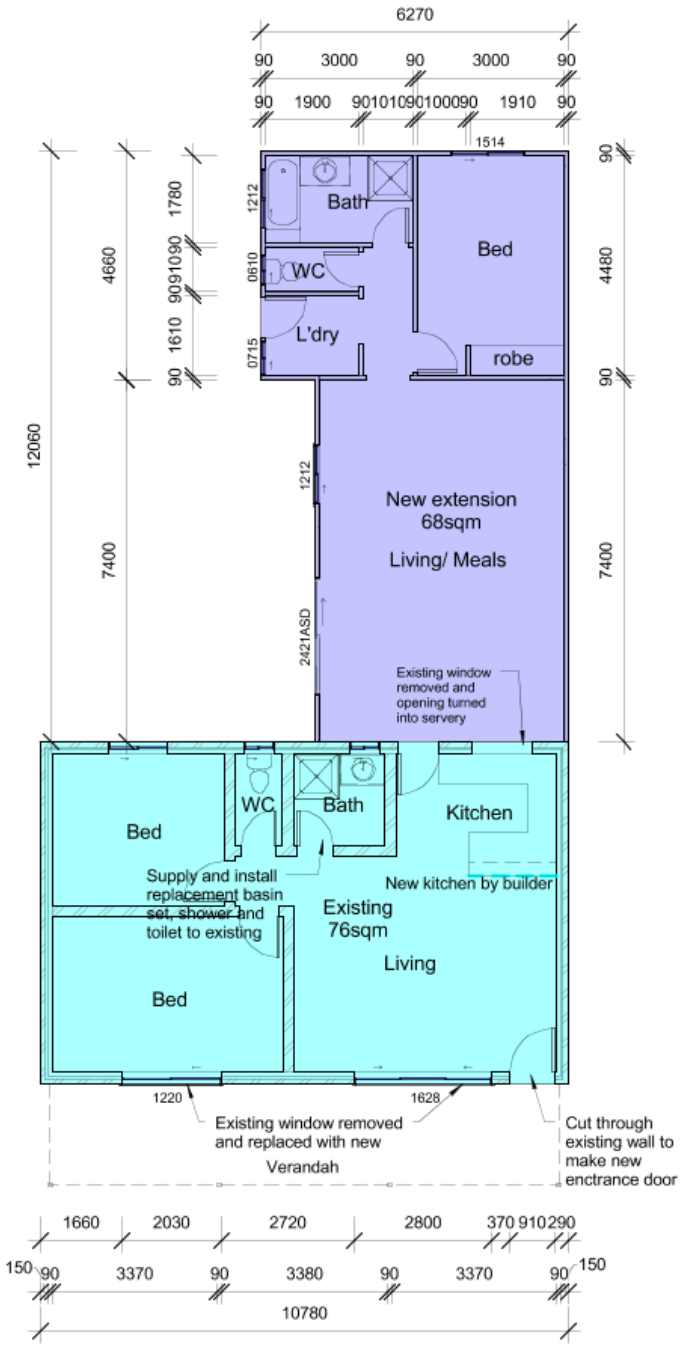
[4] See https://www.energycodes.gov/sites/default/files/documents/BECP_Building%20Energy%20Codes%20Resource%20Guide%20Code%20Officials_October2010_v00.pdf

10. REFERENCES

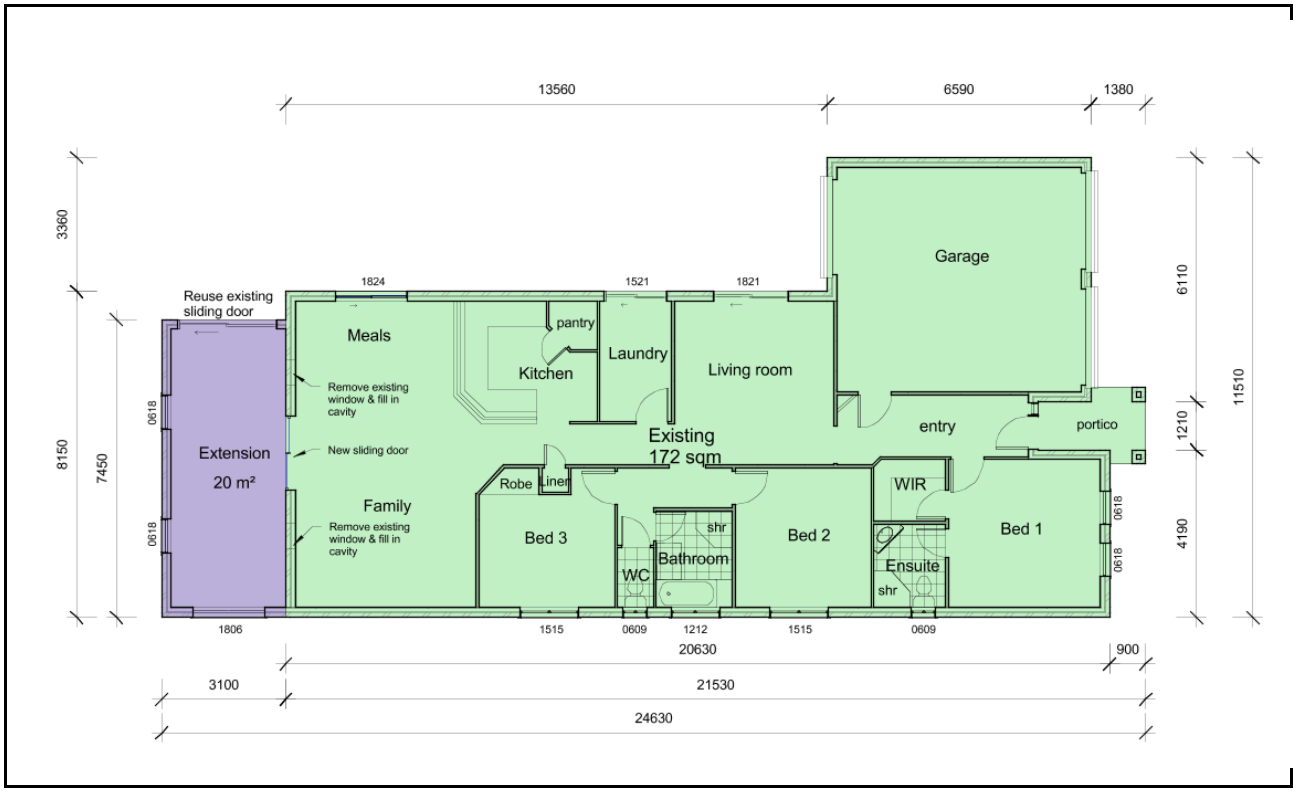
- ABCB, 2015. NCC Volume Two Energy Efficiency Provisions 2015 Handbook 2nd Edition.
- ACT Parliamentary Counsel, 2015. Planning and Development Regulation 2008 Replication No 70 Effective 1 July 2015.
- Australian Bureau of Statistics, 2015. Time Series Workbook 8731.0 Building Approvals, Australia TABLE 38. Value of Building Approved - Australia.
- Department of Planning, Transport and Infrastructure, 2012. *Building Advisory Notice 3/12*.
- Energy Efficient Strategies, 2008. Energy Use in the Australian Residential Sector 1986 – 2020.
- Energy Efficient Strategies, 2011. The Value of Ceiling Insulation: Impacts of Retrofitting Ceiling Insulation to Residential Dwellings in Australia.
- Government of Western Australia Department of Commerce, 2014. WA Alterations & Additions Protocol for Energy Efficiency in Class 1 or attached Class 10 buildings.
- NSW Government Planning & Infrastructure, 2011. BASIX Guide: Using Simulation for Alterations and Additions Version 0.4 2 October 2013.
- Northern Territory Government Department of Lands and Planning, 2010. *Building Advisory Services Branch Building Note, Edition Number 68*.
- Queensland Government, 2011. Queensland Development Code Mandatory Part 4.1 – Sustainable Building Guidelines.
- Roberts, N., 2015. Australian Houses are Just Glorified Tents in Winter. *The Age*, June 11 2015.
- State of Victoria, 2006. Building Regulation 2006 – Reg 608.
- Tasmanian Government, 2013. Building Regulation Advisory Note No. 4.
- Victorian Building Authority (formerly Victorian Building Commission), 2013. *5 and 6 Star Home Alterations: Characterisation of the Market.*
- Victorian Building Authority, 2014. *Practice Note 2014-55.*

Appendix A: Case study building plans

Case Study 1



Case Study 2



SUSTAINABILITY HOUSE
Phone:1300 308 525
www.sustainabilityhouse.com.au
research@sustainabilityhouse.com.au

Appendix B: Construction Costs

Construction costs used to compare energy assessment outcomes are in Tables Appendix B1 & B2. The costs assume that the buildings were finished with internal plasterboard linings and have aluminium framed standard windows. Costs are then estimates for adding insulation and other building products to the existing building and the extension.

Costs for building materials vary across the states and territories. Costs used in this study were altered as seen in the tables.

Under most current jurisdictions there is no requirement to alter the existing house as it would be an unreasonable cost. Changes to the existing building have been added onto the costs of the new materials as follows:

- Removal and replacement of internal wall linings to the existing house - $49.5 /m2.
- Removal, installation and make good of windows $120 / m2 of window.

The cost for adding insulation to the walls is $49.5 + $7= $56.6. The costs for replacing windows are calculated similarly.

