Submission to Productivity Commission Public Enquiry into Energy Efficiency

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This submission addresses mainly Section 7.8 *Minimum energy efficiency standards for new Dwellings* of the draft report and comments made in relation to my previous submissions.

The Commission has been accused by several critics of placing too much weight on my previous submissions (in particular #28) and to have therefore drawn invalid conclusions. To the extent that my evidence is being read and interpreted as an definitive statement of the failure of present regulations (including HERS), I concur with this observation. My intention was not to present conclusive data, rather to demonstrate the paucity and inconsistency of existing evidence that may inform the development of effective nationwide regulations (including HERS) aimed promoting the energy-efficiency of residential buildings.

What may be construed as elements of a thesis contained in the submission #28 are linked to the question, "what evidence exists to demonstrate a causal connection between the construction elements of a dwelling (eg thermal insulation, materials, shading, etc) and relevant aspects of energy-efficiency?" similarly "what evidence exists to demonstrate the integrity of NatHERS (and related) HERS".

The general conclusion made in the submission is that "There is little or no evidence to show that energy efficiency standards and regulations (including HERS) will be in any way effective." That is, there little or no evidence that the objectives established for these standards and regulations will be met. Critics have sought in the main to reinterpret the evidence I presented to demonstrate that the existing regulatory environment operates satisfactorily rather than produce new robust evidence of effectiveness. There appears, for example, to be no research done that looks at the actual energy efficiency of actual rated houses. Student work and case studies presented in #28, while obviously limited, were undertaken to explore issues rather than give definitive answers.

I am particularly alarmed by the belief expressed, for example, by the Moreland Energy Foundation Ltd who say, *"MEFL understands that Tony Isaacs has put together a comprehensive response to the evidence of Dr Williamson. We fully support the report that he has compiled as coming from a person very well regarded in the industry. We note that he has shown that Williamson's case studies demonstrate how well the simulations are actually describing reality."* (MEFL DR#115 p10) I totally reject such a statement.

Energy efficiency policies (and regulation) embody and reinforce ideas about normal and acceptable practices and standards of daily life. Case studies (including those presented in #28) are a valuable method of studying the actual performance of buildings in comparison to theory that inform the regulation instruments. The case studies presented suggest that the constructions that inform current regulation do not accord with actual practice. Comments on the case studies have attempted to frame the results within a fixed techno-economic paradigm, rather than seeing them as reflections of case by case combinations of physical, material and social circumstances and understanding the policy implications of this reality.

I find that the draft findings 7.2 & 7.3 are self evident and do not require recourse to data to be shown to be correct. I would add a further finding (again self evident) - that a lack of clarity in the objectives expressed in the BCA energy-efficiency provisions result in a confusion of means to ensure effective outcomes are achieved.

In light of the lack of substantial evidence regarding the effectiveness of BCA regulations and associated HERS, the recommendation of the Commission that "*New or more stringent energy*

efficiency standards for residential buildings should not be introduced until existing standards have been fully evaluated." appears eminently sensible.

Brief Comments on Submissions

Submissions ICANZ/Isaacs DR#94, Alan Pears DR#113 and MEFL DR#115 make overlapping comments of my submission #28. Because most critical comment has focused on just two aspects of submission #28, "The Adelaide (Student) Studies" and the "Case Studies" I will concentrate on these and offer the following observations.

The ICANZ/Isaacs DR#94 submissions says,
"*Dr. Williamson's central thesis is that policy should be based on evidence and that there is no evidence to suggest that the application of an energy rating which simulates annual energy loads will result in lower actual energy consumption.*"

and elsewhere
"*….Williamson's central thesis (is) that a regulation based on simulated loads will not save energy*"

These are misconstructions of my submission #28 and a narrow interpretation of my intentions.

In addition although there is a lack of clarity in objectives, it does seem clear that saving energy *per se* is not an objective of the BCA.

