ABCB

Energy efficiency: NCC 2022 and beyond

Scoping study

Copyright

Enquiries about this publication can be sent to:

Australian Building Codes Board
GPO Box 2013
CANBERRA ACT 2601
Phone: 1300 134 631
Email: ncc@abcb.gov.au
Web: abcb.gov.au

Attribution

Disclaimer

Version history

Original

Publish date: Jul 2019
Print version: 1.0

Contents

Executive summary

The Australian Building Codes Board (ABCB) has been directed by the Building Ministers' Forum (BMF) to investigate possible changes to the National Construction Code (NCC) energy efficiency provisions, with an emphasis on residential buildings in NCC 2022. This work is to be carried out in consideration of the Council of Australian Governments (COAG) Energy Council's Trajectory for Low Energy Buildings (the Trajectory) (coagenergycouncil.gov.au). The Trajectory proposes incremental changes to the NCC to reduce the operational energy use and associated greenhouse gas emissions of buildings.

To commence this process, the ABCB has produced this scoping study for public consultation. The study outlines a possible approach and scope for this project, with a particular focus on the 2022 version of the NCC (NCC 2022).

Residential buildings

For residential buildings (houses and apartments), the ABCB is proposing to developed two sets of NCC provisions (or options), which it will test through regulation impact analysis to determine the appropriate option for adoption in NCC 2022. The two options are as follows:

- Option 1 involves a set of provisions which would result in residential buildings having a level of thermal comfort equivalent to 7 stars NatHERS and net zero annual energy use for the regulated building services, i.e. space conditioning, heated water systems, lighting and pool and spa pumps.
- Option 2 involves a set of provisions which would result in residential buildings having a level of thermal comfort equivalent to 7 stars NatHERS and a moderate amount of annual energy use for the regulated building services.

The two options will enable a 'whole-of-house' approach to be used to achieve compliance. In particular, compliance through Verification Methods (or whole-of-house tools) will allow some trading between the energy efficiency of building services, and allow limited offsetting with on-site renewable energy.

Testing the two options will enable the ABCB to identify the most appropriate provisions for adoption in NCC 2022 and whether a transitional period should be applied. If the less stringent Option 2 is chosen, the development of Option 1 will, nevertheless, provide industry with an indication of the provisions that may be adopted in a future version of the NCC.

Commercial buildings

Given the substantial changes that were made to the commercial building energy efficiency provisions in NCC 2019, the ABCB is considering more moderate changes in NCC 2022. This is likely to include some refinement of the provisions for fabric and glazing, air-conditioning and the use of on-site renewables.

More substantial changes for commercial buildings may be considered for NCC 2025. This may involve the same approach used for residential buildings in NCC 2022, i.e. the development of two possible options with one being net zero.

Next steps

In addition to this scoping study process, further opportunity will be provided for comment throughout the development of the proposed changes to NCC 2022. This includes a full public consultation process on the detailed changes proposed for NCC 2022, which is likely to occur around early 2021.

In developing the proposed changes to NCC 2022, the ABCB will also undertake a holistic review of the residential energy efficiency provisions. This will include consideration of related issues, such as condensation and heat and cold stress. The ABCB will also ensure the residential energy efficiency provisions take account of regional differences.

Regulation impact analysis will be undertaken to ensure all potential changes to the NCC are underpinned by a rigorously tested rationale, are effective and proportional to the issue and generate a net societal benefit. This is a requirement of the ABCB's Inter-Governmental Agreement (IGA), as well as the COAG Principles for Best Practice Regulation.

In this respect, this scoping study does not constitute a decision to change the NCC, but rather a commitment to undertake a thorough process to determine if changes to the NCC are warranted, and if so, to what extent.

1 Introduction

The NCC is a performance-based code containing minimum necessary requirements to efficiently achieve safety, health, amenity, accessibility and sustainability through the design, construction, performance and liveability of new buildings and new work on existing buildings throughout Australia. The NCC is developed and maintained by the ABCB on behalf of the Australian Government and the State and Territory Governments. The ABCB's objectives, described in its IGA between all levels of government and the NCC, is given legal effect by relevant legislation in each State and Territory.

Energy efficiency requirements were initially introduced into the Building Code of Australia (BCA) (now NCC) as part of the Government's response to climate change. A joint agreement was reached between the Commonwealth, and State and Territory Governments to introduce mandatory energy efficiency provisions into the BCA in 2000.

Energy efficiency requirements for residential buildings were introduced in 2003 for houses and 2005 for multi-residential buildings. Requirements for commercial buildings took effect in 2006 with the housing provisions simultaneously increased to 5 stars. In 2009, COAG adopted the National Strategy on Energy Efficiency, which recommended further increases in building energy efficiency standards. As a result, the provisions for housing and multi-residential buildings were increased to 6 stars in 2010. At the same time, the commercial building provisions were also lifted to a higher level of stringency[1].

In 2015, COAG Energy Council endorsed the National Energy Productivity Plan (NEPP), which aims to improve Australia's energy productivity by 40 per cent between 2015 and 2030[2]. Among its package of measures, Measure 31 was aimed at improving new building work through the NCC. Furthermore, under the Paris

[1] ABCB, NCC Volume Two Energy Efficiency Provisions Handbook 2016, abcb.gov.au/Resources/Publications/Education-Training/NCC-Volume-Two-Energy-Efficiency-Provisions, page 17–18.

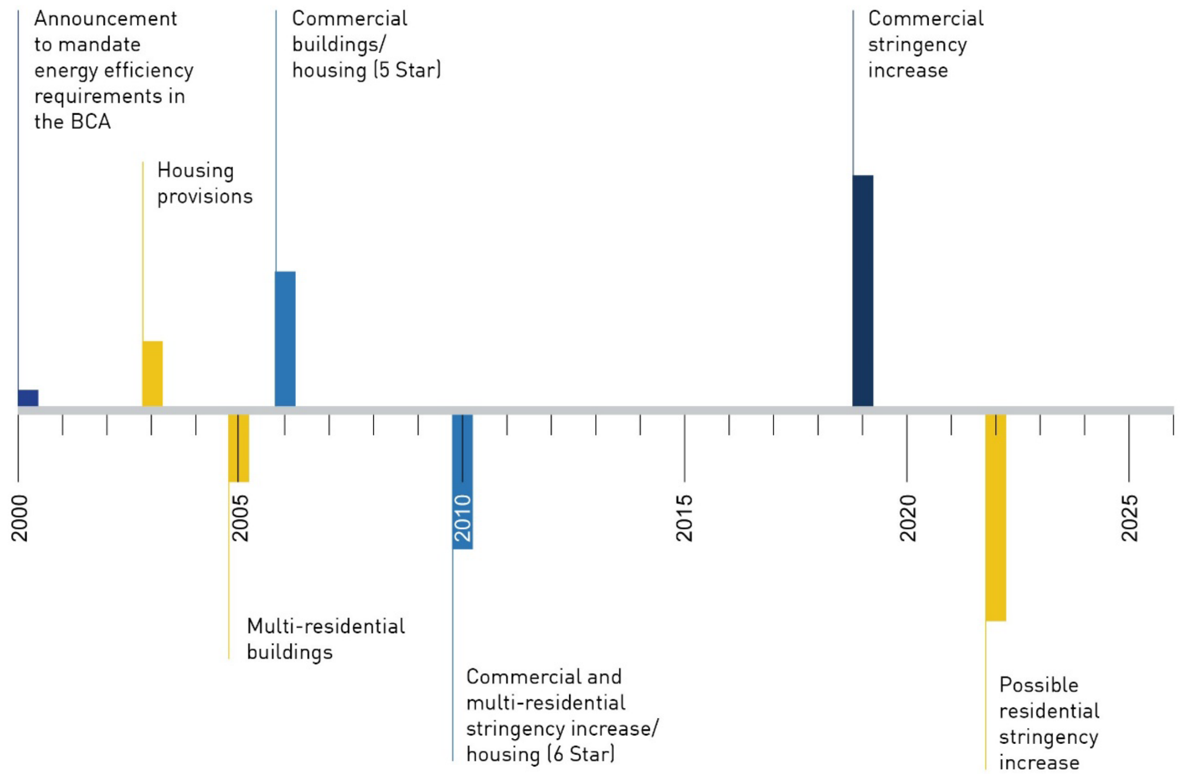
[2] COAG Energy Council, National Energy Productivity Plan 2015–2030, coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/National%20Energy%20Productivity%20Plan%20release%20version%20FINAL_0.pdf, page 6.

Agreement, signed by Australia in 2016, the Government committed to reduce greenhouse gas emissions by 26–28 per cent of 2005 levels by 2030[3].

On the basis of these policies, major changes were carried out to the commercial building energy efficiency provisions in NCC 2019. For residential buildings, changes were introduced to improve interpretation and compliance, with the expectation that evidence would be obtained to investigate a stringency increase in a future version of the NCC.

The evolution of the energy efficiency provisions in the NCC is shown in Figure 1.

Figure 1 Timeline of changes to the NCC energy efficiency provisions



1.1 The Trajectory

In early 2019, COAG Energy Council agreed to a *Trajectory for Low Energy Buildings*. The Trajectory proposes a pathway towards achieving 'zero energy (and carbon)

---

3 Australian Government, Australia's 2030 climate change target, environment.gov.au/system/files/resources/c42c11a8-4df7-4d4f-bf92-4f14735c9baa/files/factsheet-australias-2030-climate-change-target.pdf, page 1.

ready' buildings, primarily through ongoing increments of change to the energy efficiency provisions in the NCC.

The Trajectory was developed by the Commonwealth Department of the Environment and Energy (DEE) in consultation with state and territory senior officials for energy and a wide range of industry stakeholders. The overarching government objectives that sit behind the Trajectory are the commitment to improve Australia's energy productivity and reduce greenhouse gas emissions.

The Trajectory expands upon the NEPP, through which the energy efficiency changes to NCC 2019 were undertaken. The Trajectory was also informed by the Australian Sustainable Built Environment Council's (ASBEC) report, *Built to Perform: An Industry Led Pathway to a Zero Carbon Ready Building Code*.

The Trajectory proposes ongoing incremental changes to both the residential and commercial energy efficiency provisions in the NCC. However, rather than specify overarching targets for each increment, the Trajectory details some specific changes for consideration, particularly for NCC 2022, and suggests a means of determining the appropriate cost-effective stringency level.

The Trajectory recommends incremental changes to each triennial update of the NCC, possibly into the 2030s, until the provisions result in buildings being 'zero energy (and carbon) ready'. This is defined as[4]:

> *Zero energy (and carbon) ready buildings have an energy efficient thermal shell and appliances, have sufficiently low energy use and have the relevant set-up so they are 'ready' to achieve net zero energy (and carbon) usage, if they are combined with renewable or decarbonised energy systems on-site or off-site.*

COAG Energy Council requested that the BMF consider implementing the NCC changes proposed in the Trajectory. Consequently, in consideration of advice from the ABCB, at its meeting on 16 July 2019, the BMF:

[4] COAG Energy Council, Trajectory for low energy buildings, December 2018, page 4.

> *… agreed to the development of enhanced energy efficiency provisions for residential buildings in the National Construction Code, informed by the COAG Energy Council's trajectory for low energy buildings. The ABCB will shortly release a paper for public consultation on options for implementing these provisions in the NCC.*[5]

This scoping study has subsequently been prepared in consideration of the Trajectory and as a first step in the development of possible energy efficiency provisions for NCC 2022 and beyond. The scoping study:

- explores the approach to developing and assessing appropriate changes for NCC 2022 and beyond in consideration of the overarching objectives of the Trajectory; and
- outlines possible technical changes to both the residential and commercial provisions and the rationale for each change.

The purpose of the scoping study is to seek initial stakeholder comment on the approach and possible technical changes that may be appropriate in consideration of the Trajectory's objectives. Once the ABCB commences work on specific possible changes to NCC 2022, further opportunity will be provided for stakeholders to have input during the development of the updated provisions (See section 'Next steps')

[5] Building Ministers' Forum Communique, 16 July 2019, industry.gov.au/sites/default/files/2019-07/bmf-communique-18-july-2019.pdf

2 Residential buildings

2.1 Current situation

For the purpose of this scoping study, residential buildings are defined in accordance with the NCC building classifications as Class 1 buildings[6], Class 2 Sole-Occupancy Units (SOUs), and Class 4 parts of buildings. Energy efficiency requirements for common areas of Class 2 buildings are captured by the requirements for commercial buildings. This separation between residential and commercial buildings has been used consistently in the development of the NCC provisions.

Residential building energy efficiency provisions appear in all three NCC Volumes as shown in Table 1.

Table 1 NCC residential energy efficiency provisions

Building classification	Building provisions	Plumbing provisions
Class 1	Part 2.6 and Part 3.12 Volume Two	Part B2 Volume Three
Class 2 SOUs and Class 4 parts of buildings	Section J Volume One	Part B2 Volume Three

Since the introduction of minimum energy efficiency requirements for houses in 2003, the focus of the NCC's provisions has been on the thermal performance (building fabric) of the building. Provisions for water heating, water pumps and lighting were introduced in 2010.

As mentioned in the Introduction, the States and Territories adopt the NCC through their jurisdictional building regulations. The States and Territories sometimes vary requirements in particular circumstances, although this is discouraged under the ABCB IGA in preference for geographic variations within the NCC itself.

[6] NCC Building Classifications are included in **Appendix E**.

For example, one of the compliance options under the residential energy efficiency provisions involves achieving a specified star rating using software accredited under the Nationwide House Energy Rating Scheme (NatHERS). In general, the minimum star requirement is NatHERS 6 stars with an allowance in NCC climate zones 1 and 2[7]. Houses built in climate zones 1 and 2 can achieve NatHERS 5.5 stars if there is an outdoor living area that meets certain criteria. Alternatively, a design is permitted to achieve NatHERS 5 stars in climate zones 1 and 2 if the house has an outdoor living area that meets certain criteria and at least one permanently installed ceiling fan. These allowances were introduced in acknowledgement of how outdoor areas are used in warmer climates.

These basic provisions are further varied jurisdictionally by the Northern Territory (which has maintained the 2009 energy efficiency provisions) and Queensland (which has separate requirements through the Queensland Development Code). New South Wales also has separate Performance Requirements and compliance options based on its Building Sustainability Index (BASIX). BASIX is described in detail in Section 2.4.2.2.2 of this scoping study.

