National Framework for Energy Efficiency

Background Report (V4.1)

Preliminary Assessment of Demand-Side Energy Efficiency Improvement Potential and Costs

20 November 2003

NATIONAL FRAMEWORK FOR ENERGY EFFICIENCY

Acknowledgements

This report has been prepared by the Sustainable Energy Authority Victoria in association with Graham Armstrong and Saturn Corporate Resources for the Energy Efficiency and Greenhouse Working Group (E2G2), as part of the development of the National Framework for Energy Efficiency. The study reported on here prepared technical inputs for an economic modelling and policy issues study undertaken by the Allen Consulting Group (ACG) in association with the Centre for Policy Studies at Monash University (COPS or Monash).

Work that has been undertaken to date for the National Framework for Energy Efficiency includes a Stock Take of Australian Energy Efficiency Programs, an Assessment of Barriers to Energy Efficiency and a Statistical Analysis of Energy Use in Australia.

CONTENTS

FIGURES

TABLES

Executive Summary

Introduction

In November 2002, the Ministerial Council on Energy (MCE), comprising commonwealth, state and territory energy ministers, endorsed a proposal for development of a National Framework for Energy Efficiency (NFEE or National Framework) to define future directions for energy efficiency policy and programs in Australia. The objective of the National Framework is to unlock the significant economic potential associated with increased implementation of energy efficient technologies and processes, to deliver a least cost approach to energy provision in Australia.

The National Framework will be strategic in focus and developed cooperatively with all jurisdictions and key stakeholders. It will aim to achieve a sustained, measurable improvement in Australia's demand-side energy efficiency, primarily in the residential, commercial and industrial sectors. It will be a coordinated nationally-consistent program to achieve a "step change" in energy efficiency. While some current energy efficiency programs are effective, taken as a whole, existing programs have not been adequate to address an increase in the real energy intensity of the Australian economy over the last decade.

The National Framework will focus on approaches to achieve net economic benefits and improve the energy efficiency and competitiveness of the Australian economy, stimulate investment in sustainable industries, and help to reduce Australia's environmental impacts. While it will encompass energy use across a wide range of sectors and activities, comprehensive economic analysis will assist in targeting sectors which generate the greatest net economic benefits.

Energy efficiency improvement potential study

For this study, energy efficiency improvement (EEI) is defined in terms of the energy savings that could be achieved as a percentage of current energy use for a specific energy service. The objective of the study was to provide, in a short time frame, a *preliminary estimate* of the potential for, and costs of, energy efficiency improvement (EEI), in the residential, commercial and industrial (stationary) energy end-use sectors in Australia, in order to:

(i) provide inputs for economic modelling (reported on in a separate study) to give an *order of magnitude* estimate of the national costs and benefits of energy efficiency improvement, beyond the business-as-usual levels, over a 12-year period;

(ii) stimulate discussion on the potential for, and means of achieving, significant energy efficiency improvements in Australian stationary end-use sectors; and

(iii) provide an initial indicator of the extent of further EEI analysis required for the development of the National Framework.

A three step process has been employed to develop the initial *order of magnitude* estimates of the national costs and benefits of energy efficiency improvement, to guide the development of the NFEE, as shown in Figure 1 below. This report covers the first two steps in this process, namely the development of the EEI potential estimates, which were then used as the inputs to the National Energy Efficiency Improvement Potential (NEEIP) model, used to derive the 'raw' estimates of the implementation costs and energy savings. This data was then used as the 'exogenous shock' data input to the economic modelling study.

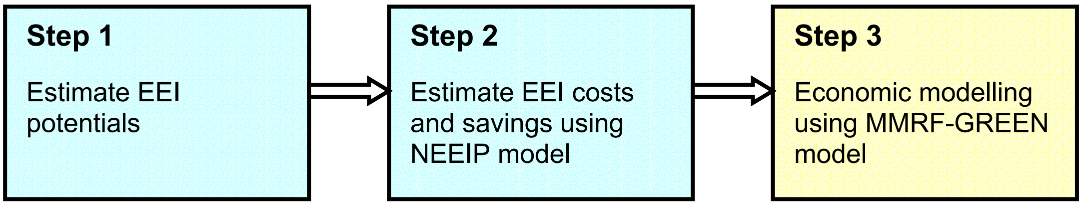


Figure 1: Three step process to estimate costs and benefits of EEI

This work does not purport to be a definitive study on energy efficiency improvement potential in Australia, and its inherent limitations are recognized. The key limitations, which underscore the preliminary nature of the estimates provided and point to the need for further detailed work in this area, are as follows:

- due to the short time-frame available for the study, it was not possible to undertake original research, meaning that the EEI potential and cost estimates were based on a range of existing data sources in each energy end-use sector;

- estimates are based on national averages (EEI potential, implementation costs and energy prices), as adequate data was not available to take into account regional variations;

- the limitations of the available data meant that it was not possible to analyse, in the commercial and industrial sectors, detailed sub-sectoral EEI opportunities, or to analyse different types of dwellings in the residential sector;

- in most cases, it was not feasible to take into account fuel substitution (changes in the energy mix) in each sector over the study period. Nor was it possible to consider the optimal energy efficiency improvement of energy services, systems and processes;

- the EEI implementation cost estimates are based on current costs, and do not take into account any cost reductions that might arise through an increased scale of implementation of more energy efficient technology. Also, in most cases, the extent to which the estimates used included transaction costs is not known;

- in the commercial and industrial sectors simple paybacks are used as the investment criterion to identify EEI opportunities (as this is the most commonly used criterion). Paybacks tend to under-value the return on longer life investments. In general, the paybacks are based only on the energy savings, as most available data does not quantify the non-energy benefits, such as overall productivity improvement. Also, energy saving cost estimates do not include any non-market environmental costs;

- the EEI potential estimates do not take the “rebound effect” - associated with reduced costs of energy services - into account, although provision for this was included in the associated economic modelling.

Defining the energy efficiency improvement potential

In this study, the starting point for energy efficiency analysis was at the level of the energy services provided in each end-use sector of the Australian economy. In this context, energy efficiency may be defined as the ratio of energy output to energy input in the performance of a specific task (energy service).

For the purpose of this study a distinction was made between three different types of energy efficiency improvement (EEI) potential.

Technical potential
This is the energy efficiency improvement that is *technically* possible for a specific energy service (eg refrigeration). In this study LOW potential estimates are based on current commercially available technologies, while HIGH potential estimates include consideration of emerging technologies or processes. Estimates of the technical EEI potential were not explicitly made; rather, this concept served as a reference point for the economic EEI potential estimates.

Economic potential
Economic energy efficiency improvement potential estimates apply economic criteria to the technical EEI potential estimates. In this study the economic EEI potential estimates were based on market energy prices forecast over the 12-year study period (2001 to 2012) and simple paybacks. For the commercial and industrial sectors an average four-year payback was used as the basis for estimating the LOW EEI potential estimate, and an average eight-year payback was used as the basis for estimating the HIGH EEI potential estimate. For the residential sector these paybacks were not strictly applied, especially in relation to building shell upgrades and space conditioning.

Market potential
Market energy efficiency improvement potential estimates are based on the energy efficiency improvements that are likely to be delivered by the market, taking into account market conditions and existing government programs. In this study the market potential concept is used to provide an estimate of the business as usual (BAU) energy efficiency improvement over the study period. Market potential may be enhanced: for example, by specific EEI measures or by redesign of market rules or arrangements.

The general relationship between technical, economic and market potential is shown in Figure 2 below. In economic terms, energy efficiency is optimized when the marginal cost of EEI is equated to the marginal cost of the energy saved.

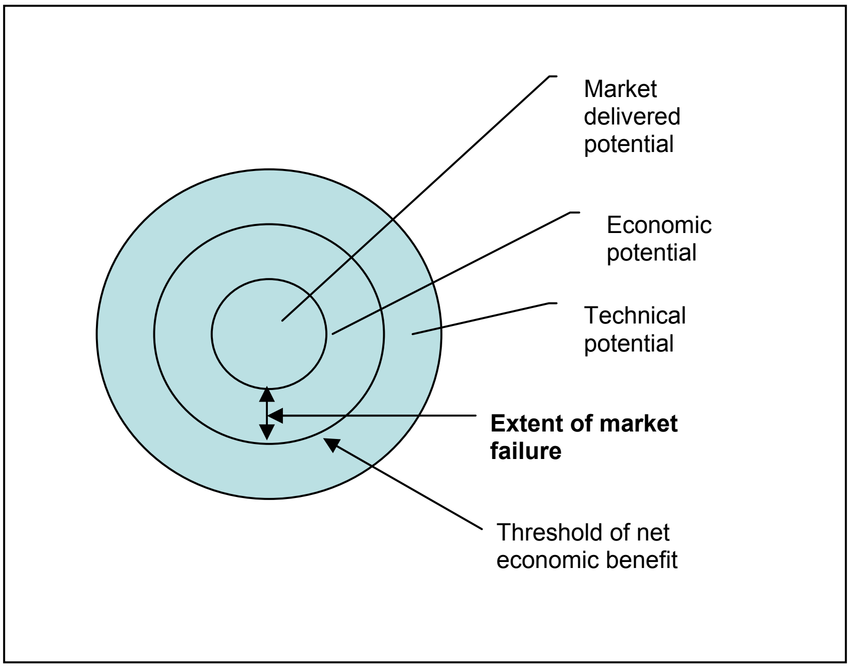


Figure 2: Relationship between technical, economic and market EEI potential

While it is recognised that not all of the technically possible improvements (*technical potential*) are also economically viable at present *(economic potential)*, it is also clear that there is a significant gap between what is both technically and economically viable, and what has actually been delivered by the *(market potential)*. This gap between the economic potential and the market delivered potential represents what might be seen as market failure. Thus, there are significant economic benefits available that, for a range of reasons, are not exploited by the market. It is this untapped potential that the NFEE seeks to address.

The focus of the work in this study was to develop the LOW and HIGH *economic* EEI potential estimates, judged to be beyond-BAU over the 12-year study period (based on the period 2001 to 2012)[1]. These estimates were then used to derive the input data for the associated economic modelling, using the NEEIP model. The estimates of the beyond-BAU EEI potential were based on a range of existing data sources, with more, and more reliable, data being available for the LOW EEI potential estimates. The HIGH EEI potential estimates were developed to give an idea of the EEI opportunities that might become feasible over time, and are not considered to be as robust as for the LOW potential estimates.

Estimating energy efficiency improvement potential

In each of the end-use sectors analysed – residential, commercial and industrial – different available data bases on energy use, activity classifications, EEI potentials and implementation costs dictated that different sectoral approaches needed to be used. The approaches used for the commercial and industrial sectors are similar, but the approach used for the residential sector is significantly different.

As has been indicated above, the estimation work is considered to be preliminary and has a number of significant limitations. However, despite these limitations we believe that the EEI potential estimates developed are a reasonable indication of what would emerge from a much more comprehensive study.

The overall LOW and HIGH EEI potential estimates developed in this study are presented in Figure 3 below, and more detailed breakdowns are provided in Figures 4 to 6 below.

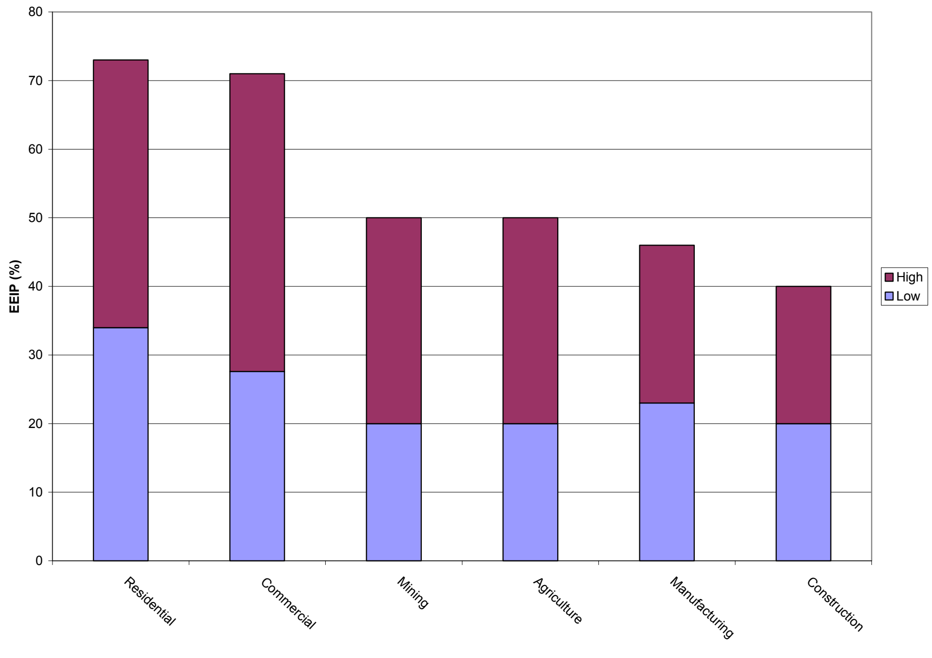


Figure 3: Percentage energy efficiency improvement potential across different sectors

[1] The 12 year modelling period is relatively insensitive to the starting date used.

Residential sector

Energy end-use was broken down into a range of energy services and the available data was used to estimate both the LOW and HIGH EEI potential, and the implementation costs. As noted above, the 4-year (LOW EEI potential) and 8-year (HIGH EEI potential) payback criteria were not strictly applied, and the estimates incorporated a range of paybacks (longer for building shells, shorter for most appliances). Where appropriate (eg space heating, water heating, cooking), the different fuel sources were differentiated.

The EEI potential estimates, on an energy service basis, for the residential sector are shown in Figure 4 below.

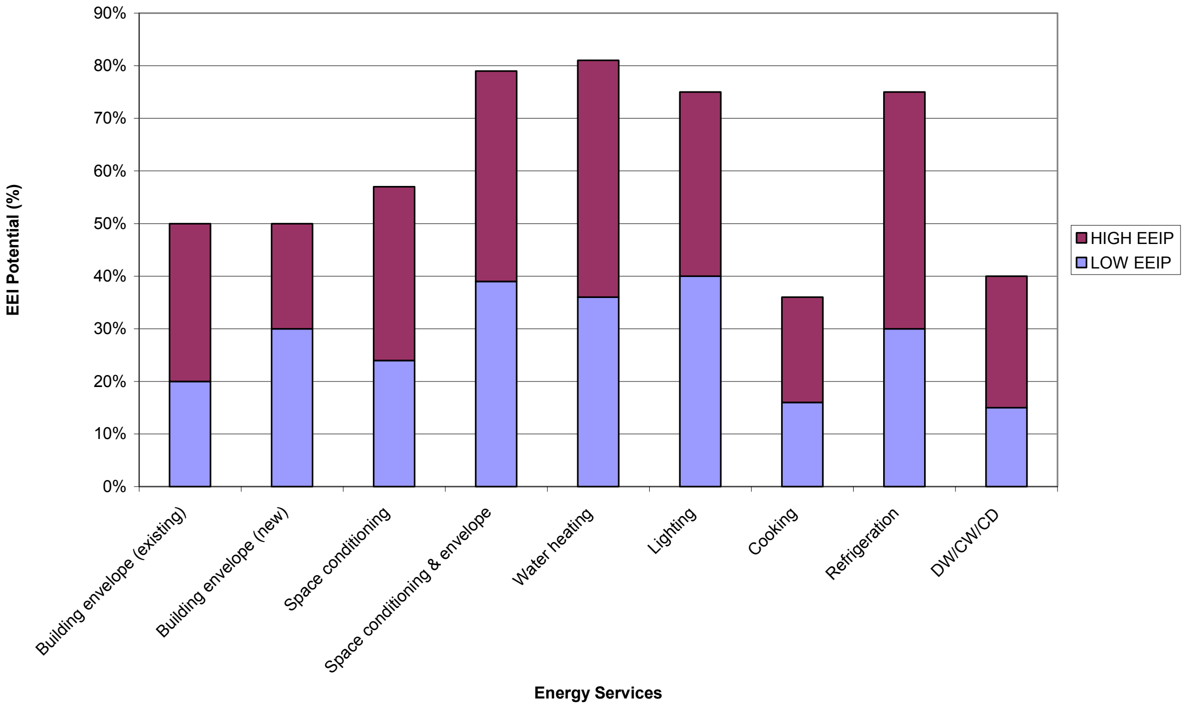


Figure 4: EEI potential estimates for the residential sector

Commercial and industrial sectors

In the commercial and industrial sectors the available EEI studies have been mainly undertaken on a sub-sectoral basis as defined by ANZSIC classifications, for example for offices (ANZSIC divisions J, K, L and M), and the food, beverage and tobacco manufacturing sub-sector (ANZSIC 21). Some information is available on an energy service basis, but most of the available data is presented on aggregated sub-sectoral EEI potential basis.

Accordingly, for the commercial and industrial sectors, although the EEI potential estimates are built up from analysis of EEI opportunities in specific energy services, equipment and energy uses, the results of these analyses are reported on a sub-sectoral (ANZSIC classification) basis.

Energy use in the ***commercial sector*** is accounted for largely by offices (91 PJ) and the wholesale and retail sub-division (66 PJ), and to a lesser extent by health & community sub-division (28 PJ), accommodation and restaurants (15 PJ), the cultural and recreational sub-division (13 PJ), and the education sub-division (5 PJ). Preliminary energy efficiency improvement potential estimates were prepared for the ANZSIC commercial sector sub-divisions.

For the commercial sector, the starting point for the analysis was the estimation of EEI potentials for the main energy services applicable to the commercial sector:- heating, ventilation and cooling (HVAC), lighting, water heating, refrigeration, office equipment, etc. These estimates were then combined with estimates of the proportion of energy consumed by each energy service in each sub-sector, to derive EEI potential estimates for each commercial sub-sector and the commercial sector as a whole.

Estimates of both the LOW and HIGH EEIP were undertaken. The LOW EEIP estimates are based on measures with an average 4-year payback, and the HIGH EEIP estimates are based on measures with an average 8-year payback.

The LOW and HIGH EEIP estimates, broken down by energy services, for the commercial sector are shown in Figure 5 below, and in Table 1 the EEI potential estimate data is provided on a sub-sectoral basis.