HERS

A contention put by the ICANZ/Isaacs submission DR#94 is that *"the application of an energy rating which simulates annual energy loads will result in lower actual energy consumption"* and/or *"….a lower heating and cooling load predicted by NatHERS WILL on average lead to a reduction in actual consumption."* The main argument is that, in fact, the data I presented demonstrates this. If this is the impression given then it must be a problem with my explanation because the data does not in any way show this. I will (re)present the data in an attempt to (hopefully) clarify this misconception.

The question that can be asked from the research data gather in the "Adelaide Study" is "does the ranking (and therefore rating) of houses based on simulated energy loads correlate statistically to the ranking of houses derived by observation of actual energy consumption (or greenhouse gas emission)". If the answer is no, then the simple corollary is that the policy instrument must be further investigated because it may be ineffective. As shown in Figure 1, the NatHERS Energy Load (MJ/m2) being the basis on which buildings are rated at present, exhibits no significant correlation with Actual Heating & Cooling Energy Consumption (MJ) in these cases.

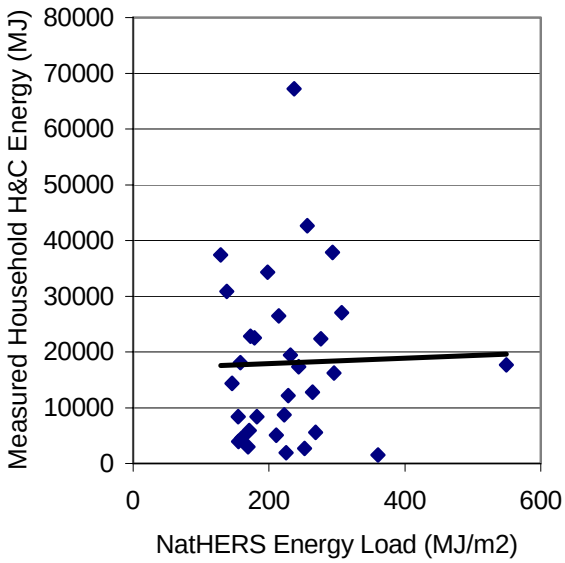

Figure 1: NatHERS Energy Load (MJ/m^2) vs Total Household Consumption for Heating & Cooling (MJ)

Note: N=31, R2=0.0007, p>0.8

Even the ICANZ/Isaacs submission acknowledges that this result is expected and says, *"NatHERS estimates the annual net energy flows through the building envelope under specified usage patterns.…This is not (and is not intended to be) directly related to the energy used by heating and cooling appliances to maintain comfort…."* (Hence draft finding 7.2)

More telling however, and as shown in Figure 2, CO2-e emissions due to heating & cooling did not correlate to the NatHERS Energy Load. Reducing greenhouse gas emissions by efficiently using energy, the objective of the BCA energy-efficiency provisions, is not demonstrated by application of the rating scheme.

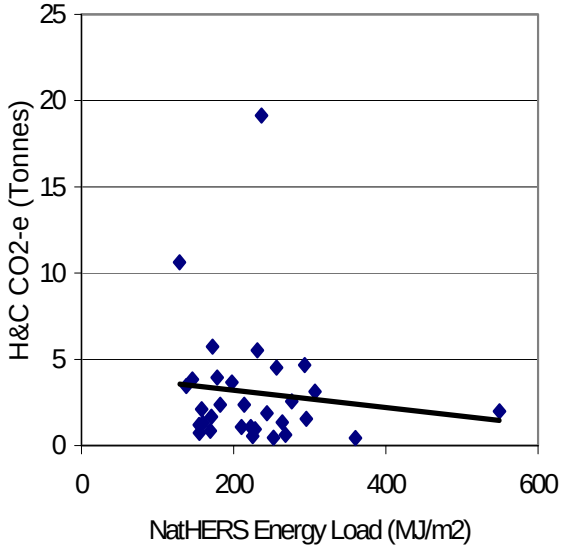

Figure 2: NatHERS Energy Load (MJ/m^2) vs Total Greenhouse Gas Emission for Heating and Cooling (Tonnes)

