INSULATION COUNCIL OF AUSTRALIA AND NEW ZEALAND (ICANZ) SUBMISSION ON:

ENVIRONMENT AND RESOURCES COMMITTEE

PAPER NO. 1 JUNE 2009

INQUIRY INTO ENERGY EFFICIENCY IMPROVEMENTS

ICANZ RESPONSE TO PAPER NO. 1

The Queensland government has called for feedback from the community to its Inquiry into Energy Efficiency Improvements. It seeks feedback in four main areas:

> *AREAS FOR COMMENT*
> *1. What have been the economic and environmental costs and benefits of energy efficiency initiatives affecting households, industries/businesses, governments and communities in Queensland?*
> *2. In economic and environmental terms, what energy efficiency initiatives have been effective in Queensland?*
> *3. What role do Commonwealth Government initiatives, including the proposed Carbon Pollution Reduction Scheme, play in encouraging energy efficiency?*
> *4. What additional policies should the Queensland Government implement to encourage energy efficiency improvements?*

ICANZ represents manufacturers of glass wool insulation products which account for 70% of the insulation market. Insulation of buildings reduces heat flows through pipes, ducts, walls, floor and ceilings reducing the need for heating and cooling. Insulation is a key part of Australia's efforts to reduce Carbon Pollution.

ICANZ has evaluated international energy efficiency programs and commissioned studies on the benefits of energy efficiency in Australia to provide assistance to government in framing energy efficiency policy. These studies show that saving energy in the building sector is estimated to be a cost ***negative*** measure i.e. it saves money and increases economic growth. A short summary of these studies is provided in this report in response to areas 1 and 2 above as shown in Appendix A. We trust the government will find these references useful when evaluating its own energy efficiency alternatives. While energy generation options for mitigation will increase the price of energy, energy efficiency helps the community to use less energy and thus reduce the effect of unit energy cost price rises.

In 2006 ICANZ commissioned Deloitte Insight Economics to undertake a macro economic evaluation of providing a $500 Commonwealth rebate for installing ceiling insulation around 1/3 of uninsulated houses over 3 years. This study found:

- ❑ Quite short paybacks for the householder which will only improve as energy prices rise
- ❑ A net cost per tonne of avoided GHG emissions of ***-$46*** (long term cost to government of $11 per tonne for the rebate)
- ❑ An improvement in GDP over the period 2008 – 2030 of almost $400 million (Net Present Value - NPV)
- ❑ A reduction in infrastructure development for electricity due to lower peak loads with an NPV of $85 million

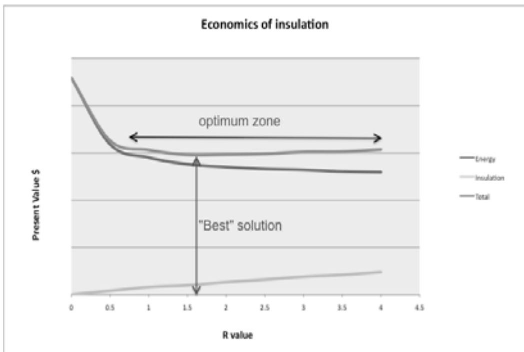
This report is available from ICANZ if required.

In terms of Commonwealth government programs that the Queensland government will be acting with (area 3 above) there a four main areas where ICANZ offers some comment and suggestions:

1. **Changes to housing BCA 2010**.

ICANZ believes that the recently announced proposed changes to the housing BCA 2010 are vital to ensure a low carbon future and encourages the Queensland government to adopt the increased stringency of both ratings and Deemed to Satisfy (DtS). Under the proposed changes the DtS will likely prove more expensive than a star rated solution. This greater use of rating tools will help to improve skills in design and the development more effective lower cost solutions.

FIGURE 1 NET PRESENT VALUE OF INSULATION R VALUES



The current BCA Deemed to Satisfy were prepared before 2nd generation star bands were available and could not be designed to meet a specific performance outcome. It is therefore not surprising that a number of cases have been found where the application of the DtS has resulted in much lower performance than 5 stars; in some instances as low as 3 stars. The increased stringency of the DtS is vital to ensure successful policy outcomes. While R values may seem excessive to bring all houses up to a minimum standard a DtS system needs to be aggressive. And the traditional method of selecting optimum R values shows that a broad range of R values have similar Present Values so while these R values may be 'sub-economic' in traditional terms the private disbenefit is minimal.

There has been some controversy in the past about the use of high insulation levels in hot climates. ICANZ believes that the far more comprehensive modelling of building fabric performance offered through the improved 2nd generation NatHERS software - particularly in accounting for the improved comfort provided by air movement - means that energy rated solutions will use less energy ***and be more comfortable****. See Appendix B and C.*

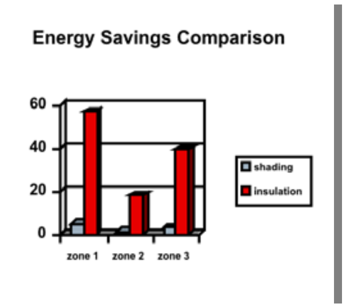
High performance house fabric will enable future generations to better deal with a warmer climate and the higher air-conditioning loads this brings and higher energy prices brought about by reducing the carbon emissions of energy generation. ICANZ case studies show economical solutions for achieving 6 stars however, even if 6 stars was not economic for Queensland under today's conditions it will be in future. This will be particularly critical as the baby boomers age and a substantially greater proportion of our population becomes less tolerant to heat stress in a warmer climate.

Studies conducted in 2006 of building regulations in other OECD countries with similar climates and energy prices to Australia show that their building fabric regulations are equivalent to 6 to 7 stars in Australia. Many of these countries have since further increased their energy efficiency stringencies. The regulations often extend beyond building fabric to the appliances used in the home. By moving to 6 stars Australia is simply bringing its standard closer to those countries with similar conditions.

ICANZ is concerned at the number of ways in which one can avoid installing insulation which still persist in the revised BCA. In its submission to the ABCB for the initial 5 star regulations ICANZ noted that:

> *Insulation produces benefits which are in the order of 6 to 10 times greater than the minimal wall shading required by the regulations. On this analysis the trade off for wall shading provided in the BCA can not be supported. While quite deep verandas may have a substantial effect - and some credit should properly be given for them - the best way to do this is to simulate the effects of the actual shading rather than presume it is equivalent to insulation.*

FIGURE 2 COMPARISON OF SHADING WALLS AND WALL INSULATION



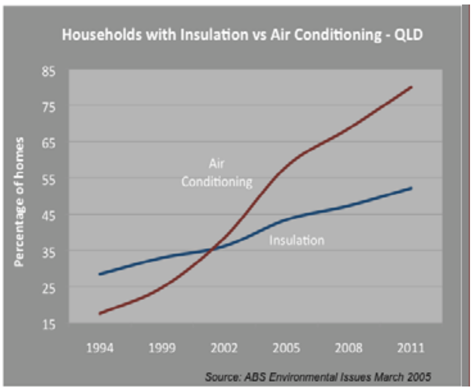
Although the shading requirements have been increased it is unlikely provides equivalent performance to insulation. ICANZ encourages the Queensland government to review these provisions to ensure that the energy savings levels of the regulations are maintained.

