An economic assessment of the benefits of retrofitting some of the remaining stock of uninsulated homes in Australia

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ICANZ
THE RIGHT INSULATION MATTERS

Contents

Executive summary

While there has been a range of government actions within Australia at both the State and Federal levels to address climate change, more action is needed in order to substantially slow the growth in Australia's emissions of greenhouse gases. In particular, there are reductions that can be made without risk to the economy and, indeed, which may even have a positive economic impact.

A study published in the McKinsey Quarterly plots a cost curve for greenhouse gas reduction, and finds that building insulation is the cheapest form of energy efficiency.[1] Pursuing GHG emissions through energy efficiency is often a 'no regrets' policy option, in that it actually saves money for those groups which pursue it.

In Australia, while regulations exist for new dwellings, around 40 per cent of the existing housing stock is currently uninsulated, or substantially under-insulated. Although insulation generally makes financial sense, a number of market imperfections, such as split incentives between landlords who own property and tenants who pay energy bills, act as barriers to installing insulation. In this case there is little financial incentive for landlords to invest in insulation when they do not accrue the benefits of this investment. This and other market failures described in this report, provide government with a clear rationale to intervene in the market to improve social and environmental outcomes.

Deloitte Insight Economics has used the energy savings provided by Energy Efficient Strategies to estimate the individual yearly saving by household of installing ceiling insulation. For houses with space heating, which comprise the majority of the housing stock, the average yearly paybacks and payback periods range from just over 2 years in the case of the ACT for self installation to around 10 years in Queensland when a contractor is being paid to put the insulation in for the household. In most States, the payback is only a few years.

We have also calculated the average paybacks for all houses. This includes houses without installed space heating and conditioning. Even in this case the paybacks are still generally good and range from 2 years for the ACT for self installation to 15 years for Queensland when installed by a professional. Again, in most states the payback is only a few years.

These payback periods are very sensitive to price increases, indeed, an increase in energy prices as a result of either a carbon price or any other price shock will improve the payback periods. A fifteen dollar carbon price is likely to improve the average yearly paybacks per household by just $2 in Tasmania (where electricity supply is mainly carbon free), but will increase the yearly savings by about $28 in Victoria where brown coal is the predominant fuel type in power generation.

This summary report presents ICANZ's preferred option, a $500 subsidy which is assumed to drive an uptake of approximately 9.3 percent of currently uninsulated stock per year for three years.

From the table presented below we can see that the net total cost of the policy is negative at -$47 dollars per tonne. If the period of analysis is expanded to 2050 to accommodate for the long lifetime of housing stock and Energy Efficient Strategies' assumptions hold (see page 12 for more detail) then the net cost to government will be $11 per tonne of GHG avoided.

Moreover, if, instead of offering $500 for all households that install insulation, the policy offers either a $500 subsidy or 50 per cent of the total cost of insulation (whichever is

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[1] Enkvist, Per-Anders et al, 2007, '*A cost curve for greenhouse gas reduction*', The McKinsey Quarterly

smaller), the cost to government will reduce further. In this case the net costs to government will become $10 per tonne for the period 2008-2050.

ICANZ's proposed $500 subsidy: a summary of key findings (2008-2020)

Costs/benefit type	(28.1% uptake)
Total cost ($m)	758
Value of energy savings ($m)	1,222
GHG avoided (million tonnes)	9.9
Cost to government ($m)	390
Cost to households ($m)	368
Net cost per tonne of GHG avoided ($)	-46.81
Net cost per tonne of GHG avoided with a carbon price ($)[2]	-59
Net cost per tonne of GHG to government ($)	39
Net cost per tonne of GHG to government 2008-2030 ($)	21
Net cost per tonne of GHG to government 2008-2040 ($)	15
Net cost per tonne of GHG to government 2008-2050 ($)	11

This summary report also presents the findings of the MMA energy market model used to evaluate the benefits produced by the reduction in peak demand for electricity in the case of the policy option. This model predicts substantial savings for this policy option as a result of postponing necessary investment in infrastructure. The total NPV(5 per cent discount rate) for the period 2008-2030 of delayed infrastructure savings for this policy is $85 million.

Moreover, we are likely to see a reduction in electricity prices which is largest for the NEM and which peaks at around 4.6 per cent in 2014. The decrease in energy prices then dwindles away, to some extent, as a result of the impact that the lower price has on demand. Although this has not been explicitly modelled, these energy price reductions are likely to mean further substantial savings by households in their total energy bills.

This report also uses the Monash University MMRF Green economic model to assess the broader macroeconomic impacts of the policy. There is a positive impact in NPV terms (2008-2030, five per cent discount rate) for GDP, and real total consumption. MMRF also

[2] The carbon price is assumed to be $15 from 2010 to 2014, $20 from 2015 to 2020 and $30 from 2021 to 2030

estimates GHG emission avoided as a result of each of the policies, and gives figures which are similar, although slightly lower, to those we have calculated.

The change in a range of national indicators for the policy over the period 2008-2030 is presented below.

Economic Impacts

Option	GDP	Real total consumption	GHG avoided 2008-2020 tonnes
ICANZ's $500 subsidy	$384 million	$465 million	9.1 million

Source MMRF Green. All dollar values are in NPV terms with a conservative 5 percent discount rate over the period 2008-2030.

These economic impacts are substantial and suggest there is a strong rationale for government policy action. Looking at the impact on consumption (a proxy for economic welfare) alone demonstrates that the Australian community would be better off under the policy option presented in this summary report, than in the business as usual scenario. It is also important to note that these economic benefits accrue quite independently of the benign impact on greenhouse gas emissions. Increasing the rate of insulation is clearly an important 'no regrets' policy.

1. Climate change policy and energy efficiency

Climate change is now at the forefront of the policy debate, both in Australia and overseas. The fourth report of the Intergovernmental Panel on Climate Change, published this year, has confirmed that the world is getting warmer, that the climate is changing and that human actions are almost certainly responsible for this. If left unchecked, the IPCC estimates that average global temperatures will be up to 6 degrees higher in 2100. Sir Nicholas Stern's report on the economics of climate change, published in late 2006, has confirmed that the costs of climate change to the world economy is likely to be significantly higher than the cost of taking early action to arrest it.

While broad action at the global level is required to address climate change effectively, there are a number of actions that individual countries such as Australia can take without causing significant competitive disadvantage to their economies. This is particularly important for Australia, which records one of the highest rates of per capita emissions in the world. While Australia is likely to introduce a national emissions trading scheme (ETS) in the next few years, the carbon price is likely to be fairly modest initially. This means that there are strong arguments for governments to complement the ETS with measures designed to bring about emissions abatement through technological and behavioural change. So called 'no regrets' measures are of particular value in this context because they bring net benefits to the community even without accounting for the benefits they offer in terms of reducing the growth in greenhouse gas emissions.

Increasing the efficiency with which the community uses energy is an area which promises significant benefits in terms of emissions abatement and which in many cases offers 'no regrets' opportunities. One avenue that is highly prospective in terms of energy conservation is improving the insulation of buildings to reduce energy use while retaining the level of comfort provided by heating or cooling. The cost of reducing emissions in this way can be much cheaper and more efficient than a number of other options for reducing greenhouse gas (GHG) emissions. For example, a recent study by McKinsey plots a cost curve for greenhouse gas reduction, and finds that building insulation is the cheapest option for increasing energy efficiency.[3]

2. The role of building insulation

A number of studies have shown that Australian homes are far less well insulated than their counterparts overseas. The most recent data for basic insulation are shown in Table 1.