Note: N=31, R^2=0.013, p>0.50

The fact that the a small correlation was found between an Equivalent NatHERS Heating & Cooling Energy (that is, from the energy loads and knowledge of appliances, calculating an imputed energy consumption) and Measured Heat & Cooling Energy Consumption as shown in Figure 3 provides NO evidence (or encouragement) that the rating scheme, as presently constituted, will be effective. All this results indicates is that there is perhaps hope, that with substantial modification to the scheme to include appliance efficiencies, a match can be found between the rating measure and household energy consumption of an extended population of households. In addition, subsequent evaluation of the same data normalised by conditioned floor area, shows no significant correlation (R^2=0.070,p=0.15) indicating that the observed relationship may actually be spurious.

Further the ICANZ/Isaacs submission suggests that, if so called outliers are removed, then the correlation improves. Such a manipulation of the data has no foundation. Outliers should only be removed with knowledge that the sample is not representative of the larger population. No such knowledge exists.

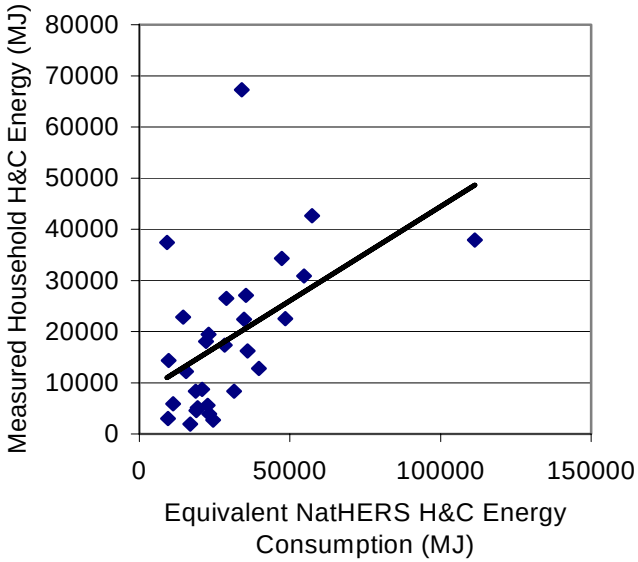

Figure 3: Equivalent NatHERS Energy Consumption vs Actual Energy Consumption
Note: N=31, R^2=0.185, p<0.05

The ICANZ/Isaacs statement *"…Williamson's own research suggests that a lower simulated load would lead to lower actual consumption (and) these modifications would benefit the current occupants in terms of even lower energy consumption or improved comfort*" is entirely incorrect.

However, while this "controversy" rages, a more fundamental question is being ignored. We can ask "is this single piece of evidence, produced by two students as part of an honours thesis, sufficient to inform the operation of a significant plank of national energy policy?" Hardly, but unfortunately it is about all we have.

The Building Fabric

"*Williamson's submission…. suggests there is no data linking energy consumption with the building fabric*" (ICANZ/Isaacs DR#94 np)

This assertion is simply wrong and again a misconstruction. My submission gives numbers of instances of links between building fabric and energy use (see for example Figure 1 and Tables 1 & 2). The point is, that the data pointing to such links are *often counter intuitive, often confounding and are often inconclusive.* The research results quoted in the ICANZ/Isaacs DR#94 submission (Gas & Fuel Corporation and Tasmanian research) fall precisely into these categories. These research examples, included only heating (no account was taken of cooling), both examples are from cold climate regions and they include only a limited range of heating appliances, etc.

Taken as a whole the present body of research evidence cannot be relied upon to sensibly inform the effectiveness of the national energy-efficiency regulations.

Case Studies

A claim by the Moreland Energy Foundation Ltd (MEFL DR#115 p11) says,
"We also note that the PC has bent it's own rules, by allowing the inclusion of energy conservation which is the practice described by Williamson of the householders achieving low energy bills. We ask for consistency, either allow energy conservation to be reviewed as part of the report or drop this evidence as being irrelevant." Pears (DR#113 p17-18) makes the same point, "*the case studies Williamson refers to seem to involve a significant element of energy conservation rather than energy efficiency*".