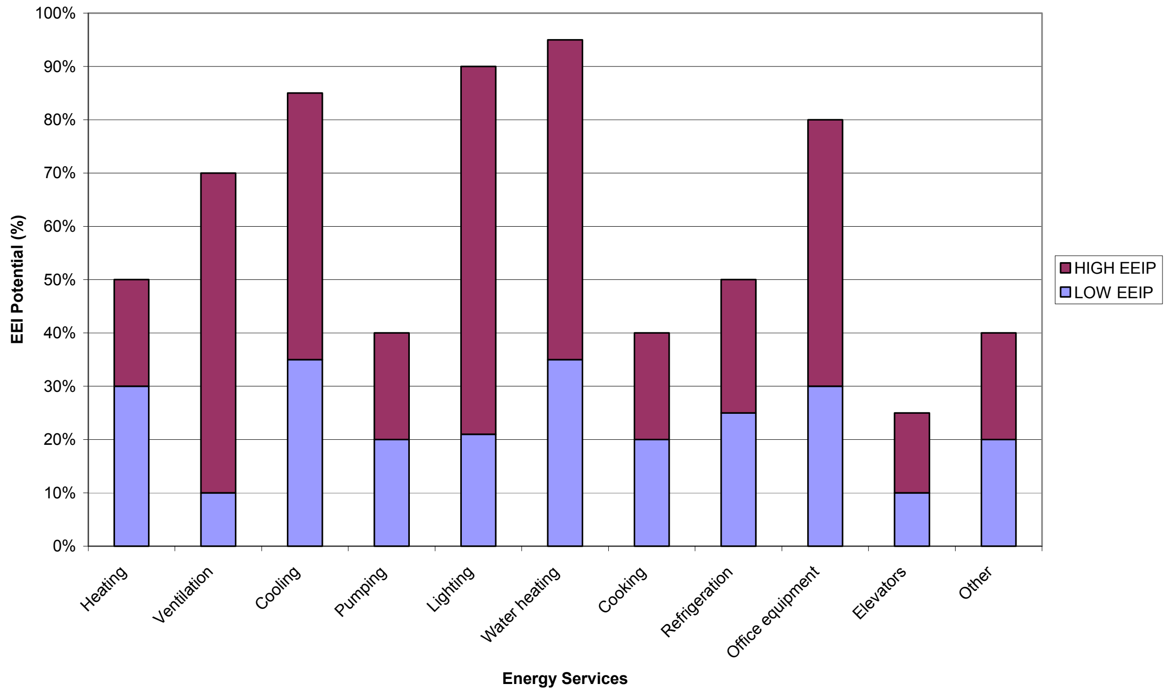


Figure 5: EEI potential estimates, by energy service, for the commercial sector

Sub-Division	ANZIC Code	Low EEIP	High EEIP
Offices	J, K, L, M	28%	74%
Wholesale & Retail	F, G, Q	26%	70%
Health & Community	O	29%	66%
Accommodation & Restaurants	H	29%	69%
Cultural & Recreational	P	28%	67%
Education	N	28%	72%
Total*		**27.6%**	**71%**

* Total potential derived from weighted average of individual figures

Table 1: EEI potential estimates for commercial sub-sectors

Energy use in the ***industrial sector*** is accounted for mainly by manufacturing (1,181 PJ), and to a much lesser extent mining (200 PJ), agriculture (11 PJ) and construction (2 PJ). Preliminary energy efficiency improvement potential estimates were prepared generally on the basis of 2-digit ANZSIC industry classifications.

For the industrial sector, the starting point for the analysis was an estimated breakdown of the energy consumption in each industrial sub-sector. The available data sources were then used to prepare the LOW and HIGH EEI potential estimates for each sub-sector.

The LOW EEIP estimates (average 4-year payback) covers improved maintenance, modification of existing equipment and processes, and the replacement with higher efficiency equipment at end of life. The HIGH EEIP estimates are based on measures with an average 8-year payback – in addition to the basic measures achievable under the LOW EEIP scenario, it includes major upgrades to and replacement of existing equipment and processes.

The LOW and HIGH EEIP estimates for the industrial sub-sectors sector are shown in Figure 6 below.

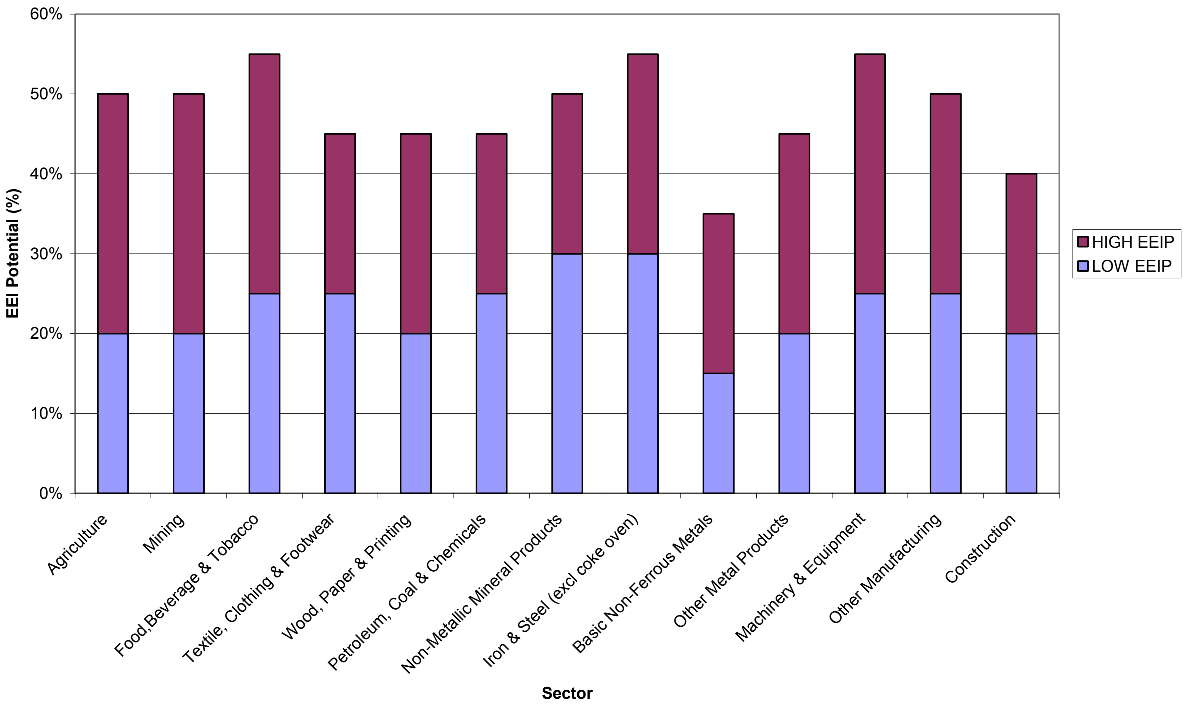


Figure 6: EEI potential estimates for industrial sub-sectors

Estimating EEI savings & implementation costs

As was the case with the EEI potential estimates, the availability of data dictated that different approaches be used in the residential sector compared with the commercial and industrial sectors.

Residential sector

In the NEEIP model – used to derive the input data for the economic modelling - the EEI implementation costs for existing dwellings were estimated on a dwelling/energy service basis (eg one dwelling, one water heater), and the results were multiplied by the number of applicable dwellings (building shells retrofitted and equipment replaced) in each year to estimate the national implementation cost for that year. The associated energy savings in each year were estimated on the same basis.

To estimate the overall implementation costs for existing dwellings (pre-2001) in the NEEIP model, assumptions were made regarding:

- the proportion of dwellings that the EEI potential was applied to;
- savings and costs associated with the estimated EEI for a specific energy service;
- retrofit (building shell) and replacement (equipment) rates of the 2000 stock (1/12th per year);
- equipment life: 12 years, and longer than 12 years but unspecified for building shells; and
- unit energy costs ($/GJ, $/MWh).

New dwellings were treated differently to existing dwellings, with different base energy efficiency and equipment penetration rate assumptions. For new dwellings, each new dwelling built each year over the modelling period was fitted with the EEI equipment levels assumed for the LOW and HIGH EEI potentials.

Baseline energy use patterns and levels used were for 2000; fuel mixes for each energy service were fixed over the 12-year study period (based on 2001-12), but different fixed fuel and service mixes were assumed for existing and new dwellings. For existing dwellings space cooling penetration rates increased over the period.

Commercial & industrial sectors

In the available data for the commercial and industrial sectors, the implementation costs of achieving energy efficiency improvements are rarely given or, when provided, are only given for a limited range of sub-sector elements. As implementation cost estimates were required on a sub-sector basis for the economic modelling, and given the constraints of the available data, the following approach was adopted:

(i) estimate for each sub-sector, on the basis of available data, the beyond-BAU energy efficiency improvement potential that might be attained with an average 4 (LOW EEI potential) and 8 year (HIGH EEI potential) payback; and

(ii) in the NEEIP model, the estimated savings (in energy and dollar terms) achieved by implementing the specified level of EEI were used to calculate the capital costs of achieving these savings levels.

In the NEEIP model, the base-year energy consumption for each major ANZIC commercial and industrial sub-sector was based on data from the Australian Bureau of Agricultural and Resource Economics. The estimated beyond-BAU EEI potential for each of these sectors was assumed to be implemented linearly over the 12-year modelling period, and was used as the basis for estimating the savings and capital costs on an annual basis.

The NEEIP model takes structural change into account, insofar as different economic sub-sectors are assumed to grow at differing rates over the modelling period. Due to the limitations of the available data, structural change within the sub-sectors was not analysed.

Summary of estimated costs and savings

The accumulated capital costs (2001 to 2012) and accumulated lifetime energy savings (2001 to 2023), based on the 12-year study period and derived using the NEEIP model, are presented below for the LOW EEI potential (Figure 7) and for the HIGH EEI potential (Figure 8).

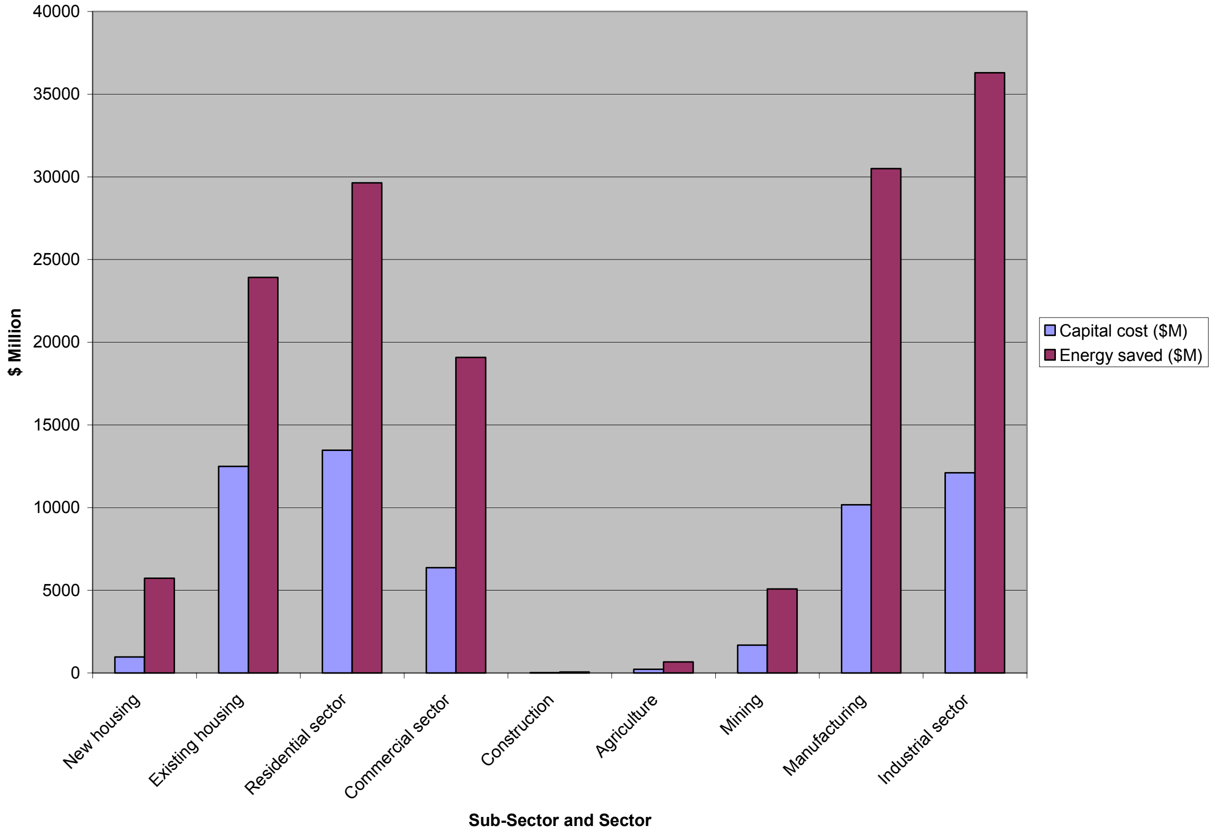


Figure 7: Lifetime accumulated costs and savings, LOW EEI Potential

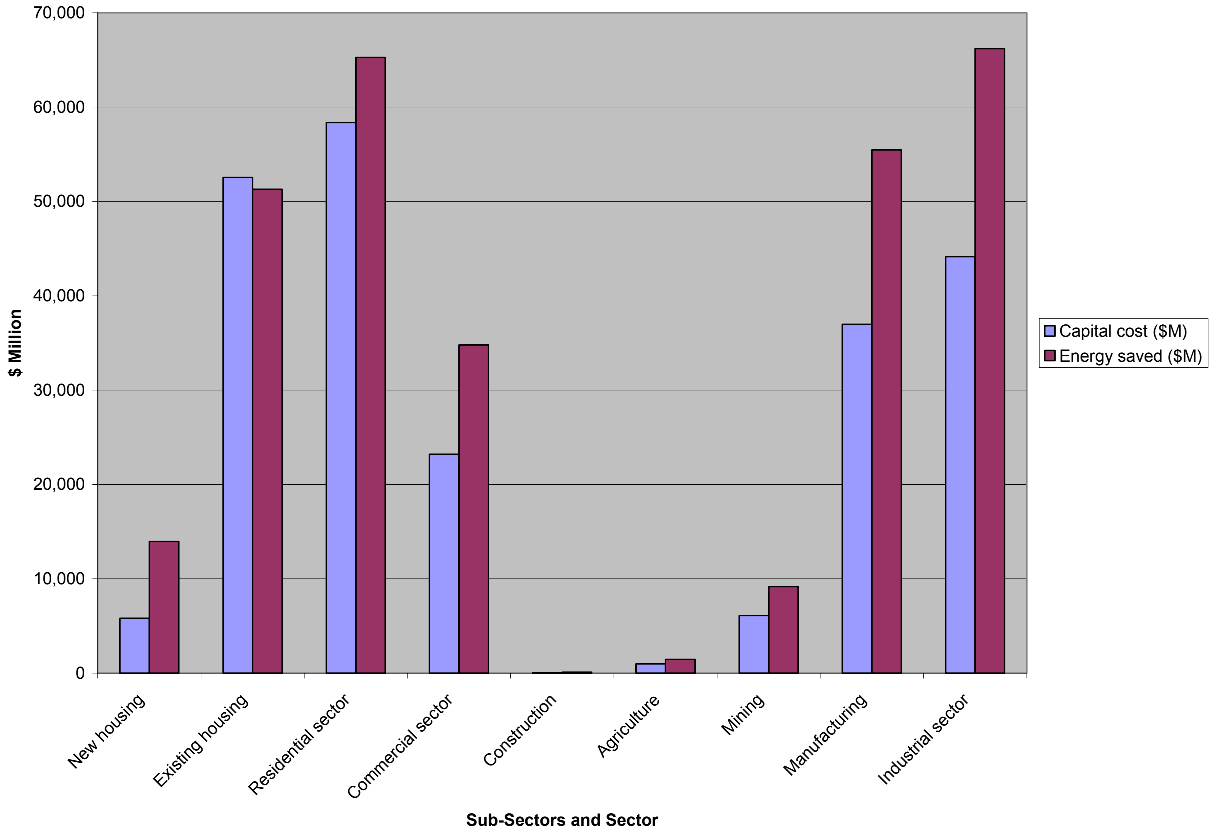


Figure 8: Lifetime accumulated costs and savings, HIGH EEI Potential

The lifetime energy savings are based on the assumption of a 12-year lifetime, that is, each capital investment in EEI will generate savings for a 12-year period. The total capital costs, and lifetime accumulated energy savings (in both PJ and $) are summarized in the table below.

Sector	LOW EEI Potential			HIGH EEI Potential		
	Capital ($M)	Energy Savings (PJ)	Energy Savings ($M)	Capital ($M)	Energy Savings (PJ)	Energy Savings ($M)
Existing housing	12,498	1,350	23,910	52,539	2,912	51,292
New housing	972	237	5,729	5,811	553	13,965
Residential	***13,470***	***1,587***	***29,639***	***58,350***	***3,465***	***65,257***
Commercial	***6,361***	***802***	***19,082***	***23,191***	***1,437***	***34,787***
Construction	18	5	53	65	9	97
Agriculture	225	29	676	982	62	1,474
Mining	1,692	531	5,075	6,117	959	9,176
Manufacturing	10,166	3,488	30,499	36,969	6,266	55,454
Industrial	***12,101***	***4,052***	***36,303***	***44,134***	***7,297***	***66,201***
TOTAL	**31,932**	**6,441**	**85,023**	**125,676**	**12,199**	**166,244**

When reviewing this data, it should be noted that the savings derived by the NEEIP model do not take the ‘rebound effect’ into account. This tends to reduce the economy-wide level of savings generated, as the energy savings lead to higher profits, disposable incomes and economic growth, which in turn leads to higher levels of energy consumption. The rebound effect was, however, explicitly addressed in the economic modelling.

This preliminary analysis suggests that implementing the LOW EEI levels will generate significantly more net economic benefits than the HIGH EEI levels, which require considerably higher capital investments. For this reason, and to assess the impact of the probability of less than full application of the estimated EEI potential with any suite of programs, in the associated economic modelling both 50% and 100% implementation of the LOW EEI potentials were modeled, as well as 50% implementation of the HIGH EEI levels.

Future work on EEI potential estimates

As was noted above, this work is a preliminary study of energy efficiency improvement potential in the stationary end-use sectors of the Australian economy.

The additional work required to develop more robust EEI estimates (potentials, costs and savings) to support the development and on-going implementation of the NFEE is summarized below:

- Further segmentation of the residential, commercial and industrial sectors, would allow more accurate estimates to be developed for each sub-sector. This is particularly important in energy-intensive industrial sub-sectors, which make a significant contribution to overall energy consumption;
- Better data on the energy services breakdown in sub-sectors, especially in the commercial and industrial sub-sectors, and likely energy service trends;
- Increased segmentation of the economic sectors would allow better estimates of growth in these sectors and sub-sectors over any chosen modelling period;
- Better definition of the business-as-usual trends (both energy consumption and EEI) in each sector/sub-sector over the chosen modelling period, as a reference point for estimating beyond-BAU EEI implementation costs and savings for different scenarios;

- Better geographic segmentation – state and regional – for energy prices, energy use patterns, EEI potentials, implementation costs, etc;
- More detailed work to analyse, in each sub-sector, the shifts in energy mix (fuel substitution, etc);
- Improved estimation of implementation costs and savings.

