Clive Blanchard
B.E. (Hons), M.I.E.Aust, CPEng, M.AIRAH
NPER

CONSULTING MECHANICAL ENGINEER

Ph (08) 8354 1062
Fax (08) 8354 4510
Mobile 0407 718 949
Email crblanchard@optusnet.com.au
Web www.coolmax.mx.com.au
Ah (08) 8443 8603
78 West St Torrensville SA 5031

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Energy Efficiency Inquiry Supplementary Submission on Draft Report

Executive summary

The draft report raises a number of important issues, however some of the data on which the recommendations are based have alternative explanations not considered in the report. I also felt when reading it that the executive summary didn't truly reflect the contents of the report.
Although air conditioning energy use for cooling is currently small, it is inseparable from energy use from reverse cycle heating. This, combined with the fact that it uses electrical energy, means its contribution to greenhouse gases is much larger than generally recognised. The rate of penetration of air conditioners into households is growing rapidly. From 1990 to 2000 there has been a 50% growth in air conditioner energy use. The future total greenhouse gas production from air conditioners is likely to be 13% of residential greenhouse gas production.
Energy use can be considered a function of appliance efficiency, building rating, usage factor and floor area. The usage factor is a combination of percentage of the floor area heated or cooled and the percent of time that air conditioning is in use. All of these factors should be considered when addressing building energy use.
As our affluence increases we see an increasing penetration of air conditioning and an increased proportion of each house heated and cooled, even when people are committed to energy saving. This tends to increase the usage factor.
Because of the way people buy air conditioners and heating appliances, households fall into two categories, one with constrained heating and cooling equipment, the other category is unconstrained. Constrained heating and cooling is where the equipment capacity is insufficient to heat and cool the whole house.
Air conditioner efficiency is critical, not just to reduce energy use, but for economic efficiency. A person can spend as little as $500 on buying an air conditioner, and require the electricity supply and distribution companies spend up to $2800 for infrastructure. This alone fully justifies MEPS for air conditioners. An alternative would be a levy on air conditioners.
The air conditioner infrastructure split incentive means low-income people are cross subsidising higher income people with large air conditioners.
Addressing air conditioner infrastructure split incentive would encourage evaporative cooling and other low energy cooling techniques.
Energy Efficiency standards for residential buildings do reflect actual energy use although there is room for fine-tuning. Energy Efficiency standards should be based on the likely use of energy in the building over the life of the building.
Recommendations for alternative wording for some of the findings and recommendations have been included.

Introduction

The draft report raises a number of important issues, however some of the data on which the recommendations are based have alternative explanations not considered in the report. I also felt when reading it that the executive summary didn't truly reflect the contents of the report. For example, of the eleven key points in the executive summary, only two (grudgingly) concede that

Clive Blanchard is a Registered Professional Engineer with a Bachelor of Engineering (Honours) in Mechanical Engineering. (University of Adelaide). He has over 25 years experience covering all aspects of air conditioning. Prior to working as a consultant, he worked at, among others, Anderson Connell and Associates, Frigrite Contracting, AFA Air Conditioning and Seeley International. In addition to working as a consultant, he has developed an innovative wall mounted evaporative cooler, which is quiet, performs well, and has very low energy use. His web site www.coolmax.mx.com.au is arguably Australia's best and most popular independent air conditioning web site.

there may be a case for taking action, the other 9 points are either observations or recommendations to stop or delay actions already under-way. The body of the report seems to me to be much more accepting of the potential for government intervention.

One of the key weaknesses of the draft report is that the terms of reference are narrow (restricting it to report on 'improvements that are cost effective for individual producers and consumers'). This means that changes, which might have a small cost but which, result in substantial greenhouse gas, environmental and resource depletion are rejected as being unacceptable. Furthermore these narrow terms of reference have been interpreted in a narrow way. This means if a small number of people would be slightly adversely affected by a policy, while a much larger number would benefit, the policy is rejected. Given that current policies implicitly economically penalise people, I think that where the negative economic efficiency consequences are small, an approach, which is economically advantageous to around 70% of the population, should be considered acceptable.

Another problem with the draft report is that the executive summary doesn't seem to adequately reflect the actual content of the report. As the whole draft report is a 2.5cm thick A4 document. Very few people are going to wade through the whole document. Thus most lay people will probably hear about the report (if at all) from newspaper articles written by journalists who have either just read the key points or at most the executive summary. Thus an incorrect impression could be given. Although I disagree with some of the body of the report, it doesn't totally oppose government intervention and with some clarifications and corrections could be a useful document.

