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Editors:

Priyadarsini Rajagopalan

Mary Myla Andamon

RMIT UNIVERSITY

The Architectural Science Association and RMIT University

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Investigating equivalence in compliance pathways to Australian housing energy efficiency

Timothy O'Leary
University of Melbourne, Australia
oleary.t@unimelb.edu.au

David Whaley
University of South Australia, Adelaide, Australia
david.whaley@unisa.edu.au

Martin Belusko
University of South Australia, Adelaide, Australia
martin.belusko@unisa.edu.au

Abstract: Current regulatory pathways to compliance in energy efficiency for Australian housing are via provisions in the National Construction Code (NCC). This paper first identifies performance evaluation criteria set out in the code presented as a comparative analysis across the different methods of achieving compliance. Jurisdictional and concessional variations are discussed and thereafter an examination of the effect of specific design and location factors that impact the commonly used deemed to satisfy route to compliance. A study is presented in the paper investigating typical South Australian temperate climate housing styles in terms of their expected energy performance and compliance. This is done to test for measurable differences or test where equivalence can be shown to be reasonably achieved. This study highlights the issue of alternative pathways, being different options of using software modelling or elemental compliance based on specification details. The sample set is a modest seven houses only but carefully chosen to show the compliance pathway results for different options across this sample set. Further measures of house energy performance evaluation and comparison are drawn from the literature.

Keywords: NatHERs, Compliance, Energy Efficiency.

1. INTRODUCTION

In Australia, there are a range of scenarios for energy efficient housing design to do with compliance that an energy assessor and/or building certifier might be faced with, including but not limited to consulting with clients, architects, builders and the local regulatory approval authority on what is the desired outcome in terms of the final design. The primary regulatory mechanism is the National Construction Code (formerly the BCA). The regulatory approach to Energy efficiency is generally to measure compliance by adhering to prescriptive deemed to satisfy (DTS) provisions around elements of the building or by using thermal simulation to predict energy use within pre-determined location specific starbands as set out in the Nationwide House Energy Rating Scheme (NatHERs). This regulatory approach to achieving more energy efficient design of housing is seen as somewhat inconsistent in Australia as different approaches can be applied to the assessment of thermal performance. There have been few studies that compare the differences in pathways to compliance under the code provisions (Anderson 2009, Floyd 2014) whereas some energy rating experts and designers have advocated for the phasing out of the DTS Elemental pathway in favour of simulation based on thermal comfort models (Daniel et al 2017, Kordjamshidi, et. al. 2009).

The adoption of the current minimum 6 star energy standard in 2010/2011 across jurisdictions was a significant event in housing energy regulation. The mandated rating software used throughout Australia for residential construction is variously based on the CSIRO developed thermal calculation engine which is called CHENATH, and implemented through the 'second generation' software either AccuRate, BERS Pro, or FirstRate (FR5). Star ratings are easy to understand, which explains why they have become the common term for an energy efficiency compliance assessment. However, no methodology has been established to reliably correlate simulated household energy use for heating and cooling with actual likely use, either on individual dwelling, or aggregated basis. Using simulation software at the design phase allows sub-standard performance to be diagnosed, and the best solution identified. On the other hand the settings and assumptions of NatHERs software has been a subject of debate and the modelled energy use has not generally corresponded well with existing energy use data from the limited surveys undertaken (Ambrose et. al. 2013, O'Leary et al. 2015). NatHERs simulation has also been criticised as being unsuitable for assessing low energy houses that are intended to use little or no heating and/or cooling in operation (Soebarto, 2000, Daniel et. al 2017).

2. METHODOLOGY

The methodology adopted in this paper is an investigation of the national regulatory mechanism, the National Construction Code. Current regulatory pathways to compliance in energy efficiency are first identified and performance evaluation criteria set out as a comparative analysis across the different methods. Jurisdictional and concessional variations are discussed and thereafter an examination of the effect of specific design and location factors that impact the commonly used deemed to satisfy route to compliance.