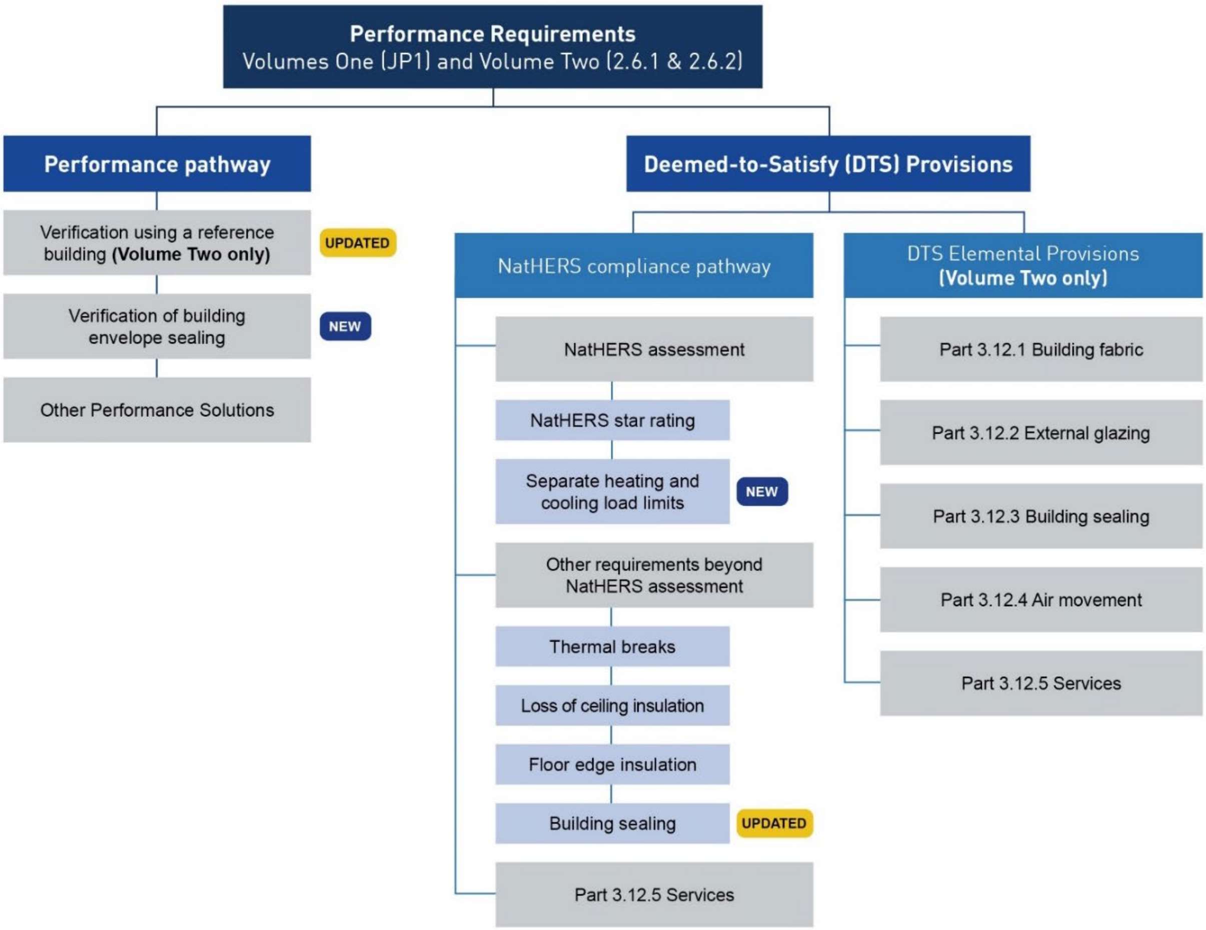
Regardless of the stringency settings, since 2003, the NCC energy efficiency provisions have offered two primary pathways to assess the thermal performance of residential buildings. The NatHERS assessment tools can be used to allow a design to meet the required standard in a more sophisticated and tailored manner. Alternatively, compliance can be achieved through a codified Deemed-to-Satisfy (DTS) set of elemental provisions, which allow limited flexibility in design. As always, the NCC also provides for the use of Performance Solutions. There is also a Verification Method which allows the use of non-NatHERS tools.

The purpose of the NCC 2019 changes for residential buildings was to improve interpretation and compliance with the current requirements. The changes also, for the first time, introduced a separate heating and cooling load limits for the NatHERS compliance pathway as a national approach. This approach has applied in NSW since 2004 through BASIX.

[7] There are eight climate zones that apply to the NCC energy efficiency provisions. Climate zones 1 and 2 cover warm, humid coastal areas from Exmouth in WA around northern Australia to Coffs Harbour in NSW. Further information about the NCC's climate zones is available at: abcb.gov.au/Resources/Tools-Calculators/Climate-Zone-Map-Australia-Wide

NCC 2019 energy efficiency provisions for residential buildings are shown in Figure 2.

Figure 2 NCC 2019 residential energy efficiency provisions



The key changes carried out in NCC 2019 include:

1. improvements to the reference building Verification Method, V2.6.2.2, to limit the software that can be used and include more detail around modelling inputs to prevent gaming;
2. a new building sealing Verification Method, JV4 and V2.6.2.3, based on blower door testing has been added as an option for verifying building sealing;
3. separate heating and cooling load limits now apply in addition to the specified star rating under the NatHERS compliance pathway to help ensure buildings are more comfortable year-round; and
4. minor improvements have been made to the DTS elemental building sealing provisions.

2.2 Approach to NCC 2022 for residential buildings

The Trajectory proposes that the focus for NCC 2022 be on residential energy efficiency provisions, with more moderate changes to the commercial building provisions. This scoping study proposes an approach to residential buildings, which contains the same basic elements of the Trajectory, but may result in a more ambitious outcome in NCC 2022 and potentially reduce the number of triennial NCC updates contemplated later on.

The ABCB's alternative approach is to develop two sets of provisions, or options, which would be tested for possible adoption in NCC 2022 through Regulation Impact Statement (RIS) process. Both options would examine a minimum level of thermal performance (or thermal comfort) equivalent to NatHERS 7 stars. However, the overall energy allowance (or annual energy use budget) of all regulated elements of residential buildings would vary between the two options.

The first set of provisions (Option 1) would incorporate on-site renewable energy (generation and storage) to the extent that the energy use of all regulated elements would be offset. Effectively, this would produce buildings which have net zero regulated energy (NZRE), i.e.:

Net Zero Regulated Energy (NZRE)

NZRE is achieved when the net annual energy use of all the services regulated by the NCC energy efficiency provisions equals zero. Regulated services include space conditioning, heated water systems, lighting and pool and spa pumps. NZRE may be achieved by offsetting the energy use of these services with energy generated by on-site renewables.

The second set of provisions (Option 2) would be more closely aligned to the basic approach suggested in the Trajectory for NCC 2022 and would not incorporate on-site renewables to the same extent. Unlike Option 1, Option 2 would establish a maximum annual energy use budget greater than zero for the regulated elements of a building.

Table 2 compares the key elements of the Trajectory with the ABCB's options.

Table 2 Comparison between the Trajectory and Options 1 and 2

	Trajectory[8]	ABCB Option 1	ABCB Option 2
Thermal comfort	NatHERS 6.5 to 7 stars equivalent (depending on the climate zone) as a starting point	Testing NatHERS 7 stars equivalent	Testing NatHERS 7 stars equivalent
Annual energy use budget	• Annual energy use budget with consideration of on-site renewable energy • Fuel neutral	• NZRE annual energy use budget • Energy use of regulated services offset by on-site renewable energy • Technology neutral	• Maximum annual energy use budget consistent with Trajectory • Offsetting energy use of regulated services with on-site renewable energy (optional) • Technology neutral
Space conditioning	Equivalent Coefficient of Performance (COP) to 5 star gas heating or 4 star electric space conditioning	Equivalent Coefficient of Performance (COP) to 5 star gas heating or 4 star electric space conditioning	Equivalent Coefficient of Performance (COP) to 5 star gas heating or 4 star electric space conditioning
Heated water systems	Equivalent to 5 star gas instantaneous or a climate appropriate heat pump hot water system	Equivalent to 5 star gas instantaneous or a climate appropriate heat pump hot water system	Equivalent to 5 star gas instantaneous or a climate appropriate heat pump hot water system
Lighting	Existing NCC provisions	Review of existing provisions	Review of existing provisions
Pool and spa pumps	Existing NCC provisions	Review of existing provisions	Review of existing provisions

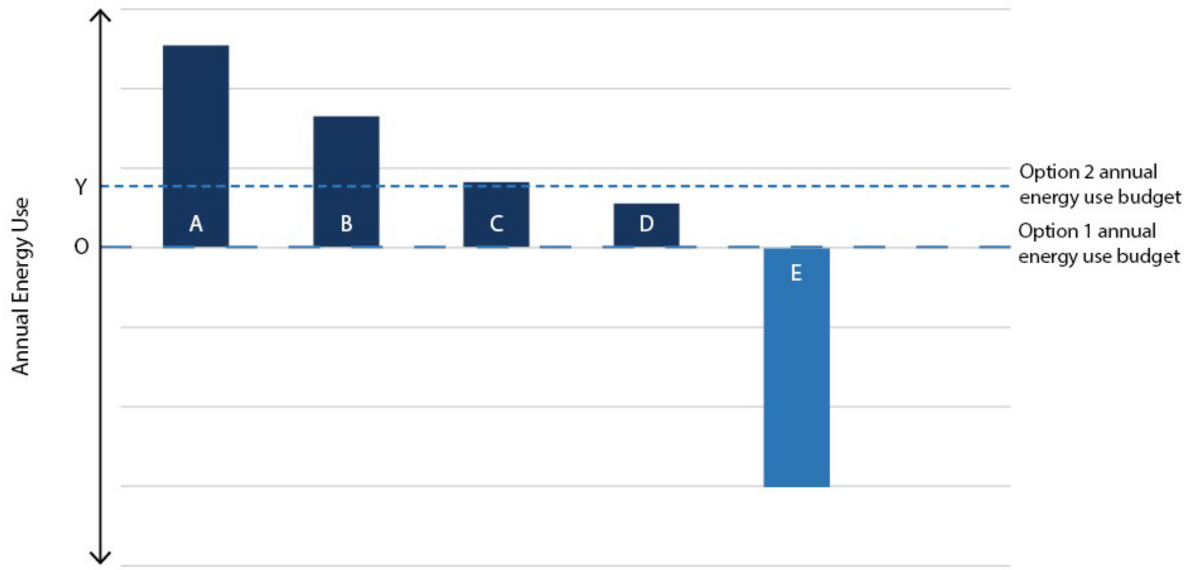
Options 1 and 2 will also allow trading between the performance of each element of a building through a ‘whole-of-house’ approach. However, the minimum level of thermal performance (i.e. NatHERS 7 stars equivalent) will not be allowed to be traded away. This arrangement will be established by having two separate Performance

8 COAG Energy Council, Report for Achieving Low Energy Buildings, December 2018, coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/Report%20for%20Achieving%20Low%20Energy%20Homes.pdf, page 6.

Requirements: one for thermal performance and the other covering the whole-of-house annual energy use budget.

The two options are represented diagrammatically in Figure 3.

Figure 3 Proposed Options 1 and 2



A: space conditioning (minimum NatHERS 7 star equivalent)
B: heated water systems
C: lighting
D: pool and spa pumps
E: on-site renewables

Under Option 1, to achieve the annual energy use budget (0), the energy generated on-site by renewables (E) would need to equal the energy used for space conditioning (A), water heating (B), lighting (C) and pumps (D) as per the formula:

$$\text{Option 1 annual energy use budget} = A + B + C + D - E$$
$$= 0$$

Whereas, under Option 2, the annual energy use budget (y) may be achieved without the need for on-site renewable energy.

$$\text{Option 2 annual energy use budget} = A + B + C + D - E \text{ (Optional)}$$
$$= y$$

If the more ambitious Option 1 is shown, through the RIS process, to be inappropriate for adoption in NCC 2022, it is anticipated that it will nevertheless provide industry with an indication of the provisions that may be adopted at a future iteration of the NCC (whether Option 1 or similar). So, this work would not be redundant, as it would in fact act as an indicator of a possible future increment of change.

The ABCB notes that the viability of Option 1 will be affected by factors such as building form and orientation (particularly in relation to Class 2 buildings), the cost of on-site renewables and the characteristics of local energy networks. It is estimated that, under this option, average-sized houses in most Australian cities would need up to 2.5 kW of rooftop photovoltaics (PV)[9]. The future RIS process will measure the impact of these options against the status quo and identify the most appropriate option for consideration in NCC 2022 or under an extended transition period.

In developing the proposed changes to NCC 2022, the ABCB will also undertake a holistic review of the residential energy efficiency provisions. This will include consideration of potential condensation issues in conjunction with Stage 2 of the ABCB's condensation project. Exploring the outer limits of NZRE (as suggested by Option 1), will allow a more comprehensive understanding of the implications for condensation and, therefore, appropriate remedies. Similarly, the ABCB will incorporate further consideration of heat and cold stress, which is currently discrete piece of work in itself. Related fire safety issues, such as in relation to on-site renewable energy generation and storage, will also be investigated.

2.2.1 Compliance pathways

In terms of the different compliance pathways, the ABCB will develop quantified Performance Requirements to facilitate the development of Performance Solutions. Consideration will also be given to expanding the compliance pathways currently in the NCC.

Specifically, it is proposed that development of both Options 1 and 2 involve consideration of the following:

1. Expansion of the Objectives and Functional Statements to capture the intended policy objectives of the NCC 2022 residential energy efficiency provisions.

[9] The calculation is based on total energy load required for NatHERS 7 star houses. The total regulated load is determined by heating and cooling loads and additional energy usage from lighting and hot water system. Then solar PV capacity is estimated from the same amount of the total regulated load. This analysis covers cities including Sydney, Brisbane, Perth, Adelaide, Melbourne, Hobart, Canberra, and Alice Springs.

2. Development of new quantified whole-of-house Performance Requirements which include:
   (a) minimum level of thermal comfort (equivalent to around 7 stars NatHERS); and
   (b) an annual energy use budget for the amount of energy used by regulated equipment and appliances (e.g. space conditioning equipment, heated water systems, lighting and pool & spa pumps)
3. Development of compliance pathways, at the level of stringency established through the Performance Requirements, which include:
   (a) An elemental pathway with basic DTS Provisions, likely for limited application to buildings under a certain size and alterations and additions.
   (b) A NatHERS compliance pathway which includes necessary DTS elemental provisions.
   (c) An expanded and more detailed 'reference building' Verification Method.
   (d) Whole-of-house 'tools', such as BASIX and the Victorian Residential Energy Efficiency Scorecard (the Scorecard).
4. New provisions that ensure buildings can accommodate the future installation of on-site renewable energy equipment and electric vehicle charging.