2. **Ceiling insulation rebate.**

Ceiling insulation has the single biggest impact on both energy consumption and peak loads. Appendix D shows how ceiling insulation affects energy consumption and peak loads in Brisbane.

Based on ABS figures the number of homes with air-conditioning in Queensland is greater than the number of houses with insulation. Uninsulated air-conditioned houses are responsible for substantial GHG emissions and peak load. Insulation not only reduces GHG emissions but also eases pressure on the electricity supply network. The rebate has a challenging target of reaching all uninsulated homes in a short time period. Support from the Queensland government in terms of publicity and ensuring uninsulated ceilings are captured during other house inspections such as for new wiring, installation of air-conditioning, at time of sale or lease and during GHG audits would help the ambitious target to be realised.

FIGURE 3 INSTALLATION OF AIR CONDITIONERS AND CEILING INSULATION IN QUEENSLAND



3. **Green Loans Scheme –** *Household Sustainability Assessments.*

In NSW, Victoria, ACT and South Australia state governments offer financial support to a range of energy saving measures. Duct and pipe insulation, retrofit insulation to walls and floors as well as ceilings are supported by these programs. Combined with a free assessment and a low interest loans these rebates provide a powerful incentive for households to take control of their GHG emissions and achieve substantial emissions reduction. A similar broad based rebate scheme in Queensland would help provide similar impetus for change. At the *very least there would be significant benefits in ensuring the existing state government rebates are well coordinated with the Household Sustainability Assessment scheme.*

4. **Mandatory Disclosure.**

Mandatory Disclosure of house sustainability at time of sale or lease was recently been announced by the Queensland government to be introduced in 2010. The federal government also plans to introduce similar measures nationally in 2011. ICANZ congratulates the Queensland government on introducing its sustainability check list which points out key house features that contribute to sustainability well ahead of the planned national introduction. ICANZ encourages the Queensland government to ensure the checklist is updated to be consistent with the national Residential Building Mandatory Disclosure scheme when it is introduced. National consistency is essential to achieving emission reduction targets.

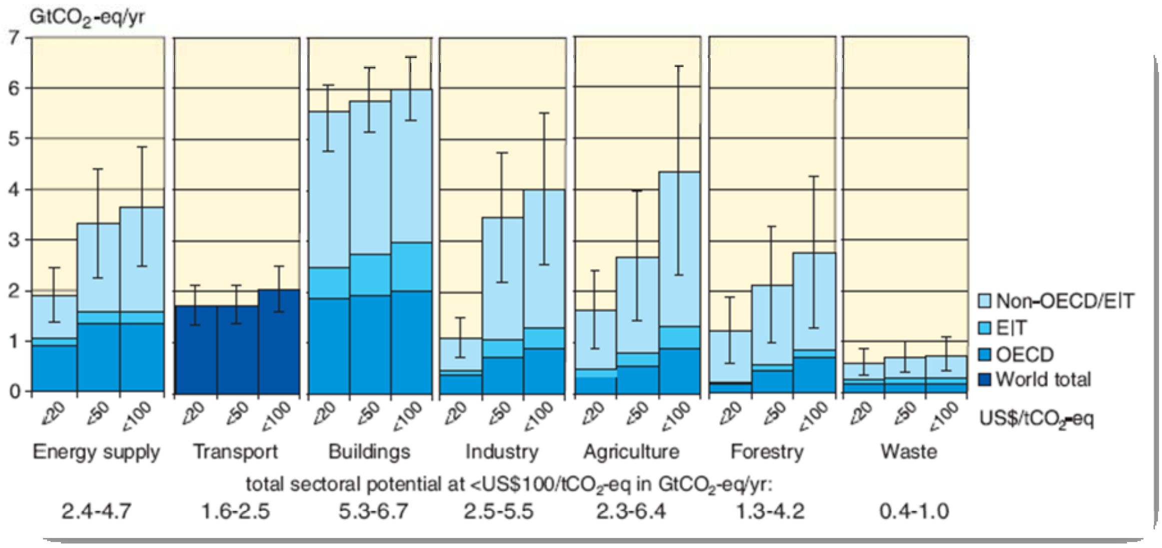
APPENDIX A ECONOMIC BENEFITS OF ENERGY EFFICIENCY: THE POTENTIAL OF BUILDINGS FOR CLIMATE CHANGE MITIGATION

IPCC ASSESSMENT OF POTENTIAL FOR GREENHOUSE MITIGATION

The IPCC has assessed potential greenhouse gas emissions reductions to 2030 from a range of sectors.[1] The building sector was assessed as having the highest potential for abatement, with a significant proportion available at low cost (see Figure 4).

Figure 4.

Economic Mitigations Potential by Sector to 2030 Estimated from Bottom-Up Studies



AUSTRALIAN NATIONAL FRAMEWORK FOR ENERGY EFFICIENCY

In Australia, the Energy Efficiency and Greenhouse Working Group of the Ministerial Council on Energy has identified the residential and commercial sectors as having the greatest potential for cost-effective energy consumption (and associated greenhouse gas emissions) reduction through to 2020[2] (see Figure 5). The Low Energy Efficiency Improvement Scenario was based upon then (2003) currently commercially available technologies with an average four-year payback. The High Energy Efficiency Improvement Scenario was based upon existing or developing technologies potentially available within the study timeframe with an average eight-year payback period. The Working Group stated:

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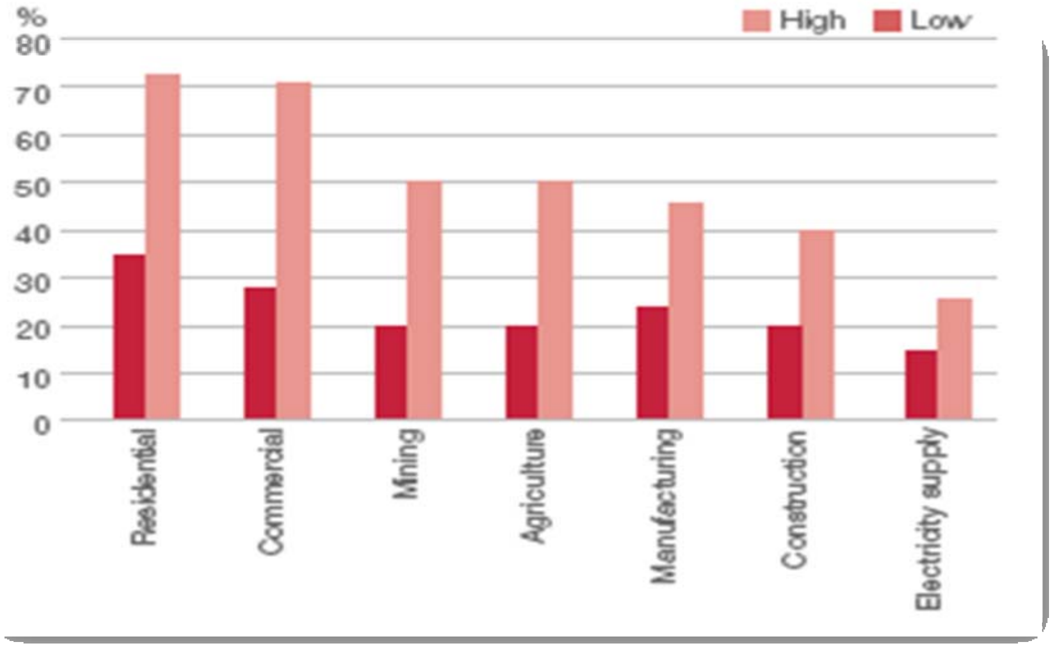
[1] Intergovernmental Panel on Climate Change (2007) *Climate Change 2007: Synthesis Report Summary for Policymakers* IPCC Fourth Assessment Report (www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf)