Table 1: Proportion of Australian dwellings insulated (2005)

	NSW	VIC	Qld	SA	WA	Tas	NT	ACT	Aust.
Proportion									
With insulation	54.4	72.3	43.2	78.2	65.6	74.6	49.2	78.5	60.5
Without insulation	24.9	9.2	35.5	8.7	20.4	12.2	16.4	3.6	20.6
Don't know	20.7	18.5	21.3	13.1	14.0	13.2	34.4	17.9	18.9

[3] Enkvist, Per-Anders et al, 2007, *'A cost curve for greenhouse gas reduction'*, The McKinsey Quarterly

ABS Cat 4602.0, March 2005, *Environmental Issues: People's Views and Practices*

While various state regulations require new houses to have a minimum level of insulation, or energy efficient standards, a substantial proportion of the Australian housing stock is uninsulated, and many more are under-insulated. This said, the recently agreed NFEE proposal to introduce legislation that all homes must have a declared energy rating when sold or released is likely to improve the rate of retrofitting. When interpreting Table 1, note that, according to ICANZ, most of the 'don't know' responses shown will be from households that do not have ceiling insulation (approximately 80 per cent). Moreover some houses with insulation do not have ceiling insulation, and some with ceiling insulation are sufficiently under-insulated to be classed as uninsulated (in particular, houses with only reflective foil insulation). Overall, therefore, it is estimated that around 40 per cent of dwellings in Australia do not have ceiling insulation. The numbers of houses which are considered uninsulated are presented in Table 2 below. Note that the analysis in this report is only directed at separate houses, semi-detached houses and row or terrace houses, and not at apartments or flats

Table 2: Number of homes[4] un-insulated (2005)

	NSW	VIC	Qld	SA	WA	Tas	NT	ACT	Aust.
Uninsulated homes 000s	977	471	843	133	265	49	28	22	2,788
Total housing stock 000s	2,089	1,763	1,369	616	744	187	45	177	6,930
Percentage of homes uninsulated	47%	27%	62%	22%	36%	26%	62%	12%	40%

ABS Cat 4602.0, March 2005, *Environmental Issues: People's Views and Practices*

Based on technical data supplied to Deloitte Insight Economics and commissioned by ICANZ, the paybacks from installing ceiling insulation are substantial. We have calculated the average payback periods for houses with space conditioning by state, and the average payback period for all houses by state.

Most houses have space conditioning equipment installed. The rates of space conditioning by state were provided to Deloitte Insight Economics by Energy Efficient Strategies on behalf of ICANZ and are shown in Table 3 on the following page.

4 These data exclude flats, units and apartments and 'other' in the ABS classification – for both calculating uninsulated houses, and total housing stock. It includes separate houses, semi-detached and row and terrace houses.

Table 3: Households with space conditioning, by State

State	Percentage of houses with some form of installed space conditioning
NSW	90
VIC	98
QLD	80
SA	92
WA	84
TAS	99
ACT	98
NT	92

The data presented in Table 4 shows the average payback per household with space conditioning which, as may be seen from the Table, vary considerably between States as a result mainly of different climatic conditions. The cost of installing ceiling insulation in an average dwelling is estimated at $1,200 if installed by a contractor, or $816 if the batts are installed on a do-it-yourself (DIY) basis.

Table 4: Payback by State per household with space-conditioning

State	Average yearly saving per house (Year 1)	Years to payback (assuming prices continue along current trends) 5 per cent discount rate	Years to simple payback	DIY ($816 cost) years to simple payback	Weighted simple payback for representative household (40% DIY 60% commercial install)
NSW	$158	9	8	5	7
VIC	$327	4	4	2	3
QLD	$126	10	10	6	8
SA	$225	6	5	4	5
WA	$269	5	4	3	4
TAS	$255	5	5	3	4
ACT	$344	3	3	2	3
NT	$278	5	4	3	4

We can see that the paybacks for most states are fairly short, particularly when households self install. The paybacks range from just over two years (in the case of Victorian households who self install) to ten years for Queensland householders who get someone to install insulation on their behalf. The average paybacks for a house with space conditioning are significantly larger than the average paybacks for all houses (Table 5).

Table 5: Average payback from installing ceiling insulation

State	Average yearly saving per house (year 1)	Years to payback 5 per cent discount rate	Years to simple payback	DIY ($816 cost) years to simple payback	Weighted simple payback assuming 40% DIY, 60% commercial installation
NSW	$136	10	9	6	8
VIC	$314	4	4	3	3
QLD	$89	15	13	9	12
SA	$198	7	6	4	5
WA	$204	7	6	4	5
TAS	$255	5	5	3	4
ACT	$336	4	4	2	3
NT	$256	5	5	3	4

These data suggest that the payback periods from installing insulation are still generally relatively short when all houses are included, ranging from a simple payback period (no discounting) of two years in the ACT when installed on a DIY basis, to 15 years in Queensland when installed by a contractor. These figures represent the average payback for all households, which means that the data includes some houses which do not have heating and cooling equipment installed, and hence have lower energy usage and potential savings.

From the data presented in Tables 4 and 5, it can be concluded that insulating a ceiling is a ‘no regrets’ option in that, over time, it saves households significant amounts of money whether we look at the average saving for all houses or just for houses with space conditioning. For the average household in many States such as Victoria, the ACT, the NT or Tasmania, even if a household takes the most expensive option and pays for someone to install insulation on their behalf, this investment will pay itself back in only a few years.

For the average household (Table 5) in other States where the paybacks are smaller (though still substantial), if a household self installs (such as in SA or WA) they will still have paid back this investment in only a few years. Even in the State which gives the lowest payback, Queensland, if we look at houses which have space conditioning (Table 4) then the simple payback for DIY is only six years. Given that the number of houses with air conditioning is rising rapidly, over time the space conditioning figures will be the most representative for Queensland.

Clearly, these results are highly sensitive to changes in energy prices. We have assumed a slow increase in energy prices in line with current trends. However, if energy prices were to increase as a result of the introduction of an emissions trading scheme, for example, as seems highly likely, the paybacks from installing ceiling insulation increase (see Table 6). Moreover, if energy prices rise at a rate which is faster than the current trend, the paybacks are likely to improve significantly.

Table 6: Increase in average yearly saving in bills given a particular carbon price

State	With a $15 dollar carbon price (2010-2014)	With a $20 dollar carbon price (2015-2020)	With a $30 dollar carbon price (2021-2030)
NSW	$8	$11	$16
VIC	$28	$38	$57
QLD	$8	$11	$16
SA	$13	$17	$25
WA	$13	$17	$26
TAS	$2	$2	$3
NT	$21	$28	$41
ACT	$22	$29	$44

As the carbon prices assumed in this analysis are relatively low and there is long lead-in time, the payback periods are not significantly improved even if there is an increase in energy savings from 2010. For instance, households within Victoria which invest in insulation in 2008 will have paid back most of their investment before a carbon price is instituted in 2010. In some States, with longer pay back periods, these are improved by a year or two, such as in NSW where the weighted simple payback for the representative household decreases from 8 years to 7 years, or in Queensland, where this decreases from 12 years to 10 years.

It is important to note that other factors may impact on energy prices besides carbon prices. If the average price for energy were to increase by just 10 per cent (an approximate 10 per cent increase across electricity, gas and LPG) the yearly paybacks would improve substantially (Table 7). In this regard, it is worth noting that in May 2007 wholesale electricity prices approximately doubled as a result of the drought.

Table 7: Paybacks by State for space conditioned houses

State	Average yearly saving per house (year 1) with a 10 percent price increase	Weighted simple payback for representative household (40% DIY 60% commercial install)	Payback with DIY
NSW	$169	6	5
VIC	$355	3	2
QLD	$137	8	6
SA	$243	4	3
WA	$289	4	3
TAS	$258	4	3
ACT	$376	3	2
NT	$278	4	3

Note: assuming 10% increase in energy prices in 2008 but no carbon price

3. The case for policy intervention

Given the benefits of insulation, as shown above, why are so many dwellings uninsulated? Since insulation provides a means of reduction in energy usage that is usually cost efficient, it might be assumed that economic agents would behave rationally and make these investments in insulation without the need for government intervention. However, there are a number of market imperfections in the area of energy efficiency, and in particular in terms of building insulation, which mean that a perfectly competitive market does not exist. As a result, many dwellings may remain uninsulated even when there are clear benefits from installing ceiling batts.

The main market distortions that exist are:

- a lack of incentives caused by the failure for persons and businesses to internalise the costs associated with carbon emissions (understandable when the greenhouse externality is not priced);
- irrational time preferences for money, or myopia regarding the overall cost savings from insulating in the longer term;
- imperfect information in energy markets; and
- split incentives in the case of rental properties, where there are few incentives for landlords to install insulation because the tenants are responsible for the energy costs.

