Validation of the DIY Option for Thermal Comfort within the BASIX Development Approval Process in NSW

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Abstract

BASIX is the web-based planning approval system recently introduced for housing in the state of NSW, by their Department of Planning (DoP), and presented as a model to other jurisdictions for adoption. This paper analyses the DIY method for the thermal comfort section of the BASIX program. The thermal performance of a basic house was compared using both the NatHERS method and the BASIX DIY method for three different climates. The effects of varying different building characteristics such as glazing and external wall surface were also tested. It was found that there were significant variations in the results from the simulation method (NatHERS) compared to the DIY results. In most cases it was found that the DIY method was considerably less responsive to changes in the building characteristics than the simulation method. These results suggest that there is considerable modification work to be done on the BASIX DIY method in order to improve the accuracy of its predictions.

In addition to this analysis, consideration is given to the impending adoption of the 2nd Generation NatHERS software packages which will widen the disparity between the simulation and DIY methods both in terms of the accuracy of the energy predictions and in the range of climate zones offered for the simulation option.

1. INTRODUCTION AND SCOPE

Initially the BASIX Development Approval (DA) website had two methods for assessing the “Thermal Comfort” merits of a particular dwelling design: Deemed to Satisfy (DTS) modelled on the energy provisions in the Building Code of Australia (BCA) Volume 2; and a full simulation alternative (primarily using NatHERS but recently allowing FirstRate and currently allowing AccuRate and BERS Pro for a group of Assessors trained under the national pilot program). By DoP’s own assessment (BASIX, 2007) this two-tier arrangement worked well.

The NSW Department of Planning (DoP) devised a third alternative compliance option called Do It Yourself (DIY) which lies somewhere between the above two – ie, it is more flexible than the DTS method (called “Rapid”) but less accurate than the simulation method. A beta version of DIY was available on the BASIX website for trial use and is now recognised for DA purposes since approximately November 2005. DoP remains publicly committed to a third assessment method and seeks to refine it rather than opt for the more accurate simulation method. The DIY software takes the form of an elaborate and articulate workbook of spreadsheets operating invisibly behind the BASIX user interface. That workbook is the intellectual property of the DoP and is still not available for public or academic critique.

It has been reported by the Association of Building Sustainability Assessors (ABSA, http://www.absa.net.au/) that previously around 70% of DAs for dwellings involved simulation of the candidate design by an accredited Building Sustainability Assessor.

This paper describes the work involved in validating the DIY option to allow it to supplement the two existing methods with the overall aim of reducing the average cost of assessment and/or compliance for new housing in NSW while maintaining the intended levels of energy efficient performance set by the NSW Government in cognisance of the economic and environmental benefits and of the standards being required in other Australian jurisdictions.

2. OUTPUTS OF THE DIY

The DIY outputs three main results:

1. direction as to the minimum acceptable added insulation to the walls, roof and floor constructions chosen and combinations of glazing types and shading;
2. a pass/fail on the Thermal Comfort requirements (established by comparing its notional annual MJ/m² results against the Heating and Cooling Caps set for each relevant BCA climate zone); and
3. a combined heating and cooling annual energy "consumption"[i] which is added to other estimated energy consumptions of the proposed dwelling to be compared with a target value set statistically as 40% less than the average for a dwelling with the same number of bedrooms in the same statistical district (as defined by the Australian Bureau of Statistics (ABS)).

As currently applied, the DIY option can be used to assess any proposed new BCA Class 1 dwelling irrespective of its complexity or novelty in design or construction. Its outputs can be used without restriction in defining a Thermal Comfort Pass and in estimating its energy "consumption" for thermal comfort purposes to assess whether the proposal overall meets the Energy requirements to be granted DA.

3. PURPOSE OF THE VALIDATION PROJECT

The introduction of the DIY option has the overall aim of reducing the average cost of assessment and/or compliance for new housing in NSW while maintaining the intended levels of energy efficient performance set by the NSW Government in cognisance of the economic and environmental benefits and of the standards being required in other Australian jurisdictions.

