

## **Appendix 2**



# COMPARATIVE COST BENEFIT STUDY OF ENERGY EFFICIENCY MEASURES FOR CLASS 1 BUILDINGS AND HIGH RISE APARTMENTS IN VICTORIA

## Executive Summary – March 2002

Prepared by Energy Efficient Strategies for the Sustainable Energy Authority of Victoria

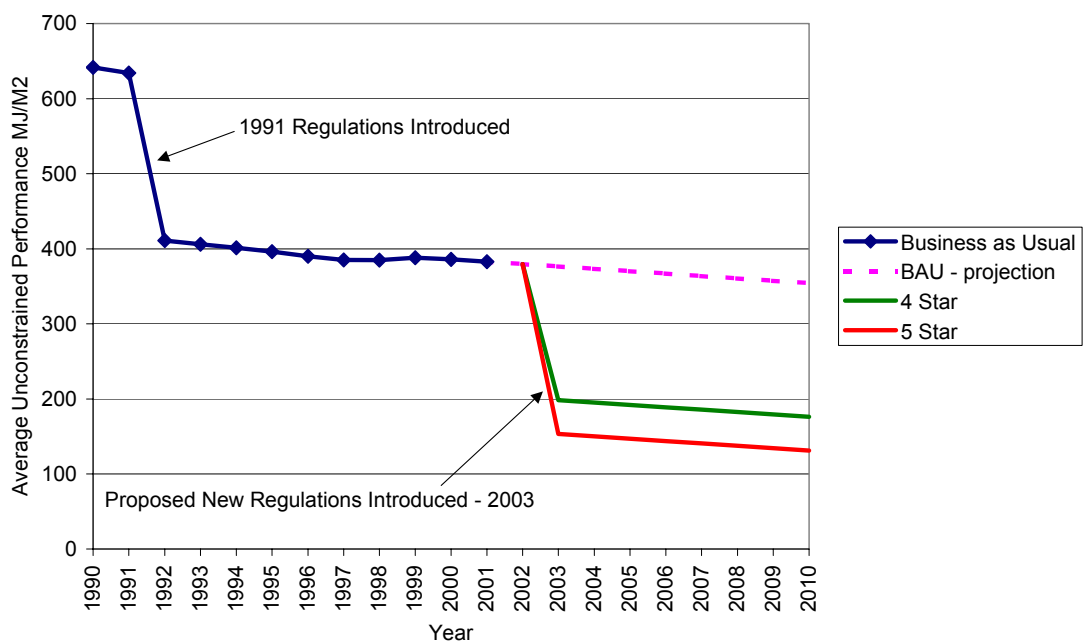
### BACKGROUND

In 1991 Victoria introduced regulations designed to improve the thermal efficiency of residential buildings. These regulations, that form part of the BCA, prescribed minimum levels for insulation of ceilings, walls and in some cases floors. A study into the impact of these regulations entitled *Study of the Impact of Minimum Energy Performance Requirements for Class 1 Buildings in Victoria* (EES 2000) found that these regulations produced a significant improvement in the performance of new housing and that by the year 2000 the regulations were saving an estimated half a million tonnes of CO<sub>2</sub>-e emissions in Victoria per annum.

The EES study also found that apart from the improvements that were a direct result of the introduction of the regulations further improvements have not been forthcoming – see Figure 1. Despite cost effective improvements being available, the market with a few notable exceptions has generally failed to respond to these opportunities.

This study examines the possibility of once again regulating to improve the thermal performance of new housing coming onto the market. The study considers the likely impacts as well as the cost effectiveness of various options for improvement.

• Figure 1 Average Thermal Performance for Victorian Housing 1990 – 2000 With Projections to 2010



## WHAT WAS EXAMINED

### SCOPE

The scope for the study included the following:

- Detached and Attached type Housing (Class 1a) as well as High Rise Apartments
- Five different climatic regions across the state. (As defined in NatHERS)
- Three levels of building occupancy.
- 4 and 5 star target building shell performance levels.
- Both deemed to satisfy and computer simulation approaches to compliance.
- Housing with either suspended timber floors or concrete slab on ground floors.
- Various combinations of home space conditioning equipment installations.