It is evident that a substantial improvement is required in the data used to develop the EEI potential estimates if energy efficiency improvement is to be accorded a high priority in Australia. This work would require a much more comprehensive and sustained approach than was possible for this initial study.

To this end, it is recommended that consideration be given to establishing Australian Energy End-Use Data Analysis Centres (AEEDACs), similar to the successful Canadian model (CEEDACs).

1 INTRODUCTION

1.1 The National Framework for Energy Efficiency

Establishing a National Framework for Energy Efficiency

Around the world, governments and business are increasingly targeting energy efficiency as a means of increasing business competitiveness, saving the community money and harnessing cost effective greenhouse gas emission reduction opportunities.

Similarly in Australia, Commonwealth and State Energy Ministers, through the Ministerial Council on Energy, have called for a National Framework for Energy Efficiency (National Framework or NFEE).

The Ministerial Council on Energy (MCE) was established in June 2001 by the Council of Australian Governments (COAG), comprising commonwealth, state and territory ministers with responsibility for energy policy. A key task of the Ministerial Council is to identify policies and programs which will deliver significant improvements in energy efficiency through co-ordinated action by federal, state and territory government agencies. In November 2002, MCE endorsed a proposal from the Energy Efficiency and Greenhouse Working Group (E2G2) for development of a National Framework for Energy Efficiency to define future directions for energy efficiency policy and programs in Australia. The Ministerial Council has placed a high priority on developing policies and programs that could assist in improving energy efficiency in Australia.

Business has also started to call for the creation of a nationally integrated approach to energy efficiency as a means of better utilising public and private sector resources to unlock the considerable economic benefits energy efficiency can deliver. These calls are based on the recognition that there is a growing need for energy and that energy efficiency has the potential to deliver significant net economic benefits while generating significant reductions in greenhouse emissions. Put simply, there should be no net cost of appropriate action on energy efficiency – but there are real costs associated with inaction. It is also recognised that energy efficiency is an important means of improving international economic competitiveness and ensuring that Australian products and services remain competitive in the world markets.

The Need for a National Framework

Improving the efficiency with which energy is used is important to Australia's economic, social and environmental well being. The magnitude of inefficient energy use represents a considerable and unnecessary wastage of economic resources as well as a range of negative social and environmental externalities. It is clear that increased action on energy efficiency could yield substantial economic and environmental dividends.

In the 11 years from 1989/90 to 2000/01, total energy consumption in Australia has grown at an average 2.2 per cent per annum. The nation's energy consumption is expected to continue to grow at approximately 2.3% per annum in the short term (to 2005-06) and 2.1% in the longer term (to 2019-20)[2].This represents a significant increase in total energy

---

[2] ABARE: Australian Energy – National and State Projection to 2019/20. Report 02.10, June 2003

consumption. Without action on energy efficiency the existing energy generation and supply infrastructure will require substantial additions over the next decade. Adopting cost effective measures that increase energy efficiency could make a significant contribution to reducing this rate of growth in consumption and the amount of economic resources that would need to be devoted to augmenting energy supplies.

Australian governments and the private sector have made a considerable contribution to the facilitation of improved energy efficiency over the past two decades, but much of this has relied on incremental improvements and the measures have captured only a small proportion of the cost effective energy efficient potential. Governments also recognise that to maintain international economic competitiveness Australia must also capitalise on a larger proportion of the cost effective efficiency measures than it currently does.

Recent analysis by the Australian Bureau of Agricultural and Resource Economics (ABARE)[3] indicates that there has been a shift in the economy over the last 20 years towards less energy intensive industries, particularly the services sector. However, when the energy intensity of the economy is adjusted for this so called "structural effect" it is apparent that since the early 1990s the real trend in energy intensity (a proxy for energy efficiency) shows little or no improvement in a number of sectors.

The Objective

The purpose of the National Framework is to achieve a step change in Australia's energy efficiency with the objective of ***unlocking the significant economic potential associated with increased implementation of energy efficient technologies and processes to deliver a least cost approach to energy provision in Australia***. Developing the National Framework will help identify major areas of inefficiency and areas for improved coordination and cooperation across jurisdictions in the delivery of energy efficiency policies and programs. The National Framework will be strategic in focus and developed cooperatively with involvement of all jurisdictions and key stakeholders, taking into consideration the individual circumstance of particular regions and jurisdictions.

Scope

The National Framework will focus on demand side energy efficiency, primarily in the industrial, commercial and residential sectors. However, it will also consider energy use in energy conversion and address intermediaries with the ability to influence energy efficiency choices, such as energy retailers, builders, appliance, equipment and material suppliers and financiers.

The development of the Framework will include:

- analysis of current and trends in Australian energy end-use;
- assessment of current Government energy efficiency programs;
- assessment of what energy efficiency improvements are likely to be technically feasible over the next 10-20 years;
- estimation of the investment and overall costs required to achieve defined energy efficiency improvement levels;
- identification of barriers to realising energy efficiency potential;
- economic modelling to determine the economic viability and impact of different energy efficiency scenarios; and

---

[3] ABARE: Trends in Australian Energy Intensity 1973/74 to 2000/01, Report 03.9, June 2003

- recommendations for policy, programs and initiatives and policy to stimulate investment in energy efficiency.

While the Framework will encompass energy use in a wide range of energy use activities, comprehensive technical, economic and financial analysis will assist in targeting sectors where policy measures are likely to generate the greatest net economic benefits. This will facilitate setting priorities for further government and private sector investment in energy efficiency.

Further Information

For further information please contact:

Mr Stephen Greig	Mr Ian McNicol
NFEE Project Manager	Project Manager, Energy Efficiency Improvement Potential
Sustainable Energy Authority Victoria	Sustainable Energy Authority Victoria
Telephone: 03 9655 3261	Telephone: 03 9655 3282
Facsimile: 03 9655 3255	Facsimile: 03 9655 3255
Email: stephen.greig@seav.vic.gov.au	Email: ian.mcnicol@seav.vic.gov.au

1.2 Scope

The objective of the work described in this report was to provide, in a short time frame, a preliminary estimate of the potential for energy efficiency improvement (EEI) in Australian energy end-use sectors, in order to:

- provide inputs for economic modelling (reported on in a separate study) to give an *order of magnitude* estimate of the national costs and benefits of energy efficiency improvement, beyond the business-as-usual levels, over the 12-year study period (based on 2001-12);
- stimulate discussion on the potential for, and means of achieving, significant energy efficiency improvements in Australian stationary end-use sectors; and
- provide an initial indicator of the extent of further EEI analysis required for the development of the National Framework.

A three step process has been employed to develop the initial *order of magnitude* estimates of the national costs and benefits of energy efficiency improvement to guide the development of the NFEE, as shown in Figure 1.1 below. This report covers the first two steps in this process, namely the development of the EEI potential estimates (Section 5), which were then used as the inputs to the National Energy Efficiency Improvement Potential (NEEIP) model, used to derive the 'raw' estimates of the implementation costs and energy savings (Section 6). This data was then used as the input to the economic modelling study (see box below).

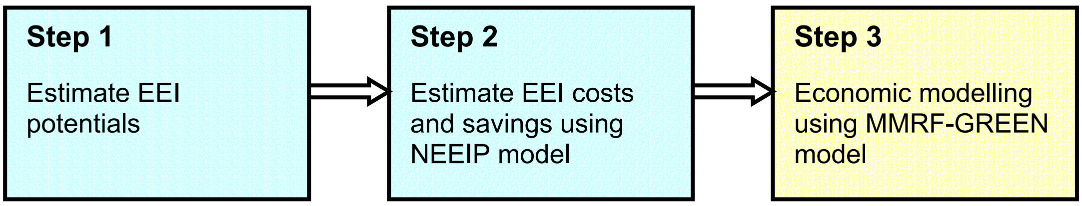


Figure 1.1: Three step process to estimate costs and benefits of EEI

In this study, energy efficiency improvement (EEI) potential is defined in terms of the energy savings that could be achieved as a percentage of current energy use for a specific energy service (such as heating a litre of water by 50^{o}C). The study focuses on energy productivity improvement through EEI, and not on greenhouse gas abatement, though energy efficiency improvements will, in most cases, also reduce greenhouse gas emissions.

In reading and reviewing this report it is very important to keep in mind the study objectives, and that the work had to be completed within a tight time frame[4]. Accordingly, it was not possible to undertake original research into, or comprehensively assess, the status of the potential for energy efficiency improvement (EEI) in Australia. Data on EEI potential and its implementation costs were, therefore, drawn from a range of existing sources covering each energy end-use sector. One output of this initial study is a description of the further work required to develop more robust EEI potential estimates, as part of the on-going work program to develop the National Framework (see Section 7).

---

[4] The EEI potential estimate analysis on which this report is based was undertaken from November 2002 to mid-February 2003.

Economic Modelling

The EEI potential, implementation cost and savings estimates from this study were provided to The Allen Consulting Group, and constituted one of the main data inputs for the MMRF-GREEN economic model - the computable general equilibrium (CGE) model operated by CoPS at Monash University – which was used to estimate the economy-wide impacts of increasing energy efficiency beyond the business-as-usual level over a 12-year period (based on 2001 to 2012).

The macroeconomic modelling results generated by the MMRF-GREEN model are dependent on the estimated EEI potentials and implementation costs developed in this study. In MMRF-GREEN this data was modelled as a twofold 'exogenous shock' consisting of a productivity (EEI) increase, due to lower energy costs, together with an additional one-off cost to companies for achieving the productivity increase.

Three scenarios were modelled as a means for undertaking a sensitivity analysis:

* **Low scenario -** 50 per cent penetration of the estimated LOW EEI potential. This scenario assumes that only 50 per cent of the LOW EEI measures are implemented over the 12-year period, with penetration increasing uniformly over this period;
* **Medium scenario -** 100 per cent penetration of the estimated LOW EEI potential. This scenario assumes that 100 per cent of the LOW EEI measures are implemented over the 12-year period, with penetration increasing uniformly over this period; and
* **High scenario -** 50 per cent penetration of the estimated HIGH EEI potential. This scenario assumes that only 50 per cent of the HIGH EEI measures are implemented over the 12-year period, with penetration increasing uniformly over this period.

Based on these three scenarios, the economic modelling estimated the potential impact of increased energy efficiency on a number of broader economy-wide factors including:

* output (GDP and GSP);
* consumption (a proxy measure for the community's welfare);
* employment;
* greenhouse gas emissions; and
* energy usage.

The economic modelling provided broad estimates of the impacts – both positive and negative – of improvements in energy efficiency and, in particular, of reducing the impediments and market failures that currently prevent the adoption of higher levels of energy efficiency in the economy.

In future NFEE work it would be useful to further test the sensitivity of the economic modelling results, for example, by varying the energy savings and cost estimates by ± 20 per cent.

The work reported in this study focused on energy end-use in the stationary energy sector: it did not analyse potential EEI in transport/mobile energy uses, or in the upstream supply side (for example in electricity generation) or energy distribution networks.

This is a technical, not a policy, study. The analysis does not question the level or type of, nor trends in, energy services (for example, space conditioning levels and trends). Although this is not a policy study, it is likely to lead, along with more refined technical analysis and economic modelling, to policy analysis work.

The energy efficiency improvement (EEI) opportunities considered in this study were those that might be introduced over the period 2001-2012, the period on which the associated economic modelling is based.[5] Over this period the structure of the economy will change. In

---

[5] Strict application of this period does not provide a close fit with the technical EEI analysis, which is more closely aligned with a 2003-14 period, particularly in the residential sector where the EEI potential estimates are beyond the EEI which will result

the NEEIP model and associated economic modelling, this is handled by applying the sub-sectoral EEI levels and costs to forecasts of industrial and commercial sector structural evolution (for example changes in the mix of industrial sub-sectors at the 2-digit ANZSIC level). In the residential sector this issue is addressed by distinguishing between new and existing residences, and consideration of trends in appliance/equipment saturation rates (for example increases in air conditioning, a trend which may be subject to policy work in the greenhouse and peak electricity areas).

Longer analytical time frames, a more detailed assessment of EEI opportunities (levels, costs), and provision for more complex structural changes (for example within sub-sectors) will need to be considered in future NFEE work to produce more robust estimates of EEI potentials and therefore more accurate outputs from the economic modelling. However, for the purposes of this study, the methodology used to develop the EEI potential estimates was considered to be appropriate.

The energy efficiency improvement potentials estimated in this study were based on estimates of the EEI that would not occur over the period 2001 to 20012 without further initiatives. That is, the EEI levels, and the costs of achieving them, are beyond business-as-usual (BAU) EEI estimates. In the NFEE process this is necessary to assess the likely benefits foregone if new energy efficiency policies/measures are not introduced.

In practice, all the estimated beyond-BAU energy efficiency improvements are very unlikely to be implemented over the period 2001 to 2012, even with the implementation of innovative measures. A scenario based on 100 per cent market penetration of the beyond BAU EEI opportunities provides inputs for the economic modelling to estimate the net economic benefits foregone if this level of EEI is not achieved. In the economic modelling, a 50 per cent market penetration of the estimated EEI opportunities was also modelled (see box above). For the estimated LOW EEI potential, this may represent a realistic indicator of the market penetration of the EEI opportunities that might be achieved with a package of new energy efficiency measures. Other EEI levels or market penetration scenarios could also be modelled, using more detailed estimates of EEI opportunities and their implementation possibilities.

1.3 Limitations

As indicated above, the time and overall resource constraints within which this study was undertaken did not permit a comprehensive review and analysis of EEI opportunities in Australia. Accordingly, it was not possible to:

(i) undertake detailed original analysis of EEI potentials, their savings and implementation costs, and likely uptake levels with current measures over the study period;

(ii) analyse regional variations in EEI opportunities and implementation costs - for this study national averages were used;

(iii) analyse, in the commercial and industrial sectors, detailed sub-sectoral opportunities, for example, below the division (commercial) and 2-digit ANZSIC (industrial) bases;

(iv) analyse, in the residential sector, types of residential dwellings (single homes, apartments, etc.), nor conduct an analysis of housing on a regional basis: that is,

---

from standards to be introduced over 2001-05. The economic modelling is relatively insensitive to commencement from the year 2001 or 2003.

average estimates for residential dwellings Australia-wide were developed (but a distinction was made between existing and new dwellings);

(v) analyse, in each sector, shifts in the energy mix (fuel substitution, etc) over the study period (although electric air conditioning market penetration increases were assumed in the residential sector); and

(vi) consider optimisation of energy services and systems, for example, cogeneration of heat and electricity, building envelope and space conditioning equipment, and EEI improvement of electric drive system elements, except where these were considered (but rarely explicitly) in data sources.

It is also important to note that:

- the EEI investment costs are derived from current estimates of the implementation costs, and do not take into account potential cost reductions, which may be significant, that might arise over the study period, such as when the scale of implementation increases or as technology improvement proceeds;
- the EEI investment costs are estimates of the total costs for achieving the beyond BAU EEI level specified; the degree to which they include transaction costs is not known, as the data sources are seldom explicit on this point;
- the energy costings are based on average national market energy prices in each sector, and do not include estimates of non-market environmental costs, such as greenhouse externalities;
- in most cases the available data used for this analysis did not include quantification of non-energy benefits, such as overall productivity improvements which might arise as a result of implementing EEI measures;
- in the commercial and industrial sectors simple paybacks are given as the investment criterion to identify EEI opportunities in most available data sources; this criterion ignores the return on EEI investment beyond the payback period, and under-values the return on longer life investments (but in the inputs to the economic modelling, the energy savings beyond the payback period were taken into account);
- the "rebound" effect, that is, the impact that EEI has on the demand for a service when its cost is reduced, was not taken into account in the energy savings estimates in this study. The rebound effect was, however, explicitly considered in the economic modelling analysis;
- by confining the EEI analysis to end-use sectors opportunities to improve energy efficiency in the entire stationary energy sector are not assessed. These opportunities may be significant: for example, some reduction in network losses and improvements in generator efficiency **may** produce large energy savings and be more cost-effective than many end-use EEIs; and
- development of more detailed and comprehensive EEI potential estimates would require a substantial expansion of the economic modelling work to specifically accommodate the additional input detail.

The study issues summarised above are discussed further in the body of the paper.

This report does not purport to be a definitive study on energy efficiency improvement potential in Australia, and its inherent limitations are recognised. However, to our knowledge, a study of this type has not been attempted since the study undertaken by the National Institute of Economic and Industry Research (NIEIR) in 1992-94 for the Electricity Supply Association of Australia, *Socio-Economic Study: Effects of Greenhouse on the Australian Electricity Industry* (ESAA 1994). That study built on previous work, for example that undertaken for the Ecologically Sustainable Development (ESD) process during the 1980s. The work undertaken in the course of these studies was conducted in more detail over a much longer time period than was possible this current study.

1.4 The challenges

Precisely delineating energy efficiency improvement potential is virtually impossible as it would require specific analysis of the myriad of energy end-use applications in the economy. Reasonably refined estimates can be made but as with the current study the assumptions behind them need to be carefully examined. That is, it is very important to understand the scope and limitations of each estimate. Similarly, estimates of the proportion of a defined potential can be realised by current market arrangements or new policy measures runs into problems of gauging the reaction of market participants to the defined potential.

Despite these substantial difficulties it is very important that the NFEE take up the challenges of delineating energy efficiency improvement potential, and of tapping the unrealised potential, because of the economic and environmental benefits that are being foregone at current energy efficiency levels.

2. Definitions and Methodology

2.1 Energy efficiency

In this study, the starting point for energy efficiency analysis was at the level of the energy services provided in each sub-sector of the Australian economy. For example, the energy services of lighting for office buildings, and space heating in the residential sector. Due to the limitations of the existing data, this approach often had to be applied on the basis of the estimated energy services breakdown in each sub-sector, and on estimates of EEI opportunities for aggregate energy services at the sub-sector level. For example, available estimates of energy savings and costs in the food, beverage and tobacco manufacturing (ANZSIC 21) sub-sector are not broken down by specific energy service EEI opportunities.

Energy efficiency, in the context outlined above, may be defined as the ratio of energy output to energy input in the performance of a specific task (energy service), for example, to heat a given quantity of water by 50^{o}C. In this case, EEI involves the application of technologies such as insulation (tank, pipes) and improved heat exchange to reduce the amount of energy to perform the given task (service).

In economic terms, energy efficiency is optimised when the marginal cost of EEI is equated to the marginal cost of the energy saved.

In the marketplace, the marginal cost of EEI will include the opportunity cost (that is their benefits in alternative uses) of the resources required for EEI. For example, resources may be used to increase market share instead of EEI, as an entity may perceive increased market share will increase long term profitability or shareholder value more than EEI. At both the business and household level income may be spent to enhance perceived utility (for example on more prestigious offices or new home entertainment equipment) compared with deriving real dollar returns from enhanced thermal integrity of an office building or dwelling. Accordingly, the market penetration of a seemingly economically attractive EEI opportunity may be well below 100 per cent.