The last point is extremely important. It is believed that a large proportion of uninsulated dwellings are rental properties, since while there are financial advantages (in terms of reduced energy use) for owner-occupiers to insulate their houses, there is little incentive for either the landlords or the lessees of rental properties to do the same. Because of these market distortions, there may be a case for policy intervention by government in order to promote the greater take up of insulation. The ABS notes that among households with no insulation, not being the home owner or party responsible to insulate the home was cited as the main reason for not having insulation.[5]

In addition to the market imperfections discussed above, there may be other benefits from such intervention. For example, a recent New Zealand study published in the *British Medical Journal* found significant improvements to the health and quality of life for low income occupants in insulated homes. The study compared two random samples of low income earners – one with insulation and one without. Obviously, climatic variations and other factors may influence the magnitude of these health benefits.[6]

4. Policy instruments

If there is a case for intervention, what is the appropriate policy instrument to provide incentives for a higher level of insulation? An economist would normally respond to this by suggesting that the price mechanism can solve the problem, particularly if we introduce a price for the negative externality. The imposition of a carbon price via an emissions trading system, however, will have some impact but probably not very much, at least in the short to medium term. This is because energy costs represent only a minor part of the household

5 ABS Cat 4602.0, March 2005, *Environmental Issues: People's Views and Practices*. p11

6 Philippa Howden-Chapman et al, Mar 2007, BMJ, *Effect of insulating existing houses on health inequality: cluster randomised study in the community*

budget and it is likely to be a long time before carbon prices are sufficiently high to trigger substantial behavioural change.

That said, there are a number of approaches that government could take to induce households that have no ceiling insulation to install it. These broadly fall into two groups, namely the provision of subsidies and the introduction of regulations. This summary report presents the costs and benefits of ICANZ's preferred option, a $500 subsidy.

5. Impact of ICANZ's policy option

- ICANZ's policy option: A $500 dollar rebate which prompts an assumed take up of 28 per cent over three years.

The main impact of this option will be to increase the number of dwellings with insulation and thereby provide private savings to owner-occupiers and tenants and public benefits to the community by reducing the burden of reducing greenhouse gas (GHG) emissions. The various paybacks and outcomes for this option are presented bellow.

This policy is based on a generous subsidy for ceiling insulation. For this policy, we assume that individuals with space conditioning are likely to self select into the scheme because they will enjoy the higher paybacks. The total costs and benefits are dependent on the take up rate.

Table 8: Costs and benefits of this policy with different take up

Take-up (per year for three years, %)	Total cost ($m)	Value of energy savings ($m)	Cost to Government $500 rebate ($m)	Cost to households ($m)	GHG avoided (million tonnes)	Net cost per tonne of GHG avoided ($)
9.4	758	1,222	390	368	9.9	-46.81
5.0	404	651	208	196	5.3	-46.81

Note that all figures are in NPV terms with a discount rate of 5 per cent. The 'net cost' is calculated by subtracting the value of energy savings from the total cost and then dividing by the total GHG avoided.

Two alternative assumptions about take-up have been used, namely 9.4 per cent per year and five per cent per year for three years. On that basis, the costs and benefits of the policy are shown in Table 8.

From these results it can be seen that that this policy presents a 'no regrets' option in both cases, in that the total net cost of the action is negative per tonne of GHG avoided. However, the policy does require significant expenditure from a government perspective.

In Table 9 it is assumed that the take up will be 9.4 per cent per year for three years for a total of 28.1 per cent. This table also includes the cost to government per tonne of GHG abated over the period 2008-2030.

Table 9: Costs and benefits of the policy (2008-2020)

Costs/benefit type	(28.1% uptake)
Total cost ($m)	758
Value of energy savings ($m)	1,222
GHG avoided (million tonnes)	9.9
Cost to government ($m)	390
Cost to households ($m)	368
Net cost per tonne of GHG avoided ($)	-46.81
Net cost per tonne of GHG avoided with a carbon price ($)[7]	-59
Net cost per tonne of GHG to government ($)	39
Net cost per tonne of GHG to government 2008-2030 ($)	21
Net cost per tonne of GHG to government 2008-2040 ($)	15
Net cost per tonne of GHG to government 2008-2050 ($)	11

Looking at these figures, it is clear that at the aggregate the option presented here represents a ‘no regrets’ policy in that its total net cost is negative. In the case of this policy just over a quarter of uninsulated homes are retrofitted. This generates avoided GHG emissions of 10 million tonnes over the period from 2008-2020 and, total monetary savings of $1.2 billion.

The next step is to examine the net cost per tonne of GHG avoided (with the specified carbon price), which is calculated by subtracting total savings in energy cost from total cost of insulation and then dividing by the GHG emissions avoided. This policy produces a net cost per tonne of -$59, which is very low. This is as a result of an assumption of self-rationing referred to earlier, in that only households with space conditioning will bother to take up the subsidy and it is these households which drive the highest energy savings. It is important to

[7] The carbon price is assumed to be $15 from 2010 to 2014, $20 from 2015 to 2020 and $30 from 2021 to 2030

note that the net cost remains low simply because the limited nature of the program only captures the highest energy users among households, even though there are still potential net benefits to be captured from extending the program further.

The policy has a cost to government of $39 per tonne over the period of analysis 2008-2020. This is because it relies entirely on a subsidy to drive GHG savings. However, it is also important to note that these high costs per tonne are related to the short period of analysis. Insulation will provide energy savings for the remaining life of the house. If this period of analysis were to be increased by just 10 years (2008-2030), there would be a significant reduction in cost per tonne abated – which will fall to around $21. It is important to note that these estimated GHG savings are based on a very conservative assumption about energy usage, which we have assumed remains static. Moreover, given that insulation continues to produce energy (and hence GHG) savings for the life of the house (the average life of a house, according ICANZ, is in excess of 70 years) in reality the cost per tonne abated is likely to be significantly below the numbers quoted. If Energy Efficient Strategies' assumptions about static energy usage and GHG intensity per household continue to be valid for this period, (it is important to note that these figures are only a best available estimate as GHG intensity by fuel source is likely to change over this period) the net cost to government will reduce to $15 per tonne for the period 2008-2040 and to $11 for the period 2008-2050.

Moreover, if policy offers either a $500 subsidy or 50 per cent of the total cost of insulation, (whichever is smaller) rather then $500 for every house, the cost to government will reduce further. This is because, in this case, those who self install will claim back $408 rather than $500. If we assume the same split between self installation and commercial installation, of 40 percent to 60 percent respectively, then the net costs to government will become:

- $36 per tonne for 2008-2020;
- $20 per tonne for 2008-2030;
- $14 per tonne for 2008-2040;
- $10 per tonne for 2008-2050.

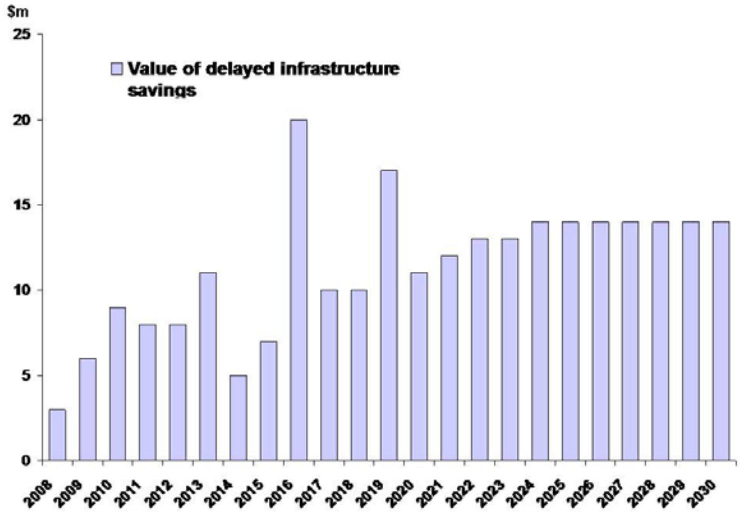
As we can see, these costs to government per tonne of GHG avoided, over a longer time period are quite low. There are some limitations to this policy option however, one being that a subsidy may not be effective in inducing landlords (who do not pay the energy bills) to install insulation.