A further comparative analysis based on a sample set of seven South Australian homes is presented with base results of testing compliance against the two options of deemed to satisfy provisions, outlined in section3 below (see figure 1). This study was part of a wider study of Industry adaption to NatHERs 6 star energy regulation in SA by the principal author who has undertaken energy ratings and HERs assessment training under the NatHERs protocols. The star rating was obtained by modelling in Firstrate 5 and each building was separately assessed under the elemental DTS provisions of the NCC. This shows the two methods compared in an action research approach were rating and assessments were independently verified by an accredited HERs assessor and certified building surveyor as duly acknowledged in section 8 of the paper. It should also be noted that star ratings were undertaken in non- regulatory mode and in both methods the focus is on building fabric, glazing and air movement rather than sealing and services (as per figure 1, section 3 below). Using the non-regulatory mode of the software assessors can test any range of modelling options they wish but in regulation mode assessors must apply the agreed protocols in the Technical Notes that have been approved by all states and territories.

3. PATHWAYS TO COMPLIANCE

The regulatory approach to Residential Energy efficiency is generally to measure compliance by adhering to prescriptive deemed to satisfy(DTS) provisions around elements of the building or by formulation a performance based alternative solution that fits the objectives of the code or a combination of both as per:

- Deemed-to-Satisfy — BCA Elemental Provisions Method
- Deemed-to-Satisfy — Thermal Calculation Star Rating Method
- Alternative Solution — Verification using a Reference Building

In understanding energy efficiency provisions for housing the primary performance requirement is P2.6.1 – Building in Part 2.6 Energy Efficiency for which the ABCB has authored several Awareness Resource Kits (ABCB 2010). Part 3.12.0 provides a roadmap for practitioners to demonstrate compliance to the DTS Provisions. There are two approaches provided for the thermal performance of the building, the energy rating approach (using house energy rating software) or the prescriptive elemental approach. Either approach fulfils the Performance Requirement P2.6.1. The Performance Requirement P2.6.2 (for domestic services such i.e. plumbing and electrical) may be satisfied using the DtS Provisions of Part 3.12.5.

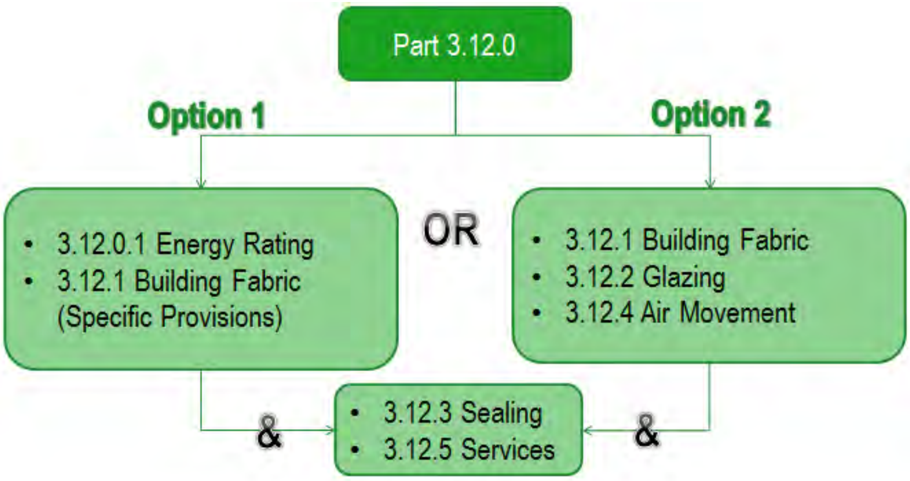

Figure 1: Part 3.12 NCC Volume 2 Optional Requirements (source: ABCB 2010)

3.1 Software Simulation (3.12 option 1)

Using the Thermal Calculation method, a building is compliant if it does not exceed an annual energy allowance based on heating and cooling loads measured in mega joules per m2. Depending on location the energy usage calculation of the building is given a Star Rating between 1 and 10 stars to reflect the overall thermal performance of the building. It is an assessment of the whole building, measuring the total performance rather than individual elements as in the Deemed-to-Satisfy Elemental Provisions method.