The assessment cost reduction potential of the DIY option for BASIX is a matter of broad consensus. The purpose of this paper is to validate its reliability and repeatability to confirm that it does <u>not</u> routinely:

- mislead the user about thermally optimum design and insulation levels;
- over-rate a dwelling (causing a lowering of environmental standards and/or an increase of life cycle costs to society or the consumer); nor
- under-rate it (causing excessive compliance costs to the consumer).

The paper also explores the range of results to check that isolated instances of a failure against the criteria listed above all lie within reasonable levels.

Such work, when completed by a reputable, independent source and published, would ensure that all three options for Thermal Comfort assessment are accepted by the building industry, consumers and the environment lobby as being credible and reliable bases for cost-effective and environmentally sound DA decisions.

3.1. Criteria for Validation

Given the capacity and natural propensity of the building industry to actively seek out lowest first cost solutions (sometimes derided as "gaming the system"), it is proposed that the validity of the DIY be assessed on the basis of its being on-average-and-mostly less stringent than the Rapid option and more stringent than the most articulate and reliable technique: the Simulation option.

In practical terms, this can be interpreted as requiring DIY results to fall within the following bounds:

- 90% of DIY assessments will be equally or more stringent than the Simulation option

- less than 50% of DIY assessments will be more than 10% more stringent than the Simulation option
- the average of the most stringent 10% of DIY assessments will be no more than 20% more stringent than the Simulation option; and
- the 10% of DIY assessments which are less stringent than the Simulation option will average no worse than 10% less stringent.

Since both the DIY and Simulation methods produce values expressed in annual MJ/m² for Thermal Comfort and annual MJ for Energy, stringency comparison should be on the basis of the difference between the two options divided by the value for the Simulation option (assumed to be the “true” or most accurate solution).

3.1.1. Recommended Insulation

Outcomes for the recommended insulation (to be added to the structure) should be assessed on the basis of the recommended insulation achieving a “just passes” result – ie, its Thermal Comfort result will be approximately the same as the Heating and Cooling Caps.

3.1.2. Thermal Comfort Assessment

Outcomes for the Thermal Comfort Assessment should be assessed against the Heating and Cooling Caps separately. (Note: The BASIX system does not process a total energy load or star band for determination of pass/fail, but has a split heating and cooling load test which must separately be satisfied.)

3.1.3. Energy Assessment

Outcomes for the Energy Assessment should be assessed against the Simulation value for the same dwelling, each expressed as annual MJ allowed for all other purposes.

4. METHODOLOGY FOR INTERIM CRITIQUE

A previous report (Energy Partners, 2005 A) showed that the DIY method gave vastly different results to the accepted simulation method using the NatHERS program. The subsequent report used an elemental process to determine where the DIY diverges from the accepted method. The method was divided into the following steps:

1. Compare results of basic house for different climates - Compare the thermal performance between the two methods for the original house using the simulation method (NatHERS) and the DIY method in a cool climate (Canberra), a mild climate (East Sydney), and a warm Climate (Byron Bay).
2. Test the impact of changing the external wall surface – done by splitting the house into two, creating an extra 42.7m^2 of external wall.
3. Vary the area of northern glazing (increase and reduce north-facing glass).
4. Vary the mass of the building by changing the floor construction from concrete slab on ground to timber with enclosed subfloor (keeping the brick veneer walls constant).
5. Reduce glazing area in each orientation in turn.
6. Test the effect of ventilation in relation to eave size. Vary eave width using dimensions of 0mm, 450mm, and 650mm.
7.

A simple single storey house with a rectangular shape, northerly orientation, and consistent 450mm eaves was used to limit the areas of inconsistency in the comparison. The house is of brick veneer wall construction with added insulation of R1.0, floor is an uninsulated concrete slab on ground, plasterboard ceiling with R3.0 insulation and roofing tiles with foil underneath. There are 3 bedrooms, and separate kitchen, living, dining, bathroom, toilet, and laundry rooms. The gross floor area of the house is 157m^2 of which 142.8m^2 is conditioned. It has a total gross wall area of 95 m² and a glazed opening area of 33.3 m² (giving a glazing ratio of 21% to GFA and 23% to NCFA).