6. Other benefits of the policy approach

So far we have presented the direct costs and benefits of the policy. However, there are also significant indirect benefits which would flow from a reduction in energy demand. One effect of this will be to reduce the need for new investment in electricity generation. This means that the community can gain the same benefits as before from a reduced supply of energy, while scarce investment capital can be put to more efficient use. Another benefit is likely to take the form of electricity prices being slightly lower than they otherwise would have been.

In order to understand the impact of these effects, McLennan Magasanik Associates (MMA) was commissioned to estimate them using its *Strategist,* a predictive model of Australia's electricity market. The modelling confirms that as a result of the interventions described above, there will be significant savings in the form of delayed infrastructure costs in the electricity sector (Figure 1).

Figure 1: Impact of reduced demand on infrastructure costs.



Source: MMA

Savings in delayed infrastructure, as a result of the low coverage of the policy, are small but substantial. Eventually, the policy gives rise to recurrent savings of around $14 million a year. The total NPV (5 per cent discount rate) for the period 2008-2030 of delayed infrastructure savings is $280 million.

When a carbon price is introduced, these savings in infrastructure costs would be marginally reduced as a result of the already lower levels of energy demand.

The reduction in energy demand means that electricity prices will be lower than they otherwise would have been, which represents a clear benefit to the economy. This would also have the effect of reducing the payback periods that we have outlined above. As a result of the already conservative assumptions underpinning these prices, however, we have not included this effect in our estimates of paybacks. Counterbalancing this point, the entire cost of the household's energy bill is likely to fall also – representing a net benefit. The manner in which reductions in wholesale energy price flows back to household cost reductions, by energy source and by state, is a complex and dynamic problem. This report has not attempted to quantify these effects as they involve a recursive feedback loop between demand and price. Moreover, as a result of the long lag times until there are large price falls, in most states those households which have invested in insulation will have paid back the initial cost before price reductions have any significant effect.

The impact of the policy on wholesale electricity prices is shown in the charts below.[8] Figure 2 shows the price impact of the policy, assuming the higher take-up of 28.1 per cent over three years.

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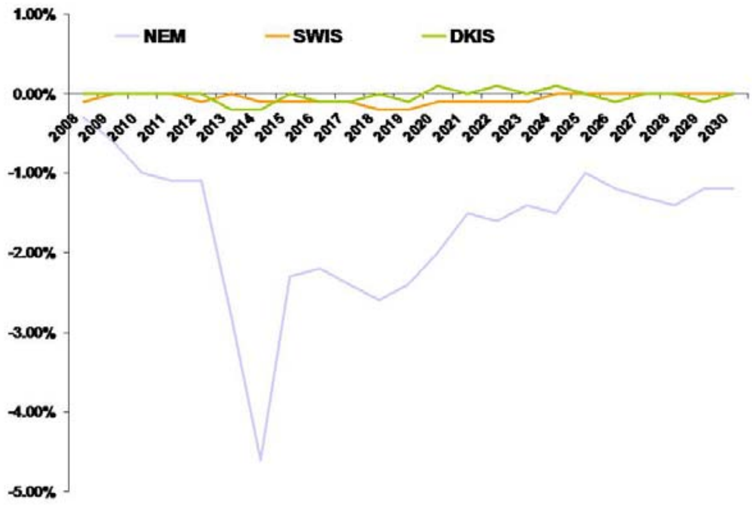
[8] Note that, in the charts, NEM refers to the National Electricity Market, a wholesale market for electricity supply in the Australian Capital Territory and the states of Queensland, New South Wales, Victoria, Tasmania and South Australia. SWIS (South West Interconnected System) is the major interconnected electricity network in Western Australia (WA). DKIS is the Darwin to Katherine Interconnected System.

Figure 2: Impact of reduced demand on wholesale electricity prices



Source: MMA

These reductions in wholesale prices are clearly significant, particularly in the NEM, where at one stage a reduction of nearly 5 per cent in the wholesale electricity price occurs.

These broader effects in the electricity market, the flow through of these price reductions to households, and the broader implications for other sectors of the economy have not been explicitly modelled here. Notwithstanding this, these effects do constitute significant and important benefits of the policy. These delays in infrastructure investment, and in peaking load cost impact, have, as already outlined, flow through effects on total consumer energy bills (particularly in the area serviced by the NEM) and drive significant benefits to households in the form of lower overall energy bills. This is in addition to the paybacks we have already presented.[9]

The benefits are not only quarantined to the household sector. The reductions in energy demand, and in this case in particular, peak electricity demand also mean that the energy once projected to be used by the household sector is 'released' for more productive uses in the economy and at a lower cost – this effect is explored in the following chapter.

7. Economic modelling

In order to assess the likely impact of the policy on the Australian economy more broadly, a computable general equilibrium (CGE) model is required. In many respects Australia leads the world in CGE modelling and the MONASH suite of CGE models has a lengthy history of development. These models, developed and operated by the Centre of Policy Studies (CoPS) at Monash University, are the most comprehensive CGE models available in Australia. They have been extensively documented, subject to comprehensive peer review and have a very high level of credibility among governments, academics and other expert bodies.

9 Although the reduction in energy bills will reduce the value in the energy saved, the cost savings for the overall bill will more than compensate for this reduction.

In assessing the wider economic impacts of the policy option we have used the Monash Multi-Regional Forecasting model optimised for assessing greenhouse gas impacts (MMRF-Green). MMRF-Green is a detailed dynamic, multi-sectoral, multi-regional model of Australia. The current version of the model distinguishes 54 industries, 58 products, eight States/territories and 56 sub-State regions. More details on the MMRF Green model are provided in Appendix B

In this case the model has been used to look at a variety of national indicators which will be affected by each of the different policy proposals. These indicators will be affected through a number of channels which include;

- there is an initial cost to the economy via an investment that provides returns down the track;
- the reduction in energy expenditure frees up money to be spent on other goods and services – increasing consumption; and
- the reduction in household energy use reduces energy prices and frees up that energy to be used elsewhere in the economy.

Note that a carbon price factored into the base case, with the carbon price being the same as is specified in the MMA simulations. That is, a $15 carbon price from 2010 to 2014, a $20 carbon price from 2015 to 2019 and a $30 carbon price from 2020 to 2030 have been specified.

The following data have been imputed exogenously into the MMRF-Green model.

- The take up rates for insulation;
- the cost of insulation has been imputed (and assumed to be static) from a weighted average of self installation (40%) and commercial installation (60%) which comes to $1046.4 for the average house;
- the cost savings per house are treated as exogenous to facilitate modelling although, obviously these would fluctuate as energy prices rise (causing them to increase) or as there is some reduction in the rate of energy price increase as a result of the reduction in peak energy demand as caused by the policy option; and
- as discussed above, the effects of a carbon price.

Note that all scenarios have used the average savings per household as a basis for determining energy savings, and so, where significant self selection is expected to occur, this should be taken as the lower bound of the economic benefits that could be expected from the policy

CoPS has modelled the outcomes as a technological change. The energy savings, which are imputed into the economy exogenously, are seen as technological improvements in the household sector. This is because the sector produces the same amount of outputs or better with a reduced amount of energy inputs. CoPS has also modelled the costs of putting in insulation as technological regress, in the sense that, for the periods where insulation is being installed, the outputs do not increase but the input costs (insulation installed) do increase.

As a result, in the initial phases, while insulation is being installed, there is a reduction to GDP, while in the later phases where energy savings are being accrued there are increases to GDP. This is because inputs which would have otherwise been used by households are released into the economy for other productive uses.

The effect on GDP is positive in the long term. We have assessed the overall impact in terms of net present value (NPV) using a conservative real 5 per cent discount rate. On this basis, over the period from 2008 to 2030, the NPV of the impact on Australia’s GDP:

- ICANZ's preferred policy, which induces approximately a 28 percent uptake, gives an increase to GDP of $384 million.

It is important to note that the effect that the subsidy had on GDP was not factored into the model. Usually, we would expect that a subsidy would put downwards pressure on GDP as a result of the effect of the tax wedge – this means that results from this analysis are upward biased.