[2] Energy Efficiency and Greenhouse Working Group (2003), *Towards a National Framework for Energy Efficiency – Issues and Challenges.* Discussion Paper (www.nfee.gov.au/public/download.jsp?id=183)

"*energy efficiency has the potential to deliver significant net economic benefits while generating significant reductions in greenhouse gas emissions. Put simply, there should be no net cost of appropriate action on energy efficiency – but there are real costs associated with inaction.*"

Figure 5

Cost-Effective Energy Consumption Reduction Across Sectors



AUSTRALIAN STUDIES ON THE ECONOMIC IMPACT OF ENERGY EFFICIENCY

The Allen Consulting Group used the MMRF Green model of the Victorian economy to estimate the impacts of the 5 star housing building fabric regulations on Victorian economic growth[3]. Allen also used the same model to estimate the economic impacts of a range of national energy efficiency measures for the Energy Efficiency and Greenhouse Working Group of the Ministerial Council on Energy's National Framework for Energy Efficiency (NFEE)[4]. Both these studies found that the modelled energy efficiency measures created economic growth. The principle mechanisms of this growth were:

- Transfer of resources from the capital-intensive energy sector (lower energy bills) to the more labour-intensive building and manufacturing sectors (installing the insulation, weatherstrips, more efficient appliances).

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[3] The Allen Consulting Group, "Cost Benefit Analysis of New Housing Energy Performance Regulations, Impact of proposed Regulations", March 2003, prepared for the Sustainable Energy Authority of Victoria.

[4] Energy Efficiency and Greenhouse Working Group of the Ministerial Council on Energy National Framework for Energy Efficiency, "Towards a National Framework for Energy Efficiency – Issues and Challenges" Discussion Paper, November 2003.

- Reduction in energy demand lowers the upward pressure on energy prices.

In the case of the NFEE measures the modelling predicted that 12 years into the energy efficiency program, GDP would be $1.8 billion higher and over 9000 jobs would be created while saving 32,000,000 tonnes of greenhouse gas emissions. The net present value of growth in GDP over 23 years is $10.5 billion. This represents a 9% reduction in stationary energy use and its associated GHG emissions. This modelling focussed on measures which have very short payback periods (2 to 4 years), suggesting that there is substantial potential for even greater savings.

In Victoria the introduction of the 5 star regulations was projected to add $566 million (Net Present Value) to Gross State Product (GSP) by from 2002 to 2015. By contrast the 4 star option was predicted to produce only a $257 million increase to GSP. This finding has particular significance:

> *"The simple payback for 4 stars was 11 years, while for 5 stars it was 16 years. Such measures would have not have 'made the cut' for the NFEE evaluation and on the basis of payback period alone 4 stars would be preferred to 5 stars. The report examined the impact of the changes on annual household cash flow i.e. by how much were mortgage prices increased compared to the reduction in fuel bills. It found that in both 4 and 5 star cases the impact was marginal: +/- $50 per annum for each level. Given such a small impact on the household budget the Victorian government preferred the option that made the greatest contribution to GHG emission reduction and economic growth."*

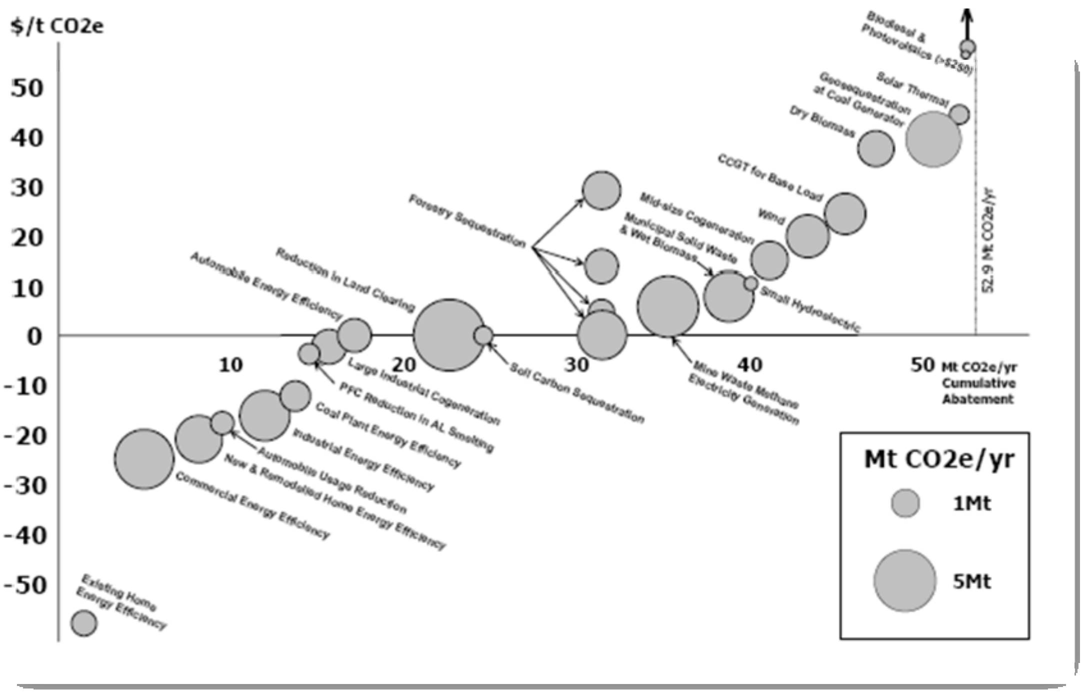
There may be many energy efficiency measures which on the face of payback alone may not be considered but which will nevertheless allow substantial GHG emissions reduction and produce significantly higher economic growth than more modest measures. Given the imperative for action in emission reductions it is important that we are not blinded by simplistic performance measures such as simple payback periods and evaluate the full impacts of all measures so that we can maximise the efficiency savings that produce growth or at the least do not reduce growth.