As indicated in the Section 1.3, the definition used in this study does not include the valuation of EEI benefits beyond those from the market-based valuation of the energy savings. That is, benefits from EEI are based solely on estimates of current and projected market prices for energy, and no other EEI benefits are included. For example, the inclusion of a value for greenhouse externalities or, in most cases, for overall productivity gains arising from implementing the improvement measures. In this respect, the estimated EEI benefits are conservative, as are the EEI capital cost estimates, which are **all** attributed to their market valued energy savings. Detailed, more comprehensive analysis may attribute part of the capital costs involved to other benefits from the EEI measures, and benefits from EEI action may include non-energy savings.

2.2 Energy efficiency potential

There is no one single definition of energy efficiency improvement (EEI) potential. For the purposes of this study technical, economic and market EEI potentials were considered.

1. Technical potential

Technical energy efficiency improvement potential estimates are based on the application of technologies and techniques to specific energy services. Estimates of the technical EEI potential are based on the energy efficiency gains that are *technically* possible from the application of these technologies in various timeframes.

In this study the **LOW** potential estimates were based on current commercially available technologies (for example currently available high efficiency equipment), while the **HIGH** potential estimates include consideration of emerging technologies (for example emerging aluminium process technologies) potentially available within the study timeframe (2001 to 2012).

In this study, only energy efficiency improvements in stationary energy uses in the industrial, commercial and residential sectors were assessed[6]. (Note that this does include energy conversion and production, such as cogeneration, within these sectors). It is acknowledged that further assessment of EEI opportunities in the total energy system is warranted, and the importance of this wider EEI perspective is illustrated by reference to work by Adam Kahane in the early 1990s[7].

Kahane pointed out that the scope for economic energy efficiency optimisation increases when the boundaries of the system to be optimised are enlarged. Examples given by Kahane are for an electric pumping system (Figure 2.1), and a commercial building where the energy end-uses of lighting and space heating (Figure 2.2) are considered. In the latter case the energy efficiency can be improved by choosing more efficient equipment or improving equipment operation (e.g. compact fluorescent bulbs, boiler controls). It can be improved further, however, through enlarging the boundaries of optimization: by considering whole end-use systems (lighting ballasts and appropriate lighting levels, zone heating controls); even further by considering the entire building shell (the impact of lighting on heating loads, insulation or building design); and even further in looking at the entire building site, by considering building orientation, and using cogeneration to meet some of the building's heat and electricity requirements.

This analysis can be further expanded by considering the theoretical level of energy required to perform a specific energy service, and consideration of alternative means of meeting the objectives of the task. For example, the replacement of distillation with reverse osmosis or molecular sieves.

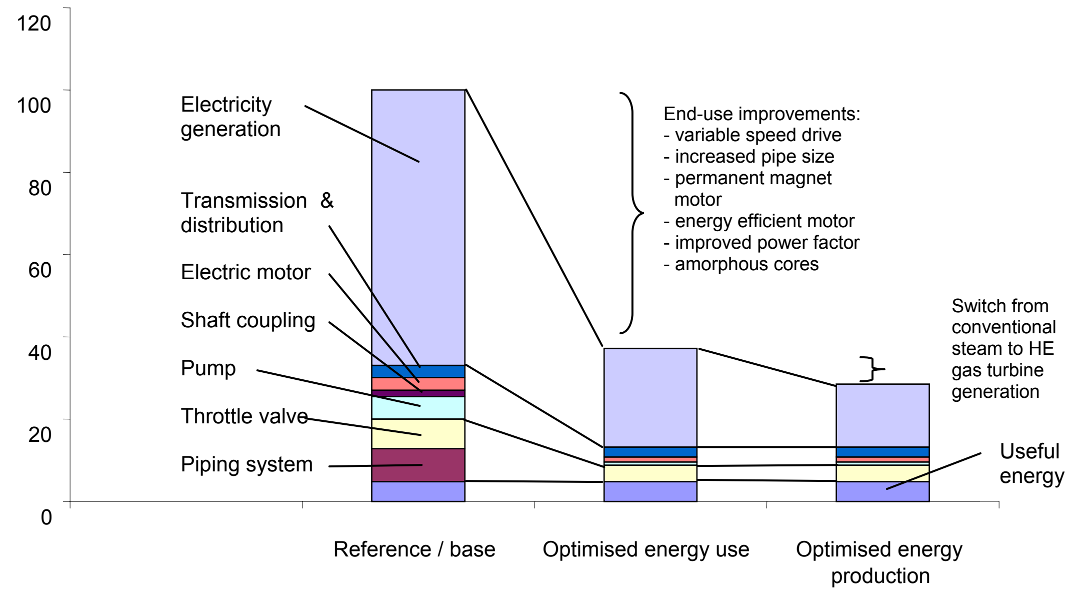
In developing a comprehensive NFEE these wider EEI optimisation boundaries need to be considered.

---

6 The study used a sectoral approach to energy efficiency improvement potential for reasons related to data availability and requirements of the economic modelling. Cross-sectoral and firm/site specific approaches may also be used. For a brief review of these approaches see Appendix 1.

7 Kahane A., "New perspectives for energy efficiency and system optimization", *Energy Policy*, April 1991

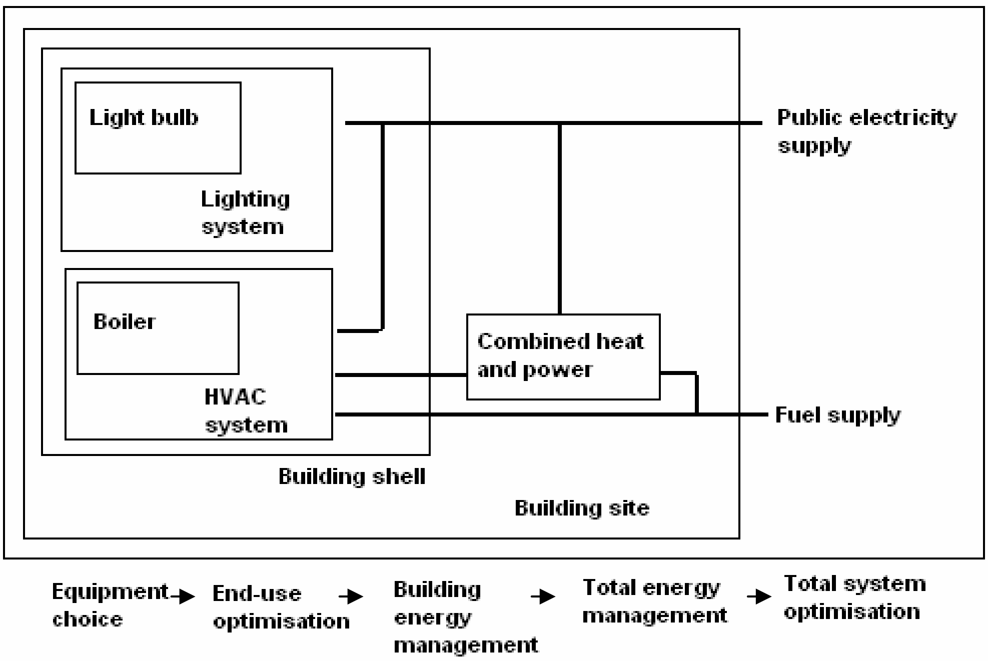
Figure 2.1: Optimising electric pumping energy-use



	Optimised energy use	Optimised energy production
Imcremental improvement	63%	24%
Total improvement	63%	79%

Source: Adapted by Kahane from Samuel F. Baldwin, 'Energy-efficient electric motor system', in Electricity, Lund University Press, Lund, Sweden, 1989.

Figure 2.2: Energy management: different optimisation boundaries



Source: Kahane, ibid.

2. Economic potential

Economic energy efficiency improvement potential estimates apply economic criteria to the technical EEI potential estimates. Economic criteria are based on the price of the energy displaced and investment criteria for the energy efficiency (EE) investments considered[8]. Market prices (current or those forecast over the study period), prices from new supply sources, or shadow prices which include a consideration of externalities (that is costs not included in market prices), may be used.

In this study economic energy efficiency improvement potential estimates were based on market energy prices forecast over the study period (2001-12), and simple average paybacks for consistency of treatment of available data. At this time, only sparse information is available on specific EEI opportunities and their implementation costs.

Investment criteria include internal rates of return (IRR) and investment paybacks. IRR[9], the discount rate (r) which would equilibrate the present value of the net benefits (here flow of energy savings) to the capital cost of the EEI investment, is the superior criterion, as it considers savings over the life of the investment. A simple payback criterion ignores discount rates and savings past the payback period, and has a negative "payback" connotation compared with "rate of return". However, as most of the available EEI data in the commercial and industrial sectors is based on simple paybacks, and investment lives are rarely given, a simple payback criterion was used for these sectors. Note that in the economic modelling, the savings beyond the payback criterion were taken into account, even though simple payback was the investment criterion used in the commercial and industrial sectors as the basis of the EEI potential estimates.[10]

The effect of investment life on rates of return/discount rates at different paybacks is given in the following examples. For a 4-year payback, a 12-year life gives a rate of return of around 22 per cent, 25 per cent for a 25-year life, and around 19 per cent for an 8-year life. For an 8-year payback, the respective rates of return/discount rates are 8 per cent (12-year life), 12 per cent (25-year life), and 0 per cent (8-year life).

The precise rates of return/discount rates depend on the period of investment (for example the construction period for a factory before it starts to produce outputs), and the discounting period used (for example annual, daily).

An ***average four-year payback*** was used as the basis for estimating the **LOW** energy efficiency improvement potential for this study. Although paybacks of less than one to three years are commonly used for EEI investments, a four-year payback gives reasonable returns, is lower than the hurdle rate (6 to 7 years) used for many investments, and accordingly could involve EEI opportunities targeted by measures emerging from the NFEE process.

---

8 Note some EEI may not require investments, for example EEI achieved through maintenance or operating procedures. Thus if **average investment** paybacks are used some zero or negligible cost EEIs are included along with some EEIs above the average. In available data most EEIs included appear to be in the lower part of the range.

9 It can be found by solving the following equation for r $\sum_t Qt\,(1 + r)^{-t} = \sum_t Kt\,(1 + r)^{-t}$

where Q is the net benefit in period t and K_t is the capital investment cost in period t. (Quirin, G.D., *The Capital Expenditure Decision*, R.D. Irwin, 1967, Chapter 3.

10 As explained in Section 2.3, the payback criteria were also used to estimate the capital costs required to achieve EEIs.

An ***average eight-year payback*** was used as the basis for estimating the **HIGH** energy efficiency improvement potential for this study, as it is similar to the implied criterion for some energy supply projects, and it captures the application of promising EEI technologies which might be applied as their costs decreased and/or as energy prices rose.

Energy price increases may arise if currently unpriced externalities become priced in the future (for example through greenhouse policy developments). In the NFEE context these EEI opportunities could be monitored to assess their evolving commercial status, and might be the focus of demonstration and commercialization initiatives.

The HIGH energy efficiency improvement potential estimate was developed to give an idea of the EEI opportunities that might become feasible over time; the savings and cost levels are quite conjectural, and therefore not considered to be as robust as the LOW EEI potential estimates.

As with the technical EEI potential estimates, it is important to note that expanding the boundaries of the EEI analysis may significantly reduce the costs of implementing the EEI measures. For example, by considering the scale effects of producing high efficiency equipment or by redesign of the energy service provided.

It is important to note that in the residential sector the simple payback criteria described above were not closely applied. For example, for space conditioning, regional service variations lead to substantial variations in stock shell retrofit economics, stock retrofit feasibilities vary widely, and step changes in EEI opportunities (for example upgrading envelope/shell insulation) have significant cost implications. Optimisation of the building shell and space conditioning equipment is required, taking into account the much longer lives of building shells compared with heating and cooling equipment. In practice, discount rates used for building code development are around 5 per cent, implying a payback of around 16 years over a building life exceeding 25 years in the residential sector.

The paybacks for the EEI opportunities covered in the residential sector are above four years (for LOW EEI potential) and eight years (for HIGH EEI potential) for space conditioning, below these payback levels for some services (water heating, refrigeration/freezing), and above for some services (clothes and dish washing, clothes drying - for these latter services data is quite limited).

It should be noted that the EEI costing model developed for the study (described below) can readily vary the assumptions used to address these issues.

3. Market potential

Market energy efficiency improvement potential estimates are based on the EEI that is likely to result from the behaviour of market participants towards the technical and economic potential for EEI. That is, estimates (or observations) of realized energy efficiency improvements in different timeframes through the action of underlying market forces (prices, interest rates, technology improvements, etc), assisted by current energy efficiency measures.[11] The market EEI potential may be well below the economic EEI potential, due to the presence of barriers such as knowledge gaps, split incentives, imperfect price signals and other perceived priorities.

[11] Note that measures are introduced to modify existing market arrangements and underlying forces. Once introduced, measures become part of market arrangements. Measure design and implementation, and the reaction of market participants to measures determine their market impact. Rigorous evaluation of measures is required to determine their effectiveness in attaining policy objectives. Evaluations can find measures have unintended impacts and/or do not have an observable impact on market behaviour.

In this study market potential, as defined above, provides the basis for an estimate of **Business-as-Usual (BAU) EEI**. (Note that market potential estimates may also used to assess the likely market response to current or new energy efficiency measures.)

The **LOW** and **HIGH** economic EEI potential estimates developed in this study were for above likely market (BAU) responses over the study period. The gap between these BAU responses and apparent economically attractive EEI opportunities provides the rationale for consideration of new EEI measures.

Specifically:

- for the residential sector the EEI potential estimates only included **beyond-BAU** responses to retrofit opportunities in existing homes, to current and scheduled minimum energy performance standards (MEPS) for appliances and equipment, and to current and planned standards for new housing;

- for the commercial sector the EEI potential estimates only included **beyond-BAU** estimates for the commercial sector divisions (new and existing facilities were not disaggregated due to data and resource constraints); and

- for the industrial sector the EEI potential estimates only included **beyond-BAU** estimates for the 2-digit (or in some cases 3-digit) ANZSIC sectors. Beyond-BAU estimates are particularly difficult in this sector due to the lack of data on likely market responses and, particularly for HIGH EEI estimates, to the difficulty of estimating what new technologies and processes will become the norm for new investments.

The beyond-BAU estimates were developed from a range of available sources, as listed in the references and on the tables which show the sectoral EEI potential estimates. Major sources included:

- residential: SEAV, SEDA and AGO analyses, and MEPS data;

- commercial: SEAV and SEDA audits, EMET Consultants, energy audits for public agencies (AGO, SEDA, etc) and private entities; and

- industrial: Energy Efficiency Best Practice Program (EEBPP) projects, SEAV, SEDA, etc. energy audits, and monitoring of audit responses.

The estimates are judgments based, as outlined above, on a range of sources. With the data and resources available we believe that the issue of estimating beyond-BAU EEI potentials was adequately addressed for the purposes of the study. As in many other areas of the study, it is acknowledged that further analysis is required. For example, the impacts of equipment and process replacement in existing facilities and introduction into new facilities: comment and further NFEE work on the estimates is essential.

The economic EEI potential estimates in this study are for 100 per cent market penetration of the EEI opportunities judged to meet the estimation criteria. Except for mandatory minimum energy performance standards (MEPS), 100 per cent penetration is very unlikely to be approached in practice. However, the assumption of 100 per cent penetration permits estimation of the benefits foregone from missed EEI opportunities, which must be set against the higher costs of pursuing higher EEI levels. In the economic modelling, as discussed in Section 1.2, scenarios based on 50 per cent penetration of both the LOW and HIGH EEI potentials were also modelled, to indicate the economic impact differences between full and lower penetration rates.

Market potential may be enhanced by specific EEI measures or by redesign of market rules and arrangements, for example, the responsibility for energy costs in commercial buildings.

The EEI potential estimation and costing model developed for the study can readily accommodate other penetration rates.

2.3 Estimating EEI potentials in each sector

In each sector, the EEI potential that would remain after current market arrangements (underlying forces, measures) stimulated energy efficiency improvements raised difficult issues. The sectoral beyond-BAU estimates, as indicated above, were based on estimates from available energy audits and reports and, where applicable, minimum energy performance standards (in place or being implemented). However, the estimates are preliminary and in the future more work on this issue will be required. For example, in the industrial sector, the current status of energy efficiency in individual plants and the likely improvement in the normal course of the investment cycle, is particularly important in energy intensive industries with a relatively small number of plants.

In each of the end-use sectors analysed – residential, commercial and industrial – different available data bases on energy use, activity classifications, EEI potential and costs of implementing EEI dictated that different sectoral approaches needed to be used. The approaches used for the business sectors – commercial and industrial – are similar, but the approach used for the residential sector is distinctly different.

In the industrial and commercial sectors the available EEI studies have been mainly undertaken on a sub-sectoral basis, for example, for the food, beverage and tobacco manufacturing sub-sector (ANZSIC 21), and for offices (ANZSIC divisions J, K, L and M). Some information is available on an energy service basis, but most of the available data is presented on aggregated sub-sectoral EEI potential basis, that is, an estimate of the EEI potential for the sub-sector as a whole.

In the residential sector some data is available on existing and new building shells, where energy efficiency improvements reduce space conditioning (heating and cooling) loads and therefore energy use. There is also a reasonable amount of data available on an energy service, appliance and equipment basis (eg, relating to heating and cooling equipment, refrigeration/freezing, lighting, water heating).

Accordingly, for the industrial and commercial sectors although the EEI potential estimates are ultimately built up from analysis of energy services, equipment, and energy use patterns leading to energy efficiency improvement opportunities, the results of these analyses are reported on a sub-sectoral (ANZSIC classification) basis. It is acknowledged that the beyond-BAU estimates for the LOW and HIGH EEI potential estimates are averages that aggregate a wide range of EEI technologies and techniques and EEI costs: analyses within the sub-sectors of specific opportunities and how they might be tapped will be covered in later stages of the NFEE development process.

In the residential sector the data on building shells and specific energy services is often more detailed than that for the commercial and industrial sectors. However, the data is very variable, being quite comprehensive and detailed where energy performance standards have been, or are being, developed (for example new residences and selected appliances), but quite sparse in the case of existing residential building shells and household electronics. Much more work on the EEI potential is required in these areas, particularly existing residential building shells, and the extent to which it will be realised with current energy efficiency measures (BAU).

Note that with some exceptions (see below) in the residential sector, the sub-sectoral energy mixes were assumed to be constant over the study period. Energy mix changes, for example gas for oil or electricity as the gas network is expanded, and their impact on EEI potential, requires further analysis.

2.4 EEI potential costing

Energy efficiency improvements generally require capital investments, although some EEI can be achieved through changes in operating and maintenance procedures (which may entail costs), and some may occur at zero or negative net cost, if pursued at the time of construction or refurbishment of a facility. These changes, and capital investment in EEI, generate energy savings, but may also be accompanied by a reduction, often significant, in non-energy operating costs. Such non-energy related costs savings were not specifically estimated in this study.