### IMPROVEMENT OPTIONS

The following performance improvement options were considered in this study:

- Fitting of seals to external doors.
- Effective sealing of Gaps and Cracks around openings and penetrations.
- Increased levels of ceiling insulation.
- Increased levels of wall insulation.
- Use of thermally improved window frames.
- Clear double glazing (either part or whole building).
- Low –e double glazing
- Shading devices to windows on selected elevations.

### COSTS

Costs were assessed from two perspectives – those for non volume builders and those for volume builders. The results of both were then weighted accordingly. Cost Rates adopted in this study were reviewed and confirmed by selected manufacturers /suppliers and by selected volume builders.

### BENEFITS

Three forms of benefit were assessed in this study. These were:

- Reductions in space conditioning energy consumption and operational cost.
- Reductions in required space conditioning plant capacity and its capital cost afforded through the construction of houses with higher (4 or 5 star) efficiency levels.
- Reductions in Greenhouse Gas emissions. Assessments was made both in terms of tonnes of emissions avoided and dollars saved (assuming reductions were valued at \$30 per tonne CO<sub>2</sub>-e avoided)

Benefit assessment allowed for actual appliance use, ownership, efficiency and fuel source rather than the standardised energy use predicted by the House Energy Rating building shell thermal performance modelling software such as First Rate.

## STUDY METHODOLOGY - OUTLINE

The methodology for this study consisted of taking a large representative sample of current Victorian housing designs and modelling their performance using First Rate. Various improvement measures were then applied to that sample until a required target performance level (star rating) was reached. At this point an assessment was made of the benefits and costs associated with the application of those improvements. Target Performance levels were deemed to have been met when a minimum proportion of the sample achieved the required performance level. For this study a minimum compliance target of 90% was set.

The sample used in this study provided for a sampling error of  $\pm 6\%$  at a 95% confidence interval for both the detached and the attached housing population. No error limits were available for the high rise apartments.

## KEY FINDINGS OF THIS STUDY

### IMPACTS AT THE STATE LEVEL<sup>1</sup>

#### Energy Consumption

The study estimated that potential reductions of between approximately 0.44 PJ (4 Star) and 0.61 PJ (5 Star) may be derived from each year of production of Victorian housing to an improved performance standard. In dollar terms, based upon current tariffs this equates to between \$4.5 million and \$6 million dollars in energy cost savings. Provided these standards are maintained into the future these savings will compound annually (subject to annual variations in building activity and other related factors).

Residential energy consumption in Victoria in 2002 is estimated to be 133.9PJ (EES 1999), of this, 58% is estimated to be used for space conditioning. The predicted growth rate in total Victorian residential energy consumption until 2010 is 1% per annum<sup>2</sup> (EES 1999). Based on the findings in this study it is estimated that this rate would decrease to 0.54% per annum (5 star performance target) or 0.66% PA (4 star performance target).

#### Greenhouse Gas Emissions

Annual reductions in Victoria's level of residential greenhouse gas emissions following the introduction of either a 4 star or a 5 star performance requirement are estimated to be between 32,000 and 43,000 tonnes respectively. This reduction will be cumulative over time i.e. each year a further thirty to forty thousand tonnes will be saved.

Projecting out to the year 2010 it is estimated that at the current long term average rate of residential building activity (average 1990-1999) that a 5 star performance target will deliver 0.38 Mt CO<sub>2</sub>-e<sup>3</sup> of space conditioning greenhouse gas abatement in 2010 and a 4 star target will deliver 0.25 Mt of CO<sub>2</sub>-e abatement.

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<sup>1</sup> The results presented in this section are, unless otherwise noted, based on the assumption that compliance with the regulations is primarily achieved through whole building performance assessment rather than through deemed to satisfy clauses as these have been shown to be a more costly approach and that for detached and attached housing, home designers will reduce the area of glazing in highly glazed houses to average 25% of the Net Conditioned Floor Area of the dwelling i.e. slightly less than current average levels.

<sup>2</sup> Note: This rate is somewhat less than the estimated rate of growth in space conditioning energy consumption alone (1.24% per annum)

<sup>3</sup> Mt CO<sub>2</sub>-e = Millions of tonnes of carbon dioxide equivalent.

## Investment

Introduction of more stringent energy standards for residential buildings will result in a need for an increased investment in the energy efficiency of those buildings. An analysis of the likely annual level of state wide investment that would flow from the introduction of a 4 star or a 5 star performance requirement was made and the results indicate between \$56 and \$115 million dollars<sup>4</sup> of added investment respectively. This represents between approximately one and a half and two and a half percent of total annual investment in Victorian housing.