Both these reports were conservative. Benefits were underestimated because real energy prices were not assumed to rise, whereas they can be expected to increase substantially under a CPRS, and the impacts on peak power loads were ignored. For every kW saved the avoided generation and distribution costs are in the order of $1,500 to $3,000. In many instances, peak load reduction produces a greater benefit than the cost of the efficiency measure.

Greenhouse gas abatement cost curves suggest that many of the most profitable opportunities for reducing greenhouse gas emissions are associated with residential and commercial buildings (Figures 6).

Figure 6

NSW GHG Abatement Cost Curve to 2014[5]



In the NSW study energy efficiency measures under "new and remodelled home energy efficiency" included improvements in insulation, building orientation, shading, HVAC equipment, water heating, hot water usage and appliances. Significantly, it did not include any improvements beyond current rating schemes for new buildings, which are well below standards already applying in many overseas countries (see below). "Existing home energy efficiency" is restricted to higher efficiency electrical appliances and lighting with a maximum simple payback time of 6.5 years. Measures for "commercial energy efficiency" include insulation and other improvements to building thermal performance, more efficient HVAC and lighting design, systems and controls; more efficient equipment for water heating, lifts and other services; and more efficient office equipment – all based on a cumulative average four-year simple payback.

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[5] Next Energy (2004), *Cost Curve for NSW Greenhouse Gas Abatement*. Prepared for the NSW Greenhouse Office 2004, 3 November (www.greenhouse.nsw.gov.au/__data/assets/pdf_file/0017/4544/cost_curve.pdf)

MCKINSEY ESTIMATES OF GHG ABATEMENT COSTS IN AUSTRAIA

The major building greenhouse gas mitigation opportunities factored into McKinsey's Australian study (Figure 7) are improvements in commercial air handling, air conditioning, residential water heating, insulation of commercial building and houses, and more efficient lighting and electrical equipment.

The Review *Issues Paper – Forum 5* states that many estimates of large cost-effective emissions opportunities:

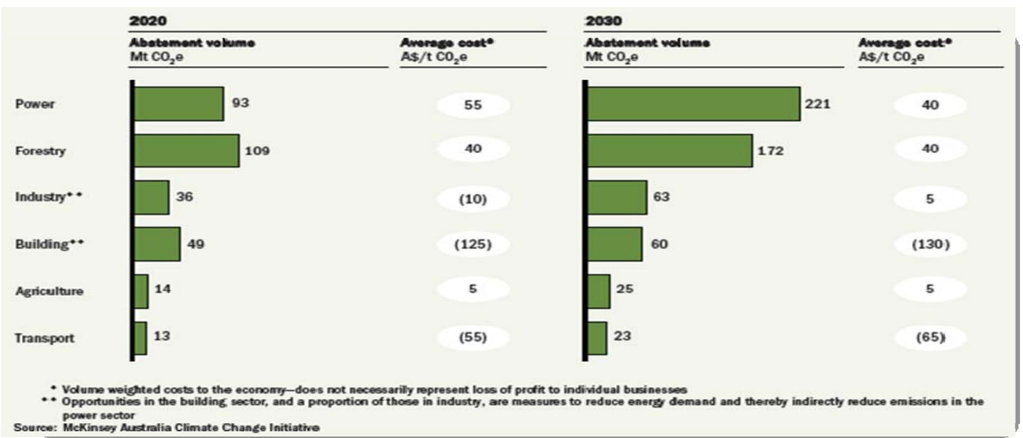
"*do not account for the full range of transaction costs faced by firms and individuals before they take up these lower emission opportunities. However, even if these costs are considered there may still be significant opportunities for emission reductions that would quickly provide financial benefits for building occupants, partially protecting against the effects of potential energy price rises.*"

Additionally, streamlining the capture of these opportunities through larger scale implementation, local targeting supported by incentives, or other strategies could reduce the transaction costs, making the opportunities more attractive.

Additionally, such benefits will accrue to the national and international emissions mitigation effort and can be accelerated and enhanced by appropriate policy initiatives. It should also be pointed out that the studies are based upon existing technologies and techniques that are available for implementation now. They are also often very conservative in their assumptions of near-term technological trends and movements in policy, which can reasonably be expected to accelerate as awareness increases of the Review's clear message that we are "moving towards high risks of dangerous climate change more rapidly than has generally been understood". As this message sinks in, the value of near-term cost-effective mitigation actions can only increase.

Figure 7

Australia: Greenhouse Gas Emissions Reduction Opportunities and Cost by Sector[6]



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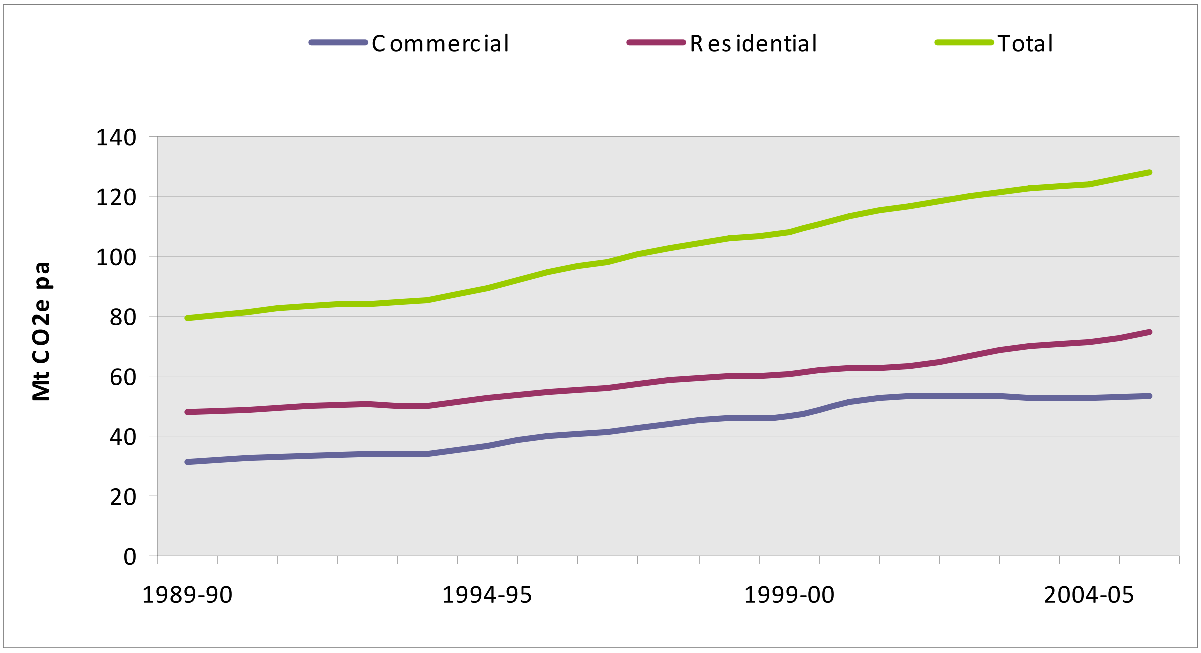
[6] McKinsey and Company, *An Australian cost Curve for Greenhouse Gas Reduction*, 15 February. (www.mckinsey.com/clientservice/ccsi/pdf/Australian_Cost_Curve_for_GHG_Reduction.pdf)

BUILDING SECTOR GHG EMISSIONS GROWING AT HIGH LEVELS

Despite widespread agreement on the significant potential for cost-effective greenhouse gas emissions reductions from buildings, such emissions have been growing strongly in Australia (Figure 8).[7] Between 1989/90 and 2005/06 total emissions associated with buildings grew by 60% or 3.0 per cent per annum. Moreover, the share of Australia's total greenhouse gas emissions attributable to buildings has been increasing in recent years and building loads have been a major driver of increasing peak power demand.