The Commission's deliberations on building rating rely heavily on Dr Terry Williamson's papers. Dr Williamson raises some very pertinent questions, however some of his results can be interpreted differently. His main thrust is that current house rating software doesn't accurately predict energy use, if at all. He argues that other factors like occupant behaviour are more important. While agreeing that occupant behaviour is at least as important as building design, I still believe that house-rating schemes are an appropriate approach, even though I believe that the schemes proposed so far can be improved. Williamson's work has shown significant correlations between certain house features and energy use and thus I believe it is possible to develop useful ratings. I believe that one of the reasons for the poor prediction of energy use in real homes, is that we do not tend to heat and cool the whole house. Thus our energy use for heating and cooling may in many cases be more related to the size of heaters and coolers than the house construction. Similarly a person with a ducted evaporative cooler will use substantially less energy for cooling than a person with a ducted reverse cycle air conditioner. **However I believe that there is a strong trend in the marketplace to higher levels of comfort for a larger portion of the house**. I recall one client saying "I want to be able to go to any room of my house, at any time of day or night and be comfortable without having to stop and switch a zone damper on." To achieve this required a 22kW unit in lieu of the 14kW unit that most people would have accepted. I believe that the energy use pattern of this client would closely follow the theoretical models. I also believe that more people will want this level of comfort in the future. Because houses are likely to last 80-100years, we need to design them now for the way we expect people to use them in the future, not as they are used now.

Air conditioning energy use and greenhouse gas production.

Potential contribution of air conditioning to greenhouse gas production

Although air conditioning energy use for cooling is currently small, it is inseparable from energy use from reverse cycle heating, and using electrical energy, its contribution to greenhouse gases is much larger than generally recognised. Air conditioning energy use for cooling (projected to be about 2% of residential energy use in 2005 by EMET Consultants [4]) is inseparable from reverse cycle heating so the total energy use from air conditioners is more likely to be 4-5% of residential energy use. (As I haven't seen any data on this it is an estimate assuming that air conditioner running hours are similar in winter to summer. In practice in Melbourne winter hours are likely to be considerably greater while in Sydney, less (see energyrating .gov.au [10])) . Because the energy is from electricity, the percentage of household greenhouse gas emissions is even greater. It is likely that at least 10% of household greenhouse gas emissions would be from reverse cycle air conditioners.

From 1990 to 2000 there has been a 50% growth in air conditioner energy use. It seems likely that it will continue to grow. The rate of penetration of air conditioners into households is growing rapidly. A projection by James Shevlin [8] forecasts substantial growth in air conditioning penetration in the next 10 years based on past growth rates. Currently only around half of all households have air conditioning but the proportion of households with air conditioning will probably increase by around 30% in the next 10 years. Finally I believe from my own personal experience in the air conditioning industry over the last 25 years, that the average floor area within a house which is air conditioned is increasing. Leith Jarvis [6] estimates ducted sales in South Australia in 1991 at 1,700 units with an average usage of 2.5-3kW compared to 10,000 units with an average usage of 4-5Kw in 2000. This represents a dramatic increase in the number of ducted units, and a nearly doubling of the area served by a typical ducted unit.

With all these factors I think the do nothing with air conditioning scenario would lead air conditioning to be at least 13% of household greenhouse gas emissions within 10 years. This estimate is crude but I believe of the right order of magnitude. It should also be noted that because the energy used is electricity, and it is generated at peak times when average generation and distribution efficiencies are lower, the raw energy percentage of energy used in households is going to be much greater than the apparent 2%.

Thus air conditioning as a potential contributor to greenhouse gas emissions is far greater (at around 13%) than the figure for cooling energy use of 2% implies. As it is so significant, we need to look more closely at it.

What drives residential household air conditioning use?

In simplistic terms air conditioner energy use can be considered as :

Air conditioner energy use =

appliance efficiency * Building rating * usage factor * floor area

- appliance efficiency for this purpose should be a seasonal energy efficiency ratio (as used in the USA).
- Where building rating is an indicator of the buildings inherent energy effectiveness.
- The usage factor is a combination of percentage of the floor area heated or cooled and the percent of time that air conditioning is in use.
- Floor area is the floor area of the house.

There are of course significant complications to each of these factors, but I am trying to give a broadbrush understanding for people outside of the air conditioning industry.

to address air conditioning greenhouse gas production we can tackle one or more of these items.

Usage factor

Unfortunately part of this factors is working against us. I believe the area of house heated or cooled is increasing This tends to increase the usage factor,. As an example whole of house ducted air conditioning is becoming more prevalent. In addition the long-term trend is for average floor area per person to increase. Unfortunately I don't see a solution to this issue without placing unreasonable restrictions.

The fact that air conditioner penetration is increasing see Shevlin [8] is an indication of this. (A house without air conditioning has a zero usage factor for cooling). In fact South Australia where most of my work is, can be considered a lead state in this area. Since I started in the industry penetration in south Australia has gone from around 50% in 1980 to near saturation at over 80%. Australia as a whole is currently around 50% and there is every reason to believe that in the next 25 years the rest of Australia will approach saturation. This has a number of implications discussed below.

I believe that for heating a similar increase in usage factor is occurring. The trend has been away from small capacity gas console heaters for example to ducted wall furnaces and now to whole of house ducted gas heating. As the capacity increases the effective usage factor increases.