Table B1: Estimated construction costs($) for Case Study 1 Large Extension

Units	Construction Item	cost / m2 or unit	VIC	NSW	QLD	SA	WA	NT	ACT	TAS
	NatHERS Climate		60	28	10	16	13	1	24	26
Each	Seals windows doors and exhaust fans to existing	40	42	40	43	40	38	33	39	40
Per m2	Existing Wall R2	56.5	4,734	4,466	4,831	4,509	4,304	3,670	4,383	4,509
Per m2	Existing ceiling R0	0	0	0	0	0	0	0	0	0
Per m2	Existing ceiling R2.5	6	439	414	448	418	399	340	407	418
Per m2	Existing ceiling R4	9	659	621	672	627	599	511	610	627
Per m2	Existing ceiling R5	12	878	828	896	836	798	681	813	836
Per m2	Existing ceiling R6	15	1,098	1,036	1,120	1,045	998	851	1,016	1,045
Per m2	Al frame standard clear glass *	0	0	0	0	0	0	0	0	0
Per m2	Al frame tinted glass	140	1,360	1,283	1,388	1,295	1,236	1,054	1,259	1,295
Per m2	Al frame 5/5/6 Lowe double	370	3,594	3,390	3,667	3,423	3,267	2,786	3,327	3,423
Per m2	Al frame 6.38 Comfortplus neutral	270	2,622	2,474	2,676	2,498	2,384	2,033	2,428	2,498
Per m2	Al frame 6.38 4mm EA Low E	170	1,651	1,558	1,685	1,573	1,501	1,280	1,529	1,573
Each	Ceiling fans to existing	75	236	223	241	225	215	183	219	225
Per m2	Addition walls R2 insulation	7	613	579	626	584	558	476	568	584
Per m2	Addition walls R2.5 insulation	10.5	920	868	939	876	837	713	852	876
Per m2	Additional ceiling R2.5	6	406	383	414	387	369	315	376	387
Per m2	Additional ceiling R4	9	609	575	621	580	554	472	564	580
Per m2	Additional ceiling R5	12	812	766	829	773	738	629	752	773
Per m2	Additional ceiling R6	15	1,015	958	1,036	967	923	787	940	967
Per m2	Al frame standard clear glass	0	0	0	0	0	0	0	0	0
Per m2	Al frame tinted glass	20	222	209	226	211	202	172	205	211
Per m2	Al frame 5/5/6 Lowe double	250	2,772	2,615	2,829	2,640	2,520	2,149	2,567	2,640
Per m2	Al frame 6.38 Comfortplus neutral	150	1,663	1,569	1,697	1,584	1,512	1,289	1,540	1,584
Per m2	Al frame 6.38 4mm EA Low E	50	554	523	566	528	504	430	513	528
Per m2	Timb frame DG 4/Ar/4LE	350	3,881	3,661	3,960	3,696	3,528	3,008	3,593	3,696
Each	Ceiling fans to existing	75	158	149	161	150	143	122	146	150
Per m2	COSG Waffle R1	2	135	128	138	129	123	105	125	129

Table B2: Estimated construction costs for Case Study 2 Small Extension

Units	Construction Item	cost / m2 or unit	VIC	NSW	QLD	SA	WA	NT	ACT	TAS
	NatHERS Climate		60	28	10	16	13	1	24	26
Each	Seals windows doors and exhaust fans to existing	40	42	40	43	40	38	33	39	40
Per m2	Existing Wall R2	56.5	6,784	6,400	6,923	6,461	6,168	5,259	6,282	6,461
Per m2	Existing ceiling R0	0	0	0	0	0	0	0	0	0
Per m2	Existing ceiling R2.5	6	856	807	873	815	778	663	792	815
Per m2	Existing ceiling R4	9	1,283	1,211	1,310	1,222	1,167	995	1,188	1,222
Per m2	Existing ceiling R5	12	1,711	1,614	1,746	1,630	1,556	1,327	1,585	1,630
Per m2	Existing ceiling R6	15	2,139	2,018	2,183	2,037	1,945	1,658	1,981	2,037
Per m2	Al frame standard clear glass	0	0	0	0	0	0	0	0	0
Per m2	Al frame tinted glass	140	3,793	3,578	3,870	3,612	3,448	2,940	3,512	3,612
Per m2	Al frame 5/5/6 Lowe double	370	10,023	9,456	10,228	9,546	9,112	7,770	9,281	9,546
Per m2	Al frame 6.38 Comfortplus neutral	270	7,314	6,900	7,463	6,966	6,649	5,670	6,772	6,966
Per m2	Al frame 6.38 4mm EA Low E	170	4,605	4,345	4,699	4,386	4,187	3,570	4,264	4,386
Each	Ceiling fans to existing	75	394	372	402	375	358	305	365	375
Per m2	Addition walls R2 insulation	7	100	94	102	95	91	78	93	95
Per m2	Addition walls R2.5 insulation	10.5	150	142	153	143	136	116	139	143
Per m2	Additional ceiling R2.5	6	147	139	150	140	134	114	137	140
Per m2	Additional ceiling R4	9	221	209	226	211	201	171	205	211
Per m2	Additional ceiling R5	12	295	278	301	281	268	229	273	281
Per m2	Additional ceiling R6	15	369	348	376	351	335	286	341	351
Per m2	Al frame standard clear glass	0	0	0	0	0	0	0	0	0
Per m2	Al frame tinted glass	20	204	192	208	194	185	158	188	194
Per m2	Al frame 5/5/6 Lowe double	250	2,544	2,400	2,596	2,423	2,312	1,972	2,355	2,423
Per m2	Al frame 6.38 Comfortplus neutral	150	1,526	1,440	1,557	1,454	1,387	1,183	1,413	1,454
Per m2	Al frame 6.38 4mm EA Low E	50	509	480	519	485	463	394	471	485
Per m2	Timb frame DG 4/Ar/4LE	350	3,561	3,360	3,634	3,392	3,237	2,761	3,297	3,392
Each	Ceiling fans to existing	75	79	74	80	75	72	61	73	75
Per m2	COSG Waffle R1	2	135	128	138	129	123	105	125	129

Appendix C: Assessment results and costs for the case studies

Headings for tables

Climate: Climate zone
Seal: Weather seals applied to windows and doors of existing house
Wall ins R: R value of insulation added to walls
Ceiling ins R: R value of insulation added to ceiling
Glazing: Glass and frames, abbreviations for the glass are in Table C1
Fans: Ceiling fans added to Living areas and Bedrooms
Roof colour: Colour of the roof of the whole building, 0.3 = Light roof, 0.5 = Medium roof and 0.85 = Dark roof
Total load: Total raw heating and cooling load in MJ as estimated by NatHERS software
Stars: Star rating from NatHERS software
Building: Total cost of building materials added to the building as per the costs set out in Appendix B
Energy: Total cost of heating and cooling energy over 7 years
Assess: Assessment fee
Total: Total cost of building energy and assessment fee
PL: Profit or loss against the base case - Existing-as-is and Extension-at-DtS for that climate

Table C1 – Glass and glazing used in the study

Window abbreviations	
alstd	Aluminium frame standard clear glass
al tint	Aluminium frame tinted glass
al dg low e	Aluminium frame 5/5/6 Lowe double
al cp	Aluminium frame 6.38 Comfortplus neutral
al low e	Aluminium frame 6.38 4mm EA Low E
timb dg low e	Timber frame DG 4/Ar/4LE

Case Study 1

1. Case Study 1 - Exisiting-as-is + Extension-at-DtS																		
	Exisitng					Addition					Roof colour	Results		Costs				
Climate	Seal	Wall Ins R	Ceiling Ins R	Glazing	Fans	Wall Ins R	Ceiling Ins R	Glazing	Fans	Floor ins		Total load MJ	Stars	Building	Energy	Assess	Total	PL
1 - Dar	N	R0	R0	alstd	N	R2.5	R5	alstd	N	N	0.5	840.9	1	1465	10,389	50	11,904	0
10 - Bris	N	R0	R0	alstd	N	R2.5	R5	alstd	N	N	0.5	268.2	0.7	1928	3,325	50	5,303	0
13 - Per	N	R0	R0	alstd	N	R2.5	R5	alstd	N	N	0.5	395.6	1.3	1101	4,848	50	$5,999.33	0
16 - Ade	N	R0	R0	alstd	N	R2.5	R5	alstd	N	N	0.5	429	1.7	1153	5,264	50	$6,466.91	0
24 - Can	N	R0	R0	alstd	N	R2.5	R5	al low e	N	N	0.5	699.4	1.7	2263	8,727	50	11,040	0
26 - Hob	N	R0	R0	alstd	N	R2.5	R5	al low e	N	N	0.5	600.2	1.9	2328	7,480	50	9,858	0
28 - Syd	N	R0	R0	alstd	N	R2.5	R5	alstd	N	N	0.5	450.5	1.3	1783	5,541	50	7,374	0
60 - Melb	N	R0	R0	alstd	N	R2.5	R5	low e	N	N	0.5	562.7	1.9	2444	6,926	50	9,420	0

2. Case Study 1 - Least cost 6 star																		
	Exisitng					Addition					Roof colour	Results		Costs				
Climate	Seal	Wall Ins R	Ceiling Ins R	Glazing	Fans	Wall Ins R	Ceiling Ins R	Glazing	Fans	Floor ins		Total load MJ	Stars	Building	Energy	Assess	Total	PL
1 - Dar	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	376.3	6.1	1163	4,710	250	6,123	-5,781
10 - Bris	Y	R0	R2.5	alstd	Y	R2	R2.5	alstd	Y	N	0.3	48.3	6.2	1772	554	250	2,576	-2,726
13 - Per	Y	R0	R2.5	alstd	N	R2	R2.5	al low e	Y	N	0.3	80.6	6	1868	970	250	3,088	-2,912
16 - Ade	Y	R0	f R4	alstd	N	R2	R2.5	al low e	Y	N	0.3	110	6.1	2166	1,385	250	3,801	-2,666
24 - Can	Y	R2	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.85	188.2	6.1	5773	2,355	250	8,378	-2,662
26 - Hob	Y	R2	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.85	179	6	5938	2,216	250	8,404	-1,454
28 - Syd	Y	R0	f R4	alstd	Y	R2	R2.5	al low e	Y	N	0.3	99.1	6.1	2368	1,247	250	3,865	-3,509
60 - Melb	Y	R2	R2.5	alstd	N	l R2	R2.5	alstd	Y	N	0.85	155.9	6.1	6234	1,939	250	8,423	-997

3. Case Study 1 - Victorian Method																		
	Exisitng					Addition					**Roof colour**	Results		Costs				
Climate	**Seal**	**Wall Ins R**	**Ceiling Ins R**	**Glazing**	**Fans**	**Wall Ins R**	**Ceiling Ins R**	**Glazing**	**Fans**	**Floor ins**		**Total load MJ**	**Stars**	**Building**	**Energy**	**Assess**	**Total**	**PL**
1 - Dar	Y	R0	R0	alstd	N	R2	R2.5	alstd	Y	N	0.3	547.3	3.7	823	6,788	500	8,111	-3,794
10 - Bris	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	55	5.6	1531	693	500	2,724	-2,579
13 - Per	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	86.7	5.7	1364	1,108	500	2,972	-3,027
16 - Ade	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	121.4	5.7	1429	1,524	500	3,453	-3,014
24 - Can	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.85	243.7	5.1	1389	3,048	500	4,937	-6,103
26 - Hob	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.85	232.4	5.1	1429	2,909	500	4,838	-5,020
28 - Syd	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	111.7	5.6	1415	1,385	500	3,300	-4,074
60 - Melb	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.85	202	5.2	1500	2,493	500	4,493	-4,927

4. Case Study 1 - WA Method

	Exisitng					Addition					Roof colour	Results		Costs				
Climate	**Seal**	**Wall Ins R**	**Ceiling Ins R**	**Glazing**	**Fans**	**Wall Ins R**	**Ceiling Ins R**	**Glazing**	**Fans**	**Floor ins**		**Total load MJ**	**Stars**	**Building**	**Energy**	**Assess**	**Total**	**PL**
1 - Dar	Y	R0	R0	alstd	Y	R2	R2.5	alstd	Y	N	0.3	531.3	3.9	1006	6,649	250	7,905	-3,999
10 - Bris	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	55	5.6	1531	693	250	2,474	-2,829
13 - Per	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	86.7	5.7	1364	1,108	250	2,722	-3,277
16 - Ade	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	121.4	5.7	1429	1,524	250	3,203	-3,264
24 - Can	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.85	243.7	5.1	1389	3,048	250	4,687	-6,353
26 - Hob	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.85	232.4	5.1	1429	2,909	250	4,588	-5,270
28 - Syd	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	111.7	5.6	1415	1,385	250	3,050	-4,324
60 - Melb	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.85	202	5.2	1500	2,493	250	4,243	-5,177