In this study, for the **commercial** and **industrial** sectors the estimated EEI savings from 4 (LOW) and 8 year (HIGH) payback investments were used to derive the capital costs of achieving these levels of savings at the ANZIC (see Section 2.6 below).

For the **residential** sector the implementation costs for the specified LOW and HIGH EEI potential estimates, were based on cost estimates from the stated sources to give a range of paybacks (higher for shells, lower for appliances).

When preparing the input data for the economic modelling using the NEEIP model, the energy savings and costs for the different scenarios modelled were linearly introduced over the 12-year study period in each sector (for example, a 24 per cent EEI was progressively introduced at 2 per cent per year for a 100 per cent penetration).

In the economic modelling, the impact of energy savings beyond 2012 had to be taken into account. Investments made during the study period (2001-12) will produce savings beyond 2012 (except for equipment with a 12-year life installed in 2001). This was handled by extending the savings from investments in each year out to the end of their specific investment life, in most cases assumed to be 12 years. For example, an investment in 2011 will produce savings out to 2022. This is probably a conservative assumption as some investments, particularly upgraded building shells, will continue to produce savings well beyond the life assumed in the economic modelling. (Please refer to the economic modelling report for further discussion of this issue.)

Again note that the EEI potential costing and economic models developed in the course of the study have been designed to be flexible enough to incorporate a range of assumptions.

2.5 Residential sector costing methodology

For the **residential sector**, the EEI implementation cost estimates used as the input to the economic modelling were obtained for the specified EEI potential level from the range of sources referenced for each service. For example, for the LOW EEI potential estimate for gas water heating, it is estimated that, beyond-BAU, there is a 20 per cent potential energy efficiency improvement which can be achieved at a cost of $100 per unit. As a 12-year life was assumed for gas water heaters in the economic modelling, each base year unit was replaced, in a linear fashion, over the projection period (2001 to 2012).

Energy use per existing dwelling was based on the total national residential energy consumption and dwelling numbers (ABS, 2001): 7,250,000 existing dwellings in 2000, and increasing at 1.7 per cent per annum (new dwellings) over 2001-12.[12]

Implementation cost estimates were undertaken on a dwelling/energy service basis (for example one building shell, one water heater per dwelling), and the results were multiplied by the number of applicable dwellings in each year to estimate the national EEI implementation cost in that year. The associated energy savings in each year were estimated on the same basis.

To estimate the overall implementation costs for existing dwellings (pre-2001) for the input data used in the economic modelling, assumptions were made regarding:

- the proportion of dwellings that the EEI potential was applied to;
- savings/costs associated with different technologies for a specific energy service (for example water heating);
- retrofit (building shell) and replacement (equipment) rates of the 2000 stock (1/12th per year);
- equipment life: 12 years, and unspecified (but over 12 years) for building shells; and
- unit energy costs ($/GJ, $/MWh): see Section 2.8.

When preparing the input data for the economic modelling using the NEEIP model, new dwelling were treated differently than existing dwellings, with different base energy efficiency and equipment penetration rate assumptions. For new dwellings, each new unit built over the modelling period was fitted with the EEI level for new shells and equipment assumed for the LOW and HIGH EEI.

Baseline energy use patterns used were for 2000; fuel mixes for each energy service were fixed over the 12-year study period (based on 2001-12), but different fixed fuel and service mixes were assumed for existing and new houses. For existing houses space cooling penetration rates increased over the period. Changes in fuel and service mixes is another area requiring further analysis.

More detailed information on the residential costing methodology and underlying assumptions is provided in Section 6.2.1.

2.6 Commercial and industrial sector costing methodology

In the available data for the commercial and industrial sectors, the implementation costs of achieving energy efficiency improvements are rarely given or, when provided, are only given for a limited range of sub-sector elements. As implementation cost estimates were required on a sub-sector basis for the economic modelling, and given the constraints of the available data, the following approach was adopted:

(i) estimate for each sub-sector, on the basis of available data, the beyond-BAU energy efficiency improvement potential that might be attained with an average 4 (LOW EEI potential) and 8 year (HIGH EEI potential) payback; and

---

[12] Note dwelling/unit numbers cover all types: one room flats to large single residences. That is, average energy and service uses covering all units are used in the analysis. Detailed work on market segmentation is required.

(ii) using the NEEIP model, the estimated energy savings (in dollar terms) achieved by implementing the specified level of EEI were used to calculate the capital costs of achieving these savings levels.

More information on the process used to derive the implementation costs for the commercial and industrial sectors is provided in Section 6.2.2.

The implementation cost estimates developed as an input for the economic modelling are for the total costs of achieving the specified beyond-BAU EEI potential. As indicated in the Section 1.3, the extent to which transaction costs are included in these total cost estimates is unknown. Again, this is an area for further analysis: note that for the economic modelling the transaction costs for displaced energy supply investments would also need to be considered.

For the **commercial sector**, the EEI implementation cost estimates developed for the economic modelling were determined with reference to the specified EEI potential (LOW or HIGH) and the base-year (2000) energy consumption figures, for each sector division or set of divisions (see Section 5.2.2 below). A major source of information was the work of EMET Consultants (Steve Pupilli) as reported in "*Energy Efficiency Improvement Potential and Policies in the Commercial Sector*", a paper presented at the ABARE Workshop held in December 2002, which covers, in average EEI potential terms, both new and existing commercial buildings over the 2000-10 period. Pupilli indicates that given the analysis period the estimates undervalue the potential EEI contribution from new commercial buildings.

Further, more detailed, analysis of the EEI potential for new and existing buildings in the commercial, and other, sectors will be required later in the NFEE development process.

The base-year energy consumption for each major ANZSIC commercial sector division or series of divisions, for example offices (Divisions J, K, L and M), was derived from ABARE data (see Section 4 below). In the NEEIP model and associated economic modelling, the estimated beyond-BAU EEI potential for each of these commercial sub-sectors was assumed to be implemented linearly over the 12-year study period (based on 2001 to 2012), and was used as the basis for estimating the energy savings (in energy and dollar terms) and capital costs on an annual basis.

For the **industrial sector**, EEI potential estimates were made by 2-digit ANZSIC categories as outlined in Section 4.2. The methodology to determine EEI implementation costs and savings for the industrial sector was the same as for that outlined for the commercial sector.

For the commercial and industrial sectors, the NEEIP model and the associated economic model take structural change into account, insofar as different sub-sectors are assumed to grow at differing rates over the modelling period. Thus, a slow growing sub-sector loses its "market share" of the total sector to the faster growing sectors. Structural change within sub-sectors was not analysed; this is another area where further analysis is required.

2.7 Energy price assumptions

The indicative **average** national energy prices used in this study are set out below. In each sector the energy prices can vary considerably, for example, within customer classes according to supply contracts. For each ANZSIC sector, judgment of the sector characteristics, and hence likely average prices, was used to select the prices used for estimating the investment costs and energy savings.

Over the period used for the economic modelling, it was assumed that the energy prices (real 2001) would remain constant; price projections for each energy source vary, but over the modelling period, the assumption of constant prices appears to be reasonable at this time.

More refined analysis would require detailed analysis of sub-sectoral energy prices, including on a regional basis, and likely price trends, over the modelling period.

Electricity - estimated from (ESAA 2001)

Residential	$130/MWh
Commercial	$100/MWh
Small industrial	$100/MWh
Large industrial	$40/MWh
	($20/MWh for aluminium)

Gas - estimated from (AGA 2001)

Residential	$10/GJ
Commercial	$10/GJ
Small industrial	$8/GJ
Large industrial	$4/GJ

Coal

Black: used $2/GJ as average industrial price [$1.25/GJ 1998-99, (ABARE 2001, page 13)].

Stationary petroleum products (excise free in stationary use)

$10/GJ (ABARE 2001, page 15), 2000 – 2020.

Renewables

Bagasse $0.25 – $1.00/GJ (ABARE 2001, page 15)

In the economic modelling savings from renewables were estimated on the basis of $80/MWh when electricity was produced, and $6/GJ when gas was displaced.

The pricing of wood for residential space heating raises particular difficulties as:

(i) the price of wood purchased varies widely by region and wood quality; and

(ii) much wood is not purchased: the *Victorian Firewood Strategy* (DNRE 2002a), indicates that in Victoria only a third of wood used in space heating is actually purchased.

A wood price of $80/tonne for dry wood (indicative price), gives an energy price of round $5/GJ (depending on the type of wood), or about $2/GJ if only 40 per cent is purchased, with the rest gathered. Wood pricing is not an insignificant issue, as ABARE reports that 81.4 PJ of wood use for residential space heating in 2000 (despite the fact the Victorian Firewood Strategy estimates a range of 0.7-1.4 million tonnes used in Victoria per year). In the costings for the economic modelling an energy price of $5/GJ was used.

3. Classifications of data

3.1 Introduction

As outlined in Section 2 above, both energy services and sub-sectoral data sources were used to develop the LOW and HIGH beyond-BAU EEI potential estimates, energy savings and implementation costs.

3.2 Residential sector

In this sector, despite some useful energy service data being available for the study, hard data is far from complete. Although the services are similar in both cases the analysis distinguished between new and existing residences. Different service levels and EEI bases and costs were used as outlined below in Section 5.2.1.

For the residential sector the following energy services were analysed in both new and existing residences.

Building shell	Though not strictly an energy service, the shell, along with heating and cooling systems, primarily determines space conditioning energy use for a given comfort/service level.
Space conditioning	
Heating	Gas, electric and wood equipment differentiated.
Cooling	100 per cent electric equipment assumed.
Refrigeration	100 per cent electric equipment assumed.
Lighting	100 per cent electric equipment assumed.
Cooking	Gas and electric equipment differentiated.
Water heating	Gas, electric and solar equipment differentiated.
Clothes washing, clothes drying, dishwashing	100 per cent electric assumed.
Household electronics	100 per cent electric, but EEI potential not costed.
Other	Split between electricity and gas; EEIP not costed.

3.3 Industrial and commercial sectors

For the industrial and commercial sectors the sub-sectoral classifications used in this study, presented in **Table 3.1** below, are based on Australian and New Zealand Standard Industry Classifications (ANZSIC) (ABS, 1993).

The ANZSIC classifications were used as much of the Australian energy use (ABARE) and EEI potential data has been collected on this basis, and these sub-sectors also form the basis for the subsequent economic modelling of the estimated EEI impacts.

In the commercial and industrial sectors, although the EEI analysis at the plant/facility level was mainly based on specific energy services such as lighting, electric drives, and process heating, it has generally only been reported on at the aggregate sub-sectoral (for example 2-digit industrial) level. More comprehensive and detailed work is required in Australia at the specific energy service and finer sub-sectoral classification (for example 3 or 4-digit) level, to obtain more robust EEI potential estimates.

Table 3.1 ANZSIC sectors used in energy efficiency potential assessment

Section	Division		2-digit	Sub-division/sub-category	3-digit	Comments
Industry	A	Agriculture, forestry and fishing	01-04			Analysis excluded mobile energy use
	B	Mining	11-15			
	C	Manufacturing	21	Food, beverage and tobacco manufacturing		
			22	Textile, clothing, footwear and leather manufacturing		
			23-24	Wood and paper product manufacturing, printing, publishing and recorded media		
			25	Petroleum, coal, chemical and associated product manufacturing	251 252-256	
			26	Non-metallic mineral product manufacturing	261 262 263 264	
			27	Metal product manufacturing	271 272-273 274-276	
			28	Machinery and equipment manufacturing		
			29	Other manufacturing		
			37	Water supply, sewerage and drainage service		
	E	Construction	41-42			
Commercial	F	Wholesale trade, retail trade	45-47	Retail/wholesale		
	G	Personal and other services	51-53			
	Q		96			
	H	Accommodation, cafes and restaurants	57	Accommodation, restaurants		
	J K L M	Communication services, finance and insurance, property and business services, government administration and defence	71, 73-75, 77, 78, 81, 82	Offices		
	N	Education	84	Education		
	O	Health and community services	86, 87	Health and community services		
	P	Cultural and recreational services	91, 92, 93, 95	Cultural and recreational		

4. Energy consumption

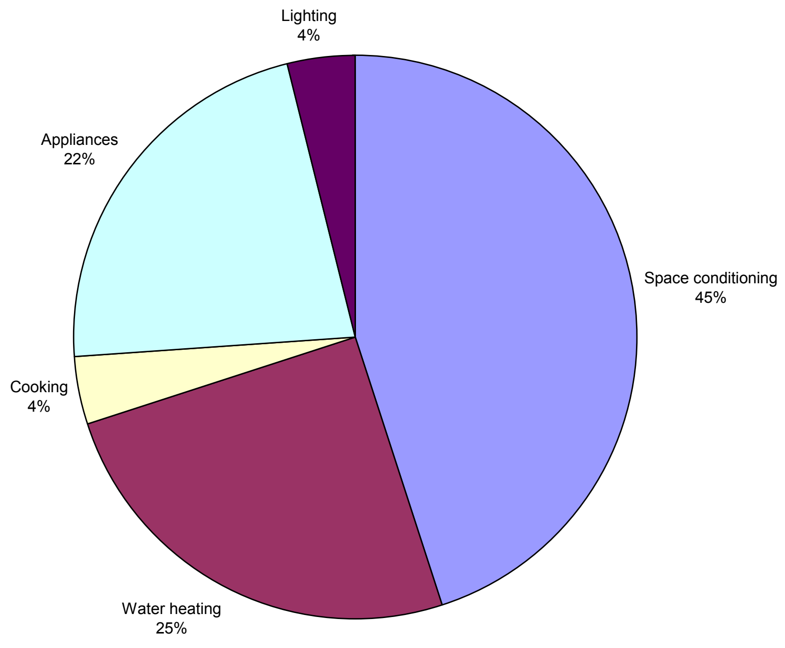
Data for the base year (2000) energy use, and energy service proportions for each end-use, were prepared by Sustainable Energy Authority Victoria (SEAV), primarily based on reports prepared for the Australian Greenhouse Office by George Wilkenfeld and Associates (GWA)[13].

4.1 Residential energy consumption

Total residential end-use energy consumption for Australia in 2000 was estimated to be 381.0 PJ, representing 12 per cent of Australia's final energy use.

On average, the main residential uses of energy are in space conditioning (heating and cooling), representing 45 per cent of energy use, water heating (25 per cent) and household appliances (22 per cent). As noted previously, regional variations, particularly in space conditioning, are substantial. Variation among dwelling types (single homes, flats, etc) can also be substantial.

Figure 4.1 Residential end-use energy consumption by application



[13] Reported in *Snapshot of Sectoral Energy Use in Australia*, SEAV, December 2002. The AGO reports prepared by GWA are:

- *Australia's National Greenhouse Gas Inventory 1990, 1995 and 1999: End Use Allocation of Emissions (draft 3)*, report to AGO by George Wilkenfeld & Associates with Energy Strategies, September 2002;
- *Energy End Use Analysis of Australia's Greenhouse Gas Emissions, 1999 (draft 2)* – report to AGO by George Wilkenfeld & Associates with Energy Strategies, September 2002;

In both reports GWA has used a wide number of data sources including the National Greenhouse Gas Inventory and Workbooks, the Electricity Supply Association of Australia, Australian Gas Association, Australian Bureau of Statistics, Apelbaum Consulting Group and the Australian Bureau of Agricultural and Resource Economics.

4.2 Commercial energy consumption

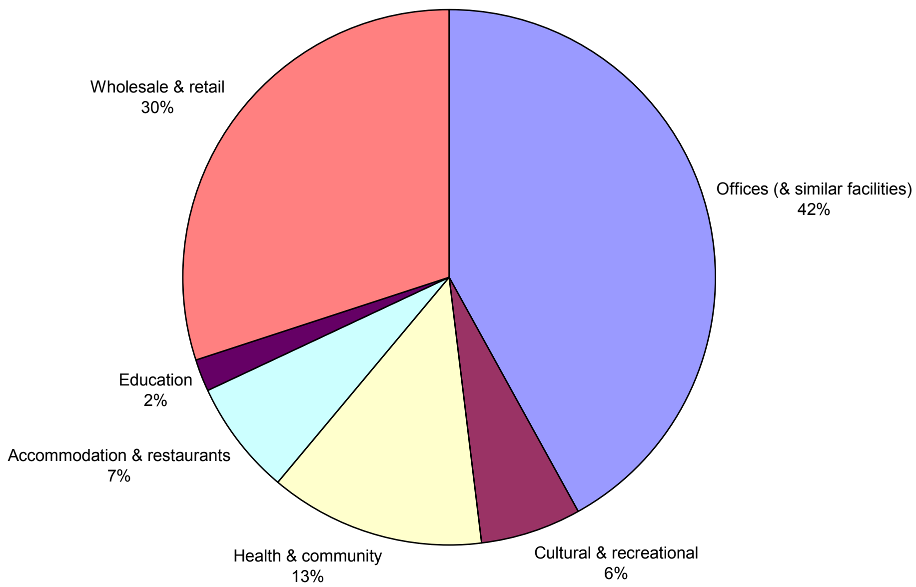
Total commercial energy consumption for Australia in 2000 was estimated to be 218.1 PJ, representing 7 per cent of Australia's final energy use.

As shown in Figure 4.2, the dominant commercial users of energy are offices and similar facilities[14], consuming 42 per cent of total commercial energy use, and wholesale and retail, which consumes 30 per cent. The main energy services in this sector (see Figure 4.3) are space conditioning (HVAC), which is the principal commercial energy application, representing some 62 per cent of total consumption, followed by lighting (17 per cent), and refrigeration (8 per cent).

The energy service mix varies significantly across the range of commercial sub-sectors. For example, lighting is more significant in the wholesale and retail sub-sector than for other sub-sectors, whilst hot water use is greater in the accommodation and restaurants sub-sector.