On the other hand I believe that the other part of the usage factor, hours of use may be reduced slightly. It is possible to reduce the hours of use without compromise in comfort by education of people. Examples are to open curtains or windows when this is advantageous etc. To this end my web site (www.coolmax.mx.com.au) has a monthly e-mail newsletter [3] which gives advice pertinent to the season. Governments have also been giving advice through their energy efficiency information centres and this should certainly continue. Long term I see more sophisticated home automation systems possibly taking a hand in reducing home energy use. However they will have to get very sophisticated before they can compete with an intelligent person, as there are some trade-offs that might be difficult for a home automation system to make. An example is that a person may prefer to keep a curtain open to see a sunset where a pure energy efficiency analysis might suggest it be closed.

When assessing other actions (eg MEPS and building rating), I believe we should consider projected usage factors, not current factors. As indicated above, projected usage factors are much higher than current usage factors.

Floor area

As the floor area of a building increases the energy use generally increases. In fact the increase is not linear because the ratio of surface to floor area is less in a larger building of similar design. This has implications for building rating discussed below. Generally the gross floor area (GFA) is used in analysis because of the simplicity of defining it, however there is an argument that net useable floor area should be used, which would exclude areas which are not generally heated and cooled (for example laundries and bathrooms).

Appliance efficiency

MEPS

The air conditioning industry has gone through and is still going through changes to reduce ozone-depleting substances. This has shown us that an environmental problem can be addressed and reversed if tackled on a worldwide basis. It is generally recognised within the industry that without government regulation changes would not have taken place because there are too many purchasers buying with very limited knowledge and little or no incentive to make changes. It is clear from this experience that leaving things to the market won't achieve the required reductions in energy use in an acceptable time frame.

Below I discuss particular issues raised in the draft report.

Why prevent householders from buying less efficient air conditioners?

As well as the more general justifications for MEPS, air conditioning has a huge impact on the cost of electrical infrastructure. Monica Oliphant [7] has shown that on a peak air conditioning day in Adelaide, already 50% of the total electrical demand is for air conditioning and refrigeration. Peak power demand is increasingly occurring in the summer and this means air conditioner sales are going to increasingly drive infrastructure needs. There is a rapidly awakening awareness that this is a huge problem. In NSW $3.5 billion dollars is projected to be needed for electricity infrastructure over 5 years, largely to support future growth in air conditioning. Similar problems occur throughout Australia

This is a classic split incentive as a person can spend as little as $500 on an air conditioner that draws 1kW. If the purchaser normally uses the air conditioner at peak power periods (and the majority of air conditioners would be in use at that time) then the electricity supply and distribution companies have to spend around $2800 per kW for the infrastructure to power the air conditioner.

Simply giving the purchaser information on their own costs is not a sufficient incentive to buy the system with the lowest overall cost for society. It should be noted that that the total number of hours of use of an air conditioner is in most of Australia relatively small (lets say 400 hours equivalent full load for heating and cooling). so even at 20cents/kWhr the electricity retailer will only recover $80 per year. This means they will take 35 years to recover the investment!

This infrastructure investment naturally needs to be recovered by increasing prices for everyone. This means those who he no air conditioning, who are more likely to be the disadvantaged are actually subsidising those with air conditioning.

Do the benefits outweigh the costs?

It is clear from the above discussion that the benefits of increased productivity from MEPS significantly outweigh the costs.

Are other interventions more cost effective?

As discussed above a voluntary approach (even with appropriate labelling) is not going to address the split incentive problem for air conditioning with current energy pricing.

If costs were to reflect wholesale electricity costs, hour by hour electricity charging could increase the cost of running a refrigerative cooler up to say $20 per hour on a very hot day (say $100 for the day) when the same cooling could be achieved by an evaporative cooler for $4 per hour ($20 for the day). The disadvantage of this approach is the current high capital cost of these meters, however this might be a viable longer term solution as it seems feasible that long term the price will drop to only a small premium over conventional meters. However it is important to separate out the costs of the hour by hour metering from the other potential advantages of smart meters when deciding to implement them. In other words the analysis should look at the costs and benefits of remote reading separately from the benefits of hour by hour metering.

One alternative that I support and would accept in lieu of MEPS, would be a levy on purchase of air conditioners. I would apply the levy based on the rated power draw (measured at the energy labelling conditions). This would automatically penalise less efficient air conditioners. Due to the difference in efficiency, a six star air conditioner would be levied about half that of a 2 star air conditioner.

As an alternative, a differential levy could be applied. In other words the levy would be proportional to the extra power draw over and above that of a 6 star air conditioner. A disadvantage of this is that a person buying a 22kW ducted air conditioner of 6 stars would pay no levy, although they would still be putting a huge demand on the electricity supply and distribution system.