5. Case Study 1 - Upgrade - Ext at DtS - upgrade ceiling insulation R5 and seal																		
	Exisitng					Addition					Roof colour	Results		Costs				
Climate	Seal	Wall Ins R	Ceiling Ins R	Glazing	Fans	Wall Ins R	Ceiling Ins R	Glazing	Fans	Floor ins		Total load MJ	Stars	Building	Energy	Assess	Total	PL
1 - Dar	Y	R0	R5	alstd	N	R2.5	R5	alstd	N	N	0.5	384.5	5.9	2178	4,710	50	6,938	-4,966
10 - Bris	Y	R0	R5	alstd	N	R2.5	R5	alstd	N	N	0.5	59.2	5.3	2867	693	50	3,610	-1,693
16 - Ade	Y	R0	R5	alstd	N	R2.5	R5	alstd	N	N	0.5	85.5	5.8	2554	1,108	50	3,712	-2,755
13 - Per	Y	R0	R5	alstd	N	R2.5	R5	alstd	N	N	0.5	118.4	5.8	2676	1,524	50	4,250	-1,750
24 - Can	Y	R0	R5	alstd	N	R2.5	R5	al low e	N	N	0.5	234.3	5.3	3115	2,909	50	6,074	-4,966
26 - Hob	Y	R0	R5	alstd	N	R2.5	R5	al low e	N	N	0.5	229.9	5.1	3204	2,909	50	6,163	-3,695
28 - Syd	Y	R0	R5	alstd	N	R2.5	R5	alstd	N	N	0.5	110.6	5.6	2651	1,385	50	4,086	-3,288
60 - Melb	Y	R0	R5	alstd	N	R2.5	R5	al low e	N	N	0.5	192.6	5.4	3364	2,355	50	5,769	-3,651

Case Study 2

1. Case Study 2 - Exisiting-as-is + Extension-at-DtS																	
	Exisitng					Addition					Roof colour	Results		Costs			
Climate	Seal	Wall Ins R	Ceiling Ins R	Glazing	Fans	Wall Ins R	Ceiling Ins R	Glazing	Fans	Floor ins		Total load MJ	Stars	Building	Energy	Assess	Total	PL
1 - Dar	N	R0	R0	alstd	N	R2.5	R5	timb dg lowe	N	N	0.5	863	0.6	3166	10,666	50	13,882	0
10 - Bris	N	R0	R0	alstd	N	R2.5	R5	timb dg lowe	N	N	0.5	256.2	0.6	4168	3,186	50	7,404	0
13 - Per	N	R0	R0	alstd	N	R2.5	R5	alstd	N	N	0.5	495.3	1.1	499	6,095	50	6,644	0
16 - Ade	N	R0	R0	alstd	N	R2.5	R5	alstd	N	N	0.5	452	0.8	476	5,541	50	6,067	0
24 - Can	N	R0	R0	alstd	N	R2.5	R5	al low e	N	N	0.5	784.1	1.2	956	9,697	50	10,703	0
26 - Hob	N	R0	R0	alstd	N	R2.5	R5	al low e	N	N	0.5	676.3	1.4	983	8,450	50	9,483	0
28 - Syd	N	R0	R0	alstd	N	R2.5	R5	alstd	N	N	0.5	504.7	0.9	494	6,234	50	6,778	0
60 - Melb	N	R0	R0	alstd	N	R2.5	R5	alstd	N	N	0.5	649.1	1.3	524	8,034	50	8,608	0

1. **Case Study 2 Least cost 6 star**

	Exisitng					Addition					Roof colour	Results		Costs				
Climate	**Seal**	**Wall Ins R**	**Ceiling Ins R**	**Glazing**	**Fans**	**Wall Ins R**	**Ceiling Ins R**	**Glazing**	**Fans**	**Floor ins**		**Total load MJ**	**Stars**	**Building**	**Energy**	**Assess**	**Total**	**PL**
1 - Dar	Y	R2	R2.5	alstd	Y	R2	R2.5	timb sg lowe	Y	N	0.3	364	6	9213	4,571	250	14,034	152
10 - Bris	Y	R2	R4	alstd	Y	R2	R2.5	timb sg lowe	Y	N	0.3	46.9	6	12563	554	250	13,367	5,963
13 - Per	Y	R2	R4	alstd	N	R2	R2.5	timb sg lowe	Y	N	0.3	75.7	6	10835	970	250	12,055	5,411
16 - Ade	Y	R2	R4	alstd	N	R2	R2.5	timb sg lowe	Y	N	0.3	101.9	6.1	11351	1,247	250	12,848	6,781
24 - Can	Y	R2	R6	dg lowe	N	R2	R6	timb sg lowe	Y	N	0.85	181.3	6	21313	2,216	250	23,779	13,077
26 - Hob	Y	R2	R6	dg lowe	N	R2	R5	timb sg lowe	Y	N	0.85	176.1	5.9	21852	2,216	250	24,318	14,835
28 - Syd	Y	R2	R4	alstd	Y	R2.5	R2.5	timb sg lowe	Y	N	0.3	95.2	6	11662	1,247	250	13,159	6,381
60 - Melb	Y	R2	R6	al cp	Y	R2.5	R5	timb sg lowe	Y	N	0.85	152.5	6	20679	1,939	250	22,868	14,260

2. **Case Study 2 Victorian Method**

Climate	Seal	Wall Ins R	Ceiling Ins R	Glazing	Fans	Wall Ins R	Ceiling Ins R	Glazing	Fans	Floor ins		Total load MJ	Stars	Building	Energy	Assess	Total	PL
1 - Dar	Y	R0	f R0	alstd	N	R2	R2.5	alstd	Y	N	0.3	706.1	1.7	224	8,727	500	9,451	-4,431
10 - Bris	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	93.5	3.4	1168	1,108	500	2,776	-4,628
13 - Per	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	144.8	3.6	1041	1,801	500	3,342	-3,302
16 - Ade	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	184	3.9	1090	2,216	500	3,806	-2,261
24 - Can	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.85	318.6	3.9	1060	4,017	500	5,577	-5,125
26 - Hob	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.85	292.6	3.9	1090	3,602	500	5,192	-4,291
28 - Syd	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	184.2	3.5	1080	2,355	500	3,935	-2,843
60 - Melb	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.85	261.6	4	1145	3,186	500	4,831	-3,777

4. Case Study 2 -WA Method																		
	Exisitng					Addition					Roof colour	Results		Costs				
Climate	Seal	Wall Ins R	Ceiling Ins R	Glazing	Fans	Wall Ins R	Ceiling Ins R	Glazing	Fans	Floor ins		Total load MJ	Stars	Building	Energy	Assess	Total	PL
1 - Dar	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	473.2	4.4	888	5,818	250	6,956	-6,926
10 - Bris	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	93.5	3.4	1168	1,108	250	2,526	-4,878
13 - Per	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	144.8	3.6	1041	1,801	250	3,092	-3,552
16 - Ade	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	184	3.9	1090	2,216	250	3,556	-2,511
24 - Can	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.85	318.6	3.9	1060	4,017	250	5,327	-5,375
26 - Hob	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.85	292.6	3.9	1090	3,602	250	4,942	-4,541
28 - Syd	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.3	184.2	3.5	1080	2,355	250	3,685	-3,093
60 - Melb	Y	R0	R2.5	alstd	N	R2	R2.5	alstd	Y	N	0.85	261.6	4	1145	3,186	250	4,581	-4,027

Case Study 2 - Upgrade - Ext at DtS - upgrade ceiling insulation R5 and seal																		
	Exisitng					Addition					Roof colour	Results		Costs				
Climate	Seal	Wall Ins R	Ceiling Ins R	Glazing	Fans	Wall Ins R	Ceiling Ins R	Glazing	Fans	Floor ins		Total load MJ	Stars	Building	Energy	Assess	Total	PL
1 - Dar	Y	R0	R5	alstd	N	R2.5	R5	timb sg lowe	N	N	0.5	408.2	5.3	4525	5,125	50	9,700	-4,182
10 - Bris	Y	R0	R5	alstd	N	R2.5	R5	timb sg lowe	N	N	0.5	71.6	4.3	5957	831	50	6,838	-566
13 - Per	Y	R0	R5	alstd	N	R2.5	R5	alstd	N	N	0.5	172.2	4.1	2168	2,078	50	4,296	-2,348
16 - Ade	Y	R0	R5	alstd	N	R2.5	R5	alstd	N	N	0.5	136.4	3.8	2070	1,662	50	3,782	-2,285
24 - Can	Y	R0	R5	alstd	N	R2.5	R5	al low e	N	N	0.5	307.2	4	2579	3,879	50	6,508	-4,195
26 - Hob	Y	R0	R5	alstd	N	R2.5	R5	a; low e	N	N	0.5	291.4	3.9	2653	3,602	50	6,305	-3,178
28 - Syd	Y	R0	R5	alstd	N	R2.5	R5	alstd	N	N	0.5	173.0	3.7	2148	2,216	50	4,414	-2,363
60 - Melb	Y	R0	R5	alstd	N	R2.5	R5	alstd	N	N	0.5	263.0	4	2277	3,325	50	5,652	-2,957

Appendix D: Online Surveys of Two Key Industry Groups: Certifiers & Energy Assessors

ONLINE SURVEYS OF TWO KEY INDUSTRY GROUPS – CERTIFIERS & ENERGY ASSESSORS

Introduction

Building certifiers and energy efficiency assessor play a key role in interpreting and applying building energy efficiency requirements for the building industry.

To gain insights into their experiences in interpreting and applying the energy efficiency requirements to Class 1 and 10 alteration and addition projects, feedback was gathered from these two focal groups using an online survey.

Methodology

Two related online survey were used to gather information from the two industry groups in all jurisdictions:

- Group One – Private and council certifiers;
- Group Two – Energy efficiency assessors.

The surveys were hosted by kwiksurveys, and were open for submission in April 2015.

Survey participants were contacted directly and invited to participate by Sustainability House, as well as with the support of several organisations:

- Australian Institute of Building Surveyors
- Association of Building Sustainability Assessors
- Building Design Association of Victoria
- Daniel Ellis-Jones – Department of Commerce (WA)
- Natasha Palich – Council Alliance for a Sustainable Built Environment (VIC)
- Steve Storer – Department of Housing and Public Works (QLD)
- Wayne Gorman – Consulting Plus
- Sally Modystach - Healthy Environs.

The survey questions are included in the results section, together with the summaries of responses.