Table 3 shows the relationship between the two Performance Requirements (point 2 above) and the compliance pathways (point 3 above).

Table 3 Compliance pathways for residential energy efficiency provisions in NCC 2022

Compliance pathways	Performance Requirement: thermal comfort (2a)	Performance Requirement: whole-of-house annual energy use budget (2b)
DTS elemental provisions (3a)	DTS Provisions for: • Building fabric • External glazing • Building sealing	DTS elemental provisions (3a) • Space conditioning • Heated water systems • Lighting • Pool and spa pumps
NatHERS (3b)	NatHERS 7 stars (including heating and cooling load limits)	DTS Provisions for: • Space conditioning • Heated water systems • Lighting • Pool and spa pumps
Reference building Verification Method (3c)	Protocol for assessing thermal comfort	Protocol for assessing annual energy use
Whole-of-house tools, e.g. BASIX and the Scorecard (3d)	Tools that assess thermal comfort and holistically assess annual energy use in accordance with the two Performance Requirements	Tools that assess thermal comfort and holistically assess annual energy use in accordance with the two Performance Requirements

Compliance pathways are required to satisfy both the thermal comfort and annual energy use budget Performance Requirements. This is particularly crucial for whole-of-house tools that may be referenced in the NCC. Combining different compliance pathways is possible provided both Performance Requirements are still met. For example, the protocol for thermal comfort could be combined with the DTS elemental provisions for the energy use budget.

2.3 Rationale and scope

2.3.1 Options 1 and 2

The Trajectory states that the proposed changes to the NCC are needed to reduce energy bills and the demand on energy networks. It also notes that buildings are long-lived and their impact will last for a long time. It also argues that the proposed trajectory provides certainty to industry on likely future changes to the NCC.

The broad approach outlined by this scoping study has been developed with the above considerations in mind. In particular, the approach is likely to optimise the level of energy efficiency by considering generally more ambitious provisions sooner (i.e. Option 1) and adopting a more holistic approach to energy use in residential buildings. It is also likely to provide industry with more certainty about NCC changes by clearly identifying the provisions that will be adopted in NCC 2022, as well as those that may be adopted in future (e.g. where Option 1 may be adopted at a later date).

The approach could also reduce the number of incremental changes to the NCC to achieve the overarching outcome. If supported by the necessary regulatory analysis, it is possible that the end target of NZRE will be achieved in the 2020's as opposed to the 2030's.

Important secondary benefits are also likely to be achieved by the proposed options. For example, both options will achieve higher thermal comfort for occupants, thereby reducing heat and cold stress. The options may also safeguard occupants against blackouts during periods of peak air-conditioner use, particularly if on-site renewable energy generation is configured to power the dwelling before excess power is fed back to the grid. These benefits are particularly relevant to occupants that are vulnerable to the effects of heat and cold, such as infants and the elderly.

2.3.2 Stringency increase

Given the request of the COAG Energy Council and the direction of the BMF, there is a need to consider a stringency increase as part of the review of the provisions for residential buildings.

The last residential stringency increase occurred in 2010. In recent years a strong desire has been expressed by some stakeholders, notably members of ASBEC, to move to a higher stringency level for residential buildings for reasons including the reduction of emissions and energy costs. The work conducted by DEE for the purpose of developing the Trajectory, as well as international evidence, also indicates there is opportunity to consider higher levels of energy efficiency for residential buildings in a cost-effective manner.

Any review of stringency should not consider energy efficiency in isolation. Other relevant areas, such as safety, health and amenity, should also be considered to avoid unintended consequences. For example, condensation and heat and cold stress are linked to the energy efficiency provisions, and are equally important for residential buildings.

The appropriate level of stringency for NCC 2022 will be determined by a review of the current energy efficiency provisions by the ABCB. Considering the end goal of NZRE will also help to establish the appropriate stringency level. In the past, where the focus was on thermal performance, the main indicator of stringency for homes was the NatHERS star rating. However, this is no longer sufficient given the proposed focus on whole-of-house outcomes.

In relation to the thermal performance of homes, the Trajectory recommends the starting point for consideration in NCC 2022 should be the equivalent of 6.5 to 7 NatHERS stars depending on the climate. This scoping study proposes to target 7 stars (for thermal performance only) subject to cost-benefit analysis.

2.3.3 Net zero regulated energy homes

A number of countries have set targets for new buildings to achieve nearly net zero energy or carbon, with varying definitions about exactly what this means. To reduce energy dependency and greenhouse gas emissions, all new buildings in member states in Europe are required to be nearly zero energy by the end of 2020[10]. Japan has a similar target of zero emissions for newly constructed houses by 2030. To

[10] The European Parliament and the Council, Directive 2010/31 on the energy performance of buildings, 19 May 2010, eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0031&from=EN, page 55.

achieve this goal, in 2015 the Japanese Government announced a zero energy buildings roadmap to provide voluntary building standards for residential buildings that will ensure zero net energy houses will be available in the market by 2020[11]. In California, all new residential buildings must achieve zero net energy by 2020[12].

Australia has a range of climates and may require a different approach to define and model net zero energy homes. Importantly, NZRE homes will help Australia meet its international climate change commitments, particularly given buildings built today are likely to still be in use in 2050.

Renewables will be a major component of the investigation into the feasibility of NZRE homes. Advances in PV technology in the last 15 to 20 years have brought down costs and shortened pay-back periods significantly. There are now over 2 million PV installations in Australia with a combined capacity of over 11.1 gigawatts as at January 2019. This is more than 80 times the installed capacity at January 2010[13]. There are around 20 per cent of Australian householders[14] now utilising PV. This trend is expected to continue as PV becomes more affordable when compared to the rising cost of energy. The increased adoption of solar energy in residential buildings will form the basis for the investigation into incorporating renewables such as PV in the NCC.

Solar energy is currently the most readily available on-site renewable source for households. However, the intent of the NCC is not to exclude the possibility of other sources that may become available in the future (i.e. it should be technology agnostic).

For the purposes of the NCC, it is proposed to focus on on-site renewables and exclude renewable energy purchased from the grid. This is because purchased renewable energy is not part of the building and the energy supply arrangement can be easily changed by the owner after occupation.

The ABCB is aware that not all homes can have on-site renewables installed. For example, building orientation, shading and the complexity of apartments and

---

[11] Japan Net Zero Energy Building Roadmap, 2015, nzeb.in/wp-content/uploads/2015/09/Japan-NZEB-Roadmap.pdf, page 1.

[12] California Public Utilities Commission Energy Division and California Energy Commission Energy Division, New Residential Zero Net Energy Action Plan 2015–2020 Executive Summary, cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=5307, page 1.

[13] Australian PV Institute, Australian PV Market since April 2001, pv-map.apvi.org.au/analyses.

[14] Australian Government Department of the Environment and Energy, Solar PV and Batteries, energy.gov.au/households/solar-pv-and-batteries, accessed on 3 May 2019.

townhouses can all create barriers to on-site renewables. Community micro-grids may need to be explored for these scenarios through other policy or regulatory means.

Any regulatory impact analysis of on-site renewables would need to consider the impacts on the grid, consumers, and the economies of scale. Other complementary standards and policies that exist under the status quo should also be considered by the analysis including:

- renewables technical standards and regulations, such as safety requirements for batteries;
- Australian energy market regulations;
- household PV subsidies (including rebates and feed-in tariffs); and
- government policies and strategies for renewables other than PV, such as the National Hydrogen Strategy.

2.3.4 Whole-of-house approach

Buildings contain a range of structural components, as well as fixed and portable equipment and appliances. The characteristics, performance and interaction of these individual elements and the building occupants' behaviour play an integral role in determining the overall energy performance of the building.

Under both Options 1 and 2, a holistic approach will be allowed to regulate the energy consumption of the building services (space conditioning, heated water systems, lighting and pool and spa pumps). This whole-of-house approach will primarily be facilitated through Verification Methods (or whole-of-house tools) which will take into account the interaction of the various parts of a building by allowing trade-offs between the building envelope (to a minimum level), services and on-site renewable energy generation. This will assist homes in achieving the intended level of energy efficiency as cost effectively as possible.

The thermal performance of the building envelope is a key factor when determining the likelihood of occupants requiring heating or cooling to keep the building at a comfortable condition. This is influenced by many factors including:

- building orientation and internal layout;
- insulation and thermal mass;
- type and size of windows;

- the ability to take advantage of natural winter warmth and exclude summer sun through appropriate shading;
- the degree of building sealing; and
- the use of natural ventilation.

Despite this, the way heating and cooling services are provided in a home can have a major influence on the energy used and can have subsequent impacts on the scale of infrastructure needed to provide this energy and the operating costs of that service. Minimising the amount of heating and cooling required is an ideal first step and this is the basis of the NatHERS assessment. Efficiently delivering the energy for heating and cooling is also an important way to improve the overall efficiency of the building.

Other fixed equipment and appliances, such as heated water systems and lighting, can have varying degrees of efficiency depending on the types and models installed and the occupant behaviour. The energy efficiency performance of many appliances are covered by Greenhouse and Energy Minimum Standards (GEMS). The GEMS program eliminates the worst products in the market, which can be installed in existing and new dwellings. The efficiency of individual appliances does not necessarily translate into efficiency at a whole-of-house level. The energy efficiency requirements for new building work coved in the NCC should consider all the relevant elements of the building including its thermal performance and fixed equipment and appliances as an overall system. This approach will also provide the flexibility to trade-offs and potential offsets via alternative energy sources.

Portable plug-in appliances cannot be regulated by the NCC as these are not fixed to the building at the time of construction and can be purchased and altered outside at a later stage. A new owner or tenant may bring in their own portable appliances and when they leave the house, the appliances may be removed and a new set of appliances installed by the next owner or tenant. It is not practical to record changes in appliance type and reassess the building energy efficiency every time there is a change in occupant. The energy efficiency of portable plug-in appliances is also covered by GEMS. Therefore, under the current scope, plug load appliances are not intended to be included.

In addition to the above, it is important to retain minimum thermal performance requirements for the building envelope for the following reasons:

- The building fabric has a longer asset life than equipment and appliances. The building fabric is the hardest part of the building to change once the building has been constructed.
- Better thermal performance means the building's interior stays warmer in cold weather and cooler when the weather is hot. This can reduce the size of any equipment needed for heating and cooling, increase the equipment's efficiency and reduce reliance on it. This can, in turn, reduce peak energy demands.
- Ensuring a good level of thermal performance will deliver a base level of performance for the life of the building irrespective of changes to fixed equipment and appliances during that time.
- An energy efficient building envelope offers a range of other benefits such as improved health and comfort.
- Optimising the thermal performance of the building envelope at the design stage is therefore the key to reducing long-term energy demand from heating and cooling loads. It is significantly more expensive to retrofit thermal performance improvements than to include these in the original design.

2.3.5 Quantification of Performance Requirements

The Performance Requirements, in addition to the Governing Requirements, are technically the minimum legal requirements of the NCC. The compliance pathways, including Performance Solutions and/or the DTS Provisions, provide the means of complying with the Performance Requirements.

Many of the Performance Requirements across the NCC are qualitative in nature, which can discourage practitioners from using them for Performance Solutions. The ABCB aims to quantify these requirements to provide objective levels of performance for practitioners to target. This will encourage both increased use of performance and more competent use of performance by practitioners developing Performance Solutions. This will also help ensure a level playing field and reduce the risk of misinterpretation.

Importantly, the quantified energy efficiency Performance Requirements will be used to develop and test the different compliance pathways in the NCC (i.e. Verification Methods and DTS Provisions). This will ensure they all achieve the minimum required level of performance.

2.3.6 Class 2 SOUs and Class 4 parts of buildings

It is acknowledged that the unique characteristics of Class 2 SOUs and Class 4 parts of buildings may present difficulties for achieving the NZRE outcome of Option 1. For example, the form of Class 2 buildings, particularly taller buildings, can restrict the area available for on-site renewables. Nevertheless, it is proposed to fully investigate both options in terms of what is technically and economically feasible. It is possible that this could result in different energy use budgets between Class 1 buildings, Class 2 SOUs and Class 4 parts of buildings.

2.4 Details of proposed Options 1 and 2

2.4.1 Performance Requirements

It is proposed that the two existing Performance Requirements relating to residential energy efficiency in Volume Two will be substantially modified for NCC 2022, with commensurate changes made to the Performance Requirement for Class 2 SOUs in Volume One. The proposed modifications are consistent with the approach suggested in the Trajectory, as well as the approach in BASIX.

The Performance Requirements will be:

- Performance Requirement 1 (PR1) – which will specify the minimum thermal performance of the building fabric; and
- Performance Requirement 2 (PR2) – which will specify a maximum energy use budget by NCC regulated equipment (i.e. space conditioning, heated water systems, lighting and pool and spa pumps).

To reflect the status of the Performance Requirements as the legal requirements of the NCC, each Performance Requirement will be written in a clear, objective and quantified manner. Practitioners will be able to comply with each Performance Requirement using a Performance Solution, without referring to the associated Verification Methods or DTS Provisions, although those approaches will also remain available.

The residential energy efficiency Verification Methods and DTS Provisions in NCC 2022 will be benchmarked against the Performance Requirements. Each method will be set so that it meets the level of performance specified in the Performance Requirements to within an acceptable degree of variation.

The complex nature of energy efficiency means that the Performance Requirements also need to be relatively complex. Despite this, the structure of the NCC will continue to allow for compliance pathways with varying levels of complexity. Similar Verification Methods and DTS Provisions to those that are currently available in NCC 2019 will be provided under the new Performance Requirements. Direct use of the Performance Requirements will only be required when developing Performance Solutions from first principles.

PR1 will specify limits to the allowable heating and cooling loads of a building. The heating and cooling loads will vary according to the climate that the building is located in, as currently occurs for total energy loads under NatHERS. PR2 will specify a limit to the total value of energy that would be expected to be purchased from energy networks, based on the size of the building, the number of occupants of the building, and the time that the energy is used. This provides a technology neutral approach which accommodates the use of electric or gas appliances and ensures only the true value of any on-site renewable energy is counted for offsetting purposes.

The structure of these Performance Requirements is proposed to be the same in both Options 1 and 2. However, the final level of stringency of the Performance Requirements will be chosen to suit the selected option.

Details of preliminary investigations into the Performance Requirements for NCC 2022 are provided in **Appendix D**.