This dwelling is one of the 6 archetypes used in the Cost Benefit Study (BRANZ and Energy Partners for ABCB and AGO, 2001) and approximates to the base house upon which the parametric NatHERS runs are applied to create the algorithms within FirstRate.

The added insulation for the two methods are shown below. The floor plans and elevations have been included on the following page.

Table 1. Insulation levels used in this study

	SIM NatHERS	DIY - Canberra	DIY - Sydney	DIY - Byron Bay
Floor	None	None	None	None
Ext BV walls	R1.00	R1.66	R1.16	R0.86
Ceiling	R3.00	R3.50	R2.50	R2.50
Roof	Foil	Foil	Foil	Foil
Windows	SG Aluminium	SG Aluminium	SG Aluminium	SG Aluminium

5. RESULTS

5.1. Base Design Results

The basic house (un-modified) was entered in to the BASIX program using the two methods of simulation (NatHERS) and DIY and the results are recorded in the table below.

Table 2. Insulation levels used in this study

Location (Postcode)	Method	Heating (MJ/m^2)	Cooling (MJ/m^2)	Cooling incl. CF Ventilation (MJ/m^2)	Heating Cap (MJ/m^2)	Cooling Cap (MJ/m^2)	Pass/Fail (BASIX)
Canberra (2600)	Simulation	287.2	33.1	29.1	273.5	55.7	Fail
	DIY	224	N/A	41.6	273.5	55.7	Pass
Sydney East (2000)	Simulation	73.6	50.8	38.1	97.1	57.7	Pass
	DIY	44.8	N/A	54.5	89.6	57.8	Pass
Byron Bay (2481)	Simulation	17.1	89	66.8	66.2	83.5	Pass
	DIY	31.9	N/A	85.1	63.8	83.5	Fail

5.2. External Wall Area

The impact of external wall surface area was tested by splitting the rectangular house into two (replacing the internal walls with external walls). This process added over $40m^2$ of external wall area to the modified design. Both the base house and the modified house were simulated in the three representative climates.

There is no entry for wall area in the DIY method, so the results remained identical no matter what the shape of the house. As expected, the results show that the simulation method recognises that having greater external wall surface area requires more heating in the cooler climates, and less in the warmer climates.

5.3. Northern Glazing

The area of north glazing was varied and the results recorded. The base design had 12.6m^2 of north-facing glazing. 10m^2 of north glazing was added to and subtracted from this base design to form 3 alternative north-glazing designs. In the simulation case, this was subtracted proportionally from the width of all windows on that face.

Reducing northern window area had a much larger effect on reducing the cooling load in the simulation method than in the DIY method for all 3 climates.

5.4. Thermal Mass

The effect of thermal mass in each method was analysed by replacing the concrete slab on ground in the base design with a timber floor and enclosed subfloor. The results of the simulation method show that both heating and cooling loads are substantially increased when the thermal mass is reduced. The DIY method results showed little to no response to changing the thermal mass of the building.

5.5. Reducing Glazing

This process removed the glazing area in each orientation in turn to test the effect in the two methods. Generally, the removal of the glazing caused greater reductions in cooling in the simulation method than in the DIY method, particularly in the North and West directions. In East Sydney and Canberra, the removal of Northern glazing increased the heating load in the DIY method more than in the simulation method. The removal of East, South and West glazing had no effect on the DIY heating load and small effects on the simulation heating loads.

5.6. Eave Length and Ventilation

To test the effect of ventilation in relation to eave size, the eave width was varied using values of 650 mm, 450 mm, and 0 mm. (The 650 mm version is selected as the equivalent of the range of 601-750 mm used in the DIY method).