Results

In total survey responses were received from 50 certifiers (Figure 1) and 86 energy assessors (Figure 11), with responses from at least one certifier and one energy assessor in each jurisdiction.

Results are in attached pdf files

Figure 11. In which State or Territory do you primarily work?

	Queensland	New South Wales	Australian Capital Territory	Victoria	Tasmania	South Australia	Western Australia	Northern Territory	Standard Deviation	Responses
All Data	4 (4.65%)	18 (20.93%)	2 (2.33%)	**45 (52.33%)**	1 (1.16%)	5 (5.81%)	10 (11.63%)	1 (1.16%)	14.02	86

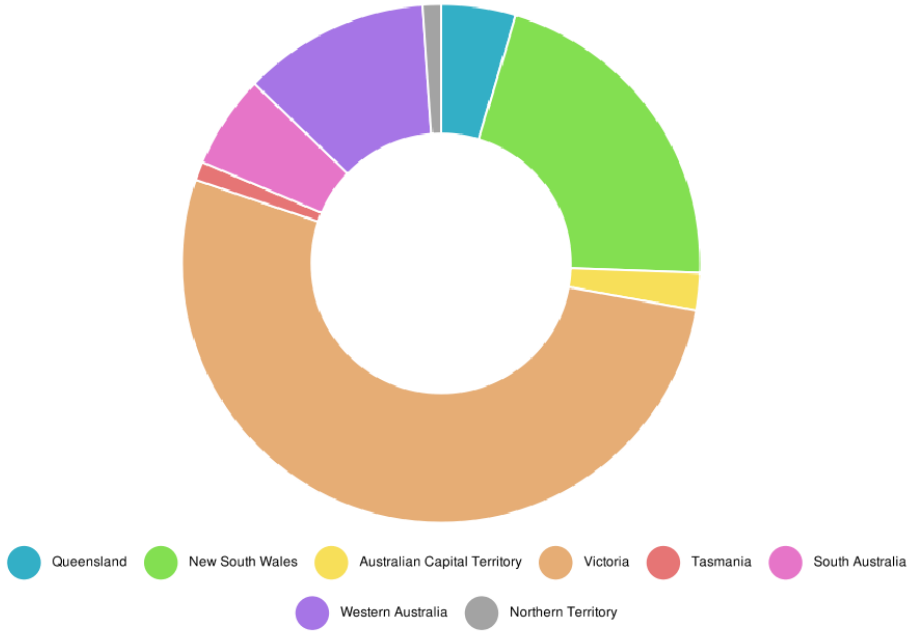


Figure 12. How many years experience do you have as an energy assessor?

	Less than 1 year	1-2 years	2-3 years	3-4 years	5 or more years	Standard Deviation	Responses
All Data	1 (1.16%)	2 (2.33%)	3 (3.49%)	10 (11.63%)	**70 (81.4%)**	26.59	86

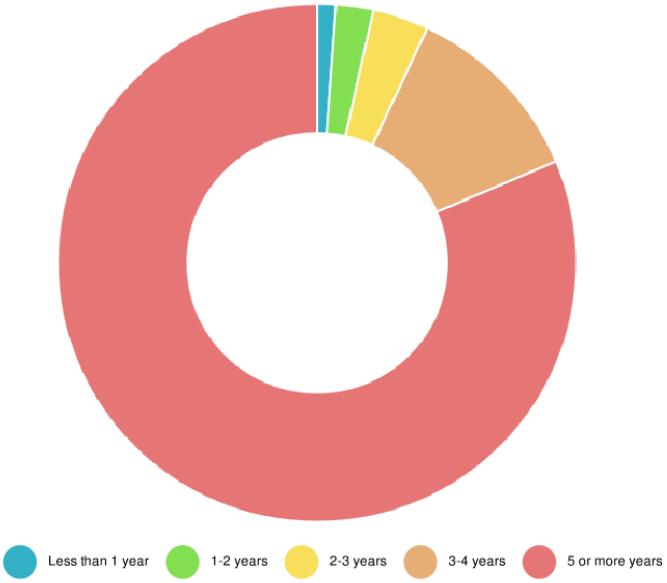


Figure 13. Are you an accredited assessor?

	Yes - ABSA	Yes - BDAV	Yes - ABSA and BDAV	No, but licensed or registered with state/ territory government	No	Standard Deviation	Responses
All Data	17 (19.77%)	**55 (63.95%)**	4 (4.65%)	2 (2.33%)	8 (9.3%)	19.59	86

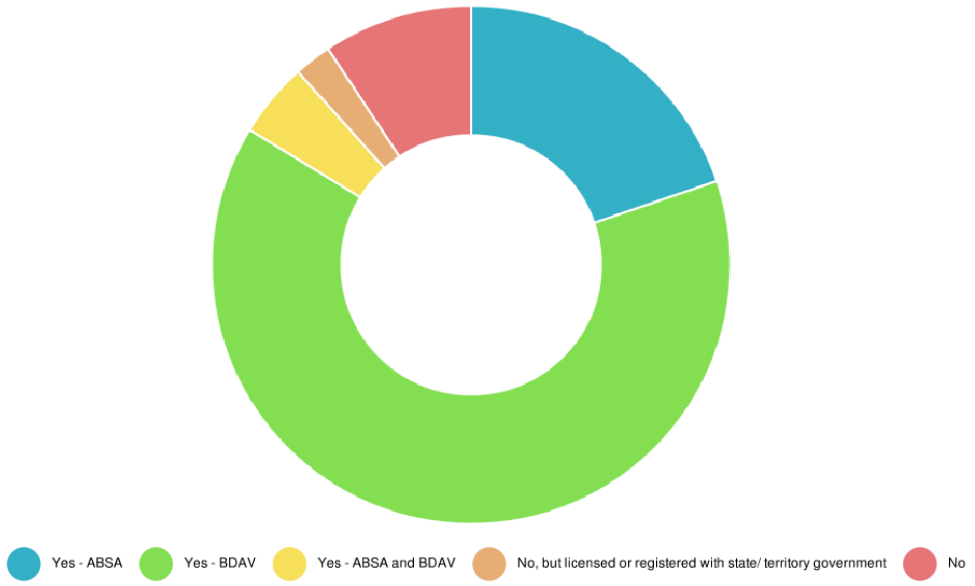


Figure 14. Have you completed the Certification IV in NatHERS Assessment course?

	Yes	In training	No, but intending to	No	Standard Deviation	Responses
All Data	21 (24.42%)	**43** **(50%)**	8 (9.3%)	14 (16.28%)	13.24	86

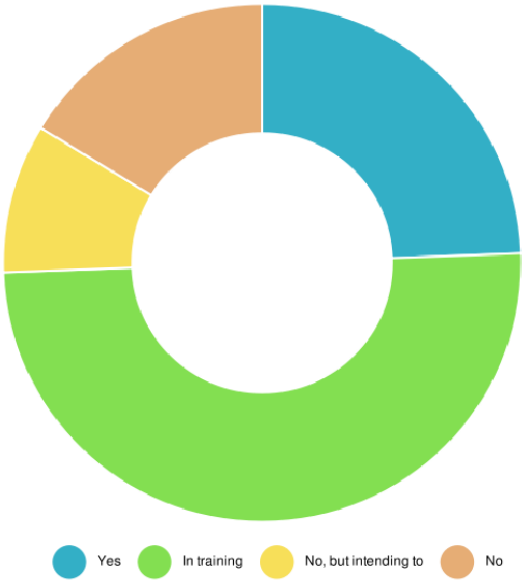


Figure 15. Please estimate the total number of building compliance reports you produce each year.

	0-49	50-99	100-199	200-499	500+	Standard Deviation	Responses
All Data	**35 (40.7%)**	15 (17.44%)	13 (15.12%)	12 (13.95%)	11 (12.79%)	9	86

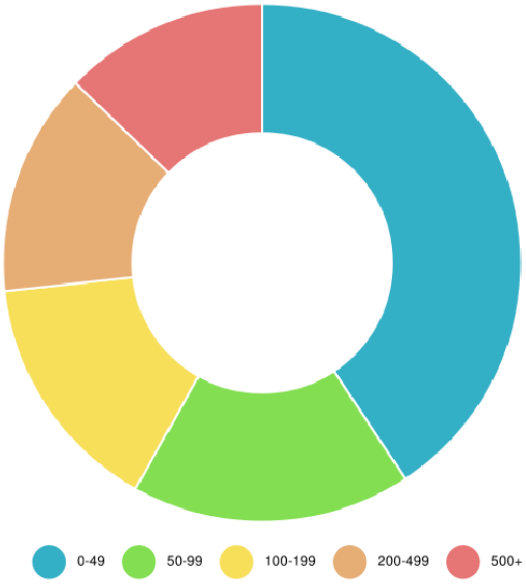


Figure 16. Of the building compliance reports you produce each year please estimate the number of alterations and additions as a percentage of the total reports.

	<1%	1-5%	5-10%	10-20%	20-50%	50-100%	Standard Deviation	Responses
All Data	11 (12.79%)	10 (11.63%)	9 (10.47%)	21 (24.42%)	**26 (30.23%)**	9 (10.47%)	6.67	86

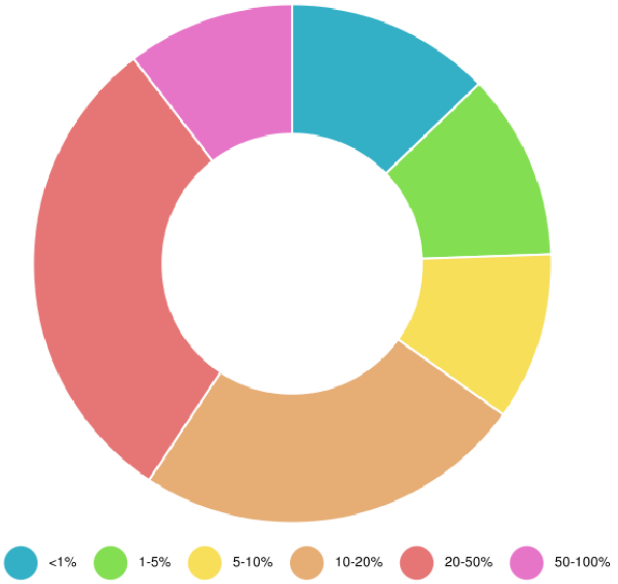


Figure 17. How many people provide energy efficiency compliance documentation in your organisation.