2.4.2 DTS Provisions

2.4.2.1 NatHERS energy rating

As discussed above, it is proposed to investigate increasing the general stringency of the NatHERS energy rating compliance pathway from a minimum 6 to 7 stars, with commensurate changes to the heating and cooling load limits under J0.2 in Volume One and 3.12.0.1 in Volume Two. Among other things, this will include consideration of different building forms, lot configurations and climate zones. In this regard, for

Class 2 buildings there may be a need to specify both an average 7 star rating for all SOUs, and an absolute minimum for any one SOU (as per the current provisions).

This investigation will also occur in tandem with the NatHERS Administrator updating the NatHERS climate files and carrying out the consequential changes to the star bands, heating and cooling load limits and area adjustment factors.

The ABCB will also work with the NatHERS Administrator to discuss matters such as the treatment of thermal bridging in NatHERS assessments.

2.4.2.2 Elemental provisions

Each element of the elemental DTS Provisions under Part 3.12 in Volume Two will be reviewed to achieve the new levels of stringency. For those elements relating to thermal comfort (i.e. fabric, glazing, sealing), the level of stringency will be commensurate to the NatHERS compliance pathway and the thermal comfort PR1. The efficiency of NCC regulated equipment and appliances (i.e. space conditioning, heated water systems, lighting, pool and spa pumps) will be established in accordance with the whole-of-house energy use PR2.

Development of the current elemental DTS Provisions in 2010 highlighted the difficulty of developing provisions at higher levels of stringency that deliver consistent building outcomes. Achieving consistent outcomes at higher stringency requires either more complex elemental DTS Provisions or much more conservative, or coarse, elemental provisions. A suggested alternative approach is to limit the application of the elemental DTS Provisions to smaller dwellings, or alterations and additions. This would reduce the need for more complex or conservative elemental provisions. Dwellings above this threshold would need to follow an alternate compliance pathway.

A possible threshold for the elemental DTS Provisions could be 120 m^2, which represents the size of smaller three-bedroom houses. Alternatively, a much larger threshold of 300 m^2 could be applied. This larger threshold is consistent with the threshold currently applied to the prescriptive provisions in BASIX. However, it should be noted that at the higher level of stringency proposed for NCC 2022, a 300 m^2 threshold would require more complexity and/or more conservatism than a smaller 120 m^2 threshold.

During the development of the NCC 2019 provisions for commercial buildings, the treatment of thermal bridging and Total R-Value calculations were noted for review. With a stringency increase possible in NCC 2022, it now possible to review these requirements for residential buildings. Glazing was another area specifically identified for review given its significant impact on the energy efficiency of dwellings. Impacts on condensation management will also be considered as part of the review of the building fabric and sealing provisions.

Given the uptake of LED technology, lighting energy accounts for a relatively small proportion of a dwelling’s energy consumption, when compared to heating and cooling, and water heating. Also, unlike commercial buildings, dwelling occupants are more likely to modify light fittings, which raises questions about the administration of minimum requirements for lighting for residential buildings. The ABCB will work with industry to seek better understanding of residential lighting to inform the development of appropriate lighting provisions.

Heated water requirements are currently included in NCC Volume Three, i.e. the Plumbing Code of Australia. As one of the key elements of a whole-of-house assessment, these provisions will also need to be reviewed in conjunction with the elemental DTS Provisions.

The Trajectory notes that new buildings should be able to accommodate the possible installation of on-site renewables and electric vehicle charging. In the case of on-site renewables, this would be regardless of whether on-site renewables were required for NCC compliance. Based on this suggestion in the Trajectory, it is proposed to investigate whether there is a need for particular elemental DTS Provisions to ensure on-site renewables and electric vehicle charging can be installed at a future date. Such provisions would ensure that the future installation of on-site renewables and electric vehicle charging was relatively straightforward and would not require expensive modifications.

2.4.3 Performance pathways

2.4.3.1 Reference building Verification Method

The reference building Verification Method V2.6.2.2 will be reviewed to ensure it delivers outcomes consistent with any increased levels of stringency for both the thermal comfort PR1 and the whole-of-house energy use PR2.

2.4.3.2 *Building sealing Verification Method*

The building sealing Verification Method JV4 and V2.6.2.3 will be reviewed to ensure it delivers outcomes consistent with any increased level of stringency applied to the DTS elemental provisions. Impacts on condensation management will also be investigated as part of this review.

2.4.3.3 Whole-of-house Verification Methods

As additional compliance options for addressing the new Performance Requirements, particularly the whole-of-house energy use Performance Requirement (PR2), it is proposed to introduce new whole-of-house Verification Methods. To be suitable for this purpose, the tools must be able to satisfy the Performance Requirements (PR1 and PR2) and be generally suitable for regulatory reference in time for NCC 2022. Regulatory impact analysis is likely to form part of the assessment of a tool's suitability.

To be referenced in NCC 2022, whole-of-house tools will need to satisfy a number of requirements including:

- suitable as a regulatory tool for new building work;
- verify compliance with both Performance Requirements PR1 and PR2;
- compliance with the ABCB's requirements for NCC referenced material (Note, the ABCB's existing protocol for referenced documents will be amended to cover whole-of-house tools);
- completion of any necessary regulatory impact analysis, including public consultation and review by the ABCB's technical committees; and
- fulfilment of the necessary timeframes for the development, approval and publication of NCC 2022.

As with all compliance pathways, the ABCB is responsible for determining if a whole-of-house tool is suitable for referencing in the NCC. In this regard, the NCC could directly reference whole-of-house tools such as BASIX, which is already used for regulatory purposes in NSW and closely aligns with the whole-of-house approach described in the Trajectory (except that BASIX also covers water efficiency). The NCC could also directly reference the regulatory tools developed by the Victorian Government, such as the Scorecard. The Trajectory suggests that NatHERS could be expanded to offer nationally accredited whole-of-house tools for verifying NCC compliance, similar to the way in which it currently accredits house energy rating software for the NCC's NatHERS compliance pathway.

2.4.2.2.1 NatHERS expansion

NatHERS currently accredits commercially developed thermal performance tools against the CSIRO developed AccuRate Benchmark tool. NatHERS aims to provide a credible and reliable rating scheme with assessment tools designed for Australia. NatHERS has an established national governance structure.

Consistent with the Trajectory's proposal, the NatHERS Administrator is currently working with jurisdictions to investigate whether NatHERS could be expanded to cover whole-of-house tools. CSIRO has developed modules for fixed appliances designed for all climate zones in Australia. These could be used in an AccuRate whole-of-house benchmark tool and either adopted by, or accredited against, other existing thermal rating tools (FirstRate 5 and BERS Pro) or other tools that may choose to be accredited under NatHERS. This could give industry a choice of tool preference and leverage established NatHERS processes.

2.4.2.2.2 BASIX

BASIX is an online tool that assesses the expected thermal performance, anticipated water consumption and greenhouse gas emissions of a proposed dwelling. It has been a regulatory tool in New South Wales since 2004 for both houses and apartments.

BASIX provides a comprehensive assessment of 'whole-of-house' energy efficiency by estimating the energy consumption of all major fixed systems, based on the specifications of a dwelling. The tool checks elements of a proposed design against sustainability targets for water, energy and thermal comfort. The targets for water and energy are expressed as a percentage saving against a NSW benchmark. BASIX also sets minimum performance levels, or ‘caps’, for thermal comfort of the dwelling, expressed as separate allowances for the energy required to heat and cool the dwelling (MJ/m^2.annum).

For BASIX to be incorporated into the NCC as a national tool, relevant energy consumption data will be required from jurisdictions other than NSW to support BASIX calculations. The BASIX thermal comfort stringency would also need to align with the stringency of the new Performance Requirements (PR1 and PR2). Given there is no Performance Requirement for water efficiency[15], this element of BASIX is unlikely to be incorporated into the NCC.

Further details about BASIX can be found in **Appendix A**.

2.4.2.2.3 Victorian Residential Energy Efficiency Scorecard

The Residential Energy Efficiency Scorecard (the Scorecard) tool has been developed by the Victorian Government to assess the energy costs of existing homes with a new functionality underway for new dwellings.

The Scorecard is being trialled by jurisdictions under NEPP Measure 5 for the disclosure of the energy performance of houses[16]. Through funding provided by all jurisdictions, a version of the Scorecard tool was developed by Victoria with expanded climate coverage for capital cities in other jurisdictions and an on-ground trial of the Scorecard in all capital cities across Australia and in select tropical locations is underway.

Scorecard star ratings represent the energy costs of the fixed features of a home. The rating covers the fixed appliances, the building shell and on-site energy generation from solar panels. The star rating is independent of household habits and is based on average behaviours to allow comparison between houses.

More information about the Scorecard can be found in **Appendix B**.

---

[15] There are Performance Requirements for water system efficiency in the Plumbing Code of Australia.

[16] COAG, National Energy Productivity Plan 2015-2030, December 2015, coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/National%20Energy%20Productivity%20Plan%20release%20version%20FINAL_0.pdf, page 19.

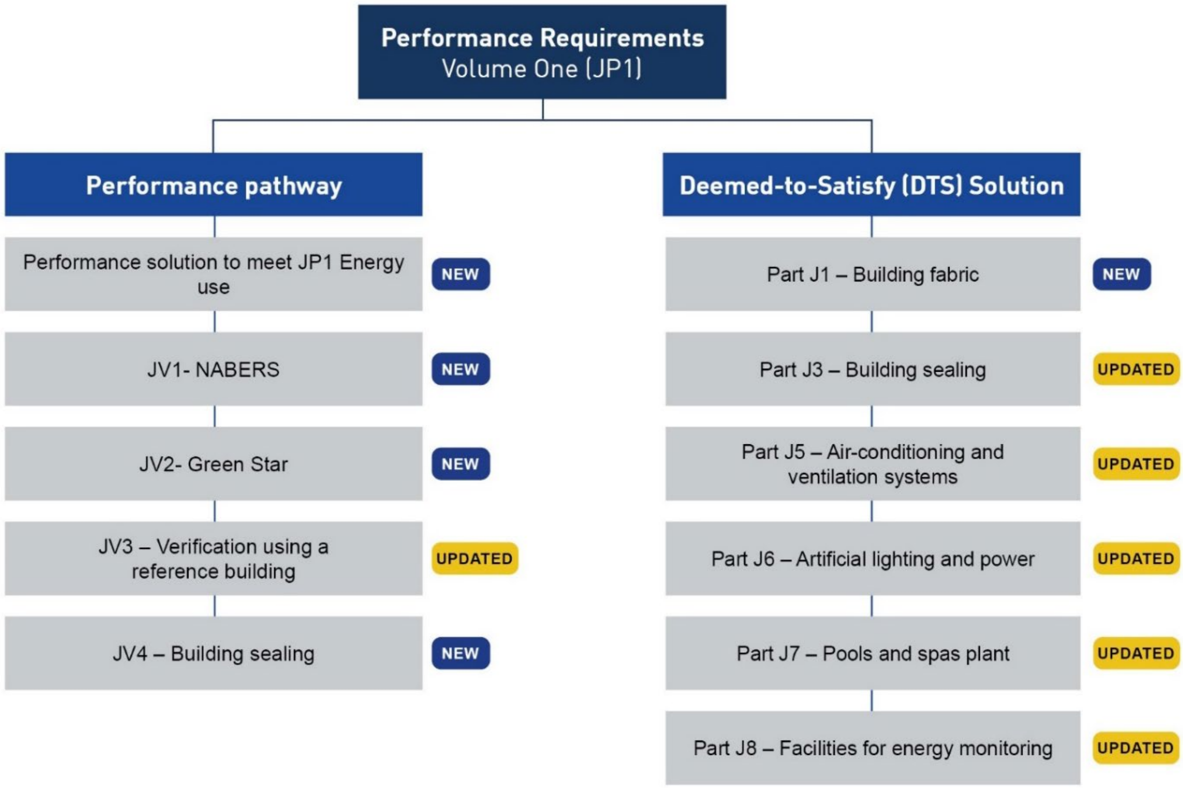
3 Commercial buildings

3.1 Current situation

The energy efficiency provisions of Volume One underwent significant changes in 2019 in terms of both increased stringency and in the way compliance with the provisions is demonstrated. A number of new requirements and new Verification Methods for NABERS and Green Star were also added. In comparison to the NCC 2016 DTS Provisions, the impact of these changes varies across building Class and climate zone from 26% to 38% in energy savings and 35% to 43% in greenhouse gas (GHG) emissions reductions.

The NCC 2019 changes are summarised in Figure 4, with further detail provided in **Appendix C**.

Figure 4 NCC 2019 energy efficiency provisions for commercial buildings



3.2 Proposed approach to NCC 2022 for commercial buildings

The Trajectory doesn't set a specific target for commercial buildings in NCC 2022, but notes areas where cost-effective improvements to the energy efficiency provisions may be carried out, including chillers, building sealing and building commissioning.

Consistent with the Trajectory, the ABCB is aware of areas where the commercial building provisions developed for NCC 2019 could be refined and possibly extended in NCC 2022. This includes areas in which the necessary research and analysis was unable to be undertaken in time for NCC 2019; areas that help lay the foundation for possibly achieving NZRE in a future version of the NCC; and areas where technology advancement or changes to international standards may necessitate a change to the NCC.

For commercial buildings (i.e. Class 2 common areas, Class 3 buildings and Class 5 to 9 buildings), possible changes will involve consideration of the following:

1. Expansion of the Objectives and Functional Statements to capture the intended policy objectives of the NCC 2022 commercial energy efficiency provisions.
2. Improvements to the provisions for heating, ventilation and air-conditioning (HVAC), the fabric and glazing of smaller buildings, and the building envelope provisions generally.
3. Improvements to the Verification Methods including the possible use of future climate files and whether the trading allowance for on-site renewable energy in the 'reference building' Verification Method is still appropriate.
4. New provisions that ensure buildings can accommodate the future installation of on-site renewable energy equipment and electric vehicle charging.
5. New provisions for on-site renewable energy and storage on particular commercial buildings.
6. Expansion of the NABERS Energy Verification Method to cover other building classifications.

3.3 Rationale and scope

Given that there has been significant change to the provisions for commercial buildings in 2019, and to the extent that there is a one-year transition period in place to allow industry sufficient time to adapt, it is not considered appropriate to carry out an in-depth review of the commercial energy efficiency provisions in NCC 2022. Some of the NCC 2019 development work included areas that could not be completed in time for the publication of the NCC. These are areas where a further changes may be warranted subject to further investigation.