In the simulation method (both AccuRate and NatHERS), heating decreased and cooling increased as expected when the eave lengths were reduced. In Canberra, reducing the eave width caused heating to *increase* (between 650 and 450 mm eaves) in the DIY method. The DIY heating load did not respond to changing between 450 mm and 0 mm eaves in the Sydney East climate. In Byron Bay, the eave length had no effect on heating in the DIY method[ii].

6. ACTUAL EVALUATION

The actual evaluation undertaken by the NSW Department of Planning was not based on analytical principles but using a methodology based on the proposition that DIY should be evaluated on the basis of ‘practical outcome’. The Department had decided that the nationally agreed and approved BCA benchmark of a 5 star minimum standard was inappropriate for housing in NSW. Consequently their evaluation of their DIY tool was based on their own assumptions of acceptable housing thermal performance based on heating and cooling annual loads (called “caps” in the jargon of BASIX). Whilst quite a good concept to pursue, it is one which is as yet not nationally agreed to nor strenuously tested. The actual evaluation therefore amounted to a critique of the well established deficiencies of 1st generation NatHERS, predominantly associated with ventilation in the warmer climates.

Any full evaluation of the “heating and cooling caps” concept would seriously analyse the potential for this constraint to reduce peak loads on the electricity and gas distribution systems in new housing[iii]. In doing so, this potential should be compared with the clear but untapped capacity of the simulation process to directly identify the peak loads for a house and the loads that it can impose at times of system peaks. Currently DIY appears as a barrier to this environmental and economic refinement when the BASIX concept has the ready potential to lead the nation in this respect.

Another marked failing of the evaluation was its inattention to other than the gross effects of climate. The DIY for each BCA climate zone was compared with the NatHERS results for just one archetypal representative for that BCA zone. It is not contended here that the archetypes were not well selected. We simply point out that if 8 archetypes are sufficient to evaluate Australian dwelling performance then the other eight jurisdictions have squandered a lot of resources in defining no less than 69 climates to cover the whole country reasonably well (Ridley and Boland, 2005), (Lee and Snow, 2006) and (Lee and Stokes, 2006) and soon to be expanded to 72. Any rigorous evaluation which would pass peer scrutiny if published would compare the DIY results for the range of actual climates within the BCA climate zones for which they each claim to be applicable. Further, any reasonable practice protocol seeking to maintain 'parity' between the DIY and simulation options would allow (until it was shown to be misleading) the simulation to be carried out in the equivalent archetypal climate rather than the real one wherever that was found to be of 'benefit' to the client (which, unless the client is to be the occupant, would generally mean that approval would be granted to a less environmentally sound design).

The unpublished report compiled by 'an independent expert', reviewed by a panel of industry stakeholders with very little understanding of thermal performance principles, showed not that the DIY tool was effective but that NatHERS needed to be improved. Indeed at the time of this evaluation, 2nd generation NatHERS software was being finalized and it is that software which should have been the evaluation tool. Even today, the NSW Department of Planning has failed to provide comparison of DIY to 2nd generation NatHERS (CSIRO's AccuRate and its emulators FirstRate-5 and BERS-Pro). It is this comparison which we believe will clearly demonstrate the failure of the DIY tool when evaluating other than the most basic of structures.

7. IDEAL METHODOLOGY FOR EVALUATION

7.1. Assess Against Nationally Agreed Protocol

The ABCB has published a software protocol (ABCB, 2005) which includes a section on "Development of simplified software for limited usage". Qualitatively compare the DIY with that set of Minimum features and Optional features and report.

7.2. Assess Logical Consistency

1. Assess the logic flow diagram of the DIY workbook to confirm that it conforms with current knowledge of the range of constructions and with building physics.
2. Use the audit functions within Excel to confirm that the Workbook follows the delineated logic.
3. Use a selection of iterative parametric changes to track the flow of calculations through the Workbook to confirm their consistency.
4. Report on the results.

7.3. Assess Empirical Outcomes in Core Climate Zone[iv]

If section 7.1 reveals scope for improvement agreed by DoP, those improvements should be implemented before initiating this empirical test.