More factors are considered holistically: like flooring, walling, roofing, glazing size / type and location, orientation and ventilation (both natural and mechanical). Currently the minimum compliance requirement across Australia is 6 stars apart from the Northern Territory where it is 5 stars. These levels are only minimum requirements; the software programs provide results up to 10 stars. A thermal calculation (Star Rating) can be produced using AccuRate, FirstRate5 or BERS Pro software, which are all accredited for this purpose. Additionally, the design must comply with specific energy saving features such as the testing and installation of insulation, thermal breaks, compensation for downlights, floor edge insulation and building sealing

3.2 Elemental provisions (3.12 option 2)

This method involves checking the building against a standard set of parameters that meet the NCC requirements. The principal focus is on floor, wall, roof and ceiling construction elements as well as air movement. There are perceived advantages and disadvantages to this method of compliance. One advantage is that it makes building assessment relatively quick and easy (the building does not have to be divided into zones) however, if the building isn't achieving compliance, this method can make it harder to integrate necessary improvements. This approach which is described as an 'all or nothing' approach can also create problems when innovative building products are specified, or when the construction cannot meet minimum requirements due to site, project budget or design restrictions.

3.3 Alternative (performance based) solutions

There also exists a Verification using a Reference Building assessment method (ABCB 2017). A building is modelled with the Elemental Provisions using thermal modelling software to create a target annual energy consumption. The building is then designed with your desired specification and this proposed building is also modelled in the thermal software. If the proposed building uses the same or less energy than the reference target then it is deemed to comply.

This process gives builders, architects and designers the freedom to design buildings that meet (or exceed) specifications while also being cost effective and compliant. Whilst the method has been promoted and utilised by energy raters since the more stringent 2010 measures were introduced it been called into question recently by the NatHERs (2017) administrator as NatHERs does not accredit tools for use under other NCC compliance pathways.

3.4 Assessment of Class 2 and 4 higher density dwellings

The NCC utilises a building classification system by function and use, where buildings are labelled "Class 1" through to "Class 10". Class 2 buildings are apartment buildings and a Class 4 part of a building is a dwelling or residence within a building of a non-residential nature. The sole-occupancy units of a Class 2 building or a Class 4 part of a building must for reducing the heating or cooling loads collectively achieve an average energy rating of not less than 6 stars; and individually achieve an energy rating of not less than 5 stars, using house energy rating software. The performance requirement is further set out in clauses of section J (NCC volume 1) for general thermal construction, thermal breaks, floor edge insulation, sealing and measures for compensating for a loss of ceiling insulation, other than where the house energy rating software used can automatically compensate for a loss of ceiling insulation. Hogg (2015) has identified several key issues with compliance particularly due to the limitation with orientation options for apartments. It is unclear whether the NatHERs thermal modelling approach as examined in this paper will remain relevant to multi-unit buildings, as recently announced major funding by federal and state governments for a new environmental performance rating tool for apartment buildings Australia-wide was been announced (Nabers 2017). The tool is now in its pilot phase to be available for public use by mid-2018. From an NCC compliance perspective the future NCC 2019 provisions may include more verification methods for these types of buildings. This is seen as a welcome development in this area as Floyd (2014) found energy assessors tested in a national benchmark study found rating an apartment very difficult with less than half the sample obtaining a rating within one star of the correct result.

4. DESIGN AND SITE CONSIDERATIONS

4.1 Glazing, Insulation and Infiltration

Glazing presents the biggest challenge in thermal envelope performance which is the basis of energy efficiency assessment. Here the contracting approaches are a stark reminder of the 'all or nothing' approach of the Elemental DTS method. Using this option 2 method fail in one and you fail in all. With the software the ability to compensate for underperformance in one area by over performance in another can be as discrete as a choice of one particular window selection over another. Since the 2010 BCA stringency changes the worksheet glazing calculator method has been the tool the ABCB developed for NCC users to assist with demonstrating compliance with the NCC energy efficiency requirements for glazing using the Elemental assessment option. Practitioners may undertake to develop their own but need to demonstrate compliance with the NCC clauses, formulae and tables.

A windows 'u' value is a measure of heat conductivity for the whole window. An assessor can generally tell in option 2 whether conductance is way too high for a glazing unit if it is between 1.5 to 1.8 u value and then model it more accurately in the software. Prior to October 2014 existing National Fenestration Rating Council (NFRC) values in the software did not align with new NFRC values adopted. The mismatch has been addressed in recent changes and software releases. The change to NFRC values required major changes to the Chenath engine in software releases in 2017 and there are now 88 default windows within the software.