My initial submission #28 described in some detail various meanings that could be given to energy-efficiency in the context of buildings. While occupants in the case study houses did indeed achieve energy conservation, suggestions that the occupants were not engaged in efficiency practices is ridiculous. For instance, if efficiency is expressed in physical-thermodynamic terms as the ratio of satisfaction (output) and energy consumption (input) then each household achieved a high level of efficiency.

Kawanda Muna case study

I am indebted to my colleague Dr Veronica Soebarto for providing the following comments on ICANZ/Isaacs submission DR#94 that addressed the case study house Kawanda Muna in the Adelaide Hills. Dr Soebarto conducted the post-occupancy research on this house.

She writes,

"Before responding to the specific issues in the submission by ICANZ/Isaacs, it is important to note that any comment to the paper, "A LOW-ENERGY HOUSE AND A LOW RATING: WHAT IS THE PROBLEM?" (ANZAScA 2000 Conference Proceedings, pp. 111-118) must be situated within the context of the time in which the paper was written and what the actual paper was about.

As stated in the abstract, the main objective of the paper "A LOW-ENERGY HOUSE AND A LOW RATING: WHAT IS THE PROBLEM?" is to "explore the question whether rating the energy performance of a design is the right way to achieve environmentally sustainable development." Further, "The actual performance of a built and occupied house is compared to the predicted performance by a rating scheme. The house performance was examined through site visits, interviews with the architect and occupants, monitoring, simulation, and analyses. The Nationwide Home Energy Rating Scheme (NatHERS) was then used to see how the house would "rate" according to the scheme. The results show that although in reality the house

performs reasonably well in terms of its comfort conditions, energy use and environmental impact, it receives a very low rating when examined with NatHERS. The paper questions the utility of the scheme, analyses some of the problems and suggests that the whole concept in the current rating scheme be re-examined**."** It should be clearly noted that the paper was written in 2000, when the scheme was not able to rate a free-running building, and when the use patterns in the tool used could not be modified. This is stated in the Discussion section "Unfortunately due to the limitation of the scheme, this house was forced to have an air-conditioning system to be rated by NatHERS. Further, it was penalised to have a zero rating because the occupancy patterns, "thermostat settings" and shading conditions could not be altered." The conclusion stated "Further, in the author's point of view, rating the energy (or environmental) performance of a house design will not guarantee that when built the house will actually have a low operating energy. A number of previous studies have shown that actual energy performance depends on the way the occupants "use" the building and does not necessarily relate to the building design (for example work by Ballinger et al. 1991, Haberl et al. 1998). Therefore, unless ratings by NatHERS are followed by post-occupancy assessments, the author doubts that there will be a significant decrease in the greenhouse gas emissions from the housing industry. The author appreciates the efforts to develop a scheme whose intention is to help reduce the greenhouse gas emissions in Australia. However, based on this investigation it is clear that it is now the time to evaluate the scheme before it becomes a national policy and sends a wrong message to the general public."

Specific responses to ICANZ/Isaacs Submission DR#94

The ICANZ/Isaacs submission presents a number of misinterpretations of the paper:

"In this paper it is explained that after they moved in [presumably after the house energy rating was carried out] the owners have modified the house to reduce heat losses through the windows by applying a shrink wrap film to the window frames to, in effect, create double glazing, have installed weather strips to reduce air leakage and added external shading to reduce heat gains in summer." and further "The modifications made to the house by the owners suggest it was not energy efficient as originally constructed".

1. The owner, the late John Smith (passed away in November 2004), installed the shrink-wrap not because of the result of the house energy rating. Initially the architect suggested the use of double-glazing; however, this was beyond Mr Smith' budget. After they moved in, Mr Smith wanted to experiment using the shrink-wrap to create the double-glazing effect to improve the performance (by reducing heat loss). He wanted to know if he could get a double-glazing effect with much lesser price[1]. That was the main intention of installing this shrink-wrap, not because he was dissatisfied with the house[2]. We monitored the house when the shrink-wrap was installed (ie. after the paper was published) but we could not see clearly whether there was any improvement in the glazing performance. The occupants still used the slow-combustion heater every now and then (because they wanted to) and therefore the reading of the indoor temperature did not show any clear indication that the shrink-wrap made any impact.