In either case I would use the levy to fund the associated infrastructure and environmental externalities. If the levy were applied at a rate that gave reasonable recovery of the external costs, it would allow a very significant drop in power prices as the funding for the infrastructure would be separate. This would improve economic efficiency and reduce cross subsidisation of those with air conditioning by those without. It would probably also make a 6 star air conditioner cheaper than a 2 star air conditioner. As this would significantly increase air conditioner prices it would strongly favour alternative (lower energy use) technologies for example ceiling fans and evaporative cooling (see below).

The big disadvantages of such a system are the administration cost and policing issues. However given that even a cheap air conditioner without the levy costs hundreds of dollars, the percentage administration cost would be quite small. In fact as the power draw is already measured as part of the labelling system, the only thing that needs to be measured is the number of each model air conditioner sold. Administration costs could be minimised by applying the levy at the manufacturer or importer level.

Energy efficiency of Evaporative Cooling and other alternatives

The author has published a paper [1] showing that evaporative coolers typically use 80% less energy than refrigerated coolers. It is possible to cool a typical family/dining room effectively with an average power use equivalent to that of only about two thirds of a 100W light bulb.

Although evaporative cooling is not applicable in all of Australia, over **7million Australians** live in areas where evaporative cooling is suitable.

Other low energy strategies include the use of ceiling fans, particularly for bedroom cooling in areas of milder summers. Another is attic ventilation, again in milder summer climates.

Overall potential saving.

The biggest saving is in the reduction in the cost of power station construction. This could easily amount to $460million dollars per year Australia wide. With the substantially reduced air conditioner power demand, the electricity generation and distribution infrastructure would be more effectively used. This will result in lower average electricity prices. It should be noted that encouraging evaporative cooling in those areas where it is effective, will also keep the lid on prices in areas where evaporative cooling is not effective because of the interconnectedness of the systems.

The lower prices for industrial users would lead to increased international competitiveness, particularly for companies competing against South East Asian countries where evaporative cooling is not an option.

Wall and roof evaporative coolers are made in Australia while most refrigerative air conditioners are imported. Substituting evaporative cooling for refrigerative cooling would beneficially impact on the balance of trade to the tune of at least $130million.

Low-income people are paying a higher proportion of their income for energy than higher income people are. However low income people are also cross-subsidising higher income people with large air conditioners as discussed above.

Barriers to the substitution of evaporative cooling for refrigerative air conditioning

The biggest barrier to encouraging evaporative cooling (or any low energy cooling technique) is the fact that the cost of providing the generation and distribution capacity required to support the air conditioner is not borne directly by the person buying the air conditioner.

Another major barrier is that decisions affecting the viability of evaporative cooling when made at a national level are often made by people who are not from evaporative cooling areas, and thus don't understand the potential. (To find out more about evaporative cooling visit www.coolmax.mx.com.au/evapcool) [2]

In very humid conditions the performance of an evaporative cooler is less effective. This is an inherent limitation, however it can be minimised by good design of the cooler and the system. Incorrectly designed evaporative cooler systems lead to a reduction in perception of the effectiveness of evaporative cooling.

A lack of awareness of the availability of wall or window evaporative coolers is a problem. Wall or window evaporative coolers are generally sold through air conditioning dealerships, however the majority of people go to discount electrical places to buy box type air conditioners and wall splits. Because the discount electrical retailers are only interested in products that they know will sell; they are not prepared to trial new products until they have already been proven to be successful. This is very much a chicken and egg situation.

The Cost of wall or window evaporative coolers is greater than cost of box type refrigerative room air conditioners. This is because the refrigerative air conditioners are mass-produced (in the millions) in low wage countries while the evaporative coolers are made in Australia in very low volumes (in the hundreds). However if box type air conditioners truly reflected infrastructure costs as discussed above, then wall or window evaporative coolers would be significantly cheaper.

Potential strategies to minimise the barriers

A levee to reflect infrastructure and other externalities as discussed above would have a dramatic impact on the acceptance of these technologies.

An alternative would be a subsidy for evaporative and alternative cooling strategies, perhaps based on the 'negawatts concept'. This could be a similar model to solar cell manufacturing subsidies.

Hour by hour electricity charging would provide an incentive although given current meter prices

Another alternative is the provision of low interest loans for evaporative and alternative cooling strategies.

Increased education would be help. This should cover the potential savings and the availability of alternatives

Building Standards

The draft report relies heavily on Terry Williamson's criticisms of the current approach to minimum efficiency standards for new dwellings. Although Terry Williamson raises some good points, for example if the embodied energy is as large as he indicates, then this should be looked at in more detail. However that is no justification for doing nothing about building energy use. As discussed above the contribution of air conditioners in houses to greenhouse gases is both larger than the impression given by most commentators and the contribution from both heating and cooling is growing. I discuss below some of the major issues.