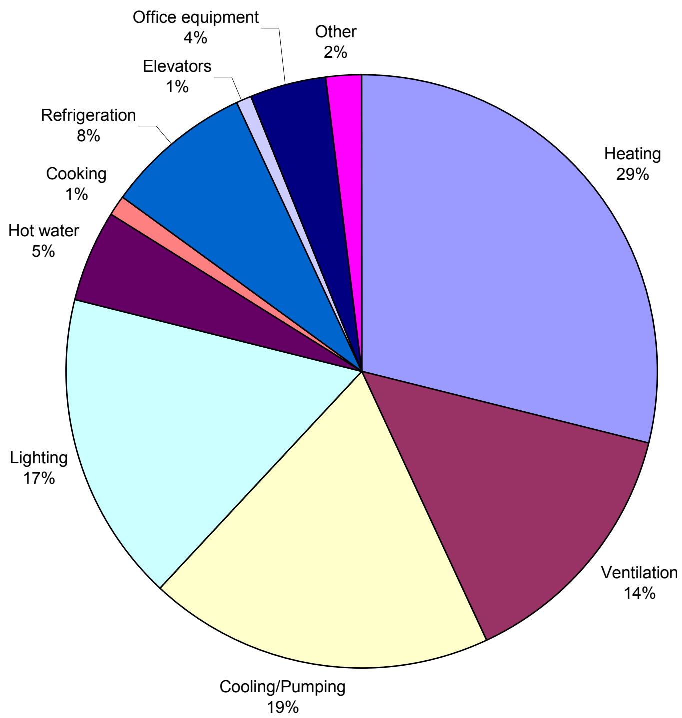
Work is required on further segmentation of commercial building types and their energy use patterns for buildings of different vintages (existing and new). Pupilli (ABARE 2002b, page 9) notes that currently, about 4 per cent of commercial buildings are retrofitted each year. This provides EEI opportunities in these buildings, and will probably change the energy use/service patterns in the sector.

Figure 4.2 Commercial end-use energy consumption by sector



[14] These facilities cover a wide range of office type buildings.

Figure 4.3 Commercial end-use energy consumption by application



4.3 Industrial energy consumption

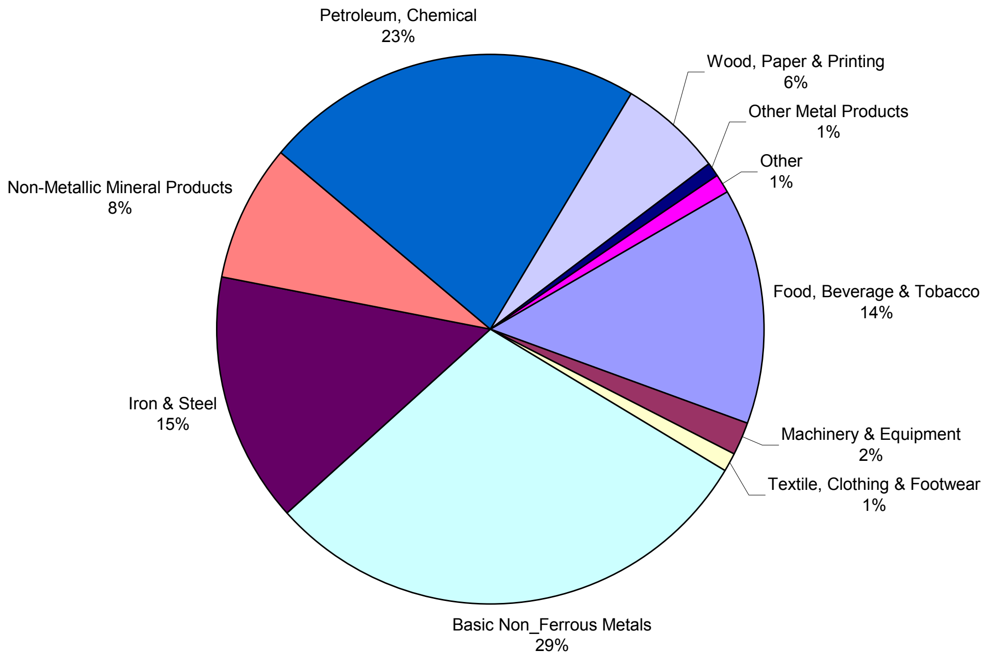
End-use energy consumption in the industrial sector (excluding mobile equipment) was estimated to be 1,404.46 PJ in 2000 which, in percentage terms, is broken down as manufacturing (85 per cent), construction (<0.1 per cent), agriculture (<1 per cent) and mining (14 per cent). Within the dominant manufacturing sector (**Figure 4.4**), the major energy use sub-sectors were basic non-ferrous metals (aluminium, alumina, etc.), which accounted for 30 per cent of manufacturing energy use, iron and steel (15 per cent), petroleum and chemicals (23 per cent)[15] and food, beverage and tobacco (14 per cent).

The major industrial energy services, which vary substantially between sub-sectors, are electric drives, electrolytic processes, high and low temperature process heating (including water heating and drying), and electricity production (in cogeneration systems). This is another area that requires further analytical work.

---

[15] The petroleum/chemicals (ANZSIC 25) includes over 150 PJ of energy used for feedstocks, that is for non-energy uses. This energy was included in the analysis as improvements in efficiency of these processes will produce energy savings although the savings level and costs are uncertain. Thus this energy use should probably have been excluded from the analysis.

Figure 4.4 Manufacturing end-use energy consumption



4.4 Energy use mixes

In the NEEIP model and economic modelling, the base year **sub-sectoral energy mixes** for the industrial and commercial sectors were maintained over the modelling period. This is another area that requires detailed analysis, over this and longer periods. However, in the modelling, the **sectoral energy mixes** changed as the sub-sectors grew at different rates.

For the residential sector the base year energy mix was also held constant, except that air conditioning, dishwashers and clothes dryers were assumed to have increased their penetration rates over the modelling period, and new dwellings were assumed to have different energy service mixes than existing dwellings (see Section 5.2.1 below).

ABARE (ABARE 2003a) projects that the gas share of total energy use is forecast to increase by about 7 per cent (from 2000-01) to 26 per cent by 2019-20. Much of the increase comes from the gas share of electricity generation, and from developments in the iron and steel (particularly Direct-Reduced Iron, DRI) and the basic non-ferrous metals sectors (particularly alumina refining). However, in several fields, particularly space heating, electrical technologies such as heat pumps (reverse-cycle air conditioners) show signs of competing very effectively with gas technologies. Further sector by sector analysis is required to predict energy mix changes.

5. Energy efficiency improvement potential (EEIP) estimates

5.1 Introduction: Summary of scope and approach

In this first phase of the analytical work for the National Framework on Energy Efficiency, the primary purpose of the EEI potential estimation work was to provide, in a short time frame, inputs for economic modelling of the impacts of implementing EEI opportunities in Australia **for the sectors analysed**. The analysis excluded transport (mobile equipment and systems), stationary energy networks and upstream energy production (generation, gas processing, etc).

Both LOW and HIGH EEI potential estimates have been developed in this study (as defined in Section 2.2), and these were used in the economic modelling to determine the impacts of various scenarios (see box in Section 1.2). In both cases the EEIP estimates were of likely unrealised potential, beyond business as usual, over the period 2001 to 2012.

As emphasized above, the work is preliminary and has a number of significant limitations. However, despite these limitations we believe that the EEIP estimates developed (levels, costs) are a reasonable indication of what would emerge from a much more comprehensive study.

Besides providing inputs to the associated economic impact modelling, this study aims to stimulate debate on future work and directions of the NFEE development process.

The purposes and acknowledged limitations of this initial work should be kept in mind when reviewing this and the associated economic impact modelling and policy issues report.

5.2 Sectoral estimates

5.2.1 Residential sector

EEI potential estimates for existing residential sector units are presented in **Table 5.1**, and for new dwellings in **Table 5.2**.

Note that in two cases, LOW EEI potential for gas heating equipment and LOW EEI potential for cooling equipment, the EEIs are achieved at zero costs, through redesign and downsizing of equipment to achieve EEI with no **net** cost increases (SEAV, etc. advice).

For each of the specified EEI potential estimates, for example existing housing shells and refrigeration, the estimated cost of the EEI implementation was obtained from the sources referenced.

Table 5.1 Residential energy efficiency improvement potential (EEIP) by application and unit costs								
		Energy Use 2000 (PJ/yr)	EEIP		EEIP $2001 (installation unit cost)			
Sector	Source		Low	High	Low	High	Notes	References
Building Shell	Existing dwelling: pre 2003	N/A	20%	50%	$1500	$5000	Low: ceiling insulation and draft sealing. High: Low + some wall and floor insulation, window treatments, shading.	AESIRB 1994, SEAV First Rate, SEAV 2002e
	New dwelling: post 2003	N/A	30%	50%	$2100	$4000	BAU assumed – 5 Star for Victoria, 3.5 Star for rest of Australia. Low: increase ratings by 1.5 stars. High: energy ratings beyond 6.5 for Victoria and beyond 5 elsewhere in Australia.	ABCB 2002, SEAV 2002e
Space Conditioning Equipment	Gas heating (natural gas & LPG)	73.3	20%	50%	0	$500	Low: condensing appliances High: Low + improved duct insulation, improved burners, heat exchange and controls.	SEAV 2002a, CAE 1996, EA 1998
	Electric heating	7.1	25%	70%	$200	$1000	Low: heat pumps, 3.5 compared to 1.5 star. High: heat pumps, 5 star replacing most resistive heaters.	SEAV 2002b, SEAV 2002f
	Wood heating	81.4	30%	70%	$200	$1500	Low: High efficiency heaters replacing low efficiency units. High: Low + high efficiency units replacing open fires	CAE 1996, SEAV 2002i
	Other (Coal, Petroleum Products	2.9	-	-	-	-	Not analysed	
	Electric cooling	5.8	10%	35%	0	$300	Low: 4 star compared with 1-2 star. High: 6 star compared with 1-2 star	AGO 2000, SEAV 2002b, CAE 1996
	Total (in shell)	**170.4**	**39%**	**79%**	**-**	**-**	**Weighted average**	
Water Heating	Gas (Natural gas & LPG)	46.9	20%	25%	$100	$300	Low: 5 Star compared with 2 star High: Higher efficiency, insulation, electronic ignition, continuous flow	SEAV 2002c, SEAV 2002d, EA 1998

Table 5.1 Residential energy efficiency improvement potential (EEIP) by application and unit costs

Sector	Source	Energy Use 2000 (PJ/yr)	EEIP		EEIP $2001 (installation unit cost)		Notes	References
			Low	High	Low	High		
	Electric	48.0	20%	80%	$50	$1500	Low: insulation and cylinder design High: heat pumps	EA 1998
	Solar Hybrid (replacement gas/electricity)	(-2.4) Reduction in purchased energy use and cost	–	75%	–	$2000	Low: in absence of subsidies not cost effective compared with electric and gas system EEI High: 50 per cent solar by 2010.	ERDC 1994
	Hot Water Management	N/A	20%	40%	$50	$200	Low: Low flow showers. High: Low + insulation, pipe sizing and layout	EA 1998
	Total	**92.5**	**36%**	**81%**	**-**	**-**	**Weighted average**	
Lighting	Electric	16.7	40%	75%	$50	$200	Low: Selective use of fluorescent lighting High: Efficient lighting and distribution systems	CAE 1996, EA 1998
Cooking	Electric	8.4	20%	40%	$50	$100	Low: Increased microwave use. High: Low + improved resistive cooking appliances.	AESIRB 1994
	Gas (Natural gas and LPG)	6.8	10%	30%	$50	$100	Low: insulation/sealing. High: Low + fan forced ovens.	AESIRB 1994, AGO 2002a
	Total	**15.2**	**16%**	**36%**	**-**	**-**	**Weighted average**	
Appliances	Refrigeration/ freezing (new)	28.7	30%	75%	$50	$200	Low: new to meet 2001 US MEPS High: Fans, door seals, improved compressors, insulation and power factors	EA 1998, Geller 1992, CAE 1996
	Dishwashing	1.8	10%	20%	$50	$125	Low: Drive systems, controls. High: Low + hot water economy.	AESIRB 1994
	Clothes Washing	1.9	20%	40%	$125	$250		AESIRB 1994
	Clothes Drying	1.8	15%	60%	$50	$350	Low: clothes washer drying efficiency High: heat pump	
	Home entertainment, Computers*	17	40%	75%	–	–	Penetration increasing. Very limited data. Significant EEI potential.	AGO 2002b
	Other (misc small appliances)*	33.9	10%	45%	–	–	Penetration increasing – mainly electric, some gas use. Limited data.	SEAV 2003 estimates.

Table 5.1 Residential energy efficiency improvement potential (EEIP) by application and unit costs								
Sector	Source	Energy Use 2000 (PJ/yr)	EEIP		EEIP $2001 (installation unit cost)		Notes	References
			Low	High	Low	High		
TOTAL		**381.1**	**34%**	**73%**	**-**	**-**	**Weighted average of all EEIs**	

* Not included in inputs for economic modelling

TABLE 5. Energy Use And EEI Potential Assumptions For New Dwellings
50 GJ/household in 122,000 new dwellingsbuilt in 2000 (base year) = total of 6.1 PJ

	Estimated[1] total energy use in new units, by energy service in 2000	Energy use per unit (GJ/Yr)	Per cent of total energy use[1]	Penetration rate (%)		EEI potential		Δ Capital (K) costs	
						Low	High	Low	High
Building shell[2]	-	-	-	100%		30%	50%	$2,100	$4,000
Space heating*	1.95 PJ (0.2 electric, 1.5 gas, 0.2 wood)	16	32%	80%		See below			
Cooling	0.6 PJ electricity	5	10%	75%		10%	35%	–	$300
Water heating	1.65 PJ Low: 1.00 Gas, 0.65Elec.; High: 0.41 Gas, 0.41Elec., 0.83Solar	13.5	27%	100%	Elec. Gas Solar HWM	20% 20% – 20%	80% 25% 75% 40%	$50 $100 – $50	$1,500 $300 $2000 $200
Refrigeration	0.5 PJ elec.	4.1	8.2%	200%		30%	75%	$100	$400
Lighting	0.3 PJ elec.	2.5	4.9%	100%		40%	75%	$200	$400
Cooking	0.3 PJ 0.2 Elec. 0.1 Gas	2.5	4.9%	100%	Elec. Gas	20% 10%	40% 30%	$50 $50	$100 $100
CW/CD/DW[2]	0.2 PJ elec.	1.6	3.2%	100%		20%	45%	$75	$250
HH electronics	0.5 PJ elec.	4.1	8.2%	200%		40%	75%	–	–
Other	0.1PJ gas/elec.	0.8	1.6%	100%		10%	45%	–	–
TOTAL	**6.1 PJ**	**50**	**100.0**						

*Heating	System Proportion (percentage energy use)	EEI potential Low	EEI potential High	Δ Capital (K) costs Low	Δ Capital (K) costs High
Gas	77.5%	20%	50%	–	$500
Electric	12.5%	25%	70%	$200	$1,000
Wood	10%	30%	70%	$200	$500

Notes

1. Our estimate
2. Improvement beyond committed jurisdictional requirements. Shell EEI in LOW case would save 30 per cent of space conditioning use at a cost of $2,100 and result in average dollar savings of only about $105 per year. This was judged not to be cost effective and not included in the LOW cost and savings estimates.
3. CW/CD/DW – clothes washing & drying & dishwashing. EEIP estimate and capital costs are weighted averages.

5.2.2 Commercial sector

Estimates for the commercial sector are presented in **Table 5.3** (estimated EEI potentials by energy end-use application)**, Table 5.4** (estimated energy services breakdown by building type/commercial sub-sector), and **Table 5.5** (estimated EEI potentials for each building type/commercial sub-sector).

The following points should be kept in mind when reading these tables:

1. Both the LOW and HIGH EEI potential estimates were developed from the sources referenced in the tables. A key reference source for these estimates (and comparisons with estimates derived from other sources), are papers by EMET Consultants and Solarch Group in 1999 (AGO 1999) and EMET Consultants in 2002 (ABARE 2002b). The work by EMET Consultants appears to be the most comprehensive EEI potential work undertaken on any end-use sector in Australia over the past five years (it includes estimates of likely BAU EEI over the period 2001-10).

2. The EEI potential estimates (Table 5.3) were used, along with estimates of sub-sectoral energy service mixes (Table 5.4), to develop the sub-sectoral EEI potential estimates (Table 5.5), which were then used to develop the input data for the economic modelling. (See worked example after Table 5.5 for more information.)

3. The estimates from sources other than EMET Consultants compare reasonably well with the EMET estimates (although note that only estimates similar to the LOW EEI potential estimates were prepared by EMET Consultants). The overall LOW (average **four year** payback) EEI potential estimate of 27 per cent beyond BAU derived for this study from a range of sources, compares favourably with the 22 per cent beyond BAU estimate for EMET Consultants' average **three year** payback case.

4. As with the residential and industrial sectors, more robust EEI potential estimates could be achieved through a more refined and detailed analysis. For example, to differentiate between EEI potentials for new and existing buildings, to take into account the impact of building envelope on space conditioning EEI potentials, and similarly the impact of equipment heat loads on space conditioning. However, the data used in this study and the estimates developed from it appear reasonable as a first estimate from available sources.