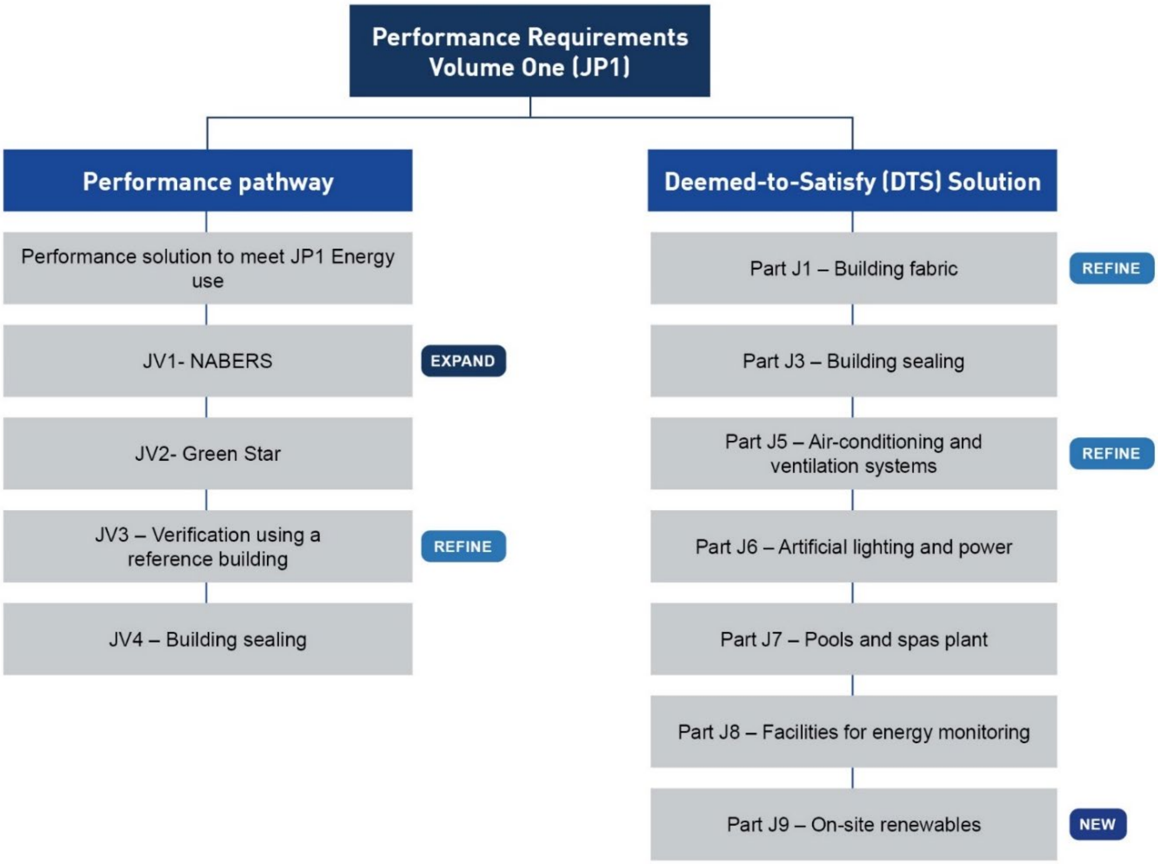
As such, the proposed areas of focus for NCC 2022 are:

- Refining areas identified as needing further adjustment in the process of developing the NCC 2019 provisions.
- Areas identified as 'high value' by the Trajectory report (e.g. chillers, fan systems, renewable energy and more efficient facades).
- Investigating the feasibility of the inclusion of DTS Provisions for on-site renewable energy technology given it will be necessary if NZRE commercial buildings are to be achieved in the future.

These areas are explored in greater detail below. As alluded to above, the areas chosen are also considered appropriate for laying the foundation for a potential future step change in commercial building energy efficiency stringency, possibly in 2025. In this regard, it is proposed that the same approach proposed for residential provisions in NCC 2022 (i.e. the development of two options, with one being NZRE) will be used to develop the commercial building provisions in NCC 2025.

Figure 5 provides a visualisation of the considered changes for NCC 2022.

Figure 5 NCC 2022 energy efficiency provisions for commercial buildings (considered)



3.3.1 On-site renewables for commercial buildings

Meeting the Trajectory's target of stand-alone 'zero energy (and carbon) ready' or NZRE buildings requires the use of on-site renewable energy generation in the current technological environment. Therefore, it is important that the ABCB look at how the NCC should address issues related to their installation. These issues are explored in further detail below.

Note, any settings within the NCC on renewable energy will need to be developed in close consultation with bodies such as the Australian Energy Market Operator and relevant State and Territory energy infrastructure departments. This work may also be coordinated with similar investigations for residential buildings and may in the first instance result in the development of guidance materials rather than new regulations.

Further, as noted in the Trajectory, it is not possible for all commercial building classifications to achieve NZRE through the use of current on-site renewable energy technology. The target these buildings will need to achieve must be explored if a version of net zero is to become the Performance Requirement for commercial buildings in the future, including investigation into whether there should be a minimum level of on-site renewables.

3.4 Details of proposed options

3.4.1 JV1-JV3 modelling

3.4.1.1 Use of future climate weather files

This proposal would involve an investigation into changing the energy modelling requirements in Verifications Methods JV1 (NABERS Energy), JV2 (Green Star) and JV3 (reference building) to use weather files based upon future climate scenarios. This would require modelling of the proposed building's energy consumption and thermal comfort with climate data reflective of the impacts of climate change. Research in this area has shown:

> *"Current industry standard weather files for building simulation are not suited to the assessment of the potential impacts of a changing climate, in particular summer overheating risks.*[17]*"*

These studies show that building energy use and comfort can vary dramatically when expected future climate models based on data within Intergovernmental Panel on Climate Change reports are included. The ABCB will investigate how significant this impact is and consider requiring a sensitivity analysis as part of the modelling process. This may necessitate design revisions and, hence, require impact analysis before it could be introduced into the NCC. Where possible this will be aligned with similar investigations undertaken for residential buildings.

---

[17] Jentsch, Bahaj & James. Climate change future proofing of buildings—Generation and assessment of building simulation weather files, 2008, researchgate.net/publication/223527579_Climate_change_future_proofing_of_buildings-Generation_and_assessment_of_building_simulation_weather_files

3.4.1.2 Expanding JV3 to apartments

Common feedback received through the NCC 2019 Public Comment Draft was that a Performance Solution based on JV3 is a usual compliance pathway for large mixed-use developments that include a Class 2 component, e.g.:

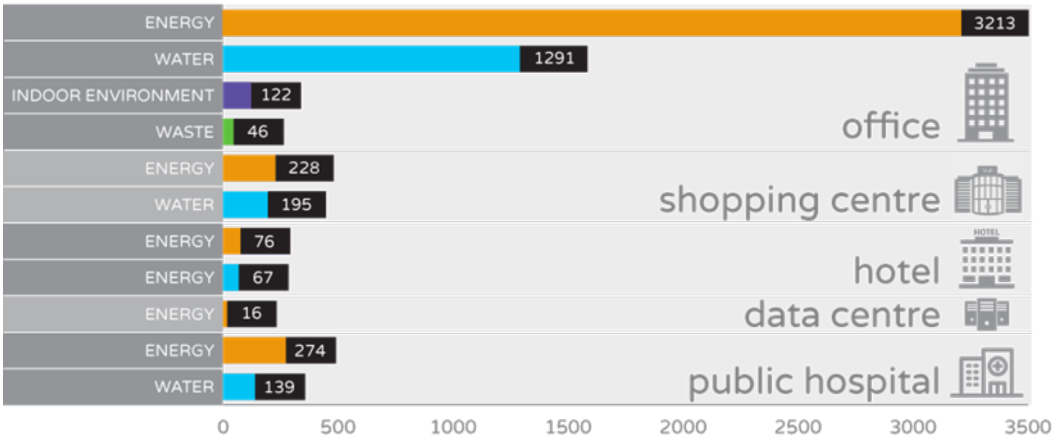
> *“We would strongly recommend that Class 2 buildings are now considered as part of the JV Alternative Verifications due to this increased stringency. Mixed-use developments will become near-impossible to develop a procurable façade across the different building classes due to the different methodologies employed for the NCC energy efficiency requirements.”*

The ABCB will assess the existing JV3 methodology to see if it could be adapted to include Class 2 buildings. This may require the development of new operational profiles and other usage assumptions, which would aim to achieve equivalence with the current stringency and provide an alternate compliance pathway that would satisfy the Performance Requirement.

3.4.1.3 Expanding JV1 (NABERS Energy for Offices) to cover more building classifications

As well as Class 5 buildings, the NABERS program has tools that cover Class 2, 3 (hotels), 6 (shopping centres), 8 (data centre) and Class 9 (hospitals) buildings. To date, there are have been many hundreds of buildings in these classifications that have been successfully rated (see Figure 6), but at this point in time only office buildings can participate in the NABERS Commitment Agreement process that underpins JV1.

Figure 6 Number of individual buildings rated as least once over the life of the NABERS program[18]



The number of buildings pursuing ratings using these tools has grown steadily since their introduction over the past decade and, by 2022, there is a likelihood that there will be sufficient data and experience with the tools to introduce them as options in the JV1 compliance pathway. As part of introducing these tools, the ABCB will assess the appropriate NABERS star rating for achieving compliance with JP1 as NABERS Commitment Agreements become available for those building types. This will include whether the Additional Requirements of Specification JVa require any alteration. The aim being to allow more compliance options for these building classifications. Note, this change would also support, but not rely on the NCC, for measure 9 of the National Energy Productivity Plan “Expand commercial building ratings and disclosure”[19].

3.4.2 Envelope provisions refinement

3.4.2.1 Extending the requirements around the calculation of thermal bridging

The existing method of calculating Total R-Value (AS/NZS 4859.2) only allows for the impact of thermal bridging from wall and window framing. It does not account for the impact of other penetrations related to HVAC equipment, shading, balconies and the

[18] NABERS, NABERS Annual Report 2017/18, 30 September 2018, nabers.info/annual-report/2017-2018/life-of-program-statistics.html

[19] COAG Energy Council, National Energy Productivity Plan 2015-2030, December 2015, coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/National%20Energy%20Productivity%20Plan%20release%20version%20FINAL_0.pdf

like. There are methods of accounting for this impact that could be included in the NCC and by expanding the methodology to include them, designs would be more accurate in their prediction of the thermal resistance of the building envelope.

3.4.2.2 Vertical shading

Through the consultation on the NCC 2019 envelope provisions, there have been calls for the introduction of a DTS Provision for vertical shading. The current DTS Provisions only cater to horizontal shading. Vertical shading elements are becoming increasingly popular and can be more effective on east and west orientations. The intent of these provisions would be to simplify compliance.

3.4.2.3 Refining the façade requirements of buildings with low volume-to-surface area ratios

In developing the NCC 2019 provisions it was noted that, in some cases, buildings which had a large perimeter zone (i.e. internal areas adjacent to a façade) relative to the total floor area, use more energy for heating in climate zones 6 and 7 when built to the minimum DTS level. This can be seen in the results for the Class 9c building in Table 4 below taken from the Energy Action Modelling and Sensitivity Analysis report completed to support the RIS for the commercial energy efficiency provisions.[20]

[20] Energy Action, Modelling & Sensitivity Analysis, December 2018, abcb.gov.au/Resources/Publications/Consultation/Energy-Action-Modelling-and-Sensitivity-Analysis

Table 4 Change in annual energy use from the impact of increased stringency 2016 vs 2019

Location	CLASS 3 30% WWR	CLASS 9c 30% WWR	CLASS 5 56% WWR	CLASS 6 30% WWR	CLASS 9b 30% WWR	CLASS 5 40% WWR
Climate Zone 1	-10%	-21%	-7%	-11%	-26%	-10%
Climate Zone 2	-23%	-19%	-11%	-11%	-29%	-14%
Climate Zone 3	-19%	-20%	-7%	-12%	-23%	-8%
Climate Zone 4	-24%	-12%	-7%	-7%	-23%	-12%
Climate Zone 5	-21%	-15%	-12%	-13%	-23%	-16%
Climate Zone 6	-25%	7%	-7%	-3%	-23%	-12%
Climate Zone 7	-24%	3%	-4%	-3%	-21%	-13%

In these cases, a lower U-Value of the total façade or a lower Facade Solar Admittance may be warranted. However, the issue may not be straightforward as these numbers were generated by comparing the NCC 2016 DTS glazing provisions with NCC 2019 requirements. The investigation found that the NCC 2016 provisions were likely to be "over-stringent":

> *There is also an issue with 2016 values being over-stringent. In many of the models of small buildings in cooler climates, no 2016 DTS compliant windows were available (see EA Glazing report REP07830-B-002). This suggests that the current 2016 DTS levels are impractical and needed to be revised, but also explains why the models produce worse results in these circumstances.*[21]

It is also the case that the increase in energy use in 2019 relative to 2016 was only found in buildings with low volume-to-surface area ratios. The ABCB will investigate

21 Ibid, page 9.

what the volume-to-surface area ratios threshold should be if changes were to be made, as well as at what level the new minimum standard should be set.

3.4.3 On-site renewables investigation

3.4.3.1 Trade-off within JV3

The existing JV3 Verification Method allows for the energy generated by an on-site renewable energy system, typically solar PV systems, to offset a proposed building's total greenhouse gas emissions, as long as only the energy that is used on-site is included. Feedback from stakeholders and via the NCC 2019 Public Comment Draft is that this allowance can be used to reduce the thermal performance of a building's façade to below an acceptable level:

- Allowing buildings to offset poor fabric with renewable energy seems in direct conflict with the requirement of JP1, and is far removed from basic principles of energy efficiency.
- Allowing greenhouse gas emissions of the proposed building to be offset by on-site renewable energy discourages good building design and performance.
- The philosophy for NCC Section J has been, and continues to be, as per clause JV3(a) in the proposed NCC2019 draft, that building envelope performance needs to be evaluated independently, and not traded off against the performance of services. The on-site renewable energy offset clause is ambiguous, and the intent should be made clear.[22]

Preliminary investigation by the ABCB showed that this was not the case as long as the calculation was in accordance with the NCC definition of renewable energy. However, with the expected increase in the use of battery storage technology, this proposition needs to be re-assessed.

[22] A selection of comments received on the allowance in JV3 to offset façade performance with renewable energy via the NCC 2019 Public Comment Draft.