Figure 8

Trends in Greenhouse Gas Emissions for the Building Sector in Australia



ENERGY EFFICIENCY PERFORMANCE OF AUSTRALIAN BUILDINGS IS WELL BELOW INTERNATIONAL LEVELS

There is very strong evidence that the energy efficiency of new Australian housing is currently well below performance in other developed countries. Hayles *et al*[8] compared the performance of a sample of 51 houses in the UK, USA and Canada spread across eight climate zones with the Building Council of Australia's 5 Star requirement. The mean Star rating of the overseas houses was 6.8 and the median Star rating was 7.5 (see Figure 8)

Hayles *et al* state:

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[7] Pears, A (2008), *pers comm*

[8] Hayles C, Horne R, Jensen C and Wakefield R (2006) *An International Comparison of Housing Energy Efficiency and Performance Standards*, Construction and Building Research Conference of Royal Institution of Chartered Surveyors 7-8 September, London (www.rics.org/NR/rdonlyres/1543A637-520D-42F0-A9CE-4F925B4613CD/0/COB06Hayles.pdf)

"the results indicate that current standards of house designs used in this study are significantly higher than the proposed 5 Star standard and will use significantly less energy[9] *than 5 Star Australian homes.*

"The house designs obtained from the UK and Canada suggest that in these countries, houses are built to very high standards, in compliance with more stringent building code requirements. In the USA the picture is less clear, although two general conclusions can be drawn here. Firstly, houses in the US tend to be more akin to those in Australia, being of very lightweight construction, although typically having a slab floor. Secondly, although there are local variations, the overall performance is comfortably above Australian 5 Star equivalent.

"The question that must therefore be asked is why houses from the USA perform better, despite similar basic characteristics. It is clear from the design ratings that, in general, these buildings are ***simply heavily insulated*** *(our emphasis). They do not have sustainable design principles outside of high performance building elements. They are, however, insulated to (on average) R2.5 in the walls, R5.5 in the ceilings and have double or double low E glazing. One or two houses in Texas have single glazing, but otherwise all are double or double low E glazed."*

Figure 8

Star Rating for Houses in US, UK and Canada 2006

Australian equivalent climate zone	Comparison location	Total number of plans rated	AccuRate Stars Range	AccuRate Stars median	AccuRate Stars Mean
Zone 1 Darwin	Florida	6	6-8.5	6.5-7	7
Zone 2 Brisbane	Texas	5	4.5-9	5	6
Zone 3 Longreach	N. Carolina	5	4.5-6.5	5.5	5.4
Zone 4 Dubbo	Arizona	4	6.5-7.5	7	7
Zone 5 Perth	California (Bakersfield)	3	7-8	7.5	7.5
Zone 6 Melbourne	California (SF Bay)	4	6-9	7.5-8	7.6
Zone 7 Hobart	UK: Canada	16	6.5-8.5	8	7.2
Zone 8 Thredbo	Pennsylvania: Mass.	8	4.5-9.5	6.5	6.8
ALL ZONES	-	51	4.5-9.5	7.5	6.8

International best practice for regulating building energy efficiency and greenhouse gas mitigation is now moving significantly beyond incremental improvements in star ratings. In late 2006, the UK Government announced that it would require all new houses to be carbon neutral by 2016.[10] Late last year the UK Department of Communities and Local Government published a report recommending that all new non-domestic buildings in the UK be carbon neutral from 2020.[11]

[9] 30-50% less on average

[10] Osborne, H (2007), *Building trade enlists for carbon targets*, 9 January (www.guardian.co.uk/environment/2007/jan/09/energy.greenpolitics)

[11] Communities and Local Government (2007), *Report on carbon reductions in new non-domestic buildings*. Report from the UK Green Building Council, 17 December (www.communities.gov.uk/documents/planningandbuilding/pdf/carbonreductionsreport)

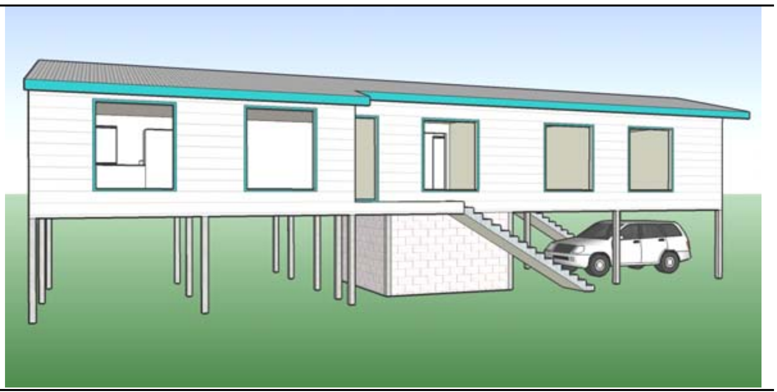
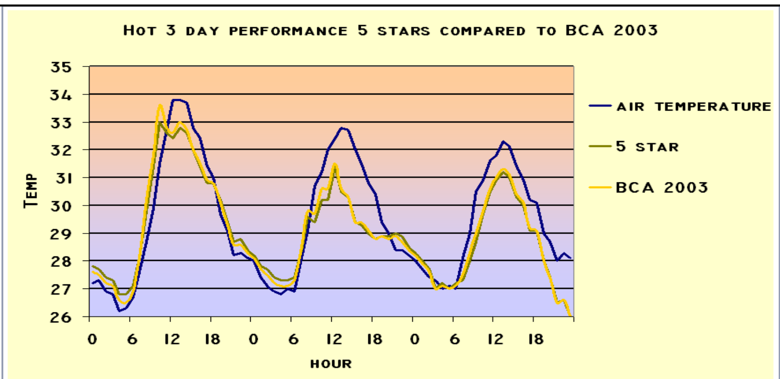
APPENDIX B: CASE STUDIES IN ECONOMICAL TECHNIQUES FOR ACHIEVING MINIMUM MANDATORY STAR RATINGS

The following Case studies were prepared with a previous release version of AccuRate (1.1.3), but its conclusions are still supported by the current version.