	1	2-5	6-10	More than 10	Standard Deviation	Responses
All Data	**60 (69.77%)**	18 (20.93%)	3 (3.49%)	5 (5.81%)	22.96	86

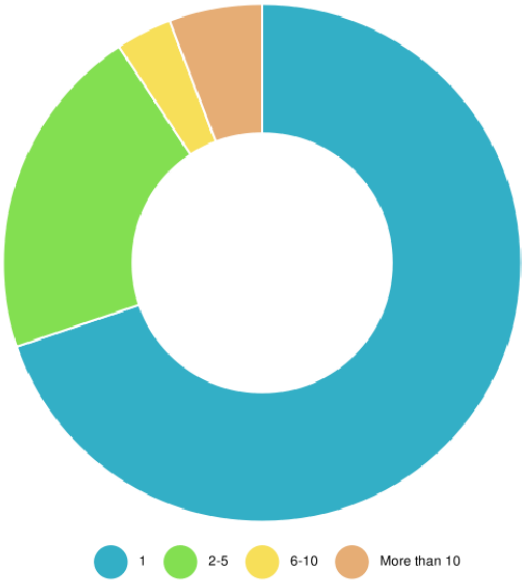
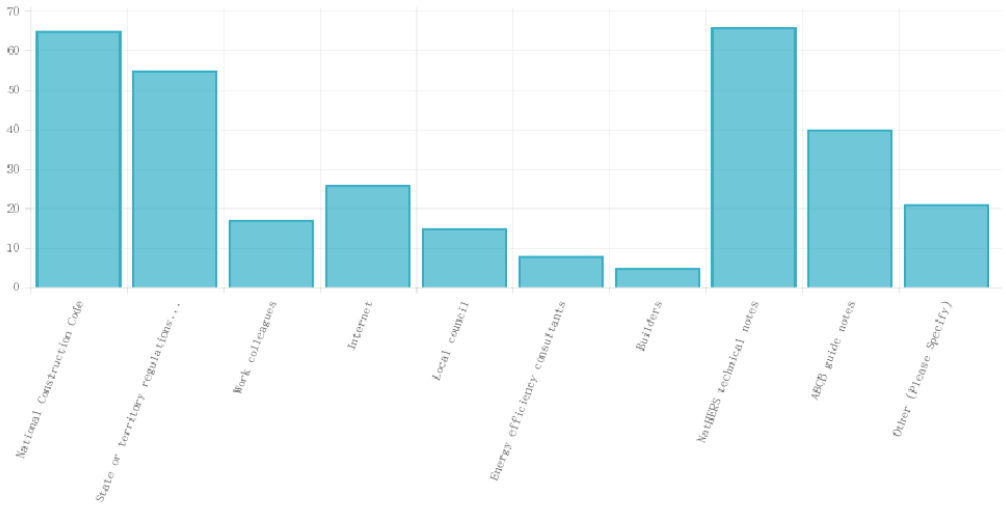


Figure 18. What sources of information do you use for clarification on energy efficiency requirement for alterations and additions? Please select all that apply.

	National Construction Code	State or territory regulations and protocols	Work colleagues	Internet	Local council	Energy efficiency consultants	Builders	NatHERS technical notes	ABCB guide notes	Other (Please Specify)	Responses
All Data	65 (75.58%)	55 (63.95%)	17 (19.77%)	26 (30.23%)	15 (17.44%)	8 (9.3%)	5 (5.81%)	**66 (76.74%)**	40 (46.51%)	21 (24.42%)	86



Summary of additional responses:
What sources of information do you use for clarification on energy efficiency requirements for alterations and additions?

- Building surveyors
- Building designers
- AIRAH and ASHRAE guides
- Building Design Association of Victoria webinars
- Google Earth
- The Royal Australian Institute of Architects (RAIA) Environmental Design Guide (EDG)
- BASIX software

Table 13. Of the additions (excluding alterations) assessments you see, how often are each of th energy efficiency compliance methods used?

	Always	Often	Occassionally	Never	Unsure	Comments:	Standard Deviation	Responses	Weighted Average
DtS Elemental	12 (13.95%)	23 (26.74%)	**31 (36.05%)**	15 (17.44%)	5 (5.81%)	0 (0%)	10.42	86	2.74 / 5
Star Rating	10 (11.76%)	**40 (47.06%)**	16 (18.82%)	18 (21.18%)	1 (1.18%)	0 (0%)	13.4	85	2.53 / 5
Verification Method using a reference building (v2.6.2.2)	1 (1.18%)	5 (5.88%)	7 (8.24%)	**67 (78.82%)**	5 (5.88%)	0 (0%)	23.75	85	3.82 / 5
Alternative Solution	0 (0%)	4 (4.71%)	13 (15.29%)	**64 (75.29%)**	4 (4.71%)	0 (0%)	22.7	85	3.8 / 5
Expert Judgement	0 (0%)	1 (1.18%)	13 (15.29%)	**66 (77.65%)**	5 (5.88%)	0 (0%)	23.62	85	3.88 / 5
Evidence of Suitability	0 (0%)	0 (0%)	9 (10.59%)	**70 (82.35%)**	6 (7.06%)	0 (0%)	25.21	85	3.96 / 5
Other - please specify in comments field	5 (5.88%)	2 (2.35%)	3 (3.53%)	**58 (68.24%)**	17 (20%)	0 (0%)	20.36	85	3.94 / 5
									3.53 / 5

Table 14. Of the alterations (excluding additions) assessments you see, how often are each of th energy efficiency compliance methods used?

	Always	Often	Occassionally	Never	Unsure	Comments:	Standard Deviation	Responses	Weighted Average
DtS Elemental	17 (19.77%)	20 (23.26%)	**27 (31.4%)**	17 (19.77%)	5 (5.81%)	0 (0%)	9.12	86	2.69 / 5
Star Rating	11 (12.94%)	**30 (35.29%)**	15 (17.65%)	28 (32.94%)	1 (1.18%)	0 (0%)	11.74	85	2.74 / 5
Verification Method using a reference building (v2.6.2.2)	2 (2.35%)	4 (4.71%)	5 (5.88%)	**69 (81.18%)**	5 (5.88%)	0 (0%)	24.59	85	3.84 / 5
Alternative Solution	1 (1.18%)	2 (2.35%)	12 (14.12%)	**67 (78.82%)**	3 (3.53%)	0 (0%)	23.95	85	3.81 / 5
Expert Judgement	0 (0%)	2 (2.35%)	13 (15.29%)	**66 (77.65%)**	4 (4.71%)	0 (0%)	23.6	85	3.85 / 5
Evidence of Suitability	0 (0%)	1 (1.18%)	6 (7.06%)	**72 (84.71%)**	6 (7.06%)	0 (0%)	25.99	85	3.98 / 5
Other - please specify in comments field	4 (4.71%)	1 (1.18%)	4 (4.71%)	**59 (69.41%)**	17 (20%)	0 (0%)	20.81	85	3.99 / 5
									3.55 / 5

Figure 19. Which NatHERS software tool do you use most often?

	AccuRate Sustainability	FirstRate5	BERS Pro	None	Standard Deviation	Responses
All Data	11 (12.79%)	**48** **(55.81%)**	26 (30.23%)	1 (1.16%)	17.7	86

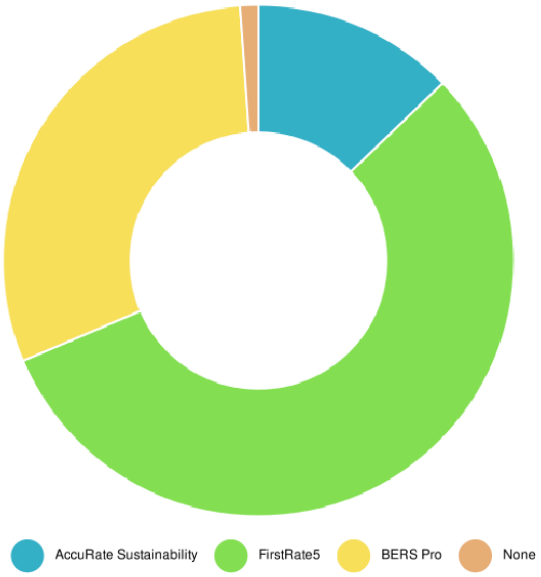


Figure 20. If a House Energy Rating (HER) is being used to demonstrate compliance, do you usually check the HER report references the correct (final for construction) building plans?

	Yes	No	Unsure	Standard Deviation	Responses
All Data	**70 (81.4%)**	9 (10.47%)	7 (8.14%)	29.24	86

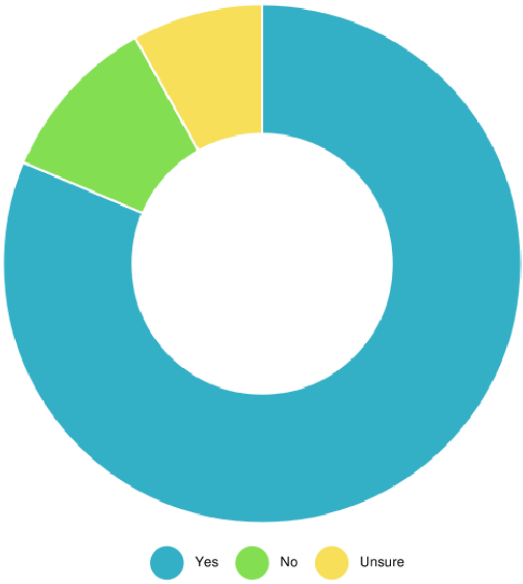


Table 15. If an addition or alteration is being made to a Class 1 dwelling, what upgrades to the existing building would you consider are reasonable to require as part of the building approval?