3.4.3.2 Minimum on-site requirements

California has recently introduced minimum requirements for renewable energy (i.e. PV) for some residential and commercial buildings.[23] Consideration will be given to whether similar requirements should be introduced for Australian residential buildings in 2022, with commercial buildings likely to follow in 2025. It is also considered likely that many commercial buildings will voluntarily integrate on-site renewable energy into their design as it becomes an increasingly cost-effective pathway for meeting the energy efficiency Performance Requirement.

Given this, there is a role for the ABCB to investigate if there are any barriers within the NCC preventing the installation of on-site renewable energy systems, or if there is a role the NCC should play in assisting Australia's energy grid cope with higher penetration of decentralised energy generation systems. This investigation would include consideration of: structural requirements that may need to change to accommodate roof mounted PV systems; what minimum or maximum system sizes should be; how energy storage systems should be treated; and if there are building design features that should be added to facilitate the introduction of renewable energy at a later date (e.g. ensuring sufficient free space on roofs and sufficient capacity for electric vehicle charging).

3.4.3.3 Electric vehicle charging

Consideration should be given to ensuring that Electric Vehicle (EV) charging stations can be accommodated in Class 7a buildings and/ or carparks associated with other commercial buildings. The number of EVs in Australia is expected to grow quickly in the coming years. Other countries, plan to phase out petrol and diesel cars by 2032 (e.g. Scotland),[24] or are considering requiring some commercial buildings to have EV charging stations (e.g. United Kingdom).[25]

---

[23] California Energy Commission, 2016 Nonresidential Compliance Manual, November 2015, energy.ca.gov/2015publications/CEC-400-2015-033/chapters/chapter_09_solar_ready.pdf

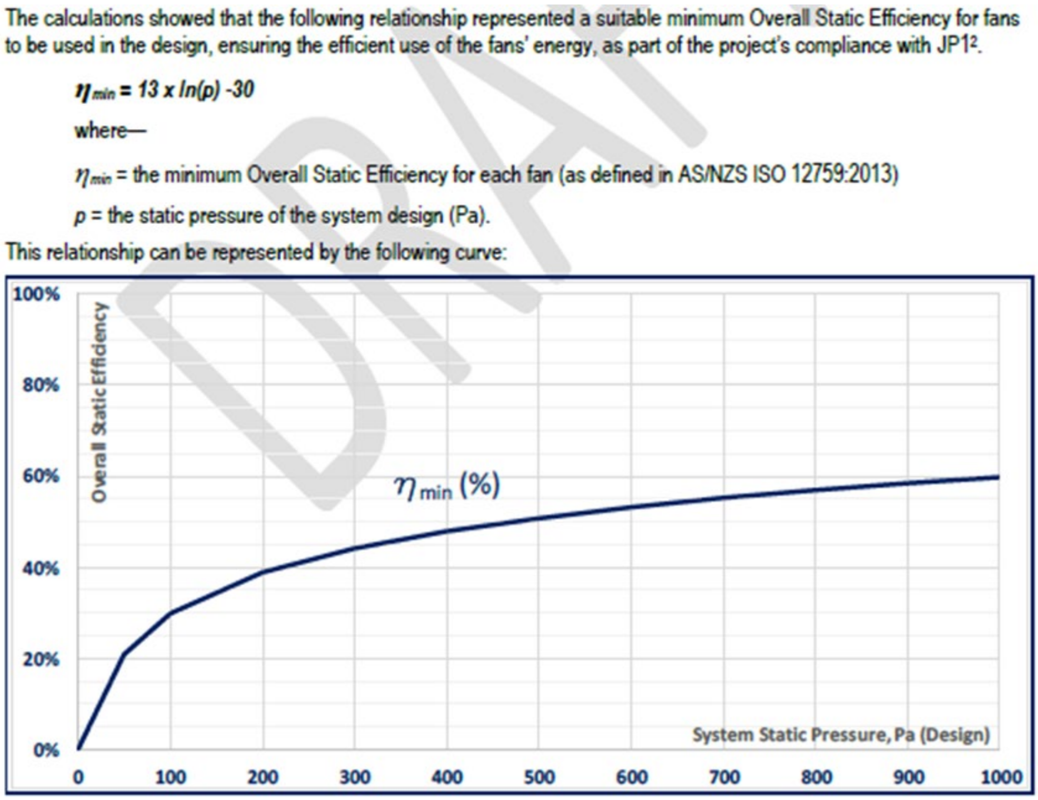
[24] Scottish Government, Low Carbon Transport, 2017, gov.scot/policies/renewable-and-low-carbon-energy/low-carbon-transport/

[25] United Kingdom Government, Policy Paper: Reducing emissions from road transport: Road to Zero Strategy, July 2018 gov.uk/government/publications/reducing-emissions-from-road-transport-road-to-zero-strategy

3.4.4 HVAC fans refinement

The Fan Manufactures Association of Australia and New Zealand (FMAANZ) has proposed a performance-based design solution as an alternative to the DTS clause J5.4 Fan systems that would simplify the provisions for fans used in an air-conditioning system. The current J5.4 provisions (both in NCC 2016 and NCC 2019) require the HVAC designer to know the system characteristics in reasonable detail, particularly what the fan 'duty point' will be before fan selection can be made. The proposed method requires less detail and should simplify fan selection and compliance demonstration, allowing selection of fans on the basis of peak efficiency instead of duty point efficiency. Note that a building using this method to demonstrate equivalence to J5.4 would still be able to follow the DTS pathway for other Section J provisions.

Figure 7 FMA-ANZ proposal for demonstrating compliance with J5.4[26]


The calculations showed that the following relationship represented a suitable minimum Overall Static Efficiency for fans to be used in the design, ensuring the efficient use of the fans' energy, as part of the project's compliance with JP1[2].

$\eta_{min} = 13 \times \ln(p) - 30$

where—

η_{min} = the minimum Overall Static Efficiency for each fan (as defined in AS/NZS ISO 12759:2013)

p = the static pressure of the system design (Pa).

This relationship can be represented by the following curve:

The intent would be to expand and simplify the current compliance pathways.

---

26 Information provided by FMA-ANZ.

3.4.5 HVAC pumps investigation - watching brief

The HVAC pumps provisions in J5.7 in NCC 2019 align with European Union (EU) minimum standards for pumps. Should the EU seek to update their minimum standards, there may be a case for Australia to follow suit. Alignment with reputable international standards is a stated aim of the Commonwealth and reduces the risk of product dumping on the Australian market.

3.4.6 HVAC chillers investigation - watching brief

The HVAC chiller provisions in J5.10 of NCC 2019 align with the levels specified by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings. These standards have been in place in the US since 2015 and are reviewed on a three-year cycle. Should ASHRAE 90.1 update the requirements for chillers in the US, there may be a case for Australia to follow suit. Alignment with reputable international standards is a stated aim of the Commonwealth and reduces the risk of product dumping on the Australian market.

4 Consultation

Meaningful consultation promotes trust between industry, the community and government. Transparency allows stakeholders to see and judge the quality of government actions and regulatory decisions. It also provides an opportunity to participate in developing policy solutions and encourages broad ownership of solutions. Early consultation is instrumental to the technical amendment processes of the NCC and on broader regulatory reform matters. Consultation assists in the ABCB's role as the regulatory 'gatekeeper', which includes considering alternatives to regulation, such as education and awareness raising activities.

The primary purpose of this scoping study is to seek initial views on the proposed approach and scope of future changes to the NCC energy efficiency provisions, particularly in 2022.

To provide comment on this scoping study, respondents will need to submit responses online via the ABCB Consultation Hub (consultation.abcb.gov.au).

Information Collection Statement

The ABCB is committed to respecting respondents' right to privacy and protecting their personal information. Please refer to our information collection statement for public consultation in **Appendix G** for detailed information.

5 Next steps

Consultation on this scoping study closes on 8 September 2019. The ABCB will review all submissions to further define the scope of the energy efficiency provisions in NCC 2022 in an outcomes report. The report will inform the development of a work plan for the NCC 2022. This does not represent the end of the consultation process, but simply the establishment of the 2022 Energy Efficiency Project. Ongoing consultation will be required during the development of NCC provisions.

In addition to informing technical content of the NCC, consultation is crucial to the analysis of regulatory proposals. The views of interested parties enhances the ABCB's understanding of what the problem is, provides suggestions of alternative options to address the problem, feedback on how the regulatory proposal will work in practice and comment on the costs and benefits of the various options.

Given this is a major proposal to amend the NCC, the ABCB will conduct regulation impact analysis to determine whether government intervention is necessary and what transition period, if any, would be appropriate. A Consultation RIS for comment by interested parties will be prepared, with the information gathered during consultation then incorporated into a Final RIS for decision.

Indicative steps and timeframes for the development of NCC 2022 are in Figure 8.

Figure 8 Indicative steps and timeframes for the development of NCC 2022

July 2019
Release scoping study for consultation

September to October 2019
Review feedback on scoping study

November 2019
Establish work plan

December 2019 to October 2020
Develop draft provisions with assistance from expert consultants, technical committees and working groups

May to October 2020
Develop Consultation RIS

November 2020
Draft provisions and Consultation RIS finalised and approved for public consultation

February to April 2021
Draft provisions and Consultation RIS released as part of NCC 2022 public consultation process

May to October 2021
Review public comment and update both provisions and RIS

November 2021
Decision RIS and provisions finalised

February 2022
NCC 2022 provisions scheduled to be published

1 May 2022
NCC 2022 comes into effect with possible transitional arrangements if necessary

APPENDICES

Appendix A BASIX

To achieve planning (and building) approval in New South Wales, residential buildings need to meet BASIX targets, which include: Thermal Comfort (heating and cooling) caps, Energy targets and Water targets.

To satisfy the BASIX Thermal Comfort requirements, both the heating and cooling load of the building fabric must not exceed the prescribed heating and cooling caps for that climate zone. The scope of BASIX Thermal Comfort requirements does not include an assessment of the heating and cooling appliances or fuel type—these are included in the Energy Index.

A Do-It-Yourself (DIY) option is available for detached dwellings to satisfy the Thermal Comfort requirements in BASIX. The DIY option has been developed with reference to the NCC DTS Provisions.

The Water and Energy benchmarks were set as the average NSW annual potable water consumption/greenhouse gas emissions from the residential sector, per capita in 2002-2003 (the year before BASIX commenced).

To achieve the Energy target, BASIX calculates the energy consumption of the whole house, based on inputs about space conditioning, hot water, lighting, pool pumps, and cooking and clothes drying appliances.

On-site renewable energy can be used to offset the greenhouse gas emissions from energy consumption in the home. BASIX rewards the use of PV in proportion to the size of the system and the performance of the system in relation to level of solar radiation at the dwelling's location. Data related to be performance of PV is obtained from the Clean Energy Regulator, which has published data for each Australian post code.

Appendix B Victorian Scorecard

The Victorian Residential Energy Efficiency Scorecard (the Scorecard) uses the energy cost of a house as its overall metric. However, the Scorecard can easily be reconfigured to produce many potential metrics (e.g. total energy use, greenhouse gas emissions, etc.) if required.

The Scorecard's 6 star rating has been designed to correlate with a NatHERS 6 star rating. For example, in Melbourne a NatHERS 6 star house of average size (220 m^2) with market average appliances (5 star instantaneous gas hot water, 4 star gas ducted heating, ducted evaporative cooling) is likely to be a Scorecard 6 star house.

New functionality is being added to the Scorecard during 2019 to allow NatHERS rating outputs to be used directly as inputs for the building shell component of the Scorecard rating. This functionality will be used for new and existing homes where a NatHERS rating is available. When the NatHERS input approach is used, most of the current Scorecard data entry screens for building shell components will be disabled. The current methodology used to calculate building fabric loads is more suitable for existing homes, it is a simplification of the load calculations in NatHERS and may not be accurate for homes with very high NatHERS ratings.

The Scorecard rating is delivered by independent accredited assessors using the Victorian government-supported Scorecard web tool and facilitated by supporting training and communications products. The Scorecard tool underlying calculations use an energy metric. A fuel tariff is used to convert to the cost metric used for the star ratings. The cost of energy used for the calculation of the metric is based on a 'cost index' that reflects the average cost difference between the various fuels, rather than the actual energy tariff used by the current occupant.

The Scorecard includes building fabric. By 2020 there will be two options to supply this data, an existing NatHERS ratings, or a simplified rating based on the Australian Greenhouse Calculator (AGC) model. The latter is a steady state heat flow calculation that uses weighting factors for each heat flow path (walls, floors, roofs, air leakage, conducted heat flow through windows and radiation heat flow through windows) to achieve a reasonable correlation with the heating and cooling loads predicted by the

NatHERS engine (Chenath). This simplified approach is not suitable for NCC compliance.

In addition to providing an estimate of energy cost the Scorecard tool provides householders with a measure of the performance of the home during heat waves with no cooling devices operational. This information is useful because of the impact heat can have on health and mortality[27].

Where possible, the Scorecard tool leverages information from other schemes to minimise data input. Appliance star ratings are used as a measure of efficiency. Minimum Energy Performance Standards (MEPS) provide guidance on default appliance efficiency where no star rating can be discovered.

27 Tony Isaacs Consulting, Technical Basis of the Victorian Residential Efficiency Scorecard-Version 1, January 2018, victorianenergysaver.vic.gov.au/__data/assets/pdf_file/0021/324183/Technical-basis-for-Scorecard.pdf, page 4.

Appendix C Summary of commercial building changes in NCC 2019

Table C.1 Summary of NCC 2019 changed for energy efficiency of commercial buildings

Part or clause	Stringency Impact	Summary of Change
JP1- Performance requirement **UPDATED**	NA	Introduces a performance metric of kJ/m^2.hour of operation, reflective of a quantification of the overall increased stringency. Opens the possibility of a full, peer reviewed building energy model as a compliance pathway.
JV1 – NABERS for Class 5 Buildings **NEW**	NA	Allows use of the NABERS Energy for Offices methodology to show compliance with JP1 via production of a valid NABERS 6-star office base building energy model and a 5.5-star NABERS. Commitment Agreement. Also requires demonstration that a comfort requirement, based on PMV, is met.
JV2 – Green Star **NEW**	NA	Allows use of the Green Star methodology to show compliance with JP1 if the proposed building produces 10% less greenhouse gas emissions than a DTS based reference building. Also requires demonstration that a comfort requirement, based on PMV, is met.
JV3 – Reference Building Verification **UPDATED**	NA	Now uses greenhouse gas emissions as the key comparison metric. As with JV1 and JV2, now also requires demonstration that a comfort requirement, based on PMV, is met. The modelling parameters have also been refined in some cases, requiring tighter temperature and air change figures and enhanced HVAC modelling in comparison to 2016.
JV4 – Building Sealing (Voluntary) **NEW**	Voluntary pathway. Low infiltration rate if this pathway followed	This VM sets the parameters for how a blower door test should be conducted and the building air tightness achieved if this method is to show compliance with JP1(e).