Upgrading of building code standards

The housing industry association has claimed that moving from a 4 to 5 star rating becomes technically more difficult than moving from 3 to 4 stars. While this is undoubtably true, I don't believe the long-term cost will be as great as feared. I think the move to 5 stars will undoubtably cause a shift to the use of the rating software in lieu of deemed to comply methods. This will then allow trade-offs to reduce costs. In addition the learning effect will, over a period of 1-2 years lead to a very significant reduction in the cost of compliance. My personal experience when working for companies threatened with government regulation (when they didn't want the regulation) is that the companies look very hard at potential costs. Subsequently when the regulations come in, alternative less costly approaches are found and the situation returned to nearly business as normal.

In 1986 on a visit examining air conditioning practices in the USA I saw buildings that show just how much can be saved for what appeared to be a minor cost increase. In Phoenix Arizona, (which is as hot as Alice Springs) I saw a home fitted with an unzoned 10kW ducted air conditioner. A similar floor area house in Australia (even today) would typically have a zoned 14.5kW air conditioner. This means the heat gain must have been only half that of a typical Australian house. This was a standard project home and was not a demonstration project or specially designed home.

Effectiveness of standards

The crux of the question is how effective are the stanards?

When assessing the effectiveness of the standards we need to look at the medium to long term situation, not the current situation. I have already demonstrated that comfort expectations are increasing. The life of a building is long (say 80-100 years). Further many changes after initial construction are very expensive. (An example being increasing wall insulation). Hence a long time scale is appropriate. In fact my personal view is that within 10 years it will become painfully obvious that our current actions are inadequate and we will need to make dramatic reductions in Greenhouse gas production. Taking all these factors into account I believe we should take into account the cost of future building upgrades when assessing cost effectiveness of measures. In other words, if we find we have too little insulation, how expensive will it be to upgrade in 10 years time?

Energy use is simulated , not measured

Dr Williamson's comment that "improving dwelling energy efficiency …is far from understood"

Is valid, but I believe there are valid explanations for many of the issues he has identified. It is clear that further research is needed in this area, however I believe that the current proposals are appropriate, although there is considerable room for fine-tuning

Does targeting simulated energy loads raise actual energy efficiency?

I believe this question needs to be considered in terms of the expected trends in comfort level projected out at least 25 years and the way appliances are selected.

Accordingly a critical variable in any analysis of energy efficiency improvements is the appliances fitted. Any meaningful analysis must attempt to weight the sample to future expectations and not look at current averages.

Case Studies

Dr Williamson gave case study results of 6 award winning houses. My comment here is that I have just recently done a job on a house that has an architecturally designed extension using similar principles. The clients said that for the majority of the time comfort was excellent. However in very hot weather and very cold weather it was unacceptable and they wanted to improve things. The impression I got was that there were only a few hundred hours of discomfort but they nevertheless wanted this reduced. Unfortunately, because of the design the heating load is 165 watts per square meter, which is above the average for a tightly insulated house. (Mainly due to a suspended floor and the large expanse of single glazing. This is in spite of the fact that my analysis used heavy drapes pulled shut during heating). Accordingly the extension was difficult to economically heat and cool. The point is that in residential buildings it is the extreme conditions that drive the purchase of heating and cooling, not the performance during normal use. Once the appliance is bought the hours of use are then far greater than initially anticipated. Accordingly as our affluence increase we can expect an increasing penetration of air conditioning and an increased proportion of each house heated and cooled, even when people are committed to energy saving. (see also above)

Selection of appliances

Another issue concerning energy use in houses is the methods used to select appliances. The majority of heating and cooling appliances are not selected based on a proper heat load calculation. Even for ducted air conditioning, a number of the largest contractors and most of the one man bands select the unit size either using an assumed watts per square meter (in Adelaide typically in the range 125W/m2 to 135W/m2) or an assumed watts per cubic meter (typically around 50W/m3). However an analysis of 32 recent residential calculations I have done shows a range from 60 watts per square meter, to 355 watts per square meter. The situation with regard to wall split air conditioners (which form the majority of the market-see EnergyConsult [5]) is even worse. The majority are sold in discount electrical retailers by people with only very limited experience of air conditioning. In one case when I have been checking on how air conditioners are sized I have been told by the sales assistant that I just had to choose the size myself and did I want the three quarter horsepower bedroom unit or the 1.5 HP lounge unit! The most sophisticated salesperson I found in my comparison shopping had a chart which was effectively a modified watts per square meter depending whether the room had "large" windows or "small" windows. (large and small were not defined.) However this chart recommended the same size air conditioner for all of Australia. A similar situation exists for recommended sizes of heating appliances.

The consequence of this is that the size of the air conditioner bears little resemblance to the actual heat load, and a high star rating building is normally going to have the same size plant as a low star building. As my calculations above show, a lot of buildings end up with undersized plant, which means they are capacity constrained. This means you would expect the energy use to be independent of star rating. Where the plant is not capacity constrained for the room it is installed in, the natural tendency is for occupants to leave doors to other (unconditioned) rooms open to get some conditioning in these other rooms. This means the appliance still behaves in a capacity constrained manner. This effectively increases the usage factor, and unless usage factor is separated out, any analysis of the effectiveness of building star rating is meaningless.