The effect of this policy on real total consumption (real private consumption plus real public consumption; a proxy for the community's economic welfare) follows a similar pattern to the effect it has on GDP. When insulation is being installed initially, there is a drop in real total consumption, but then as the energy and monetary savings accrue to households, real private consumption increases.

In NPV(0.05) terms from 2008-2030, the effects on real total consumption are:

- ICANZ's preferred policy produces a $465 million increase to real total consumption.

The modelling also shows greenhouse gas reduction as a result of the policy. For the period 2008-2020 (the same analysis period used previously for GHG) the savings are:

- 9.1 million tonnes;

These savings are slightly below that of those we calculated earlier, this is because the data imputed into this model did not take account of self selection of space conditioned houses into the subsidy.

Overall, the results of the CoPS modelling show that the policy presented in this summary report would have a significant and positive impact on the Australian economy – it is a true 'no regrets' policy.

8. Conclusions and implications

The world is faced with a major need to stabilise carbon concentrations in the atmosphere so as to slow down and eventually arrest climate change. Until there is international agreement on a concerted global action strategy, there is little that Australia alone can do to tackle the problem. One area where unilateral action is clearly justified, however, is in improving the efficiency with which the Australian community uses energy. In this regard, there are particular benefits in taking up 'no regrets' opportunities, that is actions that provide net gains even in the absence of the benefits they provide by reducing greenhouse gas emissions.

One area that appears highly prospective is building insulation. An analysis by McKinsey suggests that of the range of areas available globally to reduce emissions, improving the insulation of buildings appears to be most cost-effective. This approach offers particular advantages in Australia, where the standard of building insulation lags well behind that of other countries, especially those with a less kind climate. It appears that over 35 per cent of Australian dwellings have no ceiling insulation at all, while in many other dwellings the standard of insulation is poor. On the basis of data provided by other consultants, the benefits of installing insulation, in terms of reduced energy bills over time, make this a 'no regrets' opportunity in most States.

If it is in their own financial interests to do so, why do so many dwellings have no ceiling insulation? There are a number of reasons for this including time preferences for money and myopia: some households would rather avoid the up-front cost of insulation than worry about energy bills which are in the future. Perhaps the main reason, however, lies in the 'split incentives' problem in the case of rental properties. While it is the responsibility of the landlord to install ceiling insulation, since the tenant pays the energy bills there is very little incentive for the landlord to do so. A large number of uninsulated dwellings are rental properties.

Because of these market imperfections and the community benefits arising from greater insulation, there is a strong case for policy intervention to achieve it.

This summary report presents ICANZ’s preferred option and outlines its costs and benefits.

Overall, this is a highly prospective area for government action in the interests of increasing energy efficiency and reducing greenhouse gas emissions. The modelling presented in this summary report shows that as well as driving significant cost savings per household and GHG savings, this initiative would have a positive impact on the Australian economy in terms of GDP and consumption (a proxy for the community’s economic welfare).

Appendix A: Assumptions

1. Assumptions relating to housing stock

It is assumed that the housing stock increases with trend. The growth in housing stock has been determined separately for each state by using the ABS building approvals data from the past three years. The growth has been determined using an average. Growth is not assumed to be compound. The annual growth for each state is assumed to be. These figures drive growth that is roughly aligned with the ABS household projections. Units were excluded from the analysis.

	NSW	VIC	QLD	SA	WA	TAS	NT	*ACT*
Three year average	*36,930*	*40,248*	*39,337*	*11,031*	*25,072*	*2,792*	*1,350*	*2,321*

The assumptions about the rate of insulation are based on ABS data, and for houses where tenants or owners do not know whether they have insulation. It has been assumed that 80 per cent do not have insulation. This is a best available estimate, based on ICANZ knowledge of the market. Moreover houses with reflective foil are assumed to be equivalent to uninsulated houses. The ABS data presented in, *Environmental Issues: People's Views and Practices Cat. 4602.0*, determined the rates of uninsulated, or insufficiently insulated housing stock per state.

In the BAU case, these rates of un-insulation (and under insulation) decrease over time as the housing stock increases (new houses are all assumed to be insulated). This is because many states require it and others require a star rated performance or which, insulation is part of one possible way to achieve a good star rating.

2. Assumptions relating to energy use

Each of the states have different energy use compositions by energy source and we estimate that this will, in the BAU case, remain static. This energy use composition was provided by Energy Efficient Strategies on behalf of ICANZ, and draws on work undertaken in 1998-1999 for the Australian Greenhouse Office and subsequently published as "Australian Residential Building Sector Greenhouse Gas Emissions 1990 – 2010 – July 1999 ISBN 1876536 26 X.

Energy Efficient Strategies provides the following explanation as to the validity of its data.

Because this data is over 5 years old the enclosed estimates should be treated with caution. More accurate estimates will be possible once the 1998-9 study is updated by EES later in 2007.

Particular items to note in relation to these estimates are:

- Greenhouse gas intensities are based upon the values that were applicable in each state in 1998-9 with an allowance of a 3% improvement by 2010. This estimate is expected to be reasonably accurate for the purposes of greenhouse gas abatement estimates in 2007.

- Thermal performance modelling for the 1998-9 study was based upon the use of the NatHERS modelling software. The latest generation of this software “AccuRate” would be expected to provide more accurate estimates of heating and cooling demand. AccuRate shall be used in the 2007 update of this original study.
- Estimates of air-conditioner ownership and trends in the 1998-9 study were based on ABS data available at the time. This data, from 1994 and earlier suggested a much slower growth in AC ownership than has been observed over the past 10 years. Consequently, the original study tended to significantly underestimate forecast cooling demand in most states. Because of the significance of this trend, the cooling demand has been re-scaled to approximate the observed increases in A/C ownership (now based on ABS 2005 data)
- Estimates in the 1998-9 study were based on the addition of insulation using 75% of the level recommended by standards Australia (AS2627.1 :1993). Effectively this meant the use of a maximum of R3.0 insulation in the more extreme climate zones.
- In the 1998-9 study states were divided into a maximum of 5 common climate zones used to describe all climate regions within Australia. The 2007 study shall use approximately 10 climate zones which should improve the accuracy of the forthcoming estimates.

Moreover, the estimates of energy and greenhouse gas savings do not take into account the possibility of “comfort creep”. That is, the perceived tendency of householder to increase their minimum comfort requirements following the application of building shell improvement measures. Such improvements in comfort requirements could take the form of changed thermostat settings and or an increase in actual conditioned floor area.

This potential factor has been ignored for three reasons:

- There is no hard data in the form of post occupancy surveys that would support an estimate of the likely impact of this phenomenon.
- Recent history has demonstrated that irrespective of improvements to the building shell, householders will continue to seek improved comfort conditions in their dwellings. This is evidenced by such things as the massive increase in air conditioner ownership over the past 10 years and the steady increase in whole of house heating and cooling systems. This suggests that the trend towards higher expectations for comfort will eventuate irrespective of the application of building shell improvement measures.
- An equally plausible scenario would be that in some cases, the application of building shell improvement measures will influence householders to avoid additional space conditioning. In particular, householders may decide that the addition of space cooling to a dwelling not already fitted with an air conditioner may be unnecessary following the application of improvement measures such as ceiling insulation and external blinds.

It should be bourn in mind that, while Energy Efficient Strategies has used the most comprehensive data available to develop these estimates, some data gaps do exist and these present limitations regarding the accuracy of some of these estimates

The estimated energy savings, and GHG savings are as follows. Note that these are the average use by household, by fuel type by state. Total energy use by house (by state)is found by adding each of the different fuel types as shown in the following tables.