Table 5.3 Commercial energy efficiency improvement potential (EEIP) by application									
Sector	Sub-sector	Energy Use (1998-99 PJs) Factored up to 2000/2001 PJs				EEIP %		Notes	References
		Total	Electricity	Gas	Other(includes petroleum& biomass)	Low	High		
Space Conditioning (HVAC)	Space Heating	64.7		46.4	12.6	30%	50%	High & Low: Efficient condensing heaters and building envelope improvements - insulation, solar gain, building mass, window treatment.	CAE 1996, AESIRB 1994, PCA 2001, ABARE 2002b, GBP 2002
			5.7			20%	60%	Low: 60L building, 10% - hybrid passive and mechanical ventilation heating and cooling, widened internal temperature control band, heavyweight structure, low emissivity double glazing. High: Includes building envelope improvements, insulation, solar gain, building mass, window treatment	GPB 2002, CAE 1996, AI 2002, PCA 2001, ABARE 2002b
	Air Handling	30.6	30.6			10%	70%	Low: Sacremento Municipal Utility Customer Service Centre, 4.6% - underfloor ventilation (Shepard 1995). High: City Hall Phoenix, 70% - eliminated oversized fans, and installed variable speed drives. Improved efficiencies in motors and, driven equipment, improved duct design and controls. (Shepard 1995)	AESIRB 1994, Krieth 1997, AI 2002, ABARE 2002b, Shepard 1995
	Cooling	36.2	36.2			35%	85%	Low & High: Building envelope, shading, oversized water cooled condensers, EE fans and duct systems, economisers, absorption cooling, evaporative cooling, desiccant drying, passive cooling, reduce lighting loads, office equipment, variable speed drives, optimise internal loads and solar gain. Low: American Family Insurance HQ, 4.5% - Water side economizer; Sacremento Municipal Utility Customer Service Centre, 9.6% - underfloor ventilation. (Shepard 1995)	CAE 1996, AESIRB 1994, Krieth 1997, ABARE 2002b, GBP 2002, Shepard 1995

Table 5.3 Commercial energy efficiency improvement potential (EEIP) by application

Sector	Sub-sector	Energy Use (1998-99 PJs) Factored up to 2000/2001 PJs				EEIP %		Notes	References
		Total	Electricity	Gas	Other(includes petroleum& biomass)	Low	High		
	Cooling (cont.)							High: 60L building, 80% - hybrid passive and mechanical ventilation heating and cooling, widened internal temperature control band, optimised natural ventilation, heavyweight structure and night purging with cool air, solar shading and low emissivity double glazing, effective management of lighting and office equipment energy demands. (GPB 2002) Tatry and Pathway Social Housing 93% - argon filled low-e glass, heat recovery ventilators, envelope insulation, ceiling mounted hydronic convectors, absorption chiller, cogeneration, building mass, temperature excursions to 80 degrees F. (Shepard 1995)	
	Pumping	5.5	5.5			20%	40%	Low & High: includes building envelope improvements	DISR 2001, ABARE 2002b
	Total HVAC	**137**	**78**	**46.4**	**12.6**	**29%**	**90%**	Low: Florida Museum 11% - heat pipe exchanger installed in one air handler. (Shepard 1996) High: (CAE 1996) - gain avoidance (internal and external), more efficient mechanical cooling, supplemental alternative cooling and improved controls. Widened temp control band, night purging with cool air. EEI measures can also significantly reduce capital expenditure on equipment through, for example, lower heating and heating requirements, particularly in new buildings.	GPB 2002, Shepard 1995,CAE 1996, ABARE 2002b
Lighting		37.4				21%	90%	Low: Building glazing, fluorescent technologies, HID lamps, halogen lamps, luminaire diffusers/controllers, luminaire reflectors, electronic ballasts, compact fluorescents, installation design, control systems,	CAE 1996, RMI 1994, GBP 2002, Audin 1994, AESIRB 1994, PCA 2001, ABARE 2002b

Table 5.3 Commercial energy efficiency improvement potential (EEIP) by application									
Sector	Sub-sector	Energy Use (1998-99 PJs) Factored up to 2000/2001 PJs				EEIP %		Notes	References
		Total	Electricity	Gas	Other(includes petroleum& biomass)	Low	High		
Lighting (cont.)								optimised natural lighting, de-lamping, maintenance, metal halide & sodium - EEI also gives reductions in cooling load. High: 60L building, 90% – optimizing natural lighting, effective management of lighting, high efficiency artificial lighting GBP(2002); Boeing plants, 90% - metal halide lamps RMI(1994).	
Water Heating		9.6	4.5	3.1	2.0	35%	95%	Low: Water flow and pressure management, improved combustion, insulation (tanks & pipes) High: water pre-heat (heat reclaim), heat pumps, solar	AESIRB 1994, CAE 1996, ABARE 2002b
Cooking		2.6	0.6	2.0		20%	40%	Low: higher efficiency equipment. High: Microwave substitution	AESIRB 1994, ABARE 2002b
Refrigeration		17.6	17.6			25%	50%	Low: Insulation, improved sealing, covers, controls High: advanced systems, high efficiency motors and compressor systems, maintenance	AESIRB 1994, ABARE 2002b
Office Equipment		7.5	7.5			30%	80%	Low: Reduction in standby losses, flat screens. High: PC technologies, Energy Star program, energy efficient processors, avoiding computer room air conditioning.	AESIRB 1994, RCEP 1998, ABARE 2002b
Elevators		1.6	1.6			10%	25%	Low & High: Improved drive systems	AESIRB 1994, PCA 2001, ABARE 2002b
Other		4.9	0.6	3.4	0.8	20%	40%		AESIRB 1994
Overall		**218.1**	**140.1**	**52**	**14.6**	**27%**	**70%**	**Weighted average**	**GBP 2002 , RCEP 1998, AGO 1999, CAE 1996, ABARE 2002b**

Table 5.4 Estimated energy services breakdown, by commercial building type

Building Type	ANZSIC Division Codes	Estimated Energy Consumption by Energy Service (%)										Sub-Sectoral Energy Usage		References
		Heating	Ventilation	Cooling/Pump	Lighting	Hot Water	Cooking	Refrigerators	Elevators	Office Equip.	Other	%	PJ	
Offices	J,K,L, M	25%	18%	25%	17%	3%	0%	4%	1%	5%	2%	42%	91	ABARE 2002b, CAE 1996, PCA 2001, NSWDOE 1996
Wholesale and Retail	F,G,Q	28%	15%	12%	26%	2%	1%	8%	1%	3%	4%	30%	66	ABARE 2002b, NSWDOE 1996
Education	N	33%	18%	17%	15%	10%	0%	2%	1%	2%	2%	2%	5	ABARE 2002b, NSWDOE 1996, RCEP 1998, SEAV 2000
Accommodation and Restaurants	H	30%	6%	20%	8%	13%	4%	16%	0%	1%	2%	7%	15	ABARE 2002b, NSWDOE 1996, DPIE 1995, SEAV 2001
Health and Community	O	36%	6%	16%	8%	9%	4%	18%	0%	2%	1%	13%	28	ABARE 2002b, CAE 1996, AGO 1999, NSWDOE 1996, RCEP 1998
Cultural and Recreational	P	39%	11%	21%	9%	4%	2%	10%	0%	2%	2%	6%	13	ABARE 2002b, NSWDOE 1996, RCEP 1998
Overall		**29%**	**14%**	**19%**	**17%**	**5%**	**1%**	**8%**	**1%**	**4%**	**2%**	**100%**	**218**	ABARE 2002b

Table 5.5 Commercial energy efficiency improvement potential by building type					
Building Type	**ANZSIC Codes**	**Total Energy Use (PJ) 2000 (ABARE, EMET)**	**Energy Efficiency Improvement Potential (%)**		**References**
			Low	**High**	
Offices	J,K,L,M	91	28%	74%	ABARE 2002b,CAE 1996, PCA 2001, NSWDOE 1996
Wholesale and Retail	F,G,Q	66	26%	70%	ABARE 2002b, NSWDOE 1996
Education	N	5	28%	72%	ABARE 2002b, NSWDOE 1996, RCEP 1998, SEAV 2000
Accommodation and Restaurants	H	15	29%	69%	ABARE 2002b, NSW 1996, DPIE 1995
Health and Community	O	28	29%	66%	ABARE 2002b, CAE 1996, AGO 1999, NSW 1996, RCEP 1998
Cultural and Recreational	P	13	28%	67%	ABARE 2002b, CAE 1996, RMI 1994, GBP 2002, NSW 1996, RCEP 1998
Totals*		**218**	**27.6%**	**71%**	

Notes: * Total Potential derived from weighted average of individual figures.
* Table 5.5 has been derived from Tables 5.3 and 5.4. The potential energy savings for each application have been weighted in accordance with the energy use mix for each sector (see example below).

As an example of how Table 5.5 was derived from Tables 5.3 and 5.4, the calculation used to estimate the LOW EEI potential for the Accommodation and Restaurants sub-sector is shown below.

Energy Service	**Energy Service – Proportion of total energy use**	**LOW EEIP estimate for Energy Service**	**LOW EEIP contribution to sub-sector***
Heating	0.3	30%	9.0%
Ventilation	0.06	10%	0.6%
Cooling / Pumping	0.2	35%	7.0%
Lighting	0.08	21%	1.7%
Hot water	0.13	35%	4.6%
Cooking	0.04	20%	0.8%
Refrigeration	0.16	25%	4%
Elevators	-	-	-
Office equipment	0.01	30%	0.3%
Other	0.02	20%	0.4%
		Weighted total:	**28.4%****

* LOW EEIP contribution to sub-sector = Energy Service proportion x LOW EEIP estimate (%)

** Note that slight variation between this figure and that given in Table 5.5 is due to rounding errors

5.2.3 Industrial sector

Although the industrial sector is the dominant energy end-use sector, Australian EEI potential information/data for this sector is the least comprehensive of the three sectors covered by this study. The data limitations, together with the variation and diversity of processes and technologies that are applied within and between sub-sectors, makes for considerable difficulty in developing robust overall EEI potential estimates for each of the industrial sub-sectors, let alone for the entire industrial sector.[16]

The situation is improving, due to renewed interest in energy efficiency improvement at the State level, as well as the work undertaken in the Commonwealth's **Energy Efficiency Best Practice Program (EEBPP).** This program systematically examined EEI opportunities in several industrial sub-sectors. Unfortunately, at the time the study was undertaken complete data and analyses from the program, particularly its **Big Energy Projects (BEP)** program, were not available. The BEP approach comprehensively examined energy use and EEI opportunities in major industrial plants (for example pulp and paper) through close cooperation with Program personnel/consultants and plant/corporate personnel.

This approach justified reductions in energy costs of over 20 per cent (and up to 50 per cent in some cases), a reduction in capital investments, improved organisational structure and communications and overall improved productivity. A similar approach, albeit on a smaller scale, was used in the Warren Centre (University of Sydney) **Industrial Energy Efficiency Project** (1997-99). Estimates for this current study were drawn from available data from these projects, energy audits (undertaken as part of Commonwealth and State government programs), and consultant reports (Energy Strategies, Sustainable Solutions, etc.) for public and corporate clients.

The main limitations with the available data sources used are:

- energy saving (in PJs and dollars) and implementation cost data were often not complete, or in the form required for this study, that is, based on 4 or 8 year average paybacks (there is an urgent need to develop a standardised data reporting format);
- estimates of the energy service breakdown for each industrial sub-sector were generally not available;
- the current status (baseline) of energy efficiency in most sub-sectors varies significantly from plant to plant. Thus, average EEI potentials for a sub-sector are very difficult to determine, even at the 3- and 4-digit ANZSIC levels, and more so at the 2-digit ANZSIC sub-sectoral level mainly used in this study;
- estimates of EEI opportunities that would be taken up in a BAU scenario are sparse; and
- most estimates were for existing plants, although replacement of existing equipment with new generation (more energy efficient) equipment (such as high efficiency motor drive systems) was often considered and reported on.

For long-lived assets in capital and energy intensive industries such as steel-making and aluminium, there are significant EEI opportunities when existing plants are replaced or new

---

[16] For a good discussion of the difficulties see Hugh Saddler and Jinlong Ma, Energy Efficiency: *The Potential for Improvements and Policy Options, Industrial Sector*, ABARE workshop, Canberra, 11 December, 2002, Section 3.

plants built. The timing of these investments is, therefore, important. For example, new aluminium processes with EEI improvements of up to 30 per cent (per kg of aluminium produced) are being developed, but when the new processes will become available is uncertain.

Estimates of EEI potentials in the industrial sub-sectors are presented in **Table 5.6**. The following points should be kept in mind when reading these tables:

1. The LOW EEI potential estimates cover improved maintenance, modification of existing equipment and processes, the replacement with higher efficiency equipment at end of life, and the introduction of new equipment with sub-sector growth over the study period. The HIGH EEI potential estimates assume that the measures indicated by the LOW potential estimates are implemented, as well as further upgrades of equipment and the introduction of new higher efficiency processes before the existing plant and equipment has reached the end of its life and as each sub-sector expands over the study period.

2. The EEI potentials for emerging new processes are not reflected in the LOW EEI potential estimates, but are indicated in the HIGH EEI potential estimates, albeit with a high level of uncertainty as to their implementation costs (which ***may*** be lower than the replaced asset). Hence, in the industrial sector, particularly, although we believe the EEI estimates are reasonably robust (but subject to considerable BAU uncertainty[17]) the costings for the HIGH EEI potential estimates are quite uncertain, leading to a low level of reliability in economic modelling of the HIGH scenario.

3. As no reliable energy service breakdown data was available for most industrial sub-sectors, the EEI potential estimates have been made for the sub-sectors as a whole, and not derived from EEI potential estimates for each energy service and estimated energy service breakdowns for each sub-sector, as was the case for the commercial sector. The EEI potential estimates were based on the studies cited, and implicitly take into account the energy services breakdown for the sub-sector.

---

[17] New high EEI process technologies, when, commercially available, are likely to be the investment norm and thus be included in a BAU scenario, although policies could have a decisive impact on process selection. Policies may have a negative impact on EEI – for example energy price subsidies to attract and retain these industries.

Table 5.6 Industrial energy efficiency improvement potential estimates by sub-sector

Division	Sub-division		Energy Use 2000-01 (PJ) (ABARE, 2002c)	Energy Efficiency Improvement Potential		Notes*		References
				Low	High	Low	High*	
A Agriculture	01-04	Agriculture (non-mobile)	11.46	20%	50%	High Efficiency motors, Variable Speed Drives, PLC controls, improved hot water and cooling systems.	High efficiency motors, PLC controls; further improvement in heating and cooling systems.	DITR 2003a, AS/NZS 2000, AGO 2000d, SEAV/EPA 2002
B Mining	11-15	Mining (non-mobile)	199.86	20%	50%	High Efficiency motors, Variable Speed Drives, PLC controls.	Further improvement through High Efficiency Motors, PLC controls.	DITR 2003a, AS/NZS 2000, AGO 2000d, SEAV/EPA 2002
C Manufacturing	**21-29**	**Total Manufacturing**	**1191.1**	**23%**	**46%**	**Potential is weighted average of potentials for sub-divisions.**		
	21	Food, Beverage and Tobacco Manufacturing	165.8	25%	55%	Boiler controls, upgrade steam system, replace steam with hot water, upgrading of biomass cogeneration systems, insulation, High Efficiency motors, Variable Speed Drives, PLC controls, compressed air improvements	Boiler controls, economisers, further upgrading and greater application of cogeneration systems, High Efficiency Motors, PLC controls, compressed air improvements, low grade heat recovery.	GFCV 1989, SECV 1993, SEAV 2002h, WC 1990, SEAV 2002g, DITR 2003b
	22	Textile, Clothing, Footwear and Leather Manufacturing	15.8	25%	45%	Boiler controls, upgrade steam system, improve controls on driers and high grade heat recovery from driers, High Efficiency Motors, Variable Speed Drives, PLC controls, compressed air improvements	Boiler controls, economisers, improve controls on driers and low grade heat recovery from driers, High Efficiency Motors, PLC controls,	SEAV 2002h

Table 5.6 Industrial energy efficiency improvement potential estimates by sub-sector								
Division	**Sub-division**		**Energy Use 2000-01 (PJ) (ABARE, 2002c)**	**Energy Efficiency Improvement Potential**		**Notes***		**References**
				Low	**High**	**Low**	**High***	
	23-24	Wood, Paper and Printing	75.4	20%	45%	Boiler controls, economisers, upgrade steam system, replace steam with hot water, improvement in cogeneration systems, High Efficiency Motors, Variable Speed Drives, PLC controls, compressed air improvements.	Boiler controls, economisers, improve controls on driers and low grade heat recovery from driers, further improvement in cogeneration systems, High Efficiency Motors, PLC controls.	SEAV 2002h, GFCV 1989, SECV 1993, DITR 2003b, AI 2002
	252-6[1]	Petroleum, Coal, Chemicals	273.0	25%	45%	Boiler controls, economisers, upgrade steam system, replace steam with hot water, High Efficiency Motors, Variable Speed Drives, PLC controls.	Boiler controls, economisers, improve controls on driers and low grade heat recovery from driers, High Efficiency Motors, PLC controls.	WC 1999, SEAV 2002h, GFCV 1989, SECV 1993, TNES 1995, SEDA 2001
	26	Non-Metallic Mineral Product Manufacturing	91.9	30%	50%	Improved process heat production and management.	More extensive and deeper application of low improvements; higher efficiency processes.	AESIRB 1994, ABARE 2002a, SECV 1993, EA 1998

Note: 1. ANZSIC 25 sub-sector also includes petroleum refining (251) which was excluded from the analysis; the other ANZSIC 25 sub-sectors include over 100 PJ of energy used in feedstock (non-energy) uses. This use was included in the analysis but probably should have been omitted as although there are potential process improvements to reduce feedstock use for a given output, most of the improvement is not strictly energy efficiency improvement.

Table 5.6 Industrial energy efficiency improvement potential by sector

Division	Sub-division		Energy Use 2000-01 (PJ) (ABARE, 2002c)	Energy Efficiency Improvement Potential (%)		Notes*		References
				Low	High	Low	High*	
		263 Cement, Lime, Plaster and Concrete	-	30%	50%	Improvements to heat production and management and some introduction of higher efficiency processes.	Further improvements to heat production and management; higher efficiency processes; higher efficiency drive systems; cement blending.	
		264 Non-metallic Mineral Products n.e.c.	-	-	-			
	27	Metal Product Manufacturing	545.4	20%	42%			
		271 Iron and steel (excluding coke oven)	181.3	30%	55%	More efficient heat production and management (process controls, etc.); higher efficiency electric drive systems.	New high efficiency processes, further application of low EEIs.	GFCV 1989, SECV 1993, AESIRB 1994, ABARE 2002a, SEAV 2002h
		272-273 Basic Non-ferrous Metals	351.8	15%	35%	More efficient heat production and management (process controls, etc.) and improvements in cogeneration and electric drive systems.	Further improvements as per low plus introduction of higher efficiency processes.	DITR 2003b, DISR 2000, GFCV 1989, SECV 1993, DISR 2000a
		274-276 Other Metal Products	12.3	20%	45%	Improved heat management and electricity systems.	Further improvements as per low EEIs.	WC 1999
	28	Machinery and Equipment Manufacturing	23.5	25%	55%	High Efficiency Motors, Variable Speed Drives, PLC controls, compressed air improvements, improved heating systems.	High Efficiency Motors, PLC controls, further heating process improvements.	SEAV 2002h, GFCV 1989, SECV 1993

Table 5.6 Industrial energy efficiency improvement potential by sector

Division	Sub-division		Energy Use 2000-01 (PJ) (ABARE, 2002c)	Energy Efficiency Improvement Potential (%)		Notes*		References
				Low	High	Low	High*	
	29	Other Manufacturing	0.2	25%	50%	High Efficiency Motors, Variable Speed Drives, PLC controls, compressed air improvements, improvement in heating systems.	High Efficiency Motors, PLC controls, further heating system improvements.	SEAV 2002h, GFCV 1989, SECV 1993
E Construction (non-mobile)			2.04	20%	40%	Heating and electricity system improvements.	Further improvements in gas dryers and electricity systems.	IUA 2002
TOTAL			**1,404.46**	**22%**	**46%**			

***Note**:* * High efficiency potential is achieved by completing both low and high efficiency potential initiatives. Low potential covers improved maintenance, modification of existing equipment and processes and the replacement with higher efficiency equipment at end of life. High potential covers further upgrades of equipment and the introduction of new higher efficiency processes.

6. Development of input data for economic modelling

6.1 Introduction

As described in Section 1.2, the EEI potential estimates developed for the residential, commercial and industrial sectors were used to derive the input data for the subsequent economic modelling.

As part of this study, the National Energy Efficiency Improvement Model (NEEIP), developed by Saturn Corporate Resources Pty Ltd and Greenworld Pty Ltd, was used to derive estimates of the annual savings (in both energy and dollar terms) and annual implementation costs for implementing the specified EEI level (LOW or HIGH) for each sector over the 12-year period used for the modelling[18].

These estimates were then provided to The Allen Consulting Group, and constituted one of the main data inputs for the MMRF-GREEN economic model which was used to estimate the wider economic impacts of implementing higher levels of energy efficiency. In this model, the EEI potential and cost data was modeled as an exogenous twofold 'exogenous shock' consisting of a productivity increase, due to lower energy costs, together with an additional one-off cost to companies for achieving the productivity (EEI) increase.