A number of Dr Williamson's results can be explained by this analysis.

The NEEHA Project

Dr Williamson reports that in the NEEHA Project [9] the main heater & cooler and use of the heater and cooler had significant effects on heating and cooling energy use. This supports my contention that usage factor (including whether heating and cooling are constrained, hours of use, method of use) is vital to an understanding of what is happening.

In fact this project showed a number of correlations of building features with energy use. Given the confounding effects of the factors discussed above, this means that if corrected for these effects, the correlations are likely to be very strong, and that other correlations would be revealed.

The ACTHERS Review

If we examine Williamson's Figure 2 in 'Evidence based policy making' [9] it appears there may be two populations not one. I have marked up the diagram (Figure 1) with one line for capacity limited plant, which has little correlation with ACTHERS rating and the other as unlimited capacity plant, which is a remarkably straight line and acceptably close to the predicted line. Only a single outlier is left after this analysis and there could be any number of reasons for this as discussed by others elsewhere.

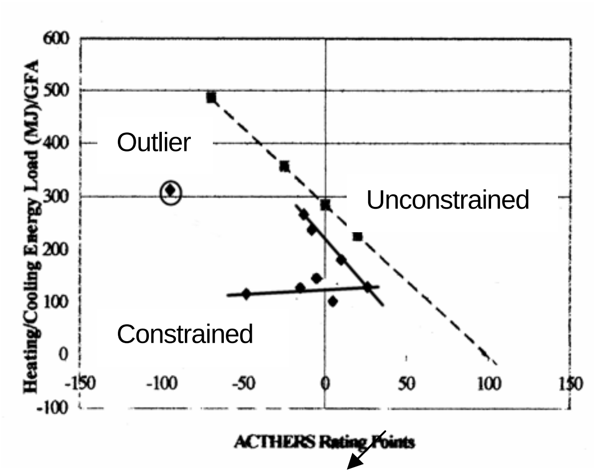

Figure1 ACTHERS Points vs Household Heating/Cooling Energy Load/GFA. (Modified from Williamson [9])

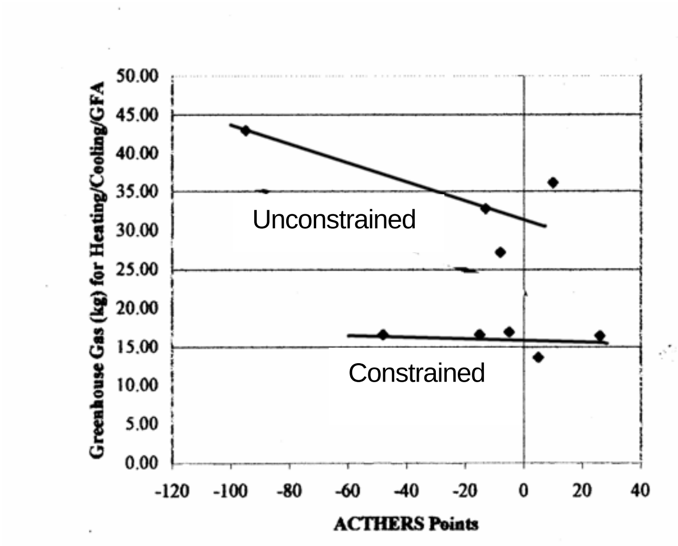

Figure 2 ACTHERS Points vs Greenhouse Gas /GFA. (Modified from Williamson [9])

In Dr Williamson's Figure 3 I would not necessarily expect a correlation. A star rating is on a square meter basis and a larger house will use more energy. As the second to highest rating house is obviously much larger than the average for the sample, we can conclude that it is not a random sample. Total household energy use also depends on other factors, which again would be expected to hide any results in a small sample.

I have again marked up Dr Williamson's Figure 5 (see Figure 2), which again appears to be two populations. One capacity constrained (with no correlation) and the other unconstrained and with the same slope as the predictions. given the uncertainties in the analysis and small size of sample, it is again acceptably close to the predictions. Because greenhouse gas production is also dependent on type of fuel the fact that the correlations are slightly less strong is not surprising.

Corroboration survey

In the Corroboration survey reported by Dr Williamson [9] The most meaningful of the graphs presented is figure 7. I have again marked this up (see Figure 3). I have removed the outliers (circled) (which could be caused by a number of factors as discussed elsewhere in this paper), added the expected curve and then drawn in the revised best fit (by eye). Given the fact that the graph doesn't make allowance for useability factor or capacity constraints, it is a remarkably good justification for the AGO approach (As pointed out by the AGO in submission 069).

Again this data appears to me to be two populations, one with a usage factor similar to the program assumptions and a second where the usage factor is very much less. Because of the self-selection in the survey, energy conscious people would be in a majority in this sample, so that it is likely that they switch off areas, which are not in use and switch off when no one is home. In other words their usage factor is likely to be less than for the average population.