1. Select an agreed sample of dwellings that have been already "rated"[v] in NatHERS and input their characteristics into the DIY.
2. Record the results for DIY.
3. Modify the NatHERS file to have the same insulation as the DIY recommendations and re-simulate and record the result.
4. Repeat for the other 5 core climate zones.
5. Compare the DIY and simulation results and statistically analyse the simulation results in terms of both star bands and MJ/m² to enable direct comparisons with neighbouring jurisdictions.

6. Report on the results including any recommended enhancements.

7.4. Assess Empirical Outcomes in Non-Core Climate Zones

7. Repeat for the 8 non-core climate zones.
8. Report on the results including any recommended enhancements.

7.5. Assess the Robustness of the Outcomes

In the event that the analysis in sections 7.3 and 7.4 reveals substantive failures relative to the validation criteria, sort the sample by selected constraint criteria and repeat the analysis within the constrained subset and report. Candidate subsets identifiable at this stage are as follows:

1. not more than 6 facades
2. not more than 2 levels
3. not more than 200 m² GFA (180 m² NCFA?)
4. not less than 100 m² GFA (90 m² NCFA?)
5. not more than 30% glass:floor area ratio (cf 50% in FirstRate)
6. not more than 20% glass:floor area ratio in one direction (cf 25% in FirstRate)
7. no novel constructions
8. no attached neighbours
9. no significant overshadowing by neighbours (the AGO sample set ignores this aspect)

7.6. Assess the Applicability of the Outcomes to 2nd Generation NatHERS

Due to the tight time frame originally proposed for this work, this “ideal” brief excludes any consideration of 2nd Generation NatHERS. It was, however, recommended that the validation processes adopted be repeated for the new regime at the earliest opportunity to maximize the acceptance of BASIX (including its DIY option) in other jurisdictions and to prepare for a smooth transition within NSW in May of 2006.

7.7. Required Information to be Supplied by DoP

The following information is required to ensure an efficient and cost effective analysis can be undertaken in the shortest practicable time:

7.7.1. To Assess Logical Consistency

1. A fully-enabled copy of the DIY Excel Workbook.
2. A logic flow diagram of the DIY workbook.
3. A copy of the record of corrections/enhancements since the beta version was first accessible to the public.
4. Access to key staff who developed and maintain the Workbook.

7.7.2. To Assess Empirical Outcomes

5. A list of the 6 NatHERS climate zones that DoP has selected as the Core Climate Zones.
6. Access to any empirical/comparative studies to internally validate the routines and factors within the Workbook.
7. Copies of any dwelling plans and results used to test the beta version (and any results from retesting on the version currently intended for launch and use for DA purposes.
8. A set of plans with their NatHERS files and/or results (could be some or all of the files created for AGO by Energy Partners representing 195 designs 41 of which are of NSW origin and most of which have uninsulated, ~DTS and thermally enhanced versions).

8. CONCLUSIONS AND PROSPECTS

BASIX presents as a 'technologically proficient and efficient' sustainability assessment tool. But is it? Perhaps the analogy that BASIX could be viewed similar to a game of cricket – the ball when it was new looked perfect but after a lot of overs perhaps someone should ask the umpire to inspect the ball. It may be that it should be replaced. Alas, it appears that the umpire is the bowler and no inspection is planned.

This Paper looks at one aspect of BASIX – thermal performance. The Department of Planning argues that the DIY tool delivers acceptable 'practical outcomes', but makes this assertion only on the basis of one 'expert' opinion and only when compared to a 1st generation NatHERS tool.

The expectation by the NSW Government that any unqualified person can competently and objectively complete the sustainability evaluation of a house is a flawed belief. Further, within BASIX many algorithms are judgmental, out dated and not consistent with today's energy efficiency understandings.

This Paper has looked in depth at one aspect of BASIX - that is thermal performance (called thermal comfort within BASIX). Our findings are that the simplistic DIY tool is not a device that can competently evaluate thermal performance of any other than a simple structure in an archetypal climate. The NSW Department of Planning should either remove the DIY tool from their BASIX scheme or, in the very least, limit its use to simple house designs and size to contain the potential it has for delivering to NSW the worst energy efficiency and thermal comfort in new housing in the whole country.