2007 - Total Electric Space Heat/Cool

Energy Consumption	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
No Insulation (MJ/Household)	2279	1271	4029	3335	2969	2591	13785	2202
Ceiling Only (MJ/Household)	1271	841	2404	1772	1573	1712	9297	1455
Saving (MJ/Household)	1008	430	1625	1564	1396	879	4488	747
Greenhouse Gas Emissions								
No Insulation (t CO2-e/Household)	0.57	0.47	1.06	0.90	0.82	0.00	2.88	0.55
Ceiling Only (t CO2-e/Household)	0.32	0.31	0.63	0.48	0.43	0.00	1.94	0.36
Saving (t CO2-e/Household)	0.25	0.16	0.43	0.42	0.39	0.00	0.94	0.19

2007 - Total Mains Gas Space Heat/Cool

Energy Consumption	**NSW**	**VIC**	**QLD**	**SA**	**WA**	**TAS**	**NT**	***ACT***
No Insulation (MJ/Household)	5012	51715	109	8178	10177	0	29	*37478*
Ceiling Only (MJ/Household)	2795	34219	65	4344	5393	0	20	*24762*
Saving (MJ/Household)	2217	17496	44	3834	4785	0	9	*12717*
Greenhouse Gas Emissions								
No Insulation (t CO2-e/Household)	0.33	3.29	0.01	0.52	0.63	0.00	0.00	*2.44*
Ceiling Only (t CO2-e/Household)	0.18	2.18	0.00	0.27	0.33	0.00	0.00	*1.61*
Saving (t CO2-e/Household)	*0.14*	*1.11*	*0.00*	*0.24*	*0.29*	*0.00*	*0.00*	*0.83*

2007 - Total LPG Space Heat/Cool

Energy Consumption	**NSW**	**VIC**	**QLD**	**SA**	**WA**	**TAS**	**NT**	***ACT***
No Insulation (MJ/Household)	1316	1308	167	1092	823	3198	108	*485*
Ceiling Only (MJ/Household)	734	865	99	580	436	2113	73	*321*
Saving (MJ/Household)	582	442	67	512	387	1085	35	*165*
Greenhouse Gas Emissions								
No Insulation (t CO2-e/Household)	0.09	0.09	0.01	0.07	0.06	0.21	0.01	*0.03*
Ceiling Only (t CO2-e/Household)	0.05	0.06	0.01	0.04	0.03	0.14	0.00	*0.02*
Saving (t CO2-e/Household)	*0.04*	*0.03*	*0.00*	*0.03*	*0.03*	*0.07*	*0.00*	*0.01*

2007 - Total Wood Space Heat/Cool (Closed Combustion)

Energy Consumption	**NSW**	**VIC**	**QLD**	**SA**	**WA**	**TAS**	**NT**	***ACT***
No Insulation (MJ/Household)	6968	10150	1606	6723	12163	56650	62	*5429*
Ceiling Only (MJ/Household)	3886	6716	958	3571	6445	37434	42	*3587*

Saving (MJ/Household)	3082	3434	648	3152	5718	19216	20	*1842*
Greenhouse Gas Emissions								
No Insulation (t CO2-e/Household)	0.03	0.04	0.01	0.03	0.05	0.25	0.00	*0.02*
Ceiling Only (t CO2-e/Household)	0.02	0.03	0.00	0.02	0.03	0.16	0.00	*0.02*
Saving (t CO2-e/Household)	*0.01*	*0.02*	*0.00*	*0.01*	*0.03*	*0.08*	*0.00*	*0.01*

2007 - Total Wood Space Heat/Cool (Open Combustion)

Energy Consumption	NSW	VIC	QLD	SA	WA	TAS	NT	*ACT*
No Insulation (MJ/Household)	1383	2015	319	1337	2413	11246	12	*1087*
Ceiling Only (MJ/Household)	771	1333	190	710	1279	7431	8	*718*
Saving (MJ/Household)	612	682	128	627	1134	3815	4	*369*
Greenhouse Gas Emissions								
No Insulation (t CO2-e/Household)	0.08	0.12	0.02	0.08	0.14	0.65	0.00	*0.06*
Ceiling Only (t CO2-e/Household)	0.04	0.08	0.01	0.04	0.07	0.43	0.00	*0.04*
Saving (t CO2-e/Household)	*0.04*	*0.04*	*0.01*	*0.04*	*0.07*	*0.22*	*0.00*	*0.02*

2007 - Total All Fuel Types

Energy Consumption	NSW	VIC	QLD	SA	WA	TAS	NT	*ACT*
No Insulation (MJ/Household)	16958	66459	6229	20665	28545	73685	13996	*46681*
Ceiling Only (MJ/Household)	9457	43976	3717	10977	15125	48690	9439	*30842*
Saving (MJ/Household)	7501	22484	2512	9689	13420	24995	4557	*15839*
Greenhouse Gas Emissions								
No Insulation (t CO2-e/Household)	1.10	4.01	1.11	1.59	1.69	1.11	2.89	*3.11*
Ceiling Only (t CO2-e/Household)	0.61	2.65	0.66	0.85	0.90	0.74	1.95	*2.06*
Saving (t CO2-e/Household)	*0.48*	*1.36*	*0.45*	*0.75*	*0.80*	*0.38*	*0.94*	*1.06*

Estimates were also made by energy efficient strategies, for average households with space-conditioning. That is, households which have either an installed heating or an installed cooling device.

2007 - Total Electric Space Heat/Cool

Energy Consumption	**NSW**	**VIC**	**QLD**	**SA**	**WA**	**TAS**	**NT**	**ACT**
No Insulation (MJ/Household)	2851	1660	5779	3988	4759	2396	14972	2330
Ceiling Only (MJ/Household)	1590	1098	3448	2118	2522	1583	10097	1540
Saving (MJ/Household)	1261	561	2331	1870	2237	813	4875	791

Greenhouse Gas Emissions								
No Insulation (t CO2-e/Household)	0.71	0.62	1.53	1.07	1.31	0.00	3.13	0.58
Ceiling Only (t CO2-e/Household)	0.40	0.41	0.91	0.57	0.70	0.00	2.11	0.39
Saving (t CO2-e/Household)	0.32	0.21	0.62	0.50	0.62	0.00	1.02	0.20

2007 - Total Mains Gas Space Heat/Cool

Energy Consumption	**NSW**	**VIC**	**QLD**	**SA**	**WA**	**TAS**	**NT**	**ACT**
No Insulation (MJ/Household)	5569	52711	136	8883	12103	0	31	38187
Ceiling Only (MJ/Household)	3106	34878	81	4718	6413	0	21	25230
Saving (MJ/Household)	2463	17833	55	4165	5690	0	10	12957
Greenhouse Gas Emissions								
No Insulation (t CO2-e/Household)	0.36	3.35	0.01	0.56	0.75	0.00	0.00	2.49
Ceiling Only (t CO2-e/Household)	0.20	2.22	0.00	0.30	0.40	0.00	0.00	1.64
Saving (t CO2-e/Household)	0.16	1.13	0.00	0.26	0.35	0.00	0.00	0.84

2007 - Total LPG Space Heat/Cool

Energy Consumption	**NSW**	**VIC**	**QLD**	**SA**	**WA**	**TAS**	**NT**	**ACT**
No Insulation (MJ/Household)	1462	1333	208	1187	978	3232	117	494
Ceiling Only (MJ/Household)	815	882	124	630	518	2135	79	327
Saving (MJ/Household)	647	451	84	556	460	1096	38	168
Greenhouse Gas Emissions								
No Insulation (t CO2-e/Household)	0.10	0.09	0.01	0.08	0.07	0.22	0.01	0.03
Ceiling Only (t CO2-e/Household)	0.05	0.06	0.01	0.04	0.03	0.14	0.01	0.02
Saving (t CO2-e/Household)	0.04	0.03	0.01	0.04	0.03	0.07	0.00	0.01

2007 - Total Wood Space Heat/Cool (Closed Combustion)

Energy Consumption	**NSW**	**VIC**	**QLD**	**SA**	**WA**	**TAS**	**NT**	**ACT**
No Insulation (MJ/Household)	7742	10346	2007	7302	14464	57243	67	5532
Ceiling Only (MJ/Household)	4318	6846	1198	3879	7664	37825	45	3655
Saving (MJ/Household)	3425	3500	810	3424	6800	19417	22	1877
Greenhouse Gas Emissions								
No Insulation (t CO2-e/Household)	0.03	0.05	0.01	0.03	0.06	0.25	0.00	0.02
Ceiling Only (t CO2-e/Household)	0.02	0.03	0.01	0.02	0.03	0.17	0.00	0.02
Saving (t CO2-e/Household)	0.01	0.02	0.00	0.01	0.03	0.09	0.00	0.01

2007 - Total Wood Space Heat/Cool (Open Combustion)