The requirement for assessors using AFRC procedures is to refer to published performance values however this can sometimes be lacking or confused by slightly different terms (including "U-factor", "U-Value" or "Uw" for Total System U-Value and "SHGC" for Total System SHGC). Such values may be used in 3.12.2 provided they measure combined glass and frame performance according to AFRC requirements. In practice often window selection is problematic at assessment stage and assessors may have to rely on 'worst case' default values for generic windows rather that manufacturers own data or corresponding data form the national Windows Energy Rating Scheme (WERS).

The Zoning tab in simulation software option 1 allows you to enter details of features that may increase air leakage into and out of the dwelling, ceiling penetrations that cause gaps in insulation, and the number and size of ceiling fans in the zone. Essentially the issue is that the application of the principles in NatHERs for the loss of ceiling insulation due to ceiling penetrations is inconsistent as it is modelled in the software for any penetration however within the Elemental approach the R value of the insulation of the remainder must be increased once the "free allowance" of 0.5% of uninsulated ceiling area is exceeded.

4.2 Shading and Ventilation

Both DTS options have somewhat different ways at looking at the effect of shading devices and in option 2 an assessor will have to do 2 reports for winter/summer 'device' if there are retractable devices. One other consideration for shading under the various compliance options is that in option 2 no shade concessions are provided for colder NCC climate zones 6 to 8. This is due to the conditioning requirement being heating dominated, so shade would not be as beneficial as it would reduce the amount of solar gain received. The shown in the glazing calculator (section 4.1 above) a P and H value is applied to each window to calculate the exposure of windows. P is the horizontal projection of the shading projection from the face of the glazing. In a NatHERs rating under option 1 shading is accounted for by wing walls that are projections are perpendicular to the plane of a wall and cast shade on that wall. Wing walls also affect the flow of wind around and through a dwelling. The Chenath simulation engine modifies air flow through a dwelling where there are wing walls which does not occur under option 2.

The CHENATH calculation engine in option 1 ratings uses a complex ventilation model, and there is no capacity to override the number of air changes per hour (AC/h) using this model. There has been some debate as to the efficacy of the engine in modelling real air movement particularly in hot climates (Isaacs 2017). When it comes to the Deemed-To-Satisfy assessment method particularly for warmer climates if you have a heat load problem ceiling fans reduce the ventilation requirement as per Table 3.12.4.1. In the Glazing Calculator, more ventilation from openings & ceiling fans increases the glazing allowance. In simple terms then under option 2 Elemental DTS, adding ceiling fans means you can have more glass. NatHERs has a number of modelling assumptions around ceiling fans and ventilation (i.e. opening of a window). In modelling exercises, as in section 5 of this paper its been found for temperate climates there isn't much credit in 'star increment' compared to what can be achieved in Elemental under 'air movement'.

4.3 Building Zones and Element Proportions

A stark contract between options is the zoning requirements of option 1, whereas option 2 considers the envelope to be the primary determinant of heat loss/gain against the performance requirement. The software used in option 1 is weighted in its calculations to living areas (as it should be), the Elemental approach has no relationship to zoning however an advantage is that designs that are cumbersome can benefit from this more basic approach of option 2. Net Conditioned Floor Area (NCFA) as a proportion of the External Wall Area is of paramount importance and NatHERs software performs an area adjustment to determine adjusted loads that determine the star rating, this does not occur in the Elemental approach in option 2. Because heat transfer is a function of surface area, the greater the ratio of the wall area to floor area, generally the worse the thermal performance, all other things being equal. For example in an earlier study by EES (2002), for detached concrete floored houses in the Melbourne climate zone with a 25% limit on glazed area it was found that 10% of the sample failed to meet the 5 star performance target after application of a range of improvement measures.

As with restrictions to glazed areas in option 2 it was proposed by EES that it may be appropriate to apply restrictions to NCFA/Wall area ratios. Restrictions (minimum levels) would need to be set such that above the adopted level there is likely to be an acceptably high certainty that application of the deemed to satisfy measures would provide adequate levels of compliance to the performance standard. It should be noted that analysis in the EES study sample found (as would be expected) that there was a strong correlation between low floor area and low NCFA/Wall area ratio.

