Submission to Productivity Commission Public Enquiry into Energy Efficiency

Comments on Section 7.8 of the Draft Report

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1. The concept of energy efficiency as it applies to building envelopes

The term "energy efficiency" is used extensively in section 7.8 when discussing the envelopes of residential buildings (as distinct from the appliances contained within them, the efficiency of which is covered in earlier sections of the report). In the Overview (pXXI) the report distinguishes between efficiency and conservation measures. Yet section 7.8 often equates, or appears to equate, ***energy efficiency*** with ***energy consumption***. This submission contends that they are two different things.

The energy efficiency of a building envelope is in fact rather difficult to define, as shown in the discussion by Dr Williamson (submission 28, pp5-6), who noted that "In the context of the BCA no understanding of energy-efficiency has been defined and the notion is therefore ambiguous and contested".

The fact that the term "actual energy efficiency" is also often used strongly suggests that what is meant is "actual energy consumption". Examples with commentary follow.

P144, para. 2: "*In contrast, energy efficiency under the Building Code is*

- *simulated, rather than measured directly*
- *defined in terms of a variable that is not an indicator of energy consumption.*"

The implication of the second dot point is that a variable that ***is*** an indicator of energy consumption (presumably secondary energy) would be a suitable indicator of energy efficiency. If secondary energy consumption is indeed meant, then such a variable is in fact not suitable, as shown by the heating example below.

P145, para. 5: "*If Dr Williamson's observations are correct, then simulated energy performance may not be an accurate indicator of actual energy efficiency*".

Simulated energy performance based on heating and cooling loads will not in general be an accurate indicator of actual (secondary) energy consumption, if only because of differences in appliance efficiency. It does not follow that it is not useful for ranking building envelopes.

Attachment 1 of Dr Williamson's submission (sub. 28) indeed demonstrates, for a sample of 31 Adelaide houses, the lack of correlation between energy loads obtained

from the NatHERS software and measured secondary energy consumption (e.g. figures 4 or 6). Yet once the NatHERS loads are factored by the appliance efficiencies, the correlation is surprisingly good (figure 7), given that other factors that determine energy consumption are not controlled for. This result must not be misinterpreted as being an argument for including appliance efficiencies in an assessment. Rather, it shows that once the variability due to appliance efficiency is removed, the NatHERS–based ranking of the houses does correspond, to some extent, to how the houses would have been ranked on the basis of energy consumption if they all had had the same appliance efficiencies. The fact that the houses rank differently on the basis of actual secondary (metered) energy consumption is simply a red herring caused (to some extent) by differences in appliance efficiencies.

P147, para. 2: "*In essence, policy makers have sought to isolate the impact of a building's design and physical location from the many other factors that affect its energy efficiency, such as householder behaviour, appliance efficiency, whether heating and cooling equipment are installed, and inter-year variability in climate.*"

P147, para. 3: "*Given that simulated energy loads exclude many of the determinants of building energy efficiency…*"

It is clear that in these two statements "energy efficiency" should be replaced by "energy consumption". Otherwise how can appliance efficiency, for example, have any bearing on the performance or efficiency (however defined) of the building envelope?

Consider two identical houses, occupied by identical families, with one heated by a gas heater (seasonal efficiency of say 0.7), and the other by a reverse-cycle heat pump (seasonal efficiency of say 3.0 – the actual values are not critical, except that they are very different). The metered energy consumption of the gas-heated house will be about 4.3 times (3.0/0.7) greater than that of the heat pump-heated house, but does that make it 4.3 times less efficient? It is hard to see how it could, given that the occupants and envelopes are identical. **Simply including the appliance efficiency in the assessment of these two buildings leads to an absurd outcome**.

(Note also that while the secondary energy consumptions may differ by a factor of 4.3, the energy costs to the householders will not differ by this factor because of the difference between the price of gas and electricity. Furthermore the primary energies or greenhouse gas emissions will also not differ by this factor).

Similar arguments can be applied to the other factors mentioned:

- Householder behaviour: householders who choose to heat to say 18°C instead of 20°C, or who are often out, will presumably use less energy, but can we conclude that the building envelope is more efficient?
- Presence of heating and cooling equipment: no equipment equals zero energy consumption, even though the building may be extremely uncomfortable – does that make the building envelope more efficient?
- Inter-year variability in climate: a very mild winter may result in lower heating energy consumption, but does that make the building envelope more efficient?

The answer is always no – the factors listed have little or no bearing on the performance (or efficiency) of the building envelope. They affect the energy consumption.

P149, Draft finding 7.2: "*Energy efficiency standards for residential buildings are based on computer simulation models…that exclude many of the determinants of a building's actual energy efficiency.*"

The models deliberately exclude many of the determinants of a building's actual (secondary) energy consumption, because they focus on the building envelopes. The draft finding criticises such standards for excluding determinants such as appliance efficiency – yet the example given above shows that their inclusion would result in absurd outcomes (or at least it would without further modifications, such as comparing on the basis of primary energy rather than secondary energy).