9. REFERENCES

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10. **RELEVANT CLIMATE ZONES** (INFORMATION ONLY)

For house energy evaluation and rating purposes, Australia has been divided into climate zones. For the purposes of the Building Code of Australia (BCA) and especially its Deemed-To-Satisfy (DTS) provisions, 8 zones was seen as sufficient. For simulation and energy rating purposes, further differentiation based on nodes of housing development was required and accordingly an updated and enhanced set of 69 climates was generated in the format of the Australian Climate Data Bank (ACDB).

10.1. BCA Climate Zones

Areas of NSW fall within 6 of the 8 BCA climates zones (all except CZ01 - Hot Humid Summer, Warm Winter Zone and CZ03 - Hot, Dry Summer, Warm Winter Zone).
A description of each BCA climate zone and the definition used by BOM to guide the setting of its boundaries are as follows:

10.1.1. CZ01 - Hot Humid Summer, Warm Winter Zone

- average January max temp >= 30°C[vi]; and
- average 3 pm January water vapour pressure >= 2.1 kPa[vii]

10.1.2. CZ02 - Warm Humid Summer, Mild Winter Zone

- average January max temp <= 30°C; and
- average 3 pm January water vapour pressure >= 2.1 kPa

10.1.3. CZ03 - Hot, Dry Summer, Warm Winter Zone

- average January max temp > 30°C;
- average 3 pm January water vapour pressure < = 2.1 kPa) ; and
- average July mean temperature > = 14°Celsius (no heating is required if the mean temp in coldest month is above 15°C).

10.1.4. CZ04 - Hot, Dry Zone With Cool Winter

- average January max temp > 30°C;
- average 3 pm January water vapour pressure <= 2.1 kPa) ; and
- average July mean temperature < = 14°Celsius

10.1.5. CZ05 - Warm Summer, Cool Winter (Warm Temperate Zone)

- average January max temp <= 30°C;
- average 3 pm January water vapour pressure <= 2.1 kPa; and
- average annual heating degree days[viii] <= 1,000, using base 18°C

10.1.6. CZ06 – Mild To Warm Summer, Cool-Cold Winter (Mild Temperate Zone)

- average January max temp <= 30°C;
- average 3 pm January water vapour pressure <= 2.1 kPa) ; and
- average annual heating degree days 1,000 to 1,999, using base 18°C (this is the thresh-hold where edge insulation of concrete slabs becomes cost-effective).

10.1.7. CZ07 – Mild To Warm Summer, Cold Winter (Cool Temperate Zone)

- average January max temp <= 30°C;
- average 3 pm January water vapour pressure <= 2.1 kPa) ; and
- average annual heating degree days >= 2000, using base 18°C (this is the thresh-hold where edge insulation of concrete slabs becomes cost-effective.)

10.1.8. CZ08 - Alpine

- a subset of the Mild To Warm Summer, Cold Winter (Cool Temperate Zone).
- taken as areas with an elevation above 900m in Tasmania and 1200 metres on mainland Australia.

10.2. Current (1st Generation) NatHERS Climate Zones

Table 1 Current NatHERS Climate Zones (emphasizing the 14 relevant to NSW)

Climate zone	Location	Year	Heating thermostat setting (°C)	Cooling thermostat setting (°C)
1	Darwin	71	20	28
2	Port Headland	79	20	28
3	Longreach	72	20	28
4	Carnarvon	81	20	28
5	Townsville	80	20	27
6	Alice Springs	72	20	28
7	Rockhampton	76	20	26
8	Moree	79	20	27
9	Amberley	79	21	27
10	Brisbane	86	21	27
11	Coffs Harbour	79	21	26
12	Geraldton	72	21	27
13	Perth	74	21	26
14	Tamworth	66	20	27
15	Williamtown	74	21	26
16	Adelaide	87	21	26
17	Sydney	85	21	26
18	Nowra	87	21	26
19	Cloncurry	69	20	28
20	Wagga	70	21	26
21	Melbourne	79	21	26
22	East Sale	87	21	26
23	Launceston	83	21	26
24	Canberra	86	21	26
25	Alpine	80	20	25
26	Hobart	79	21	26
27	Mildura	70	21	27
28	Richmond (West Sydney)	85/86	21	27