Part or clause	Stringency Impact	Summary of Change
J1 – Walls and Glazing **NEW**	Varies depending on a buildings Window to Wall Ratio. There is now a stronger focus on controlling solar gain (SHGC) over preventing heat loss (U-Value). An updated definition of Total R-Value provides clarity on the need to include the effect of thermal bridging in calculations may lead to design alterations for those who have not previously properly addressed this impact correctly.	A very significant change to how a building's façade demonstrates compliance. It combines the window and wall elements into whole of façade requirements for U-Value and Solar Admittance. There is also a new DTS pathway for facades that allows trading between aspects that reduces the need for JV3.
J3 – Building sealing **UPDATED**	NA	Slight refinements. Requires rapid roller doors be used in refrigerated warehouses.
J5 – AC Controls **UPDATED**	NA	Low, slight changes to requirements.
J5 – Ventilation Controls **UPDATED**	NA	Low slight changes to requirements.
J5 – HVAC Fans and ducts **UPDATED**	Varies depending on system pressure for HVAC systems. An increase in stringency for heat rejection equipment.	A significant change to both the efficiency metric and the method of demonstrating compliance. There is now a focus on understanding the system static pressure and its relationship with fan motor efficiency that is hoped will improve overall system design. There are now two pathways to show compliance: with a "whole-of-system" method added to the existing component level compliance path.

Part or clause	Stringency Impact	Summary of Change
J5 – HVAC Pumps and pipework **UPDATED**	The stringency level for most HVAC pumps now aligns with the minimum energy performance (MEPs) in the European Union (EU).	As with fans a significant change to both the efficiency metrics and the method of demonstrating compliance. There is now a focus on understanding the system pressure and its relationship with pump efficiency that is hoped will improve overall system design. There are now two pathways to show compliance: with a "whole-of-system" method added to the existing component level compliance path.
J5 – Ductwork Insulation **UPDATED**	Small increase in stringency	NA
J5 – HVAC Boilers **UPDATED**	The stringency increase aligns the NCC with EU & US MEPS for HVAC boilers.	NA
J5 – Chillers **UPDATED**	The stringency increase aligns the NCC with both the USA Building Code and the forthcoming Australian MEPS.	The range of products covered has been expanded to include units with a greater than 350 kW capacity.
J6 – Lighting **UPDATED**	The new stringency requirement is based on the widespread use of LEDs in new buildings and considered BAU.	Some minor adjustments have been made to the Control Adjustment factors, including the introduction of factors based around light colour. The penalty for installing track lighting has been removed. The requirements for external lights have been simplified, now applying only to lights attached to or directed at the building and requiring that at least 90% of external lighting power be LED.
J6 – Lifts & Moving walkways **NEW**	The new efficiency requirement is considered BAU.	Demonstration of compliance requires designer to calculate the frequency and distance travelled by lifts. Lifts that travel further have stricter efficiency requirements.
J7 – Pools & Spas **UPDATED**	Gross Thermal Efficiency increase to match those of HVAC Boilers.	Low

Part or clause	Stringency Impact	Summary of Change
J8 – Metering **UPDATED**	Large buildings now require some form of Building Management System that is capable of providing access to useful energy data.	Low

Appendix D Preliminary NCC 2022 Performance Requirements

D.1 Background to PR1 (Thermal fabric performance)

In NCC 2019 Performance Requirement PR1 is qualitative and subjective in nature. Due to its subjectivity, it is difficult for different practitioners or certifying authorities to interpret or use the Performance Requirement without referring to the Verification Methods or DTS Provisions.

For NCC 2022 it is proposed to make Performance Requirement PR1 quantitative and objective in nature. This will be achieved by including quantified values for the maximum heating and cooling loads that will be allowed in a building. Quantifying the Performance Requirement will add clarity in how it should be interpreted, and will enable practitioners to use creative Performance Solutions whilst still achieving the required outcomes of the code.

Heating Load Limits (HLL) and Cooling Load Limits (CLL) are already included in the DTS Provisions of NCC 2019. These limits effectively operate as a quantification of the performance of the thermal fabric of a building. The limits are currently only applicable when using the NatHERS software DTS compliance option. It is proposed to include Heating and Cooling Load Limits in the 2022 version of Performance Requirement PR1 (building thermal performance).

The conceptual quantification of PR1 allows a practitioner to calculate the allowable Heating and Cooling Load Limits based on the Heating Degree Hours (HDH), Cooling Degree Hours (CDH) and Dehumidification Gram Hours (DGH) of the climate that the building is in. HDH, CDH and DGH are new metrics that are similar in principle to the established metrics of Heating Degree Days and Cooling Degree Days. However, they use a smaller time window of hours rather than days, and in the case of DGH, use grams of humidity as the basis of measurement rather than degrees Celsius. HDH is a measure of the heating requirement of a climate, CDH is a measure of the cooling requirement of the climate and DGH is a measure of the humidity load of the climate.

The use of HDH, CDH and DGH means climate zones do not need to be considered to use the Performance Requirement. Other effects of the use of these metrics are that the Heating Load and Cooling Load targets adjust automatically for future climate conditions, and that there is a level playing field for buildings around Australia, as buildings in similar climates are given similar allowances. Under the quantified concept for PR1 buildings that are in hotter climates are uniformly allowed an increased cooling allowance, and buildings in colder climates are uniformly allowed an increased heating allowance.

The ABCB office has calculated HDH, CDH and DGH for all 69 NatHERS climate zones, and this information could be published so that practitioners will not need to perform the calculation. Comparisons of the proposed Performance Requirement to existing NCC 2016 heating and cooling load limits are shown below. Note that the stringency of the NCC 2022 Performance Requirement will be determined in the future based on the policy direction that is given to the ABCB office (e.g. 2022 Heating and Cooling Load Limits may be 15% lower than what is shown below).

Figure D.1 Climate vs Cooling Load Limits

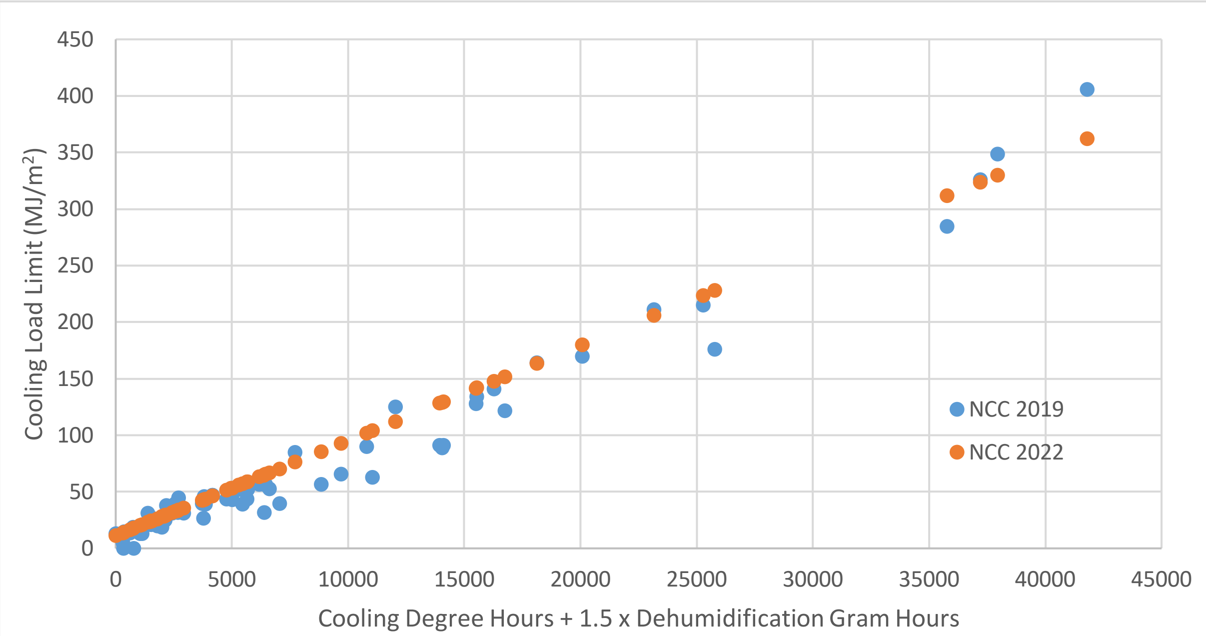
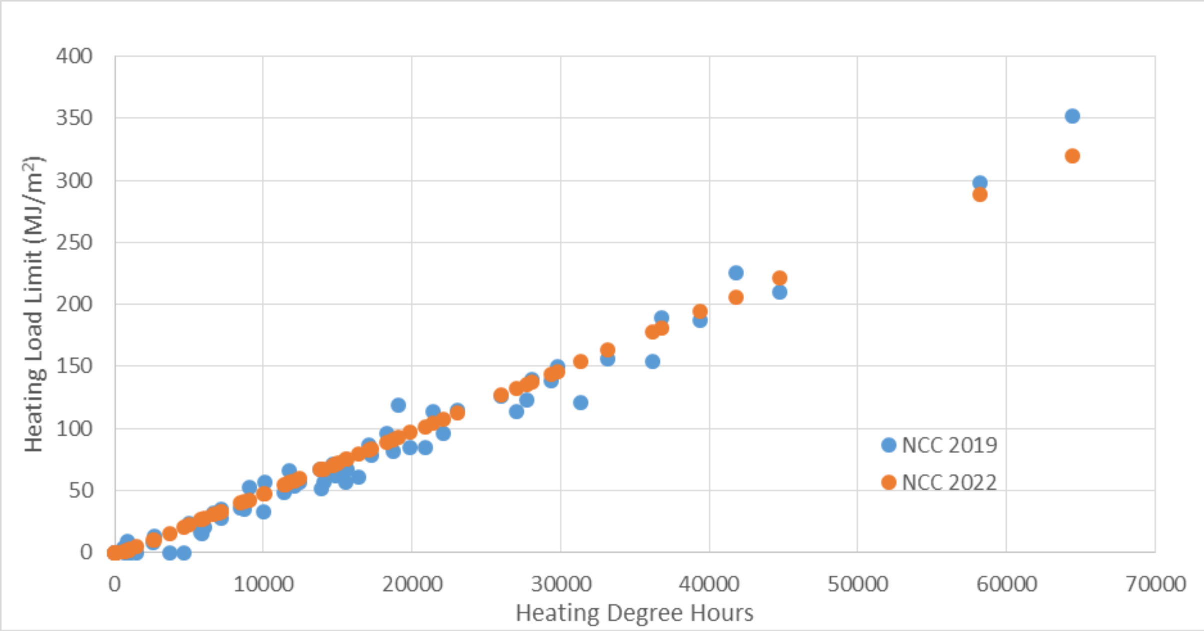


Figure D.2 Climate vs Heating Load Limits



Quantifying Performance Requirement PR1 provides a benchmark against which the Verification Methods and DTS provisions for NCC 2022 can be set. In addition, by being clear about the target level of performance that must be achieved, a quantified Performance Requirement allows appropriate flexibility for practitioners to use Performance Solutions.

D.2 Performance Requirement PR1 (Thermal fabric performance)

(a) A building must have a *Cooling Load* less than the *Cooling Load Limit* of:

CLL = 11.5 + 0.0084 x (CDH + 1.5 DGH)

Where:

CLL = The *Cooling Load Limit* of the building, measured in megajoules per square metre per annum (MJ/m^2/annum); and

CDH = The *Cooling Degree Hours* of the building location; and

DGH = The *Dehumidification Gram Hours* of the building location; and

(b) A building must have a *Heating Load* less than the *Heating Load Limit* of:

HLL = (0.005 x HDH) – 2.6

Where:

HLL = The *Heating Load Limit* of the building, measured in megajoules per square metre per annum (MJ/m^2/annum); and

HDH = The *Heating Degree Hours* of the building location.

D.3 Example use of PR1

A practitioner is building a house in Brisbane. The house contains 200m^2 of conditioned rooms. The practitioner decides to complete a Performance Solution to show compliance with PR1.

1. The practitioner downloads the Brisbane climate file from the ABCB website[28]. Published alongside the climate file are the following values for Cooling Degree Hours, Dehumidification Gram Hours and Heating Degree Hours.

Table D.1 CDH, DGH, HDH for Brisbane

Type	Values
CDH	2,154
DGH	503
HDH	11,557

2. The practitioner uses the formulas in PR1 to calculate the Cooling Load Limit and Heating Load Limit for the building location:

$$CLL = 11.5 + 0.0084 \times (2154 + 1.5 \times 503) = 35.9\ MJ/m^2/annum$$

$$HLL = (0.005 \times 11557) – 2.6 = 55.2\ MJ/m^2/annum$$

3. The practitioner multiplies these values by the conditioned floor area to determine the total Heating and Cooling Load Limits:

$$Building\ CLL = 35.9\ MJ/m^2/annum \times 200m^2 = 7,180\ MJ/annum$$

$$Building\ HLL = 57.8\ MJ/m^2/annum \times 200m^2 = 11,560\ MJ/annum$$

4. The practitioner models the building using a modelling software package compliant to ASHRAE 140 to determine the predicted heating load and cooling load of the building. The inputs to the model will be defined in an ABCB modelling protocol. If the predicted heating and cooling loads are less than the heating and cooling load limits, the building is compliant with PR1.

D.4 Background to PR2 (Annual energy use budget)

Performance Requirement PR2 is the fundamental legal requirement for the energy use of space conditioning, heated water systems, lighting and pool & spa pumps. As a legal requirement, it is necessary for PR2 to be objective and quantified. To understand the intentions behind, and to inform the nature of the Performance

[28] A practitioner may use a different climate file from a credible source if they wish (for instance a climate file using more up to date data, or using future climate data), however they will have to calculate CDH, DGH and HDH separately.

Requirement, the COAG Energy Council's Trajectory for Low Energy Buildings is instructive. In addition to safeguarding the thermal performance of a building, the Trajectory states that energy efficiency regulations are used to:

- Save energy for the benefit of the wider economy
- Lower energy bills
- Increase productivity
- Improve electricity network resilience
- Reduce emissions.

Stated in another way, inadequate energy efficiency of buildings has the following negative impacts:

- A financial cost for the building owner
- A flow-on cost for society (including lower productivity, higher network costs and an environmental impact).