P149, Draft finding 7.3: "*A ranking of residential buildings by star rating…may be very different from a subsequent ranking based on actual energy consumption or efficiency.*"

This is a good example of how the report equates energy efficiency with energy consumption. The statement is true, but if secondary energy is meant it is misleading, for the reasons given above.

2. Some comments on submitted case-study evidence

Some weight is given in the report to the submission by Dr Williamson which includes six case study houses "*…that had won awards from the Royal Australian Institute of Architects. Each house had above-average energy efficiency, but achieved only a 0 or 1 star rating.*" (draft report, p147).

Examination of the details given for the six houses in Dr Williamson's submission (sub. 28, pp25-28) shows that five of these houses (not six – energy consumption for house 5 was not available) had below-average energy consumption. This is not the same as saying that they had an above-average efficiency (and Dr Williamson did not in fact claim that these houses had an above-average energy efficiency).

Accepting that these houses did indeed have below-average energy consumption, it is important to try to understand the reasons for this, and in particular, whether it was attributable to good envelope design (which the energy efficiency standards and rating schemes address), or by other factors that would have resulted in low consumption irrespective of the performance of the envelope.

In fact it is not difficult to find some common features that suggest that the latter explanation plays at least some role:

- Four of the houses were partially or wholly autonomous. Where on-site generation of electricity is concerned, one might expect that this would lead to frugality with respect to electrical appliance use (this is not to say that autonomous houses should not be given credit in a rating scheme – they should).

- None of the houses had mechanical cooling. Thus even if the houses became uncomfortably hot, there was no possibility of reflecting this in cooling energy consumption.
- In some of the houses the occupants were quite temperature-tolerant. Attachment 2 of submission 28, referring to the Queensland house, notes that "*Although this house can be cool in winter '[Y]ou can always put on more clothes if you are cold'*" (the embedded quote is from the architect/occupier). Similarly, for the Darwin house, "*My house gets hot during mid-day during the buildup; if it's 40°C outside it's 40°C inside*" (house owner quoted in submission 28, attachment 2).

Even this brief discussion suggests that considerable care, and further analysis, is needed before recommendations can be influenced by such case studies.

3. The consequences of basing ratings of residential building envelopes on actual energy consumption

Draft findings 7.2 and 7.3 implicitly criticise energy efficiency standards and energy rating schemes for excluding many of the determinants of actual energy efficiency (by which is meant actual energy consumption). But the average period of residential building ownership is far shorter than the expected life of the buildings. Appliance turnover periods are also shorter. Thus awarding a building envelope a high rating because it happens to be heated by a reverse-cycle heat pump, or because the current occupants happen to be frugal, or more tolerant of temperature variations, or are simply often out, is problematic. The next set of occupants may be very different, with different but legitimate needs. In any case, occupant characteristics are often unknown at the design approval stage.

If ratings were to be based on actual energy consumption, then the consequences of doing so would be:

(a) the rating would be highly specific to the current occupants and heating and cooling appliances;
(b) the building would have to be re-rated each time the occupants change or make substantial changes to the heating and cooling appliances.

Such an approach to rating the building envelope is very impractical.

4. A recommendation regarding the treatment of calculated energy loads

This submission contends that criticising energy efficiency standards and computer simulation models for excluding many of the determinants of a building's "actual energy efficiency" (by which is probably meant actual secondary energy consumption) – a key one being appliance efficiency – is incorrectly assuming that actual secondary energy consumption is a suitable index of performance. Basing a building assessment on energy loads (instead of secondary energy consumption) is justifiable because it focuses on the performance of the envelope.

However, the report has not commented on the fact that the current way in which heating and cooling energy loads are used to derive a rating or target is not

satisfactory, because they are simply added together. Doing so is physically incorrect: if heating and cooling loads are to be added, then appliance efficiency must be taken into account before doing so. But this then leads to complications: for example, for a given pair of heating and cooling energy loads, assuming gas heating and refrigerative cooling may lead to an outcome quite different from assuming reverse-cycle heating and refrigerative cooling, and in some climates can affect design decisions because of the difference in the relative importance of heating and cooling. In any case a difference in secondary energy consumption does not necessarily mean a difference in the cost of the energy to the householder. Furthermore, as noted above, appliances will change over the life of the building. Finally, including appliance efficiency to allow heating and cooling energy to be added together ignores the primary energy and greenhouse gas implications of the appliance fuel type.

Thus this submission suggests that the report recommend that separate ratings or energy targets be given for heating and cooling, based on annual energy loads. This avoids questions of appliance efficiency and primary vs secondary energy, at the expense of replacing one index of performance with two.