The fact that total household heating and cooling load doesn't correlate with NatHERS energy load per square metre (Williamson's Figure3) suggests that there is probably an inverse correlation of building size with NatHERS energy load per square metre in that sample. (Bear in mind also that this ignores plant efficiency, which also blurs any trends that may exist.) The possible inverse relationship between floor area and energy load per square meter, does in fact point out one area for discussion about the approach being used. When a rating is based on an energy use per square metre, increasing the floor area reduces the ratio of total surface area to floor area. This then reduces the rating. (This trend was also seen in the review of the effects of ACTHERS where one of the responses appears to have been to increase floor area). However we need to be careful about reading too much into the Adelaide study given the self-selection in the sample. In addition it may be that floor area was positively correlated with wealth and NatHERS energy load inversely correlated with wealth. In other words if you are interested in energy use (and hence responded to the advert) and wealthy, you would probably have a large house but would have taken the actions

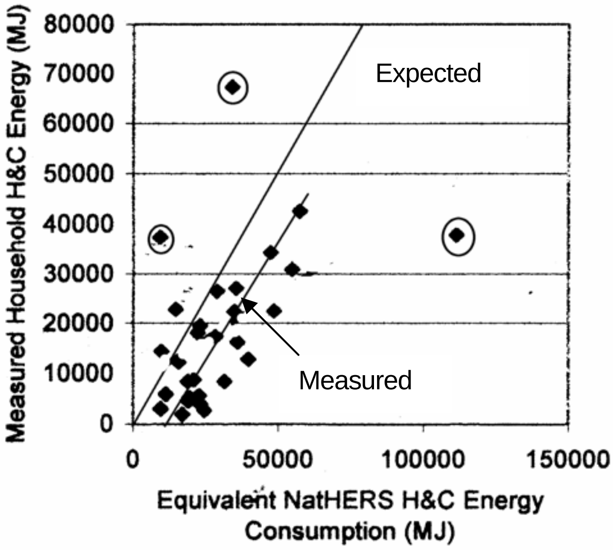

Figure 3 Equivalent NatHERS Energy Consumption vs Actual Energy Consumption (modified from Williamson [9])

to minimise the load. (For example, heavy insulation, good window orientation, good shading etc -all of which cost money and may have been less prevalent in the smaller houses).

When the data is again reduced to a per square meter basis which is the only basis for comparing the validity of the model, Williamson's Figure 4 shows a correlation of actual energy use per square metre with NatHERS calculation per square metre. I again believe there are two populations (as discussed above in the ACTHERS review)although they are harder to separate out. It would be interesting to correct this data for appliance efficiency, to see if the constrained and unconstrained groups became clearer. (In the ACTHERS review above, 8 of the 9 homes had gas heating and hence the appliance efficiency variations would likely be smaller than the variations in the NatHERS study).

However as I have indicated above, all the evidence is that people want to increase their comfort levels and air condition and heat a larger portion of their home, so in predicting future energy use, the unconstrained group is more valid than the constrained group.

Conclusions about building energy use

From the above I have shown that:

1. Energy use can be considered a function of appliance efficiency, Building rating, usage factor and floor area.
2. Air conditioner energy use is much more significant than the fact that currently 2% of household energy use is for cooling. (It s future contribution to household greenhouse gas use is more likely to be around %13)
3. The peak load implications of air conditioning use have a critical impact on economic efficiency
4. When testing a computer model for validity you need to remove the influence of the factors, which are treated as external to the model.
5. Heating and cooling appliances in many cases are insufficient to heat and cool all the occupied areas of the house and so there is a population of capacity constrained houses and a population of capacity unconstrained houses
6. There has been over the last 25 years a general trend to higher levels of comfort, which is expected to continue.
7. Because of the items above, a house-rating program needs to assume unconstrained capacity, and a high (if not unity) usage factor.
8. When compared using valid methods the current rating methods give valid results.
9. Although currently house-rating schemes do not on the face of it seem to correlate strongly with reductions in energy use or greenhouse gases, the evidence suggests that they will reduce future energy use below growth expected without them.
10. Appliance energy efficiency is critical to reducing energy use and greenhouse gases.
11. The best ways to improve appliance energy efficiency are labelling, in conjunction with either MEPS or a levy on the sale of air conditioners which reflects external costs (environmental and infrastructure)
12. More extensive research, particularly into consumer behaviours that influence heating and cooling usage factors (but bearing in mind we need to look at the projected future behaviours).

The draft report summary and key points don't reflect the contents

Reading the key points and /or executive summary leaves one with an overriding view that we should do virtually nothing. However this does not fully reflect the contents of the report. For example in chapter 13 a key point is that 'including environmental externalities associated with the use of energy…would encourage a greater uptake of energy efficiency…' Unfortunately no concrete suggestions on how to do this are put forward, and this and similar ideas are not reflected in the overall key points.