## Cost Effectiveness of the Proposed Measures

Based on the results of this study the application of a state wide average 4 or 5 star performance requirement could be justified in terms of the benefit to cost ratio outcome (see Table 1). In this table an investment period of 40 years and a discount rate of 4% has been used.

• Table 1 State Average Benefit to Cost Ratios - All Housing Types

Benefits Evaluated	Simulation <sup>5</sup>		Deemed to Satisfy <sup>5</sup>	
	4 Star	5 Star	4 Star	5 Star
Savings in Fuel Costs	1.64	1.17	1.41	1.00
Savings in Fuel and Plant Costs	2.14	1.49	1.70	1.23
Savings in Fuel and Plant and Emissions Costs	2.49	1.73	1.97	1.43

Note: These results are state wide averages. Cost benefits vary between different climate areas and types of house. If required different performance levels could be set for different floor types or climates to select the most cost effective option.

It should be noted that these estimates are considered conservative. No account has been taken in these estimates of factors such as:

- Real increases in fuel prices
- The likely fall over time of the cost of energy efficient house design as the industry becomes more familiar with energy efficient design techniques,<sup>6</sup>
- Trends towards houses with larger floor areas
- Increases in use of whole house space heating,
- Increased penetration of space cooling in Victorian houses
- Increased demand for energy efficient building products leading to reductions in costs
- Macro economic benefits such as the shift of capital from the energy sector with low levels of employment per \$ invested to the manufacturing sector with higher levels of employment per \$ invested.

## IMPACTS AT THE HOUSEHOLD LEVEL

Average impacts at the householder level are presented in Table 2. Home loan impacts are based upon a 25 year loan at 6.1% interest rate and assume the average value of a new home to be \$144,800 (HIA 2001). Net Present Values (NPV) estimates are based upon a real discount rate of 4% over a 40 year investment period.

<sup>4</sup> These figures represent the net present value of both the initial investment and replacement costs over a 40 year time frame. The initial investment accounts for more than 90% of this amount.

<sup>5</sup> Deemed to Satisfy implies the application of a prescribed set of improvement measures that when applied to any house will under the regulation deem that house to satisfy the performance requirement. A simulation approach relies on the use of a thermal performance modelling tool such as FirstRate to demonstrate compliance with the performance requirement.

<sup>6</sup> Based upon experience from the Energy Smart Builders program in Victoria

Savings and benefit/cost estimates only include savings in fuel costs. If plant cost savings are also included, the total NPV of the savings shall be improved by approximately 25% to 30%.

• Table 2 Average impacts on New Victorian Households (Simulation method of compliance)

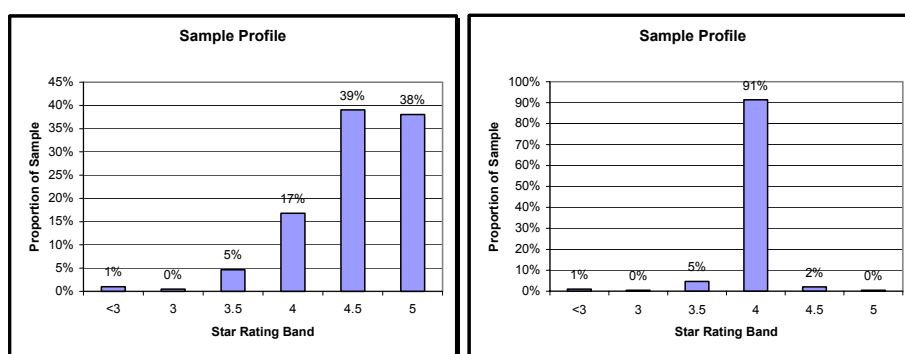
Performance Target	Initial Investment Costs	Average increase in house cost	Annual Increase to Home loan	Annual Fuel Cost Savings	NPV of Fuel Cost Savings	Annual Green - house Gas Savings
4 Star	\$ 1686	1.2%	\$ 132	\$148	\$2933	1.05 t
5 Star	\$ 3280	2.3%	\$ 256	\$205	\$4141	1.45 t

## SIMULATION APPROACH OFFERS GREATER BENEFITS

Benefits accrued differently depending upon whether the Deemed to Satisfy method or the simulation method was applied. In the case of deemed to satisfy, the average level of required improvement was greater than compared to the simulation method. This meant that the deemed to satisfy method delivered greater benefits but also greater costs. Analysis of the results demonstrated that the increase in benefit associated with the deemed to satisfy method was consistently outweighed by the associated increase in costs.