10.3. Proposed (2nd Generation) NatHERS Climate Zones

Table 2 ACDB Climate Zone Locations within NSW (continuing, new and deleted)

<u>**New South Wales**</u>	
Cobar AMO	
Coffs Harbour MO	
Mascot AMO	
Moree MO	
Nowra RAN	
Orange AP	
Richmond	
Sydney RO	
Wagga AMO	
Williamtown AMO	
Armidale	Included for high elevation tablelands
Cabramurra	Alpine open upland site
Dubbo Airport	Included for Central West NSW
Thredbo Village	Alpine valley site
	Lord Howe Island deleted due to prioritisation
	Tamworth AMO deleted because of unreliable data

Table 3 ACDB Site List Ordered by BCA Climate Zone and Latitude (emphasizing the 22 of relevance to NSW)

No.	ACDB name	State	Longitude	Latitude	Climate Zone
1	Darwin	NT	130.842	-12.462	CZ0101
2	Weipa	QLD	141.884	-12.632	CZ0102
3	Wyndham	WA	128.122	-15.488	CZ0103
4	Willis Island	QLD	149.983	-16.983	CZ0104
5	Cairns	QLD	145.768	-16.915	CZ0105
6	Broome	WA	122.236	-17.962	CZ0106
7	Townsville	QLD	146.801	-19.265	CZ0107
8	Pt Hedland	WA	118.601	-20.310	CZ0108
9	Learmonth	WA	114.081	-22.241	CZ0109
10	Mackay	QLD	149.184	-21.148	CZ0201
11	Rockhampton	QLD	150.501	-23.365	CZ0202
12	Gladstone	QLD	151.251	-23.832	CZ0203
13	Brisbane	QLD	153.018	-27.465	CZ0204
14	Amberley	QLD	152.714	-27.636	CZ0205
15	Coffs Harbour	NSW	153.118	-30.315	CZ0206
16	Halls Creek	WA	127.668	-18.227	CZ0301
17	Tennant Creek	NT	134.191	-19.650	CZ0302
18	Mt Isa	QLD	139.485	-20.715	CZ0303
19	Longreach	QLD	144.234	-23.432	CZ0304
20	Newman	WA	119.730	-23.358	CZ0305
21	Alice Springs	NT	133.868	-23.699	CZ0306
22	Carnarvon	WA	113.660	-24.890	CZ0307
23	Charleville	QLD	146.251	-26.398	CZ0308
24	Giles	WA	128.300	-25.031	CZ0401
25	Meekatharra	WA	118.497	-26.591	CZ0402
26	Oodnadatta	SA	135.450	-27.550	CZ0403
27	Moree	NSW	149.835	-29.465	CZ0404
28	Kalgoorlie	WA	121.470	-30.750	CZ0405
29	Forrest	WA	128.100	-30.850	CZ0406
30	Woomera	SA	136.813	-31.165	CZ0407
31	Cobar	NSW	145.835	-31.498	CZ0408
32	Dubbo	NSW	148.601	-32.248	CZ0409
33	Katanning	WA	117.555	-33.691	CZ0410
34	Mildura	VIC	142.157	-34.193	CZ0411
35	Wagga	NSW	147.368	-35.115	CZ0412
36	Oakey	QLD	151.716	-27.433	CZ0501
37	Geraldton	WA	114.615	-28.779	CZ0502
38	Perth	WA	115.974	-31.928	CZ0503
39	Swanbourne	WA	115.760	-31.957	CZ0504
40	Bickley	WA	116.091	-32.008	CZ0505
41	Ceduna	SA	133.675	-32.127	CZ0506
42	Mandurah	WA	115.723	-32.529	CZ0507
43	**Williamtown**	**NSW**	**151.843**	**-32.815**	**CZ0508**
44	Esperance	WA	121.892	-33.861	CZ0509