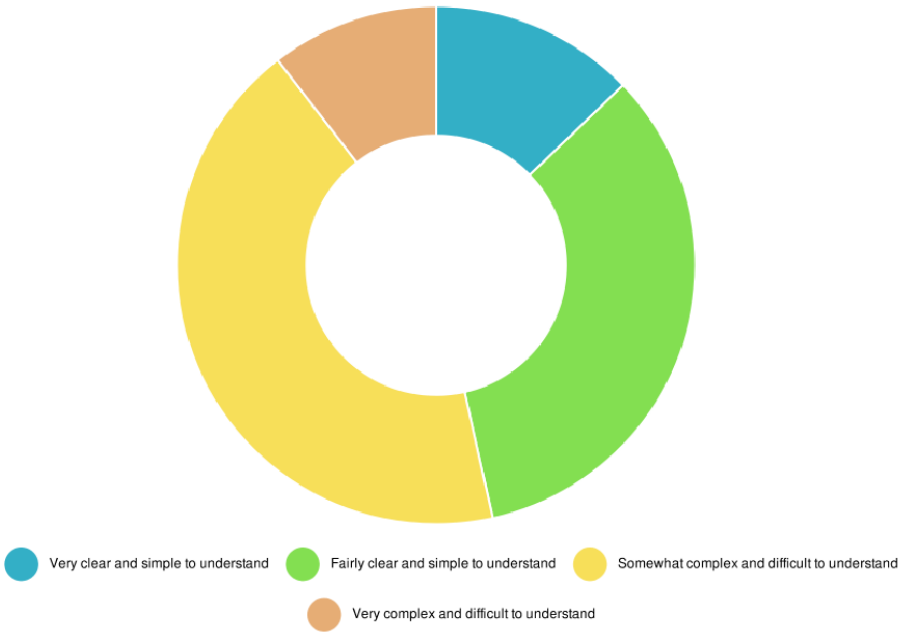
	Always	Often	Occasionally	Never	Unsure	Comments:	Standard Deviation	Responses	Weighted Average
Glazing films to improve SHGC and/or U-value	5 (5.81%)	13 (15.12%)	**32 (37.21%)**	32 (37.21%)	4 (4.65%)	0 (0%)	13.07	86	3.2 / 5
Glazing sealing improvement	19 (22.09%)	**25 (29.07%)**	18 (20.93%)	20 (23.26%)	4 (4.65%)	0 (0%)	9.07	86	2.59 / 5
Remove and replace glazing systems for some existing glazing (such as main living zone)	1 (1.16%)	13 (15.12%)	27 (31.4%)	**41 (47.67%)**	4 (4.65%)	0 (0%)	15.07	86	3.4 / 5
Remove and replace all existing glazing systems	1 (1.16%)	2 (2.33%)	22 (25.58%)	**58 (67.44%)**	3 (3.49%)	0 (0%)	20.93	86	3.7 / 5
Self-sealing exhaust fans	**35 (40.7%)**	22 (25.58%)	16 (18.6%)	11 (12.79%)	2 (2.33%)	0 (0%)	11.95	86	2.1 / 5
Seal wall vents and other cracks and gaps	**35 (41.18%)**	24 (28.24%)	11 (12.94%)	12 (14.12%)	3 (3.53%)	0 (0%)	12.05	85	2.11 / 5
Add ceiling insulation	**45 (52.33%)**	31 (36.05%)	3 (3.49%)	5 (5.81%)	2 (2.33%)	0 (0%)	17.28	86	1.7 / 5
Add roof insulation	11 (12.79%)	16 (18.6%)	**38 (44.19%)**	19 (22.09%)	2 (2.33%)	0 (0%)	12.61	86	2.83 / 5
Add external wall insulation	7 (8.14%)	18 (20.93%)	**38 (44.19%)**	20 (23.26%)	3 (3.49%)	0 (0%)	12.87	86	2.93 / 5
Add underfloor insulation	6 (6.98%)	**34 (39.53%)**	31 (36.05%)	12 (13.95%)	3 (3.49%)	0 (0%)	13.37	86	2.67 / 5
Add internal thermal mass	0 (0%)	3 (3.49%)	26 (30.23%)	**53 (61.63%)**	4 (4.65%)	0 (0%)	19.48	86	3.67 / 5
Add internal wall insulation	3 (3.49%)	17 (19.77%)	23 (26.74%)	**39 (45.35%)**	4 (4.65%)	0 (0%)	13.73	86	3.28 / 5
Change roof colour	1 (1.16%)	6 (6.98%)	23 (26.74%)	**52 (60.47%)**	4 (4.65%)	0 (0%)	18.5	86	3.6 / 5
Add ceiling fans	7 (8.24%)	20 (23.53%)	**33 (38.82%)**	22 (25.88%)	3 (3.53%)	0 (0%)	11.74	85	2.93 / 5
Increase shading of walls and windows incorporating the use of awnings, planting vegetation or other measures	6 (6.98%)	**27 (31.4%)**	27 (31.4%)	23 (26.74%)	3 (3.49%)	0 (0%)	11.54	86	2.88 / 5
Heating/ cooling system	3 (3.49%)	6 (6.98%)	23 (26.74%)	**47 (54.65%)**	7 (8.14%)	0 (0%)	16.33	86	3.57 / 5
Hot water system	5 (5.81%)	13 (15.12%)	25 (29.07%)	**37 (43.02%)**	6 (6.98%)	0 (0%)	12.85	86	3.3 / 5
Lighting	13 (15.12%)	24 (27.91%)	**25 (29.07%)**	20 (23.26%)	4 (4.65%)	0 (0%)	9.6	86	2.74 / 5
									2.96 / 5

Summary of additional responses:

- Energy Recovery Ventilation (ERV)
- Photovoltaic (PV) system
- Floor coverings (e.g. from carpet to tiles in hot locations to expose thermal mass, adding carpet in cold locations to increase insulation)
- Airtightness testing
- Internal blinds
- Roof vents in hot locations
- Including an airlock between old and new zones
- Enclose the subfloor
- Seal existing chimneys or add dampers
- Cross-flow ventilation by altering window configuration
-

Figure 21. What is your view of the rules and protocols for energy efficiency of alts and adds?

	Very clear and simple to understand	Fairly clear and simple to understand	Somewhat complex and difficult to understand	Very complex and difficult to understand	Standard Deviation	Responses
All Data	11 (12.79%)	29 (33.72%)	**37 (43.02%)**	9 (10.47%)	11.86	86



Summary of responses:
Would you like to provide any other comments about energy efficiency regulations and protocols for Class 1 and 10 alterations, additions and existing buildings?

- The various rules around Australia are difficult to follow
- There is a lot of confusion around the regulations and protocols and when rules apply in different situations
- More similar regulations between jurisdictions then they would be much easier to follow
- It would be good if there were a harmonised national approach for alterations and additions, in the same way as for new builds
- The regulations should be simplified and use wording understandable to the average person
- Many building surveyors are not requiring a report for alterations, only additions, which is creating confusion in the marketplace
- Regulations in the ACT are impossible to understand and every certifier has a different interpretation of them
- In Tasmania there is significant confusion about what the regulation are
- Surveyors should have more discretion in applying the energy efficiency regulations to alterations and additions as every situation is different
- There should be more consideration of clients needs and budgets in applying the regulatory requirements
- Building surveyors have a powerful regulatory role, but do not properly understand building thermal performance or their discretion to allow nuances in requirements
- Compliance requirements should relate to the type of the building works rather than the extent. All new structures should comply however where minor works and treatments are undertaken the requirements should be solely base on the complexity and cost of changes rather then the extent
- The NCC and software provide minimal guidance on how to approach alts and adds
- The ACBC glazing calculator is very difficult to use for alteration and addition projects due to the constraints of the existing building and location of additions (e.g. south-facing)
- There are several instances when it is not possible to apply the current national regulations and protocols to alteration and addition projects, including using the NatHERS software to assess the star rating
- In NSW consumers should be given a choice as to whether they would like their dwelling assessed under the simulation method as the glazing calculator in the BASIX tool is too simplified and restrictive. It is the product of political interference from HIA and MBA that the simulation option isn't typically allowed
- In Victoria, the current protocol requiring two star ratings to be done (if new building works less than 50 % of existing volume) creates unnecessary work for the assessors and the results often yields little cost-benefit for the home owner
- A thermal assessment should be mandatory once new building works exceeds a certain area
- It can not be expected that by adding one room to an existing house that the whole building needs to comply
- There should be a national calculation to determine the required star rating based on the age of the existing dwelling and percentage of floor area of the new building works (similar to the alts and adds protocol in WA)
- A more comprehensive manual for FirstRate 5 would be helpful
- It should not be more expensive to produce a compliance report for an alteration and addition project than for a new house
- It is often difficult to obtain baseline information on the existing dwelling
- As assessors we often need to make assumptions about constructions based on the age and location of a dwelling. It would be useful if there was a standard for when information is lacking.

Figure 1. In which State or Territory do you primarily work?

	Queensland	New South Wales	Australian Capital Territory	Victoria	Tasmania	South Australia	Western Australia	Northern Territory	Standard Deviation	Responses
All Data	7 (14%)	5 (10%)	1 (2%)	11 (22%)	1 (2%)	8 (16%)	**13 (26%)**	4 (8%)	4.09	50

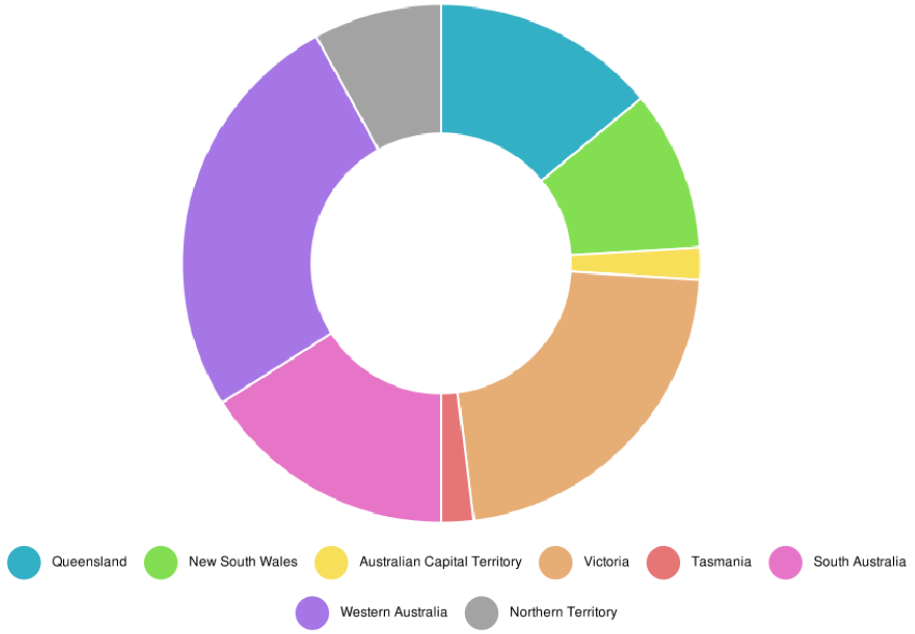


Figure 2. Do you work as a private or council certifier?

	Private	Council	Both	Retired or discontinued work as a certifier (within past 3 years)	Standard Deviation	Responses
All Data	**24 (48%)**	22 (44%)	4 (8%)	0 (0%)	10.62	50

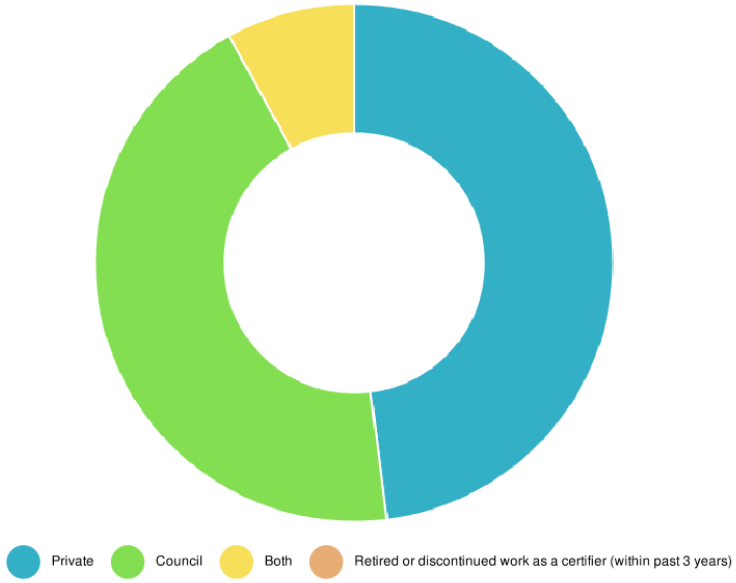


Figure 3. Estimate the total number of building approvals cases you process each year.