The case studies were prepared to show

- the performance advantage of the then newly introduced 5 star regulation over the previous deemed to satisfy,
- Energy and peak load savings due to 5 star,
- The positive impact on un-airconditioned comfort of moving from DtS to 5 star,
- How the regulation affects the design of well ventilated houses compared to poorly ventilated concrete block houses,
- How higher insulation levels help to achieve 5 stars more cost effectively in warm climates, and
- How further simple modifications can be made to achieve 7 stars.

Studies containing this information have been sent previously to the Queensland government. While this does not apply directly to the proposed 6 stars introduction, it does demonstrate that higher insulation levels are compatible with high levels of performance in hot climates – in this case Townsville.

House:	Well ventilated lightweight house in Townsville
Plan	`
Elevation facing south	
5 Star: energy savings	**30%**
5 star: reduction in appliance size/utility load	**20%**
Changes to achieve 5 stars: high insulation	***Changes to achieve 5 stars: low insulation***
R3.5 roof insulation R1.5 floor insulation R2.0 wall insulation Trim 2.4 m^2 from glazing area	R1.5 insulation + foil in roof R0.0 in floor (uninsulated) R1.0 in east and west unshaded walls Reduce glazing size by 11.5 m^2 High shading coefficient glass using an 'eclipse blue' tint or equivalent Weather-strips to all windows and doors as well as self-sealing exhaust fans. 2-metre verandas all around the house.
Impact on Comfort High insulation slightly improves comfort. No hot box effect because ventilation is excellent.	
Seven Star design changes	• Use ceiling fans: 2 x 1200 mm in living and 1 x 1200 mm in bedrooms • Use heavier window tint such as 'super grey'

House Construction

The house has a light coloured metal deck roof with foil underneath and R1.5 insulation on the ceiling. Walls are constructed from weatherboard and are uninsulated except for east and west walls, which contain R1.0 insulation. The floor is assumed to be particleboard with timber veneer sheet over. Windows are constructed from lightly tinted louvers in an aluminium frame. Cross ventilation is excellent with one room deep plan and windows on either side. This house is similar to the classic well- ventilated houses constructed in the northern territory such as the C19.

High insulation levels make compliance easier

If high insulation levels are used, compliance is cheaper and less restriction is placed on the design.

Note: Weather stripping *may* also require casement windows to be used rather than louvre windows if the window is to achieve an effective seal.

High insulation levels won't create a hot box in Townsville

The graph shows temperatures in the living room without air conditioning over a three-day hot period in Townsville. It compares the house constructed to the specifications of the BCA 2003 DtS and the modification outlined in Table 1 using high insulation levels to achieve the new 5 star requirements.

The graph shows virtually no difference between temperatures on the hottest three days period of the year. The 5 star houses are slightly cooler during the day and slightly warmer overnight (less than a degree). Over the whole year the 5 star houses reaches a temperature of over 30 degrees around 50 hours less than the house specified to BCA 2003 level.

Why does insulation reduce the energy required for cooling energy but not affect comfort?

In a well-ventilated house without air conditioning the temperature inside is about the same as outside air temperature, though it may feel cooler if there is air movement. If there is no temperature difference between inside and outside there is no heat flow, so the insulation has little effect in walls and floor. Insulation in the roof will improve comfort even though there is no air temperature difference because the sun shining on the roof can have an effect equivalent to a 40 degrees air temperature difference.

If the house is air-conditioned the temperature in the house is reduced creating a temperature difference between the inside and outside. This temperature difference causes a heat gain through the walls and floor. Under these circumstances adding insulation makes a difference because insulation can reduce this heat flow.

Seven Star design changes

Note that ceiling height would need to give a 2.4 m clearance to the underside of fans, however this house has a 2.4 m ceiling height. To install fans safely would require cathedral/raised ceilings and/or higher external walls. Ceiling fans were therefore overlooked as part of the 5 star solutions due to the extra cost this would involve.

House: Concrete block house in Townsville

Plan

Elevation facing west

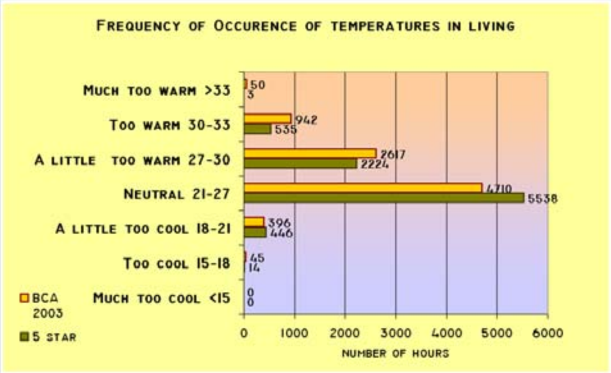
5 Star: energy savings — ***50%***

5 star: reduction in appliance size/utility load — ***40%***

Changes to achieve 5 stars: high insulation	***Changes to achieve 5 stars: low insulation***
R3.5 roof insulation and roof ventilators, Use louvre or casement windows, that can be fully opened Blinds to west windows: 7.4 m^2, Trim 8.1 m^2 from glass area, Tinted glass such as evergreen, Ceiling fans: family and living.	All items opposite except R1.5 + foil in roof & Blinds to east windows: 10.5 m^2

Impact on Comfort

5 stars provides: 400 fewer hours over 27, 450 fewer over 30 compared to BCA 2003



Seven Star design changes

- Construct external walls using aerated autoclaved concrete block (higher R value) or insulate external walls
- Add ceiling fans to all bedrooms

House Construction

This house is typical of the concrete block spec. homes constructed on slabs in northern Australia. While insulation can only help heat flows through the ceiling in this house, using higher levels of insulation can still provide enough performance boost to reduce the cost of achieving 5 stars.

To meet BCA 2003, minimal upgrade is required because walls are shaded with eaves and are not required to be insulated. The glass area is also low enough to use standard aluminium frame clear glass. Only a R1 reflective backed blanket under the roof deck was required. It only achieves 1.5 stars. While insulating the wall would help, the cost is very high so it will not be considered for 5 star solutions.

Changes required meet 5 stars

The design changes needed to achieve 5 stars using higher insulation levels compared with the design changes required to meet the current regulatory minimum shows a small but significant benefit. Again, using high insulation levels helps to cut the cost of 5 star compliance.

Concrete slab homes compared to well ventilated homes

It is far easier to achieve 5 stars with high set, lightweight houses than in the concrete block wall and slab floor in this house. This is particularly seen in the extent of glazing.

The well ventilated lightweight house is able to achieve 5 stars at a 40% glass to floor area ratio (GFR) while the concrete house must cut glass areas back to 20% GFR and use external blinds to reduce heat gains. The ventilated style allows the house to achieve comfort with more than double the heat gains through windows.