No.	ACDB name	State	Longitude	Latitude	Climate Zone
45	Mascot (Sydney Airport)	NSW	151.188	-33.900	CZ0510
46	Sydney RO (Observatory Hill)	NSW	151.210	-33.865	CZ0511
47	Adelaide	SA	138.599	-34.928	CZ0512
48	Richmond	NSW	150.768	-33.598	CZ0601
49	Manjimup	WA	116.148	-34.249	CZ0602
50	Nowra	NSW	150.601	-34.882	CZ0603
51	Albany	WA	117.884	-35.017	CZ0604
52	Mt Lofty	SA	138.700	-35.000	CZ0605
53	Tullamarine (Melbourne Airport)	VIC	144.842	-37.675	CZ0606
54	Mt Gambier	SA	140.780	-37.824	CZ0607
55	Melbourne RO	VIC	144.976	-37.818	CZ0608
56	Moorabbin	VIC	145.095	-37.975	CZ0609
57	East Sale	VIC	147.117	-38.100	CZ0610
58	Warrnambool	VIC	142.484	-38.384	CZ0611
59	Cape Otway	VIC	143.500	-38.900	CZ0612
60	Armidale	NSW	151.665	-30.515	CZ0701
61	Orange	NSW	149.098	-33.274	CZ0702
62	Canberra	ACT	149.201	-35.315	CZ0703
63	Ballarat	VIC	143.854	-37.560	CZ0704
64	Low Head	TAS	146.800	-41.067	CZ0705
65	Launceston (Ti Tree Bend)	TAS	147.140	-41.440	CZ0706
66	Launceston Airport	TAS	147.200	-41.500	CZ0707
67	Hobart	TAS	147.323	-42.882	CZ0708
68	Cabramurra	NSW	148.485	-36.015	CZ0801
69	Thredbo (Village)	NSW	148.439	-36.535	CZ0802

[i] DIY actually emulates NatHERS in estimating the thermal demand (heat required to be added to or removed from the dwelling to maintain defined comfort levels during defined hours). To estimate the dwelling's "consumption" these values would need to be adjusted to account for appliance efficiency (eg, divided by 0.61 for conventional ducted gas heating).

[ii] Note that the Heating and Cooling Caps are the same for NatHERS and AccuRate in line with the protocols of the NSW pilot use of AccuRate now underway. Accordingly, the Heating and Cooling values (MJ/m².a) reported for AccuRate are not those output by the software directly but rather those outputs adjusted to their "NatHERS equivalents" in accordance with the draft ratios prepared by Arup (2005) (in association with Energy Partners) for the AGO to allow AccuRate results to be used in the current version of BASIX which remains "calibrated" for NatHERS outputs.

[iii] The BASIX proponents rationalize this as requiring 'seasonally balanced design' rather than achieving any particular and quantifiable environmental or economic outcome.

[iv] The Core Climate Zone is the NatHERS Climate Zone nominated by DoP to calibrate the DIY for each of the 6 BCA Climate Zones.

[v] The file sample held by AGO was created using input protocols agreed to minimise the interpretation differences between the three software packages. Hence the NatHERS file will not necessarily be identical to one generated by a NSW Accredited Assessor for BASIX. If these files are to be used they should be checked and modified as necessary to be "rating compatible".

[vi] A temperature of 29.5°C has been suggested by Australian research as the upper limit for thermal comfort.

[vii] This is about the upper humidity limit for comfort. The American Society of Heating, Refrigeration and Airconditioning Engineers (ASHRAE) uses 1.87 kPa. It also coincides most closely with the 24°C wet-bulb isotherm, which determines where evaporative cooling starts to have some effect.)

[viii] definition supplied for Glossary