4.4 Climate Zones and Postcodes

An important distinction between the 2 pathways is the differentiation in climate location. NCC climate zones 1 and 2 are assigned to locations with hot or warm and humid summers and warm or mild winters where a desire for cooling is likely for most of the year. Climate zones 3 and 4 have hot dry summers and warm or cool winters so that both cooling and heating may be desirable. In climate zone 4, a need for heating is for more of the year than a need for cooling. Climate zone 5 is considered a warm temperate climate with limited need for cooling or heating although, in balance, the need for heating is likely to be greater. Climate zones 6 and 7 are considered to be cool temperate climates respectively, with the winter cold enough to require significant heating. Climate zone 8 is an alpine climate where heating is the predominant need. This contrasts to NatHERs which divides Australia into 69 climate zones. This allows the software to appropriately consider the effects of Australia's diverse climate when modelling the heating and cooling requirements of a home. Weather files have been compiled from Bureau of Meteorology records for each NatHERs climate zone and include information on air temperature, humidity, solar radiation and wind speed and direction. The weather file for each climate zone, called the Reference Meteorological Year (RMY), is compiled from at least 25 years of Bureau records. When conducting a NatHERs rating, the software uses the weather files to assess the impact of weather on the building's internal temperature. This impact is calculated for every hour in a full 12 month period.

Individual State and Territory versions of the map are available on the ABCB website at www.abcb.gov.au. The *climate zone* maps are updated as local government area changes are brought to the attention of the ABCB. Climate zones are generally aligned with postcode boundaries for convenience, except where there is likely to be a topographical or other feature within the postcode area that impacts the local climate. In this scenario, alternative zones are offered for the same postcode. For example, if a postcode includes a mountainous area, an alternative climate zone may be used above a certain altitude. This impact has not been fully measured but there are some unintended consequences or anomalies in the fit of NatHERs climate zones to ABCB climate regions. For example, in South Australia the postcode for Victor Harbor a major coastal town and surrounds is 5211 as shown in figure 2 below:

Selected Zones for Postcode 5211			
Zone Type	Key	Climate Region	Location
Principal		16	Adelaide

Figure 2: Example of distribution of regional postcode to NatHERs Climate region in SA (Source NatHERs 2015)

However using the Climate zone map designation for Elemental assessment the location of Victor Harbor is Climate Zone 6 (cool temperate) and not the Zone 5 (warm temperate) Adelaide zone. In effect, a higher specification requirement for the adverse winter performance in zone 6 can be gamed by choosing the software route that models the house under a milder climate of the Adelaide metropolitan region. It is worth noting that Victor Harbor is colder in the winter months consistently and would have a longer more intense heating season than Adelaide. What this means is that the choice of zone that is a result of compliance option chosen may suit a design that is better performing in heating rather than cooling and vice versa. Research conducted in South Australia has identified highly rated houses performing poorly in heat stress during summer months (Hatvani-Kovacs et. al. 2018, Soebarto & Bennetts 2014) and for the 2019 NCC there is now a proposed introduction of heating and cooling load limits into the NatHERs compliance pathway with the release of a consultation regulatory impact statement (ABCB 2018).

5. DEEMED TO SATISFY COMPLIANCE STUDY OF SA HOUSES

A set of seven houses of typical Australian temperate climate design and specification that were constructed between 2014 – 2016 have been assessed under both DTS methods outlined earlier in this paper. Table 1 below presents the results of the analysis and gives a pass or fail as to compliance showing how a house of exact same construction may be rated a pass in one method but a fail in the other. The houses are all typical of Australian mass market temperate climate house design being single storey free standing dwellings except for house 5 having a relatively small area of upper floor (3 upper rooms). House 3 also differed from the norm in that it was an extension, albeit a substantial extension adding twice the area of the existing retained older structure. All houses are in the metropolitan area of Adelaide which falls in NCC Zone 5 covering the temperate climate regions of South Australia which is a similar NCC zone in major parts of NSW, WA and Queensland.

Table 1: Results of SA houses compliance in both DTS star rating and elemental assessment

	OPTION 1 NatHERs Stars	OPTION 2 Elemental Compliance	OPTION 2 Glazing Assessment	OPTION 2 Glazing Assessment	Glazing area % of storey	Net Conditioned area
			Conductance (u-value)	Solar heat gain		
House 1	6.0	YES	Pass	Pass	15%	142.3
House 2	5.3	YES	Pass	Pass	20%	158.9
House 3	3.8	NO	Fail	Fail	15%	181.3
House 4	7.7	YES	Pass	Pass	20%	121.8
House 5	6.0	YES	Pass	Pass	24%	177.3
House 6	6.1	NO	Pass	Fail	29%	184.7
House 7	6.7	YES	Pass	Pass	20%	140.2

Note: shaded row indicates a house that has failed in one option and has passed in an alternative option.