APPENDIX C: INSULATION NEED NOT CREATE A HOT BOX IN HOT CLIMATES

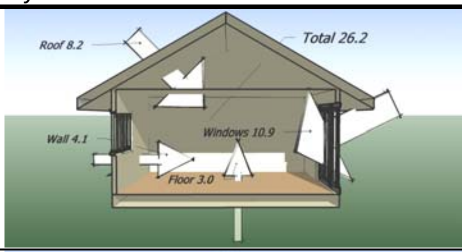
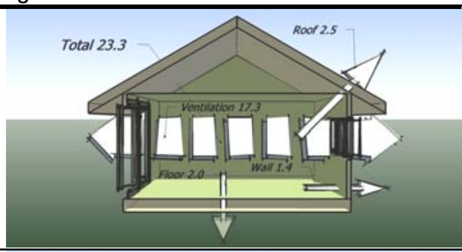
AccuRate shows that a ventilated house is far better suited to warm climates and that insulation will improve comfort levels. It also shows that significant improvements can still be made to houses of a concrete block design.

With poor ventilation and uncontrolled sun penetration insulated houses can become hot boxes. However, the new regulations ensure that sun penetration is controlled and that the house can achieve minimum levels of ventilation.

In these circumstances insulation should not create a hot box, even at very high levels of insulation. This is because insulation can slow down heat gain during the day and can reduce the amount of heat lost at night when it is cooler.

As shown in the Figure below insulation cuts heat gains by more than it cuts heat losses where good levels of ventilation are provided.

HOW THE HEAT GAINS AND LOSSES UNDER PEAK CONDITIONS ARE AFFECTED BY INSULATION.

<table>
<tr><th></th><th>Day Gains</th><th>Night Losses</th></tr>
<tr><td>Uninsulated</td><td>
</td><td>
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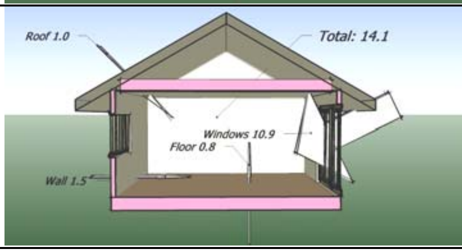
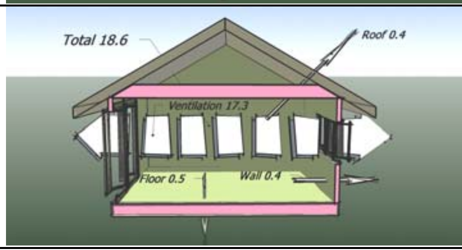
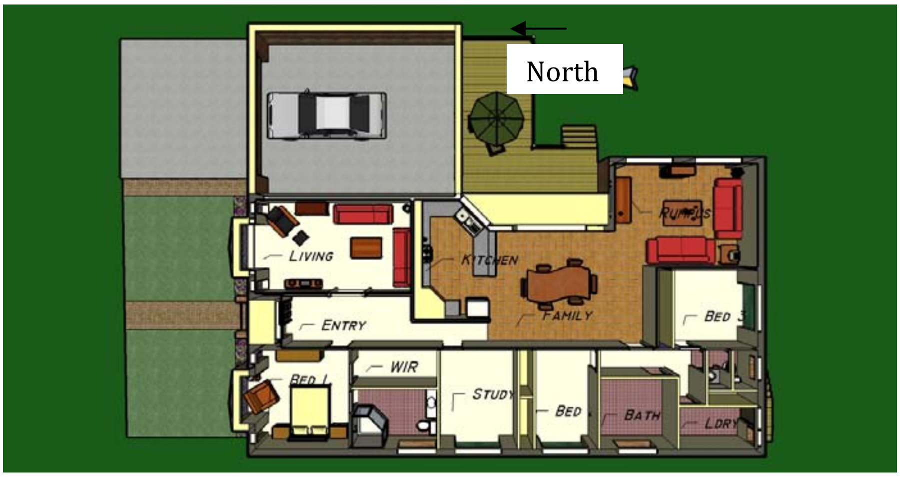
<tr><td>Insulated</td><td>
</td><td>
</td></tr>
<tr><td>Difference</td><td>Insulated 12.1 less gain</td><td>Insulated 4.7 less loss</td></tr>
</table>

APPENDIX D: RELATIVE EFFECTS OF VARIOUS ENERGY SAVING MEASURES

MODELLING ENERGY USE AND GREENHOUSE GAS EMISSIONS

To scope out the magnitude of the energy savings AccuRate was used to determine energy loads with and without ceiling insulation for the house shown in Figure 1:

FIGURE 4 HOUSE USED FOR ACCURATE MODELLING



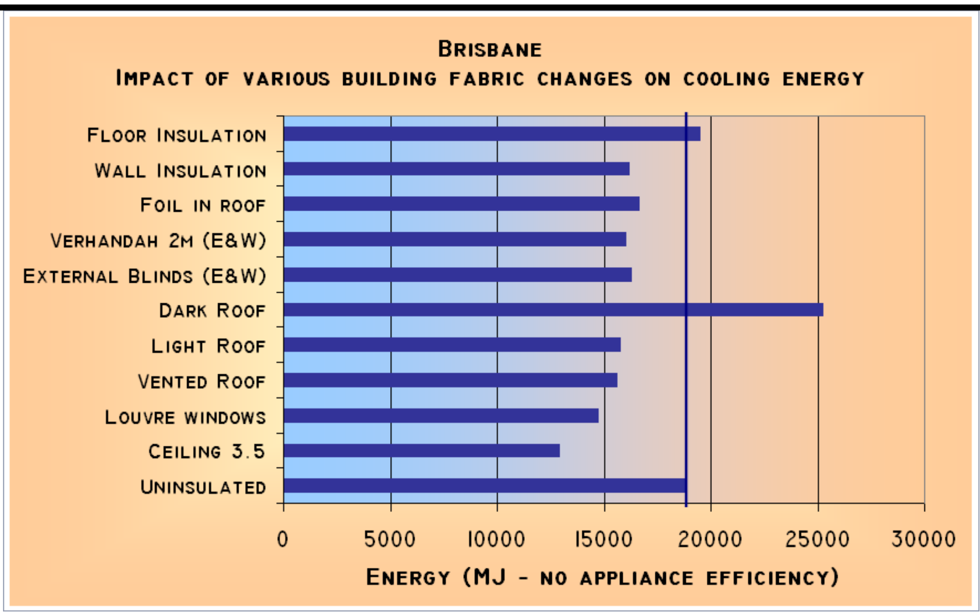
Three cases are presented below.