Reference to performance distribution charts (eg Figure 2 – Timber floored detached housing – 4 star target performance level) reveals that the simulation method accurately matches an appropriate level of improvement to each house in the sample such that the target performance level is reached but rarely exceeded. In the case of the deemed to satisfy method the same set of improvements are applied to all houses in the sample resulting in many houses significantly exceeding the target performance level. Diminishing returns apply to higher levels of investment, this means that the deemed to satisfy method offers reduced cost effectiveness compared to the simulation method.

• Figure 2 Performance Distribution Charts for Timber Floored Detached Housing – Deemed to Satisfy Method (Left) and Simulation Method (Right)



The use of the simulation method of compliance is estimated to save Victorian home builders in the order of \$40-\$50 million dollars in investment costs per annum. In reality, users of the simulation approach would be able to achieve compliance at a lesser cost than that modelled in this study. The experience of some builders in the SEAV Energy Smart Builders program suggests that improvement costs using the simulation method can be reduced to as little as one half of the costs estimated in this study when they design for energy efficiency from scratch rather than use the simulation to fix up an existing design.

## BENEFITS OTHER THAN FINANCIAL BENEFITS

Apart from the estimated financial benefits to the Victorian householder of improved thermal performance standards, other non financial benefits are also likely to be available. These are:

- Improved weather proofing of homes.
- Improved all weather outdoor amenity – where verandahs or substantial eaves are incorporated.
- Improved acoustic attenuation – where double glazing is used. This can be especially important in medium to high density housing developments.
- Health Benefits – especially for those with respiratory illness, through the limitation on internal temperature swings and elimination of condensation and associated mould growth.
- Peak Demand Reduction – Improved residential thermal performance will help to limit the demand for space cooling from the improved new housing.

## CONCLUSIONS

This study has found that:

- The application of higher thermal performance standards for Victorian residential buildings can be justified on financial grounds at both the 4 and 5 star level.
- A 4 star level offers a superior cost to benefit ratio than a 5 star level. Victoria is responsible for 57% of Australia's greenhouse gas emissions for residential heating and cooling - three times more than any other state. Consequently, the 5 star level may be justified in terms of the national significance of Victoria's emissions.
- The application of higher thermal performance standards for Victorian residential buildings offers a number of benefits other than financial benefits including reduced cost of heating and cooling appliances, the value of greenhouse gas mitigation and a number of amenity improvements.
- At a 4 star level the rate of growth in Victoria's residential energy demand is estimated to be reduced by 34% while a 5 star level is estimated to reduce the rate of growth by 46%.
- The benefits to the state in terms of greenhouse gas emission reductions and reduced growth rates in energy demand are significant.
- The impost on the homeowner in terms of added home loan repayment costs is small and that this cost is largely and in many cases completely offset by savings in fuel costs.
- While a universal standard has advantages in terms of simplicity, construction of the floor and climatic differences do slightly alter benefit to cost ratios and a variable minimum performance level may be appropriate..
- Deemed to Satisfy measures alone will make it difficult to achieve the across the board energy efficiency levels that a simulation approach would guarantee.
- The simulation method of compliance offers improved cost effectiveness compared to the deemed to satisfy method and could save Victorian home builders an estimated \$40-\$50 million dollars in investment costs per annum.

## ABOUT THIS STUDY

This executive summary was prepared by Energy Efficient Strategies under contract to the Sustainable Energy Authority of Victoria.

This is an executive summary of a report entitled, “*COMPARATIVE COST BENEFIT STUDY OF ENERGY EFFICIENCY MEASURES FOR CLASS 1 BUILDINGS AND HIGH RISE APARTMENTS IN VICTORIA*”, available from the Sustainable Energy Authority of Victoria

Readers should bear in mind that, while we have used the most comprehensive data available to develop our estimates, some data gaps do exist and these present limitations regarding the accuracy of some of these estimates.

**Comments and further information is available from Mr Tony Isaacs, Sustainable Energy Authority of Victoria, 215 Spring St Melbourne 3000 or email <[tony.isaacs@seav.vic.gov.au](mailto:tony.isaacs@seav.vic.gov.au)>.**