As noted in the introduction, since 2010 using option 1 of part 3.12 requires that a minimum rating of 6.0 stars is achieved. **Houses 2 and 3** do not achieve this hurdle rating however in the case of house 2 the compliance under the elemental provisions of NCC 3.12 is a pass. The rating report for **house 2** shows results went down by about 0.6 stars when the non-wet area (and kitchen) floors were changed from concrete to carpet as per NatHERs Tech Note 1. This in itself would not be sufficient explanation of its fail in star rating. Roof colour has been left at the more likely/common "medium" rather than the NatHERs temperate (worst case) default of "light" however in temperate zones this does not appear to have any but a very marginal effect on the rating, as was also identified in the case of **house 4.** It was found in rating mode that a change of zoning of two principal and a smaller spare room to office and study spaces rather than additional bedrooms was a difference of 0.5 stars in rating result.

House 3 presents the challenge of achieving compliance for extensions which has been the subject of more recent studies (Sustainability House, 2016). In South Australia, to assist designers and private certifiers, a separate Advisory Notice 03/12 (DPTI, 2012) provides guidance on the application of the provisions to existing buildings where there are various methods of making an addition/extension comply with the energy efficiency provisions of the housing NCC, Volume 2. One such approach is to the whole house and include whatever is reasonably necessary to make it comply (such as applying the new glazing to the whole house) but then only require the extension to be constructed accordingly. This approach essentially designs the whole house for a 6-star rating and then amputates the extension that is to be constructed. This recognizes that the rest of the house already exists (but could be upgraded at some time in the future). The 3.8 star rating in table 1 represents a whole house rating using FR 5 and the whole house as constructed. Subsequent to the house achieving compliance through the building certification process and being built in 2014 a separate rating of the extension was commissioned which showed a rating of 6.4 for the extension.

A post occupancy envelope audit was undertaken which included a staged set of air pressurisation tests to ISO 9972 combined with thermal imaging analysis. The testing reveals air leakage factors attributed to deterioration and degradation of the older portion which was built in the 1920's, however a superior test result of above minimum code building sealing for the very recent extended portion of the single storey dwelling. Using an internationally accepted ACH@50 testing the existing portion showed a figure of 19.65 whereas the extended portion showed 5.27. When a whole of dwelling test in employed using standard calibration methods and multiple runs the ACH@50 figure is recorded as 10.91 which aligns with the code minimum value required for houses in the United Kingdom whereas a study by Ambrose & Syme (2017) showed overall average air change rate for new built Australian homes was 15.5 ACH@50Pa.

House 4 is by far the most highly rated house and exceeds the minimum star rating comfortably, it had high levels of insulation, has a glazing area that is not excessive and of high performance thermally broken double glazed High Solar Gain low-E –Clear glass. Features of this higher performing house included high R-value external wall insulation, Hebel external walls and internal wall insulation, mainly for sound deadening and to a lesser extent improved thermal comfort levels. Particular attention was placed on reducing transfer of heat through the garage and into the house by including such items as; external garage wall insulation, R 6 insulation in the garage ceiling, weather stripping the garage door, and insulated garage (panel-lift) doors.

When rated under option 1 it was noticed that the roof colour (FirstRate 5 options of: light, medium or dark) made no difference to overall star rating. What this did do, however, was adjust the amount of heating and cooling required, yet the total amount of heating and cooling (which is what is used to determine the star rating) remained unchanged. For instance, with a light roof, less cooling was required, yet more heating was needed; conversely, a dark roof required more cooling but less heating. It is unclear how these numbers would vary in a house with much less roof or ceiling insulation.

Houses 1, 5 and 7 all achieve the minimum 6.0 stars and pass the elemental provisions. Whilst the area of glazing of **house 1** at 15% of storey area is the lowest it has achieved the very minimum 6.0 stars in its final design iteration. The original early design (back when it was approved) with higher performing double glazed windows and tiled northern living space achieved had achieved an 8.1 star result. The glazing was modified and in the software method is Aluminium single glazed Generic 01 (U=7.32, SHGC=0.77) except for front door sidelight (Gen 03 (U=5.75, SHGC=0.69). The report shows the results went down further and substantially from 7.2 stars to 6.0 stars when the floor finish to the northern living spaces went from "none" to "carpet" as required by NatHERs Tech Note 1. This is a more dramatic reduction is star rating than the effect of the technical note on **house no. 2**.