	0-49	50-99	100-199	200-499	500+	Standard Deviation	Responses
All Data	3 (6%)	2 (4%)	9 (18%)	17 (34%)	**19 (38%)**	6.99	50

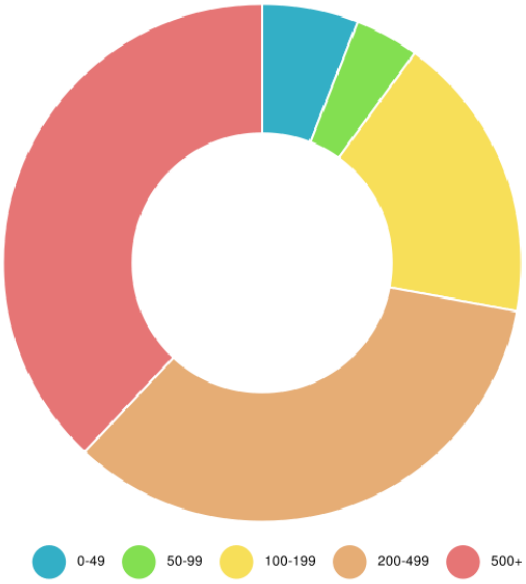


Figure 4. Of the building approvals cases you review, estimate the number of alterations and additions as a percentage of the total approvals you see.

	<1%	1-5%	5-10%	10-20%	20-50%	50-100%	Standard Deviation	Responses
All Data	1 (2%)	2 (4%)	6 (12%)	14 (28%)	**23 (46%)**	4 (8%)	7.8	50

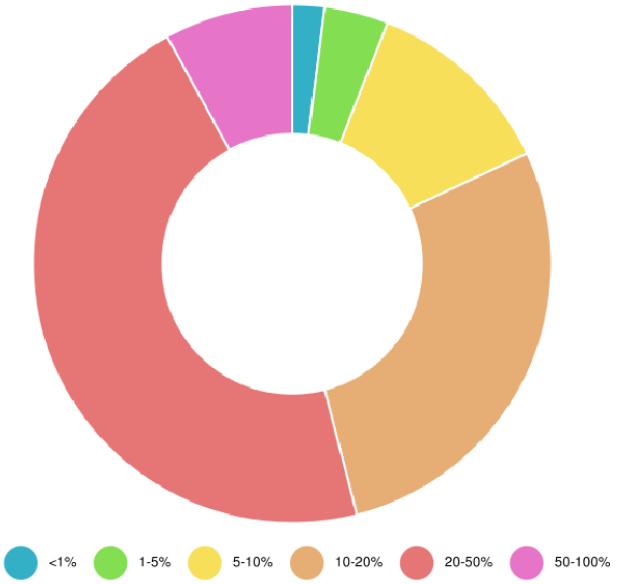


Figure 5. What sources of information do you use for clarification on energy efficiency requirements for alterations and additions? Please select all that apply.

	National Construction Code	State or territory regulations and protocols	Work colleagues	Internet	Local council	Energy efficiency consultants	Builders	NatHERS Technical Notes	ABCB guide notes	Other (Please Specify)	Responses
All Data	**43 (86%)**	29 (58%)	15 (30%)	10 (20%)	3 (6%)	29 (58%)	2 (4%)	10 (20%)	15 (30%)	6 (12%)	50

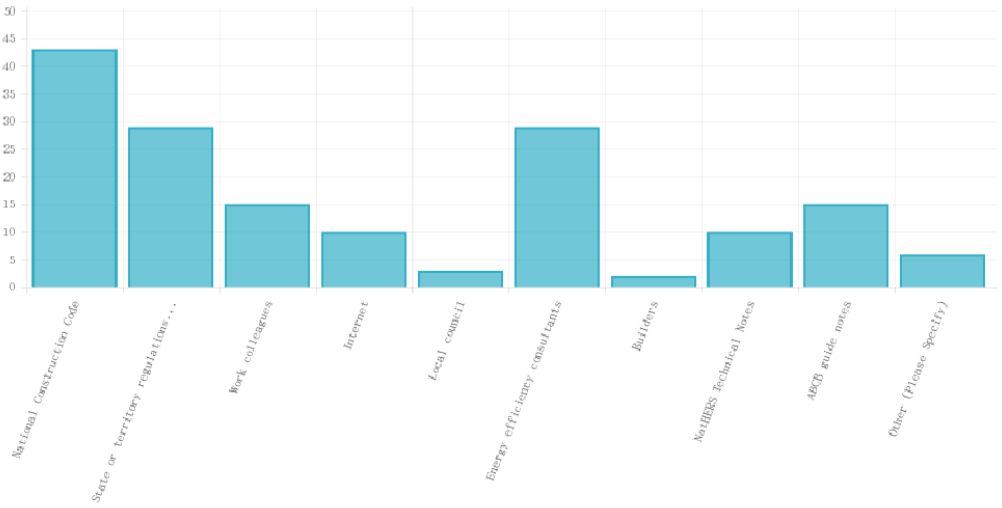


Table 10. Of the additions (excluding alterations) assessments you see, how often are each of the efficiency compliance methods used?

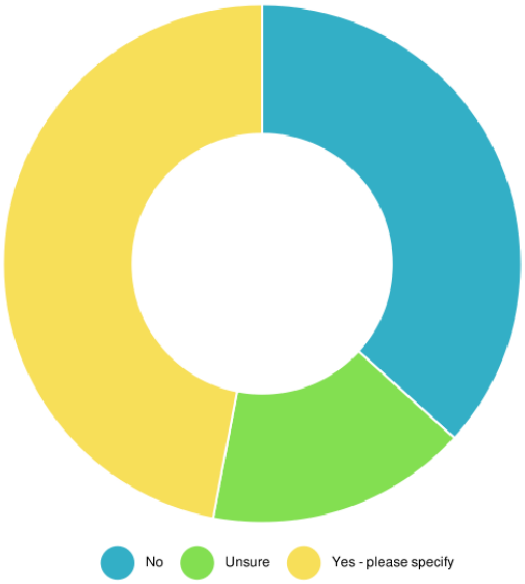
	Always	Often	Occassionally	Never	Unsure	Comments:	Standard Deviation	Responses	Weighted Average
DtS Elemental	3 (6%)	**26 (52%)**	13 (26%)	5 (10%)	3 (6%)	0 (0%)	8.86	50	2.58 / 5
Star Rating	7 (14%)	**25 (50%)**	14 (28%)	2 (4%)	2 (4%)	0 (0%)	8.77	50	2.34 / 5
Verification Method using a reference building (v2.6.2.2)	0 (0%)	8 (16%)	15 (30%)	**25 (50%)**	2 (4%)	0 (0%)	9.14	50	3.42 / 5
Alternative Solution	0 (0%)	2 (4%)	18 (36%)	**27 (54%)**	3 (6%)	0 (0%)	10.4	50	3.62 / 5
Expert Judgement	0 (0%)	1 (2%)	11 (22%)	**36 (72%)**	2 (4%)	0 (0%)	12.94	50	3.78 / 5
Evidence of Suitability	0 (0%)	2 (4%)	8 (16%)	**38 (76%)**	2 (4%)	0 (0%)	13.54	50	3.8 / 5
Other - please specify in comments field	0 (0%)	1 (2%)	1 (2%)	**29 (58%)**	19 (38%)	0 (0%)	11.46	50	4.32 / 5
									3.41 / 5

Table 11. Of the alterations (excluding additions) assessments you see, how often are each of the energy efficiency compliance methods used?

	Always	Often	Occassionally	Never	Unsure	Comments:	Standard Deviation	Responses	Weighted Average
DtS Elemental	6 (12%)	**19 (38%)**	12 (24%)	9 (18%)	4 (8%)	0 (0%)	6.07	50	2.72 / 5
Star Rating	5 (10%)	**20 (40%)**	13 (26%)	10 (20%)	2 (4%)	0 (0%)	6.85	50	2.68 / 5
Verification Method using a reference building (v2.6.2.2)	0 (0%)	4 (8%)	11 (22%)	**33 (66%)**	2 (4%)	0 (0%)	11.64	50	3.66 / 5
Alternative Solution	0 (0%)	2 (4%)	10 (20%)	**35 (70%)**	3 (6%)	0 (0%)	12.39	50	3.78 / 5
Expert Judgement	0 (0%)	1 (2%)	8 (16%)	**39 (78%)**	2 (4%)	0 (0%)	13.98	50	3.84 / 5
Evidence of Suitability	0 (0%)	1 (2%)	7 (14%)	**39 (78%)**	3 (6%)	0 (0%)	13.92	50	3.88 / 5
Other - please specify in comments field	0 (0%)	0 (0%)	0 (0%)	**32 (64%)**	18 (36%)	0 (0%)	12.46	50	4.36 / 5
									3.56 / 5

Figure 6. Are there any circumstances in which you provide exemptions to compliance or upgrade requirements for alterations, additions or existing buildings?

	No	Unsure	Yes - please specify	Standard Deviation	Responses
All Data	18 (36.73%)	8 (16.33%)	**23 (46.94%)**	6.24	49



Summary of additional text responses:
Are there any circumstances in which you provide exemptions to compliance or upgrade requirements for alterations, additions and existing buildings?

- Heritage buildings where it is not possible to achieve requirements;
- When the requirements seem unreasonable;
- Minor alteration works such as changing a window to sliding door;
- Internal alterations;
- Existing unlawful structures off the power grid; and
- When the changes would have no bearing on the energy efficiency.

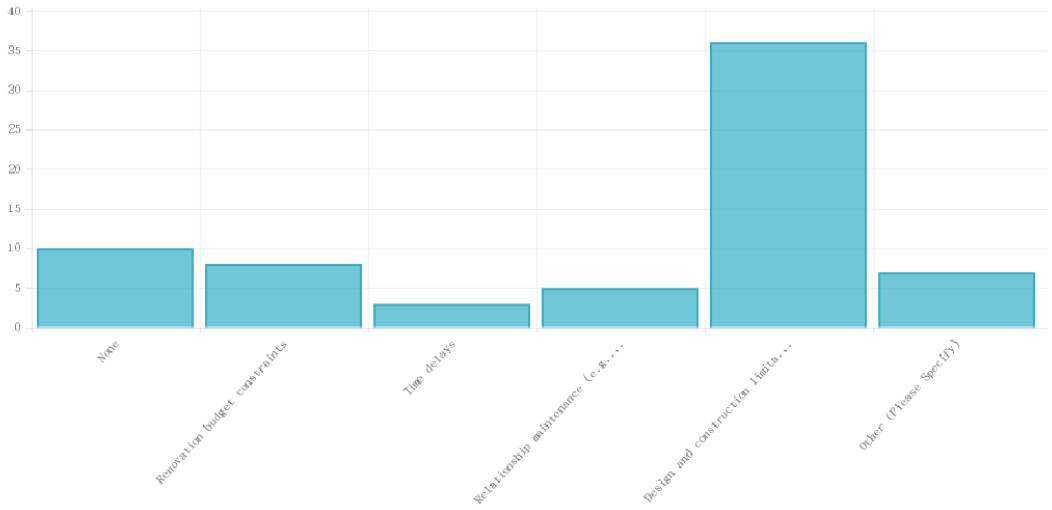
Table 12. If an alteration or addition is being made to a Class 1 dwelling, what upgrades to the existing building would you consider are reasonable to require?