1. Only the Kitchen, Family Meals and Rumpus rooms were heated and cooled and the ceiling to all rooms insulated (Table 1).
2. As above, but with insulation only installed in heated and cooled rooms (Table 2).
3. Whole house heating and cooling with whole house insulation (Table 3)

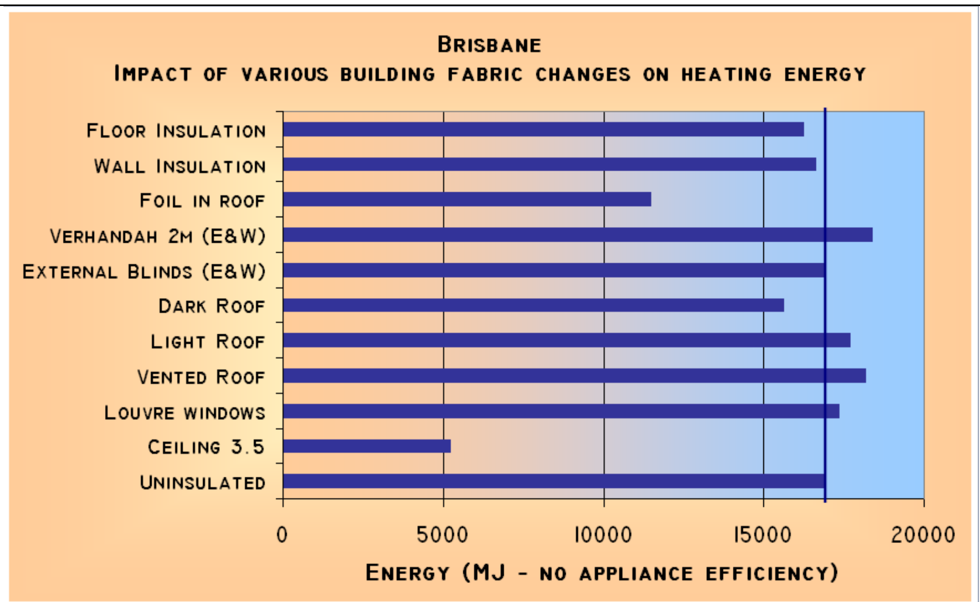
In each case Heating was applied from 7 am to 10 am, and from 5 pm to midnight to 21^{o}C. Cooling was applied from 5 pm to midnight in the living areas with a thermostat of 24^{o}C rather than the more intensive all day assumed by AccuRate. This will provide a more accurate indication of peak loads. In the whole house heated/cooled case cooling was applied to bedrooms from 9pm to 7 am. Houses were modelled in the Brisbane climate.

CEILING INSULATION EFFECT RELATIVE TO OTHER BUILDING FABRIC CHANGES

The impact on cooling energy use of a variety of energy efficient building fabric improvements in a number of climates were analysed. Ceiling insulation had the biggest single impact of any measure.



Cooling

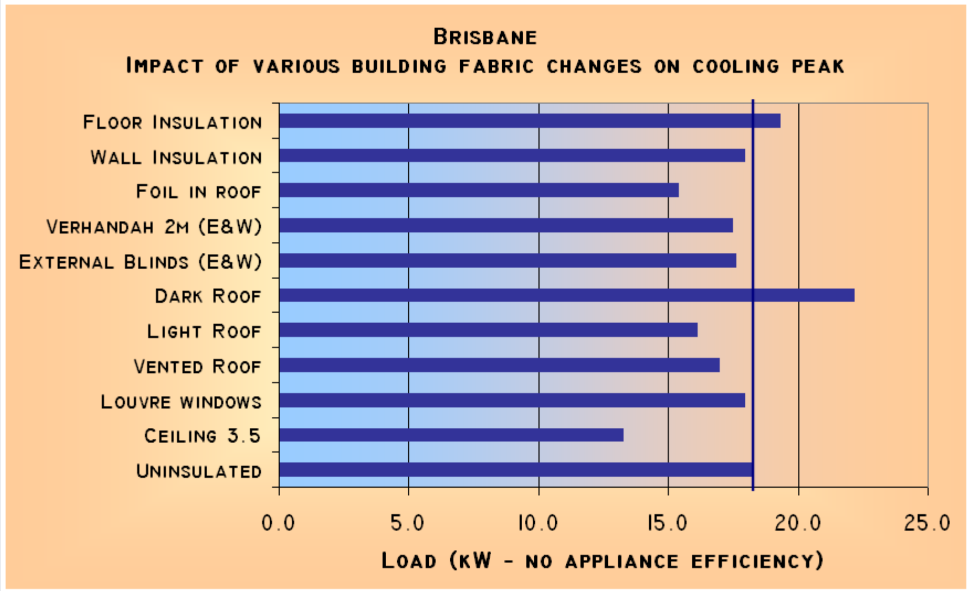


Heating

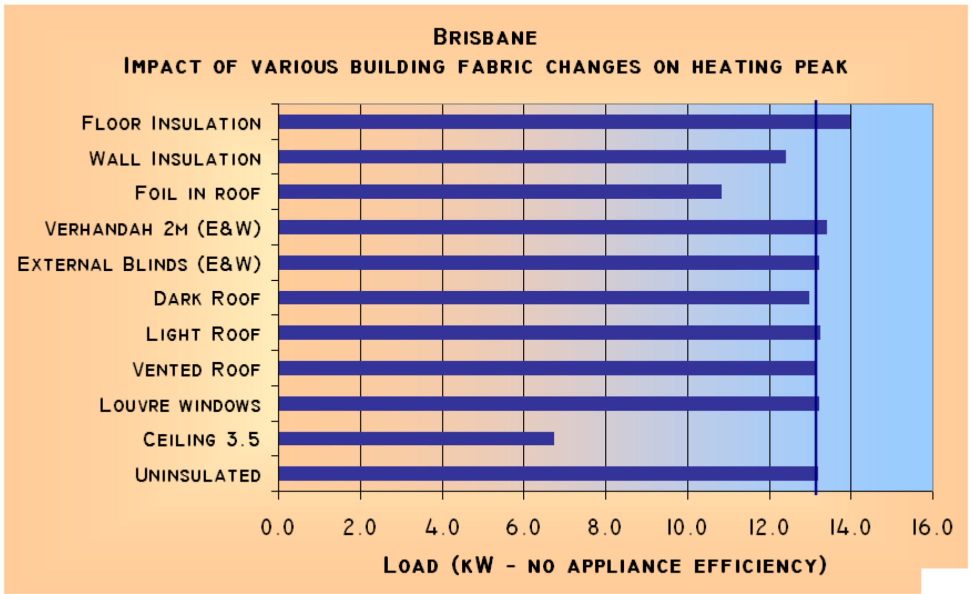
FIGURE 5 IMPACTS ON HEATING AND COOLING ENERGY OF VARIOUS BUILDING FABRIC STRATEGIES

PEAK LOADS: CEILING INSULATION RELATIVE TO OTHER MEASURES

The load which was not exceeded for more than 10 hours per year as predicted by AccuRate was used to represent the peak load. Ceiling Insulation has the largest effect on both heating and cooling peak load of any measure examined.



Cooling



Heating

FIGURE 6 IMPACT OF VARIOUS MEASURES ON PEAK HEATING AND COOLING LOADS