House 6 is perhaps the most interesting result in this study as it achieves a 6.1 star rating and passes the glazing test in option 2 in Conductance (U-value) however fails in Solar Heat Gain Coefficient (SHGC) allowance. Reviewing the glazing calculation for this house revealed a SHGC of 0.62 based on window type selection. On further examination the failure could be attributed to larger windows on either of the east and west elevations. These windows accounted for 16% (east) and 14% (west) of total SHGC element share which was an excessive 118% of the allowance. Removing the east window of 5.5m2 area brought the calculated outcome to a complying 99% whereas removing only the west window of 4.62m2 brought it to 101% just over the compliance limit. It is known that solar heat gain can provide free heat in the winter but can also lead to overheating in the summer. How to best balance solar heat gain with an appropriate SHGC depends upon the climate, orientation, shading conditions and other factors. In this case it appears the lack of shading devices was a contributory factor and the house has by far the highest ratio of glass to floor area.

6. DISCUSSION

It is perhaps unsurprising given the different approaches that some houses may pass the compliance requirements of the NCC using one option and fail using an alternative option. Whilst the research on compliance pathways presented here has not focused on any benefit to cost considerations, as with other research findings (SuHo 2012) it may point to software simulation as finding cheaper cost to construct options when alternatives in design elements can be cross traded to achieve either minimum compliance or even better energy performance. As per Whaley et al (2017) there are in fact multiple ways to improve the energy efficiency of existing houses and a suggested path / optimised approach can be taken to reduce the cost of achieving this.

The selection of appropriate glazing is paramount in achieving compliance using both options and in the case of option 2, the more prescriptive elemental pathway, it was shown that a single glazing unit could be the difference between a pass or fail. The requirements of NCC minimum energy standards (set out in part 3.12 under the deemed to satisfy provisions) are fundamentally determined by NatHERs assumptions and default values when software modelling is invoked. The study shows some dramatic reductions in star rating because of different floor coverings, whereas in temperate climates at least, the roof colour selection appears to have very limited measurable effect.

The selection of a climate zone between two different options shows certain anomalies though not highlighted specifically in any of the houses in the study due to the limitations. What can be seen is naturally a wide diversification of climate in Australia, however option 2 takes a pathway of least resistance with just 8 major climate zones to cover the entire continent. Either of the two options has the inherent problem of setting minimum thermal energy requirements derived from historical bureau of meteorology weather data that are translated to very local site specific requirements.

7. CONCLUSIONS

The approach adopted in this paper is to highlight the alternative methodologies in assessing Australian houses for minimum NCC energy compliance noting however the main theme of the ASA 2018 conference is higher density living. The study shown here does underline that the regulatory approach to achieving more energy efficient design of housing is somewhat inconsistent in Australia. Procurement options for dwellings particularly the single detached style and unique allotment housing of major Australian cities and regional areas can impact the pathway adopted for compliance. Several different approaches can be applied to the assessment of thermal performance and what passes the compliance test using one method in some cases may not (at least in current design) achieve a pass in an alternative method.

One striking difference in the choice of compliance options is that NatHERs modelling software goes beyond compliance as it can be used as a design tool. Using thermal simulation to model thermal energy characteristics to predict energy use for comfort is a powerful way to improve energy efficiency but also gives some flexibility over the 'all or nothing' elemental DTS method. There may be some misconceptions in the market and concerns with the software technically, however assumptions and settings could be further improved and modified, in the process supporting the uptake of house energy simulation during design. The energy assessment sector should perhaps be looking to moving beyond just proving a compliance service but rather a design service and in supporting the design process there would be a natural motivation to continuously improve the NatHERs scheme in a virtuous circle supporting the residential industry.

It is a plausible argument in conclusion, that there should perhaps be a move away from the elemental option and a focus only on one single pathway. A pathway which allows better modelling of thermal energy characteristics of both individual dwellings and high rise multi storey dwellings, that also has benefits of avoiding unwanted outcomes and reducing complexity for the sector.

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