Suggested revised findings

In light of my comments above I propose the findings and recommendations be changed as follows:

Finding 5.2

Other barriers and impediments that are not market failures (for example, high transaction costs, risk and uncertainty in implementation) may provide rational reasons for the non-adoption of energy efficiency improvements that appear (to an outsider) to be privately cost effective. Where there are a large number of small transactions governments can consider techniques like Minimum Energy Performance Standards (MEPS) to reduce the transaction costs, and funding of demonstration projects to reduce risk and uncertainty

Recommendation 7.1

Add to the list of items to be analysed:

- Quantify the cost of reductions in peak demand on infrastructure costs where relevant (for example air conditioners), the environmental externalities, and other split incentives which may apply.

Finding 11.2

The current state and territory based variation in energy efficiency standards for new houses has been created by a lack of Federal Government leadership. The Federal Government needs to be seen to be actively pursuing the issue so that the states retain a coordinated approach to minimise costs to the building industry (although there will be variations between the states due to climate and other factors).

Finding 7.2

Energy Efficiency standards for residential buildings are based on computer simulation models - such as the Nationwide House Energy Rating Scheme energy-rating software - and should be based on the likely use of energy in the building over the life of the building.

Finding 7.3

A ranking of residential buildings by star rating (using energy rating software - such as the Nationwide House Energy Rating Scheme) may be different from a subsequent ranking based on actual energy consumption due to among other factors variations in appliance efficiency, comfort level chosen by the occupants and hours occupied. Nevertheless it is a useful comparator which will improve in usefulness over time both because consumer behaviour will more closely follow the assumptions and expected future modifications to the software will improve its modelling.

Recommendation 7.3

More stringent energy efficiency standards for residential buildings than those currently proposed should be based on an evaluation of existing standards. The evaluation should be commissioned by the Australian Building Codes Board to:

- Quantify the cost of reductions in peak demand on infrastructure costs and other split incentives, which may apply.
- Investigate how weaknesses in energy rating software that can potentially favour less cost-effective designs can be minimised.
- Evaluate costs and benefits in a way that takes into account the likely growth in expectations for comfort level, increased comfort level as a valuable commodity, split incentives and takes into account likely future usage patterns.
- Investigate the appropriateness and feasibility of incorporating peak load and embodied energy in the standards
- Assess how effectiveness and compliance costs differ between the deemed to satisfy and performance based standards
- Analyse the distributional impacts of standards on different socioeconomic groups, including first homebuyers and less affluent groups, taking into account the distributional benefits these groups gain from reductions in peak infrastructure demand.

- Examine the process used to set the stringency of standards in the building code of Australia, including the impact of any increase in stringency by individual states and territories.

Appendixes

Limitations on estimating heating and cooling energy use from energy bills

The majority of large-scale tests on energy use in houses have used energy bills to estimate heating and cooling energy use. Although the low cost of this approach is advantageous, it does seem likely that it underestimates heating and cooling energy use in most cases, but in some cases overestimates the use. This doesn't preclude its use, but it does mean that the real correlations are likely to be stronger than the analysis suggests. This means where this technique says there is a correlation, we can conclude that this is the case, but if it says there is no correlation, then we can only conclude that no correlation has been proven, not that no correlation exists.

If we consider an analysis based on treating the spring and autumn bills as base load energy use and assume the excess of the winter bill is the heating load and the excess of the summer load we are underestimating heating and cooling loads. During spring and autumn both heating and cooling are used, so the actual base load is less than the bills indicate. For example, considering my house, in March we used cooling extensively, in April we used both cooling and heating and this month (May) we have used heating most evenings and sometimes during the day. This problem is compounded by the fact that the bills don't neatly follow the seasons anyway.

These two problems seem to be well addressed by the use of what might be called a "best fit HDD/CDD" (best fit Heating Degree Day/Cooling Degree Day) method used in the 'Corroboration Survey' [I]. If there were no other appliances whose energy use correlates with ambient temperature, this would seem to be a good approach. Although this technique, in the absence of any evidence to the contrary should be used in any future bill based analysis, it is still subject to some errors as discussed below.

Energy consumption of certain high-energy consumption devices would also correlate to some extent with ambient temperature. Many of these devices are becoming increasingly common and may well explain some of the outliers. One example is a heated spa. Whether the spa is outside or in an unheated room, it is a significant energy user and energy use would be greatest in winter and least in summer. The result would be to overestimate winter energy use and underestimate summer energy use for heating and cooling. Another example is a fridge or freezer in an un-air-conditioned room or garage. In this case the appliance would tend to overestimate cooling energy use and underestimate heating energy use. The presence of both these confounding factors is increasing and making the use of bills more difficult.

For these reasons the preferred technique would be to separately meter heating and cooling. Because this is obviously expensive, it has only so far been used for small studies (too my knowledge). However due to the contentious nature of the results of tests so far, it may be necessary to use this technique (as a minimum on a sub-sample of the overall sample) in future investigations.

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