[1] Mr Smith was an environmentalist. He also collected used/recyclable materials for years. He liked to experiment using used or cheap materials if he could. A lot of the building materials or components of the house are recycled/used materials.

[2] Similarly, he put the 'trombe wall' to experiment, not because the house did not have enough mass or due to any other reasons.

2. The paper does not mention anything about installing "weather strips to reduce air leakage and added external shading to reduce heat gains in summer". As a matter of fact, recall any additional external shading installed.

"It suggests that the performance of the house DID NOT initially meet the expectations of the owners. Importantly, this means that data collected on performance, as well as comments by the occupants, relate not to the house 'as rated' but to an improved house".

1. At no stage during interviews or contact over a lengthy period did the occupants ever indicate that the performance of the house did not meet their expectations. On the contrary, the occupants did not seem bothered when I indicated that the house seemed to be a bit warm in summer, based on the monitored data.
2. It is not clear what is meant by "…relate not to the house 'as rated' but to an improved house." The rating was done with the house in the same condition as when it was monitored. This did not include the shrink-wrap because the shrink-wrap had not been installed during the monitoring period reported in the paper.

"Furthermore, simulations using an alternative simulation software tool showed the house to be "warm and uncomfortable (based on the standardised human comfort range)" (page 18)

1. ICANZ/Isaacs has clearly misread the paper. There is nowhere that states the simulation result indicated that the house was "warm and uncomfortable". The real statement from the paper is: "However, it seems that the effectiveness of the mass was reduced by the amount of north facing glass which made the indoor temperature reach around 30° C when it was 35° C outside. During the monitoring period no blinds were used even though they were already installed. Using the simulation to analyse the problem, it was predicted that the north facing glass, although shaded from direct solar radiation, still conducted heat as well as admitted reflected heat from the ground." The simulation was conducted to find out what components of the building that may have caused the temperature to reach 30 degrees, and not to predict whether the house was comfortable or not.

2. Further, the actual statement in the paper is: "This result, however, poses an interesting question. Is a house that seems to be warm and uncomfortable (based on the standardised human comfort range) truly uncomfortable for the user?"

"Based on estimates of wood consumption by the owner the annual energy use for heating is found to be 16.5 GJ. Occupants report that they heat only at night. By contrast NatHERS predicted 39 GJ heating per year.13 Given that occupants heat only at night and heat only the living areas it is reasonable to halve the energy use predicted by NatHERS. In this case NatHERS appears to have predicted the heating load successfully once occupant use is accounted for."

1. ICANZ/Isaacs misquotes the value as reported in the paper or used a wrong figure to compare with NatHERS' prediction. The estimated actual **heating energy** is 16.5 GJ, but since NatHERS only predicted the "heating load" and **not** heating energy, we should not compare the actual heating **energy use** with NatHERS' predicted heating **load**. The paper therefore suggested a better way, and that is (page 116) "assuming that the efficiency of the slow combustion heater was 75%, the actual heating load was only 11.5 GJ." In other

words, even if we halve the heating load predicted by NatHERS (to be 19.5 GJ) it would still be almost double the actual heating load.

2. The point that the paper was trying to make was clear. “Unlike the houses which NatHERS is intended to rate for, this house was designed to not use any mechanical heating and cooling systems. Thus logically this house should have, and it indeed has, less environmental impact compared to any air-conditioned house no matter how energy efficient the air-conditioning system is. Unfortunately due to the limitation of the scheme, this house was forced (conceptually) to have an air-conditioning system to be rated by NatHERS. Further, it was penalised to have a zero rating because the occupancy patterns, "thermostat settings" and shading conditions could not be altered.” (page 117).

3. It should be clearly noted that the paper was not arguing whether the NatHERS simulation engine was or was not doing the right prediction. The paper’s objective was to point out that the NatHERS (in the year 2000 version) should not fix the occupancy patterns and thermostat settings so that houses with different use patterns, heating/cooling needs and operation, thermostat settings, etc., can be rated more accurately.