Energy efficiency regulations in the NCC aim to maximise benefit and minimise burden on the Australian Economy. It is proposed that Performance Requirement PR2 for the energy use of a building measures performance based on cost, and it is proposed to measure both individual costs to the building owner, and societal costs to the Australian economy at large.

Energy costs for an individual are familiar and intuitive to anyone who pays electricity or gas bills. Societal costs, while being less familiar for many members of the public, are well understood and routinely used by policy makers and regulators. Societal costs of energy are related to infrastructure (e.g. grid stress, upgraded transmission infrastructure, new power plants, new peaking plants, requirements for energy storage etc.) and environmental impacts (e.g. global warming caused by CO_2 emissions).

Individual costs and the above societal costs can be measured in dollar terms. In Australia these costs are already routinely measured in dollars to assess the effectiveness of regulations and policy. Overseas, a number of building codes and jurisdictions already use societal and individual cost as their performance metric (including in the International Building Code, the International Residential Code and the California Title 24 Building Energy Efficiency Standards).

Societal energy costs associated with energy use are dependent on time of use and the energy supply mix. For instance electricity sourced from a grid used during a summer heatwave when the electricity system is peaking imposes strain on the energy supply system, and therefore has a higher societal cost than electricity at other times of the year. Energy that is generated by brown coal overnight has a greater environmental impact than energy supplied by photovoltaic solar during the day, and therefore may also have a higher societal cost. A Performance Requirement that takes account of both individual and societal cost therefore requires assignment of values to the individual and societal costs of energy at different times.

Internationally, the metric for the combination of the individual and societal cost of energy is referred to as the Time Dependant Value (TDV) of Energy. A TDV Energy profile (see example demonstrated in **Appendix D.6**) contains the unit value of energy in an energy market over every hour in a year. The relevant TDV Energy profile to use will differ based on energy type (i.e. electricity or gas) and market (e.g. a different market may be applicable for each state and territory).

The energy landscape in Australia is continuously changing, and it is almost certain that new technologies for energy generation, energy efficiency and energy storage will continue to become available. Performance-based regulation allows new technologies to be assessed on an even playing field with existing technologies. Therefore, by ensuring that Performance Requirement PR2 is objective, quantitative, and encapsulates the aspects of energy efficiency that are most important (individual and societal costs), appropriate flexibility is allowed in the technologies that are used to meet the requirement, allowing innovation to maximise wider economic and environmental benefits.

D.5 Performance Requirement PR2 (Annual energy use budget)

The *domestic services* of a building must have a *Time Dependant Cost of Energy* of less than:

$$C_{Max} = V \times E$$

Where:

C_{Max} = The maximum allowable *Time Dependant Cost of Energy*, measured in dollars per annum ($/annum); and

V = *Target Unit Cost of Energy* for the building location, as specified in Table D.2 PR2 Target unit cost of energy (example); and

E = the nominal building energy use, measured in megajoules per Annum (MJ/annum) calculated using the following formula:

$$E = 788 + 292n + 3A + \frac{A_C}{11.2}(HLL + CLL)$$

Where:

n = the number of people accommodated in the building; and

A = The total area of the building, measured in square meters (m^2); and

A_C = The total area of the building that is a *conditioned space*, measured in square meters (m^2); and

CLL = The *Cooling Load Limit* of the building, measured in megajoules per square metre per annum (MJ/m^2/annum); and

HLL = The *Heating Load Limit* of the building, measured in megajoules per square metre per annum (MJ/m^2/annum).

Table D.2 PR2 Target unit cost of energy (example)

State/Territory	Target unit cost of energy
Australian Capital Territory	$0.23/kWh
New South Wales	$0.23/kWh
Northern Territory	$0.27/kWh
Queensland	$0.25/kWh
South Australia	$0.30/kWh
Tasmania	$0.20/kWh
Victoria	$0.22/kWh
Western Australia	$0.27/kWh

D.6 Example use of PR2

A practitioner is building a house in Brisbane. The house contains 200 m^2 of conditioned rooms and 250 m^2 of total floor area. The house is expected to accommodate 5 people. The calculations for the heating and cooling load limits of the building are shown in the PR1 example. The practitioner decides to complete a Performance Solution to show compliance with PR2.

- The practitioner downloads the time dependant cost of energy profiles for the building location from the ABCB website.
- The practitioner calculates the target energy usage using the formula in PR2:
- Energy target = 788 + 292 x 5 + 3 x 250 + 200 x (35.9 + 55.2)/11.2
- Energy target = 4625 kWh/annum
- The practitioner calculates the maximum allowable time dependent cost of energy using the formula in PR2:
- C_{max} = $0.25/kWh x 4625 kWh/annum = $1,160/annum
- The practitioner models the building using a modelling software package compliant to ASHRAE 140 to determine the predicted energy use of the building for each hour of the year.
- The practitioner multiplies the hourly energy use of the building by the time dependent cost of energy profile for each energy source over an entire year. An example calculation for a single day is shown below, although in practice this calculation is likely to be automated.
- If the total modelled cost of energy over an entire year for all sources is less than C_{max}, the building is compliant with PR2.

Table D.3 Example calculation for total time dependent cost of electricity (single day)

Time of day	Modelled hourly electricity usage (kWh)	Time dependent cost of electricity ($/kWh)	Hourly cost of electricity ($)
0:00	0.5	0.15	0.08
1:00	0.5	0.14	0.07
2:00	0.5	0.16	0.08
3:00	0.5	0.15	0.07
4:00	0.5	0.15	0.07
5:00	0.5	0.18	0.09
6:00	0.5	0.17	0.08
7:00	2	0.28	0.56
8:00	2	0.21	0.42
9:00	1	0.22	0.22
10:00	0.5	0.22	0.11
11:00	0.25	0.20	0.05
12:00	0.25	0.24	0.06
13:00	0.25	0.29	0.07
14:00	0.5	0.28	0.14
15:00	0.75	0.40	0.30
16:00	0.75	0.40	0.30
17:00	1	0.40	0.40
18:00	1.5	0.40	0.60
19:00	2	0.25	0.51
20:00	2	0.22	0.44
21:00	1	0.19	0.19
22:00	0.75	0.17	0.12
23:00	0.5	0.17	0.08
Total cost	-	-	$5.12

Table D.4 Example calculation for total time dependent cost of gas (single day)

Time of day	Modelled hourly gas usage (MJ)	Time dependent cost of gas ($/MJ)	Hourly cost of gas ($)
0:00	0	0.04	0
1:00	0	0.04	0
2:00	0	0.04	0
3:00	0	0.04	0
4:00	0	0.04	0
5:00	0	0.04	0
6:00	0	0.04	0
7:00	0	0.04	0
8:00	0	0.04	0
9:00	0	0.04	0
10:00	0	0.04	0
11:00	0	0.04	0
12:00	0	0.04	0
13:00	0	0.04	0
14:00	0	0.04	0
15:00	0	0.04	0
16:00	0	0.04	0
17:00	0	0.04	0
18:00	20	0.04	0.80
19:00	20	0.04	0.80
20:00	20	0.04	0.80
21:00	20	0.04	0.80
22:00	0	0.04	0
23:00	0	0.04	0
Total cost	-	-	$3.20

Table D.5 Example calculation for total time dependent cost of energy (single day)

Type	Cost of energy
Total cost of electricity	$5.12
Total cost of gas	$3.20
Total cost of energy	$8.32

Appendix E NCC Building Classifications

Class 1: one or more buildings which in association constitute—

(a) **Class 1a** — a single dwelling being—

(i) a detached house; or

(ii) one of a group of two or more attached dwellings, each being a building, separated by a fire-resisting wall, including a row house, terrace house, town house or villa unit; or

(b) **Class 1b** —

(i) a boarding house, guest house, hostel or the like—

(A) with a total area of all floors not exceeding 300 m^2 measured over the enclosing walls of the Class 1b; and

(B) in which not more than 12 persons would ordinarily be resident; or

(ii) 4 or more single dwellings located on one allotment and used for short-term holiday accommodation which are not located above or below another dwelling or another Class of building other than a *private garage*.

Class 2: a building containing 2 or more sole-occupancy units each being a separate dwelling.

Class 3: a residential building, other than a building of Class 1 or 2, which is a common place of long term or transient living for a number of unrelated persons, including—

(a) a boarding house, guest house, hostel, lodging house or backpackers accommodation; or

(b) a residential part of a hotel or motel; or

(c) a residential part of a *school*; or

(d) accommodation for the aged, children or people with a disability; or

(e) a residential part of a health-care building which accommodates members of staff; or

(f) a residential part of a detention centre.

Class 4: a dwelling in a building that is Class 5, 6, 7, 8 or 9 if it is the only dwelling in the building.

Class 5: an office building used for professional or commercial purposes, excluding buildings of Class 6, 7, 8 or 9.

Class 6: a shop or other building for the sale of goods by retail or the supply of services direct to the public, including—

(a) an eating room, café, restaurant, milk or soft-drink bar; or
(b) a dining room, bar area that is not an assembly building, shop or kiosk part of a hotel or motel; or
(c) a hairdresser's or barber's shop, public laundry, or undertaker's establishment; or
(d) market or sale room, showroom, or service station.

Class 7: a building which is—

(a) **Class 7a** — a *carpark*; or

(b) **Class 7b** — for storage, or display of goods or produce for sale by wholesale.

Class 8: a laboratory, or a building in which a handicraft or process for the production, assembling, altering, repairing, packing, finishing, or cleaning of goods or produce is carried on for trade, sale, or gain.

Class 9: a building of a public nature—

(a) **Class 9a** — a health-care building, including those parts of the building set aside as a laboratory; or
(b) **Class 9b** — an assembly building, including a trade workshop, laboratory or the like in a primary or secondary school, but excluding any other parts of the building that are of another Class; or
(c) **Class 9c** — an aged care building.

Class 10: a non-habitable building or structure—

(a) **Class 10a** — a non-habitable building being a *private garage*, carport, shed, or the like; or
(b) **Class 10b** — a structure being a fence, mast, antenna, retaining or free-standing wall, swimming pool, or the like; or
(c) **Class 10c** — a private bushfire shelter.

Appendix F Acronyms and Abbreviations

The following acronyms and abbreviations are used throughout the report:

ABCB, means Australian Building Codes Board

AEMO, means Australian Energy Market Operator

AGC, means Australian Greenhouse Calculator

ASBEC, means Australian Sustainable Built Environment Council

ASHRAE, means American Society of Heating, Refrigerating and Air-Conditioning Engineers

BASIX, means Building Sustainability Index

BMF, Building Ministers' Forum

COAG, means Council of Australian Governments

DEE, means Commonwealth Department of the Environment and Energy

DIY, means Do-It-Yourself

DTS, means Deemed-to-Satisfy

EU, means European Union

EV, means Electrical Vehicle

FMA-ANZ, means Fan Manufacturers Association of Australia and New Zealand

GEMS, means Greenhouse and Energy Minimum Standards

IGA, means Inter-Governmental Agreement

MEPS, Minimum Energy Performance Standards

NatHERS, means Nationwide House Energy Rating Scheme

NEPP, means National Energy Productivity Plan

NCC, means National Construction Code

NZRE, means Net Zero Regulated Energy

Privacy Act, means the Australian Privacy Principles in the Privacy Act 1988

RIS, Regulation Impact Statement

PR1, means Performance Requirement 1, which is proposed to specify the minimum thermal performance of the building fabric (i.e. thermal comfort) for residential buildings in NCC 2022

PR2, means Performance Requirement 2, which is proposed to specify a maximum energy use budget for residential buildings in NCC 2022

SOUs, means Sole-Occupancy Units

VMs, means Verification Methods

Appendix G Information Collection Statement

G.1 Privacy Collection Statement

The ABCB is bound by the Australian Privacy Principles (APPs) outlined in Schedule 1 of the Privacy Act 1988 (Cth) (Privacy Act), which regulates how entities may collect, use, disclose and store personal information.

Personal and sensitive information is being collected by the ABCB Office to assist the ABCB to carry out its functions including to inform the *Energy efficiency - NCC 2022 and beyond* scoping study consultation process and for other purposes including to communicate with individuals or organisations about their submission.

The personal and sensitive information collected as part of the consultation process may be disclosed to and used by the following individuals or organisations:

- the staff of the Office of the ABCB;
- the Australian Building Codes Board, its committees and any working groups established by the ABCB, and their staff and advisers;
- the Commonwealth Government, and State and Territory Ministers responsible for building regulation and policy, and their staff and advisers;
- other Commonwealth or State and Territory government departments and agencies;
- any consultant or contractor engaged by the ABCB for the purpose of undertaking work in respect of the subject matter of the consultation process; and
- any organisation for any authorised purpose with your express consent, for the purposes set out above.

Personal and sensitive information obtained will be stored and held in accordance with the ABCB's obligations under the Archives Act 1983 (Cth). Further information about how the ABCB collects, uses and discloses personal information is set out in its Privacy Policy on the ABCB website (abcb.gov.au).

If you have an enquiry or request relating to your personal information, please contact:

Privacy Contact Officer
Australian Building Codes Board
GPO Box 2013
Canberra ACT 2601

G.2 Confidential Information

All submissions and comments will be published unless they are marked ‘commercial-in-confidence’. However, any contact details you provide within your submission will be redacted prior to the submission being published.

In order to promote debate and transparency, the ABCB prefers that all submissions and comments be provided in a way that does not require confidentiality to be maintained. However, it recognises that in some circumstances you may want to provide information in confidence.

It is the responsibility of the person making the submission to ensure that any ‘commercial-in-confidence’ information is clearly identified. Please consider if you can structure your response to keep only some parts confidential. If only part of your submission is confidential, you can provide the confidential part as a separate submission so that the ABCB can publish the non-confidential part of the submission.

Where confidentiality is requested for an entire submission, it will not be published by the ABCB, nor will your name or organisation details.

Please note that we may still disclose the confidential part of your submission to any of the above identified users of the information as part of the consultation process and we will use reasonable efforts to ensure that the recipients keep the submission confidential.

The ABCB or the ABCB Office may also disclose confidential information in circumstances where:

- we are required or authorised by law disclose it;
- you agree to the information being disclosed; or
- someone other than you has made the confidential information public.

Your submission, comments, opinions and responses will not be published if the ABCB or the ABCB Office considers that your submission, comments, opinions and responses may contain potentially defamatory statements or other offensive comments.

G.3 Agreement to collection of information

By making a submission on the *Energy efficiency - NCC 2022 and beyond* scoping study you will be agreeing to:

- the collection of the information you provide in your submission; and
- the use and disclosure of the information you provide in your submission as outlined above.