	Always	Often	Occasionally	Never	Unsure	Comments:	Standard Deviation	Responses	Weighted Average
Glazing films to improve SHGC and/or U-value	0 (0%)	4 (8%)	**26 (52%)**	17 (34%)	3 (6%)	0 (0%)	9.78	50	3.38 / 5
Glazing sealing improvement	0 (0%)	6 (12%)	**23 (46%)**	18 (36%)	3 (6%)	0 (0%)	8.96	50	3.36 / 5
Remove and replace glazing systems for some existing glazing (such as main living zone)	0 (0%)	3 (6%)	13 (26%)	**30 (60%)**	4 (8%)	0 (0%)	10.62	50	3.7 / 5
Remove and replace all existing glazing systems	0 (0%)	2 (4%)	9 (18%)	**35 (70%)**	4 (8%)	0 (0%)	12.31	50	3.82 / 5
Self-sealing exhaust fans	4 (8%)	9 (18%)	**17 (34%)**	17 (34%)	3 (6%)	0 (0%)	6.67	50	3.12 / 5
Seal wall vents and other cracks and gaps	4 (8%)	8 (16%)	**18 (36%)**	15 (30%)	5 (10%)	0 (0%)	6.29	50	3.18 / 5
Add ceiling insulation	12 (24%)	**18 (36%)**	14 (28%)	5 (10%)	1 (2%)	0 (0%)	6.75	50	2.3 / 5
Add roof insulation	9 (18%)	14 (28%)	**19 (38%)**	5 (10%)	3 (6%)	0 (0%)	6.52	50	2.58 / 5
Add external wall insulation	6 (12%)	7 (14%)	**17 (34%)**	17 (34%)	3 (6%)	0 (0%)	6.52	50	3.08 / 5
Add underfloor insulation	2 (4%)	8 (16%)	**21 (42%)**	16 (32%)	3 (6%)	0 (0%)	7.72	50	3.2 / 5
Add internal thermal mass	0 (0%)	4 (8%)	12 (24%)	**29 (58%)**	5 (10%)	0 (0%)	10.08	50	3.7 / 5
Add internal wall insulation	0 (0%)	5 (10%)	16 (32%)	**25 (50%)**	4 (8%)	0 (0%)	9.18	50	3.56 / 5
Change roof colour	0 (0%)	1 (2%)	11 (22%)	**35 (70%)**	3 (6%)	0 (0%)	12.51	50	3.8 / 5
Add ceiling fans	0 (0%)	10 (20%)	**23 (46%)**	16 (32%)	1 (2%)	0 (0%)	8.84	50	3.16 / 5
Increase shading of walls and windows incorporating the use of awnings, planting vegetation or other measures	1 (2%)	6 (12%)	16 (32%)	**24 (48%)**	3 (6%)	0 (0%)	8.77	50	3.44 / 5
Heating/ cooling system	0 (0%)	7 (14%)	13 (26%)	**27 (54%)**	3 (6%)	0 (0%)	9.48	50	3.52 / 5
Hot water system	0 (0%)	14 (28%)	14 (28%)	**19 (38%)**	3 (6%)	0 (0%)	7.59	50	3.22 / 5
Lighting	3 (6%)	10 (20%)	14 (28%)	**21 (42%)**	2 (4%)	0 (0%)	7.45	50	3.18 / 5
									3.29 / 5

Summary of text responses:
Can you identify any other retrofit changes that could reasonably be applied to improve the existing building performance which aren't listed above.
- Water tank
- Include a mechanism to close the windows when the heater is turned on
- Solar panels
- Water wise taps and showerheads

Figure 7. As a certifier are there any extenuating circumstances which you take into consideration when it comes energy efficiency compliance of alterations and additions?

	None	Renovation budget constraints	Time delays	Relationship maintenance (e.g. with individual builders or property developers)	Design and construction limitations in older dwellings	Other (Please Specify)	Responses
All Data	10 (20%)	8 (16%)	3 (6%)	5 (10%)	**36 (72%)**	7 (14%)	50



Summary of additional text responses:
As a certifier are there any extenuating circumstances which you take into consideration when it comes to energy efficiency compliance of alterations and additions?

- Heritage buildings
- Rural off-grid, self-sustainable dwellings
- Benefits of change (i.e. size of additions)

Figure 8. Does energy assessor accreditation status influence your decision to accept building compliance documentation?

	Always	Often	Occassionally	Never	Unsure	Standard Deviation	Responses
All Data	**19 (38%)**	15 (30%)	9 (18%)	6 (12%)	1 (2%)	6.39	50

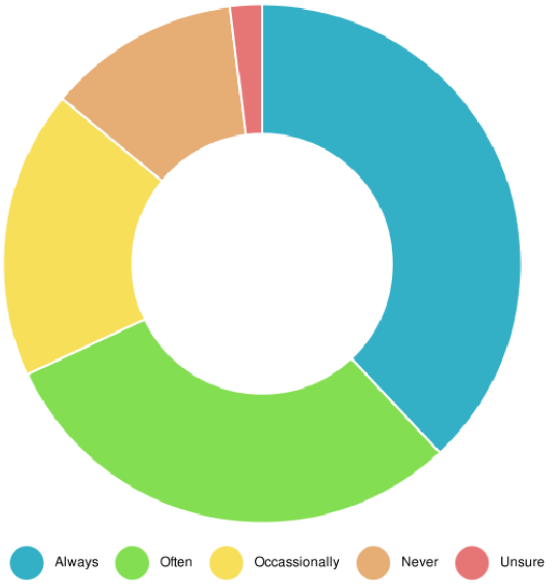


Figure 9. What level of importance do you place on gathering documentary evidence of Class 1 and 10 energy efficiency compliance?

	Low	Medium	High	Unsure	Standard Deviation	Responses
All Data	1 (2%)	11 (22%)	**36** **(72%)**	2 (4%)	14.12	50

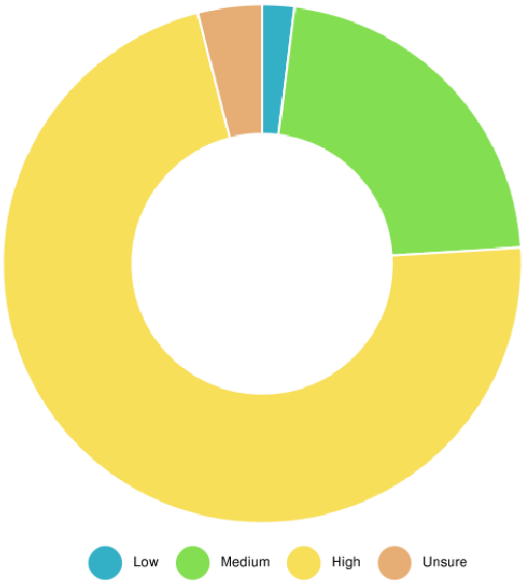
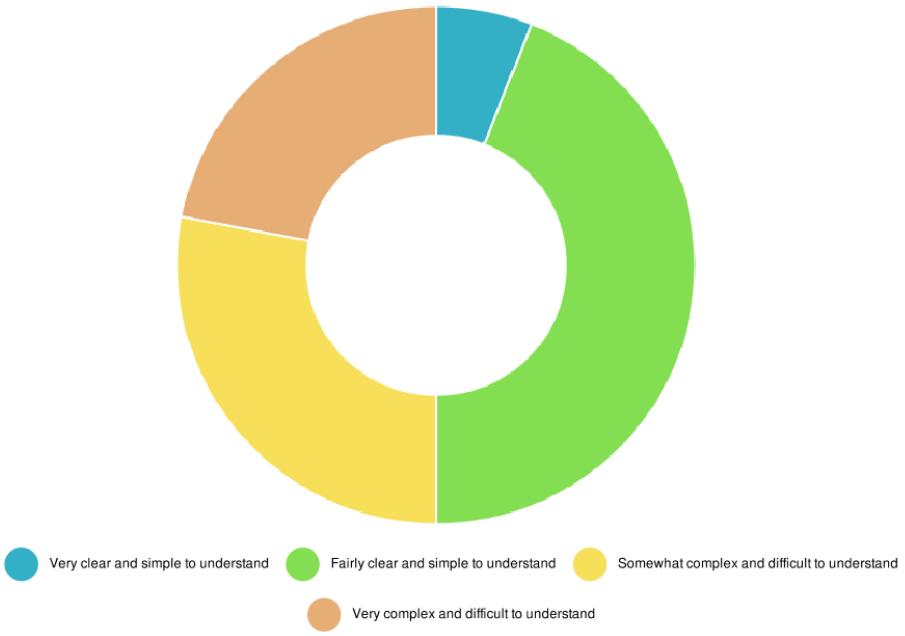


Figure 10. What is your view of the regulations and protocols for energy efficiency of alts and adds?

	Very clear and simple to understand	Fairly clear and simple to understand	Somewhat complex and difficult to understand	Very complex and difficult to understand	Standard Deviation	Responses
All Data	3 (6%)	**22 (44%)**	14 (28%)	11 (22%)	6.8	50



Summary of responses:
Would you like to make any other comments about energy efficiency regulations and protocols for Class 1 and 10 alterations, additions and existing buildings?

- Energy rating submissions often do not meet the minimum requirements
- Energy efficiency requirements are not currently enforced
- Regulations are too complex to implement
- It would be simpler if the only method was the Deemed to Satisfy method with minimum insulation and glazing requirements
- The requirements are currently spread across so many different locations - NCC, NatHERS protocols, state and territory regulations and guidance notes, etc - that it is difficult to follow regulations and know which ultimately apply. A summary notice of requirements in a single location would be very helpful
- Stringent energy efficiency requirements can mean that project costs blow-out and the development cannot proceed
- Consumers have difficulty understanding energy efficiency regulations
- It should not be the responsibility of councils and certifiers to convince people to incorporate energy efficiency requirements into their development. If there is a benefit then there should be better education of the general public. Similarly it should be the responsibility of energy assessors to certify that the energy efficiency commitments have been met in the as-built development
- There should be more training on the correct installation of insulation and minimum requirements for documentation of products installed
- At no stage should legislation require the removal and replacement of existing building materials in order to achieve energy efficiency measures
- Regulations should be flexible but result in improved energy efficiency