Finally, all the conclusions by ICANZ/Isaacs are false because they are constructions built on false or misconceived information.”

The Possible Future Occupant

Pears (DR#113 p18) says,
“…if those householders sell their homes (which happens on average, every few years), will future occupants make the same choices regarding tolerance of discomfort? Indeed, will the original occupants hold the same views when they have young children, or as they age?”

The issue of designing and building now for the future is raised in several submissions. While it is generally conceded that “present” occupants may be responsible, the question of a possibly less savvy and less responsible unknown and future occupant is often put as a justification for energy-efficiency building regulation; in particular requiring an “energy-efficient” envelope.

Since we cannot be sure of the needs and preferences of future occupants (the near future and especially the distant future) our best attempts now at energy-efficient designs may be overturned in the future. Needs and preferences in a market driven world can be manufactured by advertising campaigns. For example, buildings originally designed in the 1970s to operate on passive solar principles without air-conditioning may now have air-conditioning installed and can be said therefore to be less efficient. This is not because they didn’t operate effectively in the first place, but because the preferences of the occupants have changed. These preferences are formed in a complex environment of cultural and social practices, technologies, available resources, etc. The view of the occupant as a consumer who needs to be protected from themselves is fundamentally limited. As Shove (2003) suggests “Over the longer run, the technical efficiency of specific devices is much less important than the symbolic relationship between the technologies of indoor climate control, modernity and new, consumption-intensive, concepts of comfort.”

A meaningful method of Mandatory Disclosure of Energy Performance of Residential Buildings would do a lot to ensure prospective future owners/tenants are made aware of the likely implications of occupancy.

The Question of Comfort

"*The results of monitoring presented in the paper show that these houses spend a substantial amount of time outside the ASHRAE comfort zone (the internationally accepted conditions desired for comfort by most people)*".(ICANZ/Isaacs DR#94)

This statement displays a lack of appreciation of the contemporary understandings of the nature of thermal comfort. A recent discussion of this appreciation is provided by Chappell and Shove (2003). They detail three different understandings of thermal comfort as,

- comfort as a fixed and natural condition (exemplified by the ASHRAE approach)
- comfort as a process of adaptation
- comfort as socially constructed

In describing the policy implications of these understandings they say,

"To date, much environmental policy directed towards the home has focused on changing the behaviour of end-users and on overcoming barriers to the uptake of greener practices utilising a mix of market and information-based instruments and technical fixes. In the field of thermal comfort research this individualistic orientation resonates with the idea of comfort as a fixed condition the demand for which can be met by more or less efficient means. An adaptive school of thought sees domestic sustainability as dependent on the creation of carefully constructed opportunities for people to exercise control over their thermal environment and for choosing natural as opposed to artificial means of heating and cooling. Here account is taken of the dynamics of comfort and of variations in consumer expectation but the underlying assumption is still one of finding ways of achieving comfort and meeting needs rather than questioning the basis on which current norms of heating or cooling are constructed.

More socio-culturally inspired understandings of relations between the environment and the home require approaches that explore opportunities for the long-term transformation of expectation, convention and need. This is perhaps more tricky in terms of policy-making, but a good starting point is to look both forwards and backwards. One useful exercise is to examine and catalogue different (thermal) expectations between cultures and contexts and explore their origins. This will ensure that localised but sustainable ways of making or maintaining comfort needs are retained and do not lose out as understandings of comfort converge globally. Another approach is to think ahead about how the future of comfort is being specified today by planners, building scientists, architects, utilities and manufacturers. Here the aim is to find ways to stop unsustainable expectations taking hold…" (Chappells & Shove 2003 p..)

To examine temperature readings or computer output and pronounce a building comfortable or not comfortable related to standardised thermal comfort conditions, acts to institutionalise both comfort and lifestyles. Taking a big picture view concerning visions of sustainability around which policies promoting energy-efficiency revolve, this is exactly the wrong way to progress.

References

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