Energy Consumption	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
No Insulation (MJ/Household)	1537	2054	398	1452	2869	11364	13	1108
Ceiling Only (MJ/Household)	857	1359	238	771	1520	7509	9	732
Saving (MJ/Household)	680	695	161	681	1349	3855	4	376
Greenhouse Gas Emissions								
No Insulation (t CO2-e/Household)	0.09	0.12	0.02	0.08	0.17	0.66	0.00	0.06
Ceiling Only (t CO2-e/Household)	0.05	0.08	0.01	0.04	0.09	0.43	0.00	0.04
Saving (t CO2-e/Household)	0.04	0.04	0.01	0.04	0.08	0.22	0.00	0.02

2007 - Total

Energy Consumption	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
No Insulation (MJ/Household)	19162	68103	8529	22812	35173	74234	15200	47651
Ceiling Only (MJ/Household)	10686	45063	5089	12117	18637	49053	10251	31483
Saving (MJ/Household)	8476	23040	3440	10695	16536	25181	4949	16168
Greenhouse Gas Emissions								
No Insulation (t CO2-e/Household)	1.30	4.22	1.58	1.83	2.35	1.12	3.14	3.20
Ceiling Only (t CO2-e/Household)	0.72	2.79	0.94	0.97	1.25	0.74	2.12	2.11
Saving (t CO2-e/Household)	0.57	1.43	0.64	0.86	1.11	0.38	1.02	1.08

To increase the accuracy of the data with the newest in thermal modelling, these figures (found using the NatHERS system) were updated using AccuRate by Tony Issacs. His findings are reproduced below.

The AccuRate software is the new benchmark standard for energy rating software in Australia. It is a development of the NatHERS software and the use of NatHERS itself will be phased out over the next 12 months. It contains many improvements over NatHERS including:

- Modelling each room as its own thermal zone. This improves the accuracy of energy modelling.
- The cross ventilation model now simulates the wind speed through each zone and calculates how this affects the perception of comfort. NatHERS was criticised heavily by the design community, particularly in NSW and Qld. for not taking this into account.
- Cooling thermostat settings and activation is based on a large body of international research into thermal comfort and far better represent actual occupant behaviour.
- The climate data used for simulation far better matches historical records than the climate data used for NatHERS.

AccuRate's energy savings predictions are therefore a better measure of the energy savings potential.

The ICANZ submission is based on energy savings predictions generated by NatHERS. These savings are predicted for one house with 18 construction options at 4 different orientations. While the construction options and orientation is necessary to establish the magnitude of energy use for the stock model it does not have a significant impact on the size of energy savings obtained through ceiling insulation.

To test the effect of using AccuRate on the size of energy savings the house used for the modelling was simulated in the most common construction type: Brick Veneer Walls and Concrete Slab floor at one orientation in the 5 climate types used for the modelling work. The table below shows the simulation results for NatHERS and AccuRate.

Tool	**Climate Zone**	**Ceiling**	**Energy MJ/m2**		**Heating saving**		**Cooling Saving**	
NatHERS			Heating	Cooling	%	MJ/m2	%	MJ/m2
	I (Townsville)	Unins	12.1	745.2				
		Ins	4.1	523.8	66%	8.0	30%	221.3
	II (Brisbane)	Unins	130.0	273.4				
		Ins	66.0	155.0	49%	64.0	43%	118.4
	III (West Sydney)	Unins	311.9	221.7				
		Ins	183.0	99.2	41%	128.9	55%	122.5
	IV (Melbourne)	Unins	702.2	92.4				
		Ins	476.4	48.2	32%	225.8	48%	44.2
	V (Canberra)	Unins	938.8	88.4				
		Ins	635.4	34.2	32%	303.4	61%	54.2
AccuRate	I (Townsville)	Unins	7.8	528.1				
		Ins	0.8	289.2	90%	7.0	45%	238.9
	II (Brisbane)	Unins	135.4	247.7				
		Ins	50.1	116.7	63%	85.3	53%	131.0
	III (West Sydney)	Unins	313.3	328.3				
		Ins	148.5	135.2	53%	164.8	59%	193.1
	IV (Melbourne)	Unins	543.5	141.4				
		Ins	284.7	62.5	48%	258.8	56%	78.9
	V (Canberra)	Unins	692.3	189.1				
		Ins	370.5	67.0	46%	321.8	65%	122.1

In general AccuRate predicts higher MJ/m2 and percentage savings for ceiling insulation. The energy savings reported by ICANZ should therefore be scaled up to reflect the fact that NatHERS underestimates the energy savings delivered by ceiling insulation. Note that while AccuRate predicts lower cooling energy use due to its better handling of ventilation, energy savings for ceiling insulation are still bigger than predicted by NatHERS inj both percentage and absolute terms.
Each state is broken is allocated a different proportion of the 5 climate zones. To derive a scaling factor for each state will therefore require that the ratios for each climate zone be weighted according to their incidence in the state. The figure below shows the proportions of houses allocated to each of the 5 climate zones in each state.

Figure 27: Distribution of housing stock by climate type by state 1998

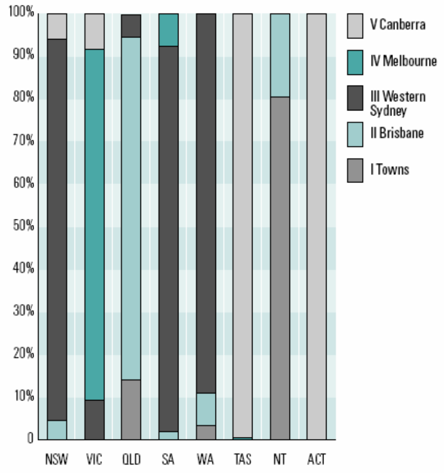
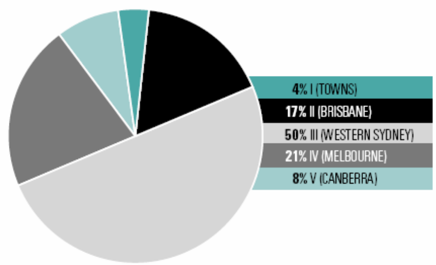


Figure 28: National proportions of housing stock in each climate type 1998



Applying the weighting as shown above delivers factors which can be used to scale up the energy savings predicted using NatHERS as shown in the table below:

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
Heating Ratios	1.28	1.46	1.29	1.29	1.28	1.44	1.34	1.44
Cooling Ratios	1.07	1.15	1.26	1.08	1.09	1.05	1.46	1.05

These weightings can be used to scale fuel type by whether it is used for heating or cooling. Electricity savings can be scaled using a weighted measure which was also provided by Tony Issacs.

	NSW	VIC	QLD	SA	WA	TAS	NT	*ACT*
Heating and cooling	*1.182*	*1.389*	*1.279*	*1.190*	*1.183*	*1.364*	*1.465*	*1.364*

3. Assumptions regarding energy prices

In general it is assumed that retail electricity prices will increase in line with increases in wholesale prices provided by COPS over the period of analysis, there is also some slight increase in gas prices over this period. This is a very conservative estimation of where energy prices will head. The prices are different for each state. The assumed current prices are as follows (based on YTD averages), we used a weighted average of these prices to generate an estimate of the average price per state.

GAS Prices

			Block	**Next**
		Block (GJ/yr)	$/GJ	$/GJ
NSW	AGL	22.0	$16.03	$14.96
Vic	AGL	21.0	$10.10	$7.98

	Origin	24.0	$11.67	$10.96
	TRUEnergy	19.2	$12.18	$10.30
Qld	Origin	6.8	$36.70	$24.37
	AGL	3.1	$39.80	$22.10
SA	Origin	18.0	$19.75	$12.92
Tas	Option One	N/a	$15.99	
WA	Alinta	15.8	$21.17	$13.69
WA	Alinta	4380	$0.0762	$0.0493

Electricity Prices

			Block	**Next**
		Block (kwh/yr)	c/kwh	c/kwh
NSW	EA	7000	11.9215	16.2358
	Integral	7000	13.57697	14.69897
	CE	N/a	16.841	
VIC	AGL	N/a	14.729	
	Origin	4000	15.994	17.27
	TRUEnergy	4080	14.81	13.81
Qld	Origin	N/a	13.882	
	AGL	N/a	13.882	
SA	AGL	4000	17.952	19.25
Tas	Aurora	6000	15.153	11.135
WA	Synergy	N/a	13.94	

LPG prices were based on Kleenheat Gas and ELGAS quotes – note that these are very conservative estimates for these prices. These worked out at approximately $25 dollars per GJ – note however, that this is an average price.

It is assumed that the cost of wood is $50 a tonne, and that there is 7 to 10 GJ of heat energy in it. This means that a conservative estimate of fuel cost would be $5 per GJ.

4. Assumptions about insulation costs

The models also make assumptions of about the cost of insulation – which has been set at $1,200. According to ICANZ, an average house would use 150m2 of R3.5 ceiling insulation at a standard supply and install rate of $8 per square metre. This would come to a total cost of $1,200. If the attic space is encumbered in any way, ICANZ estimates that the rate would increase to approximately $10 per square metre which would result in a total cost of $1,500 for a standard house installation.

The cost for DIY insulation is $816 which is taken from the Bunnings' price for R3.5 standard insulation which is $48 per 9 m2 pack. Assuming typical older existing home is 150m2 ceiling area then you need 17 packs for the house = $816.

ICANZ estimates that the DIY share of the insulation market in 40 percent. So the cost for insulation of the representative household is $1046.4 per household.

Note that the models have not added any variable that captures housing type – so in regards to energy savings, and insulation costs, these are average costs.

Appendix B

MMRF-Green

This Appendix highlights key general assumptions about the MMRF general computable equilibrium model of the Australian economy. It also provides references for further public documentation and analysis of the model.

Model overview and enhancements

The MONASH suite of CGE models has a lengthy history of development. They are the most comprehensive models available in Australia, are extensively documented and have been subject to comprehensive peer review. They have a very high level of credibility among governments, academics and other expert bodies.

MMRF is a detailed dynamic, multi-sectoral, multi-regional model of Australia. The current version of the model distinguishes 54 industries, 58 products, eight States/territories and 56 sub-State regions.

MMRF is founded on the Monash Multi-Regional (MMR) model, and was built in three stages. In the first stage, MMR was transformed into a dynamic system by the inclusion of dynamic mechanisms. These were added as self-contained blocks, allowing MMRF to include MMR as a special case. The second stage involved a range of developments designed to enhance the model's capacity for environmental analysis. In the third stage, a regional disaggregation facility was added, which allows state-level results to be disaggregated down to sub-state regions.

MMR

MMR divides Australia into the six states and two territories. There are five types of agents in the model: industries, capital creators, households, governments, and foreigners. The number of industries is limited by computational constraints. For each industry in each region there is an associated capital creator. The sectors each produce a single commodity and the capital creators each produce units of capital that are specific to the associated sector. Each region in MMR has a single household and a regional government. There is also a federal government. Finally, there are foreigners, whose behaviour is summarised by export demand curves for the products of each region and by supply curves for international imports to each region.

MMR determines regional supplies and demands of commodities through optimising behaviour of agents in competitive markets. Optimising behaviour also determines industry demands for labour and capital. Labour supply at the national level is determined by demographic factors, while national capital supply responds to rates of return. Labour and capital can cross regional borders so that each region's stock of productive resources reflects regional employment opportunities and relative rates of return.

The specifications of supply and demand behaviour co-ordinated through market clearing equations comprise the general equilibrium (GE) core of the model. There are two blocks of equations in addition to the core. They describe regional and federal government finances and regional labour markets.

From MMR to MMRF: dynamics

There are two main types of inter-temporal links incorporated into MMRF: physical capital accumulation and lagged adjustment processes. These are explained below.

Physical capital accumulation

It is assumed that investment undertaken in year t becomes operational at the start of year t+1. Thus, given a starting point value for capital in t=0, and with a mechanism for explaining investment through time, the model can be used to trace out the time paths of industry capital stocks.

Investment in industry i in state/territory s in year t is explained via a mechanism that relates investment to expected rates of return. The expected rate of return in year t can be specified in a variety of ways. In MMRF two possibilities are allowed for, static expectations and forward-looking model-consistent expectations. Under static expectations, it is assumed that investors take account only of current rentals and asset prices when forming current expectations about rates of return. Under rational expectations the expected rate of return is set equal to the present value in year t of investing $1 in industry i in region r, taking account of both the rental earnings and depreciated asset value of this investment in year t+1 as calculated in the model.

Lagged adjustment processes

One lagged adjustment process is included in MMRF. This relates to the operation of the labour market in year-to-year policy simulations.

In comparative static analysis, one of the following two assumptions is made about the national real wage rate and national employment:

- the national real wage rate adjusts so that any policy shock has no effect on aggregate employment; or
- the national real wage rate is unaffected by the shock and employment adjusts.

MMRF's treatment of the labour market allows for a third, intermediate position, in which real wages can be sticky in the short-run but flexible in the long-run and employment can be flexible in the short-run but sticky in the long-run. For year-to-year policy simulations, it is assumed that the deviation in the national real wage rate increases through time in proportion to the deviation in aggregate employment from its Base Case-forecast level. The coefficient of adjustment is chosen so that the employment effects of a shock are largely eliminated after about ten years. This is consistent with macroeconomic modelling in which the NAIRU is exogenous.

Closure assumptions

Supply-side structure

The standard MMRF treatment of input-structure applies to all industries, including the three new industries representing the core elements of the Project. Capital and agricultural land is assumed to be industry specific, while there is only one type of labour employed by all industries in all regions. There is no explicit allowance for natural-resource as a fixed factor of production. The primary-factor substitution elasticity is set to 0.5 for all industries. Trade elasticities for international and interstate imports and exports are available on request.

Labour markets

At the national level, we assume that the deviation in the national real wage rate from its Base Case level increases in proportion to the deviation in economy-wide employment from its Base Case level. Eventually, the real wage adjustment eliminates the deviation in national employment. Thus in the long-run the national labour-market impacts of the Project will be revealed as changes in the national real wage rate, rather than as changes in national employment.

At the state/territory level, we assume that labour is imperfectly mobile between State economies. Thus a region that is favourably affected by the Project will experience a mix of increased employment and increased wage-rates relative to regions that are less favourably affected.

People move between regions so as to maintain unemployment-rates at their Base Case levels.

Public expenditure, taxes and government budget balances

We assume that real consumption by regional governments and real consumption by the federal government are unaffected by the Project. We assume that all indirect tax rates have the same values as in the Base Case simulation. The Federal government's budget balance is fixed to its Base Case value via endogenous adjustments to the average PAYG tax rate. State government budget balances are fixed via endogenous changes in direct transfer payments to households.

Consumption, investment, ownership of capital and measurement of welfare

In each year of the deviation scenarios, the composition of aggregate real consumption across states/territories diverges from its Base Case level by an amount reflecting the divergence in real income available to residents. In calculating real income available for consumption we take account of: direct income from factors (with an allowance for the net flow of foreign income); income from other sources such as government welfare payments; and income tax. Because the balances on government accounts are kept fixed, the impacts on real private consumption in each region are reliable indicators of the impact of the Project on the economic welfare of incumbents.

Rates of return on capital

In deviation simulations MMRF allows for short-run divergences in rates of return on industry capital stocks from their levels in the Base Case forecasts. Such divergences cause divergences in investment and capital stocks. The divergences in capital stocks gradually erode the divergences in rates of return, such that in the longer term rates of return have returned to their Base Case values.

Production technologies

MMRF contains many types of technical change variables. In the deviation simulations we assume that all technology variables, other than those required to implement the shocks, have the same values as in the Base Case simulation.

Public documentation

Public documentation of the MMRF model is available at:

- Pezzey, J.C.V. and Lambie, N.R., 2001, Computable general equilibrium models for evaluating domestic greenhouse policies in Australia: A comparative analysis, Report to the Productivity Commission, AusInfo, Canberra.
- Adams, P.D., Horridge, J.M. and Parmenter, B.R., 2000, MMRF: A Dynamic, Multi-sectoral Model of Australia, Centre of Policy Studies, Monash University, Melbourne.