In Sections 6.2 and 6.3 below, we describe the basic approach and assumptions that were used to derive the implementation cost and savings estimates from the EEI potential estimates in each sector (detailed in Section 5), and present a summary of the data that was developed as an input to the economic model. More detailed information on specific assumptions (eg for individual energy services in the residential sector) and the savings and implementation cost estimates (exogenous shocks) over the 12 year economic modelling period are provided in Appendix 1.

Considerable flexibility has been built into the NEEIP model, allowing a range of the input parameters and assumptions to be varied, including EEI potential estimates, energy prices, base year energy data, growth rates for economic sub-sectors, penetration rates of appliances, etc. The main constraints on the model at this stage are:

(i) only preliminary EEI data is available; and

(ii) the EEI analysis is analysis is based on national averages (prices, EEIs, etc) in the sectoral breakdowns (residential, commercial, and industrial) described in Sections 4 and 5.

Further work could be undertaken to refine the NEEIP model if more robust savings and implementation costs estimates are required when developing the National Framework for Energy Efficiency. However, this would need to be matched by work

---

18 The indicative period is 2001-12 but the economic modelling is relatively insensitive to the actual modelling period chosen. For example, use of the period 2004-2016 which is probably more suitable for applying the NEEIP model, would not significantly alter the economic modelling results.

to develop a more detailed breakdown of EEI potential estimates, eg more detailed industry sector breakdowns or state-by-state breakdowns, etc.

6.2 Development of sectoral estimates

6.2.1 Residential sector

For the residential sector, estimates (although variable in accuracy) are available for EEI potential and the costs of implementing that potential.

EEI potential and implementation cost estimates for the residential sector are presented above in Tables 5.1 (existing dwellings) and Table 5.2 (new dwellings) on a per dwelling basis. A number of assumptions have been made when using this data to derive the economy-wide savings and implementation costs for the residential sector. These assumptions are set out below.

Existing dwellings

1. The 7,250,000 dwellings present in 2000 (ABS data) are retrofitted (building shell, heating and cooling systems, etc.) over 12 years (2001-12) according to the EEI potential and stock proportions specified for the building shell and each energy service, in the LOW and HIGH scenarios.

   Note that dividing the estimated residential energy use in 2000 of 381.1 PJ by the 7,250,000 dwelling units gives a national average energy use per dwelling of 53 GJ per year. Regional variations are significant. For example, for Victoria the estimated average energy use per dwelling in 2001 was 85 GJ per year (DNRE, 2002).[19]

2. The overall space conditioning EEI potential is mainly determined by the thermal integrity of the building shell, together with the energy efficiency of the heating and cooling equipment installed. The thermal integrity of the building shell also confers other comfort and noise reduction benefits which were not quantified.

3. **Improvements in the thermal integrity of the building shell** reduce the energy savings which can be achieved from heating and cooling EEIs, **at the same comfort level** (see point 11 below), as building shell EEIs reduce the amount of heating and cooling energy required to provide this comfort level. The two EEIs (building shell, heating and cooling equipment) must be taken into account when determining the space conditioning energy and dollar savings which can be achieved for the specified EEI potential.[20]

   The method employed to develop the input data for the economic modelling is presented below.

---

[19] Comprised of 20GJ electricity, 55GJ gas and 10GJ other. Note that the higher use of gas for space and water heating in Victoria partly explains the higher figure as gas is burnt at point of end use, and the climate in Victoria leads to a higher energy consumption for heating than in most other states.

[20] Analysis needs to be undertaken on optimising the combination of shell and heating/cooling system improvements. To date such work does not appear to have been undertaken. Also note actual savings after retrofit will depend on the energy use behaviour of unit occupants: this is another area requiring analysis.

It was estimated that in **existing** dwellings the building shell retrofit reduces average space conditioning energy use in retrofitted units (80 per cent of 2000 stock) by 20 per cent for the LOW EEI potential estimate. That is, if the building shells were retrofitted and heating/cooling systems were unchanged, the average space conditioning energy use would be reduced by 20 per cent. Only 80 per cent of existing unit shells are assumed to be retrofitted, to allow for demolitions and situations where retrofitting is not feasible. Currently 30 per cent of the stock has minimal heating and cooling requirements (ABS 2000), and by 2012 around 20 per cent of the stock may be in this position. [21]

Space conditioning index base = 1.00; after shell retrofit = 0.8

4. The **energy efficiency improvement approach for heating equipment** is indicated below for gas heating, based on the LOW EEI potential estimate (20 per cent) for gas heating equipment.

   After the gas heating system EEI is applied, the space conditioning EEI index is:

   = 0.8 – (0.8 x 0.2)
   = 0.8 – 0.16
   = 0.64

   That is, after shell and gas heater EEI potentials are applied, the overall heating system efficiency in gas heated dwellings (assumed to be 75 percent of significantly space heated dwellings) is improved by 36% (100 – 64) **over the 12 year study period**; that is, at about 3.0 per cent per year.

   This process was repeated for dwellings where electricity and wood are the predominant form of heating. Note that heating fuel mixes were not changed over the period, an assumption which requires further analysis. It was assumed that gas heated dwellings account for around 75 per cent of the significantly heated stock; electrically heated units 10 per cent, and wood heated units 15 per cent. These proportions are based ABARE heating energy use data and ABS survey data (ABS 2000) on the proportion of homes primarily heated with each energy source, and on regional heating considerations.

   Cooling equipment penetration is assumed to increase over the study period at a rate of 3 per cent per year.

5. A similar approach to that outlined for space conditioning has been used for **water heating**. Firstly, the existing stock (2000) of water heating systems (in all dwellings) are replaced (at a rate of 1/12 of the stock each year) over the 2001-12 period, according to the proportions of water heater type (gas, electric, etc) in dwellings, and all dwellings have their hot water management (HWM) upgraded as specified in each scenario over the 2001-12 period. (In retrospect, it may have been preferable to reverse the order in which the EEI is applied, that is, HWM first followed by equipment.)

6. A similar approach was used for the other energy services analysed. For lighting, the following assumptions were made:

---

[21] Cooling equipment penetration is assumed to increase by 3 per cent per year over 2001-12.

(i) for LOW EEI potential estimates fluorescents replaced incandescent lamps in only the highest use applications; and

(ii) for the HIGH EEI potential estimates the highest use inefficient lighting systems (for example halogen downlights) were replaced with high efficiency lighting systems at a higher cost.

7. In the case of **household electronics** (TVs, computers, etc.) **and other services** (miscellaneous appliances) it was assumed, in the absence of useful data, that energy savings from EEIs were offset by increasing penetrations. The costs and savings for this the household electronics and the other service category require more detailed analysis as these energy services are increasing. These appliances (and some other appliances, for example microwave ovens, and some dishwashers) use significant amounts of energy in standby mode. Standby power losses, and their reduction were not analysed, but measures to reduce these losses in new appliances will be introduced over the study period.[22]

8. **Increased market penetrations** over the modelling period were assumed for a number of appliances. For cooling systems, from a base of 44 per cent of existing cooling equipment (7 per cent of dwellings have more than one air conditioning unit), penetration was assumed to increase by 3 per cent per year over the 2001-12 period. For dishwashers, from a 2000 base of 34 per cent, penetration was assumed to increase at 3 per cent per year over the 2001-12 period. For clothes dryers, from a base of 56 per cent in 2000, penetration was assumed to increase at 2 per cent per year over the 2001-12 period. Base year penetrations were drawn from ABS data (ABS 2000).

9. For **other appliances** penetration rates were assumed to be fixed over the modelling period, for example clothes washers (virtually 100 per cent in 2000). For refrigerators/freezers penetration rate in 2000 approached 200 per cent and the EEI modelling assumed two units were replaced per household over the 2001-12 period.

New dwellings

10. For **new housing** the following assumptions were made:

An average growth rate of 1.7 per cent per year, from a base of 7,250,000 dwellings in 2000 was assumed (NIEIR/COPS-Monash). Again, this assumption needs to be refined through a more detailed dwelling construction analysis.

For example, to estimate the number of new dwellings in a given year:

2001	=	(7,250,000 x 1.017) – 7,250,000
	=	123,250 new dwellings added to housing stock in 2001
2002	=	(7,250,000 x 1.017 x 1.017) – (7,250,000 x 1.017)
	=	125,345 new dwellings added to housing stock in 2002, etc.

---

[22] The National Stabndby Power Strategy was approved by the Ministerial Council on Energy in November 2002, and aims to achieve a 1-Watt passive standby power target for most classes of electrical appliances by 2012. (NAEEEC 2002)

The estimated EEI potential and implementation costs, and service fuel uses for each new dwelling are presented above in **Table 5.2**.

In new dwellings the definition of business-as-usual (BAU) practice is difficult to ascertain in a period where jurisdictions are making decisions on requirements for envelope thermal performance improvement. Currently in Victoria, accounting for about 50 per cent of national space conditioning energy use, the following situation prevails. At present the average (building shell) rating for new homes is 2.2-stars with 4-stars required over 1 July 2004 to 30 June 2005, and 5-stars from 2005 onwards. The situation in other jurisdictions is uncertain but is not likely to be as stringent as in Victoria, where space conditioning (especially heating) is such an important component of Victorian residential energy use.[23]

Given this situation, and the constraints on detailed analysis, it was assumed that for new dwellings the BAU building shell was 5-stars in Victoria and 3.5-stars in other jurisdictions. Detailed analysis of this issue is required but was beyond the scope of this study.

Victorian data (SEAV, 2003) indicates that going beyond 5-stars for residential building shells in Victoria gives limited savings in space conditioning energy use at high costs. Improving the energy efficiency and appropriate sizing of space conditioning equipment is likely to be much more cost effective. Thus, when developing the input data for the economic modelling of new dwellings using the NEEIP model, only space conditioning equipment EEIs were considered in the space conditioning energy service area.

In the non-envelope EEI area each new dwelling was fitted with equipment (space conditioning, water heating, etc.) specified at the respective EEI potentials in the LOW and HIGH scenarios.

The following assumptions were made about the penetrations of energy services in new dwellings:

Heating	80 per cent - assume mix of 70 per cent gas, 25 per cent electricity, 5 per cent wood.
Water heating	100 per cent – assume mix of 40 per cent electricity, 60 per cent gas in LOW EEIP estimate; 25 per cent electricity, 25 per cent gas and 50 per cent solar in HIGH EEIP estimate)
Cooling	75 per cent
Refrigeration	200 per cent
Lighting	100 per cent
Cooking	100 per cent (60 per cent electricity, 40 per cent gas)

[23] According to the latest (August 2003) Building Code of Australia (BCA) report on the status of BCA housing provisions WA, NT, SA and Tasmania have adopted the provisions. Queensland will in September 2003, and NSW is considering the BCA provisions. Depending on interpretation and implementation of these provisions, the equivalent star ratings are in the 2.5 to 4 Star range. The ACT has an equivalent 4-Star requirement.

Dishwashing	100 per cent
Clothes washing	100 per cent
Clothes drying	80 per cent

The base energy use for new BAU dwelling units was assumed nationally to be an annual average of 50 GJ/year. Although the average new dwelling units are being built larger and demand more energy services than the average for existing units (average energy use of 53 GJ/year), it was assumed that these new dwellings used energy more efficiently (improved building shells, higher efficiency equipment). [24]

In the absence of specific data, this assumption is based on work for the mandatory 5-star house energy rating being introduced for new dwellings in Victoria, and data in the recent Victorian Energy Statement (DNRE, 2002).[25] From an average of about 80 GJ/year stationary residential energy use in Victoria in 2000 (compared with 53 PJ Australia-wide), the introduction of the mandatory 5-star rating would reduce space conditioning energy use in Victorian dwellings by about 30 GJ per year.

This would reduce average energy use for these dwellings to about 50 GJ/year. However, the energy use of the average **new** dwelling before introduction of the mandatory 5 star rating is probably higher (due to greater space conditioning use and average floor area) than the average Victorian stock unit. Nevertheless, this limited data, outlined above, suggests that a national average of 50 GJ/year per new dwelling unit is a reasonable starting point for analysis.

Behavioural impact

11. For space conditioning (heating and cooling), energy efficiency improvements come from improvements to both the building shell (thermal envelope), and heating and cooling systems (equipment, controls, etc). When these energy efficiency improvements are undertaken, the capacity to provide comfort is increased and an important question in space conditioning EEI analysis is the impact EEI will have on comfort levels.

For example, a dwelling using 25 GJ per year for space heating prior to having the shell and heating system improved might, in the LOW EEI potential scenario, use about 15 GJ per year after retrofit **for the same comfort level**. But if the comfort level were increased, that is, some of the heating dollar savings are used for increased comfort, energy use **may** settle at 20 GJ per year.[26] In this study, in the absence of data on this comfort "rebound" effect, no

---

24 This assumption needs to be tested by surveys, etc.

25 *Comparative Cost Benefit Study of Energy Efficiency measures for Class 1 Buildings and High Rise Apartments in Victoria*, Sustainable Energy Authority of Victoria, 2002, Energy for Victoria, Department of Natural Resources and Environment, 2002. Note that the report indicates that in 2000 Victorian space conditioning energy use accounted for about 46 per cent of national space conditioning usage and that the Victorian analysis indicates that 5-star dwellings would use about 60 per cent less energy for space conditioning than an equivalent sized 2.2-star dwelling.

26 Rising household incomes can have a similar impact.

rebound effect was built in to the EEI potential estimates. However, the rebound effect was explicitly analysed for each sector in the economic impact modelling study.

Behavioral preferences are also important in other areas. For example, in the case of lighting, the use of energy inefficient downlighting is increasing indicating it might be very difficult to attain the fluorescent lighting penetration assumed for this study.

Costing

12. For each specified EEI, for example existing housing shells and refrigeration, the estimated cost of the EEI implementation was obtained from the sources referenced. In two cases, LOW gas heating equipment and LOW cooling equipment, EEIs are achieved with zero costs through redesign and downsizing of equipment to achieve EEI with no net cost increases (SEAV, etc, advice).

6.2.2 Commercial and industrial sectors

In the available data for the commercial and industrial sectors, the implementation costs of achieving energy efficiency improvements are rarely given or, when provided, are only given for a limited range of sub-sector elements. As implementation cost estimates were required on a sub-sector basis for the economic modelling, and given the constraints of the available data, the following approach was adopted:

- estimate for each sub-sector, on the basis of available data, the beyond BAU energy efficiency improvement potential that might be attained with an average 4 (LOW EEI potential) and 8 year (HIGH EEI potential) payback (See Sections 5.2.2 and 5.2.3); and

- use the estimated energy savings (in dollar terms) achieved by implementing the specified level of EEI, to calculate the capital costs of achieving these savings levels in the economic modelling.

This approach to calculating the capital cost for the implementation of the specified energy efficiency improvement potential is outlined in three steps below.

The energy use for each sub-sector was used to calculate the annual energy savings through implementation of the specified EEI potential (STEP 1). The weighted average price of energy for the sector was then used to calculate the costs saved (STEP 2). Finally, the capital cost necessary for implementation of specified EEI potential (LOW or HIGH) was then calculated using estimates of cost savings and simple paybacks (STEP 3).

STEP 1: Energy saved (E_S) = Energy Efficiency Improvement Potential (EEIP) x Energy Use (PJ)

STEP 2: Energy cost saved (C_S) = Energy saved (E_S) x Energy price weighted average (E_{PWA})

$$\textbf{STEP 3:} \quad \text{Payback (simple) (PB)} = \frac{\text{Capital cost (K)}}{\text{Energy cost saved } (C_S)}$$

Where C_S = Energy saved (PJ) x Energy price ($/PJ)

Therefore: $K = PB \times C_S$

In the EEI savings/investment model, the range of assumptions may be varied.

The implementation cost estimates used as input data to the economic modelling are for the total costs of achieving the specified beyond BAU EEI potential. As indicated in the Section 1.3, the extent to which transaction costs are included in these total cost estimates is unknown. Again, this is an area for further analysis: note that for the economic modelling the transaction costs for displaced energy supply investments would also need to be considered.

6.3 Summary of input data – Low EEI Potential

The savings (both in energy and dollar terms) and implementation cost data for the Low EEI potential for the residential, commercial and industrial sectors are summarized in the tables below, with more detailed data presented in Appendix 1.

Data is presented both in an annual form (Year 1 of the economic modelling period) and an accumulated form (over the 12-year modelling period[27]). Note that annual data might change slightly from year to year, for example in response to changes in the penetration of appliances or due to growth of an industry sector. Please refer to Appendix 1 for the complete set of data over the 12-year modelling period.

---

[27] The energy savings have been accumulated over only the 12-year modelling period, as this is the data provided by the NEEIP model. This underestimates the lifetime savings by approximately 50%, as all savings from post-2000 EEI investments will not be included; for example, an EEI investment with a 12 year life commencing in 2005 will produce savings until 2017. The 12-year data from the NEEIP model was also used to estimate the lifetime energy savings (PJ and $M), based on an assumed 12-year life, for the various economic sectors, and this data is presented in Section 6.5 below.

6.3.1 Residential sector

Table 6.1 Implementation costs and savings in residential sector, LOW EEI

Description	EEIP (%)	Annual Data (Year 1)			Accumulated data (Yr 1-12)		
		Capital cost ($M)	Energy saved (PJ)	Energy Saved ($M)	Capital cost ($M)	Energy Saved (PJ)	Energy saved ($M)
Existing dwellings							
Building shell*	20%	$725.0	-	-	$8,700	-	-
Heating	25%	$18.1	4.88	$42.1	$218	380.5	$3,284
Cooling	10%	-	0.13	$4.5	-	10.9	$395
Water heating	36%	$72.5	2.81	$65.2	$870	218.9	$5,082
Lighting	40%	$30.2	0.56	$20.1	$363	43.4	$1,568
Refrigeration	30%	$60.4	0.72	$25.9	$725	56.0	$2,021
Clothes washing	20%	$75.5	0.03	$1.1	$906	2.5	$89
Clothes drying	15%	$17.3	0.02	$0.8	$231	1.9	$70
Dishwashing	10%	$10.3	0.02	$0.5	$123	1.2	$42
Cooking	16%	$30.2	0.20	$4.8	$363	15.3	$375
Sub-total		***$1,040***	***9.4***	***$165***	***$12,498***	***731***	***$12,926***
New dwellings							
Building shell*	30%	-	-	-	-	-	-
Heating	22%	$5.9	0.34	$4.4	$78	28.3	$362
Cooling	10%	-	0.05	$1.7	-	3.8	$139
Water heating	36%	$15.4	0.60	$12.2	$203	49.8	$1,017
Lighting	40%	$24.7	0.12	$4.5	$325	10.2	$370
Refrigeration	30%	$12.3	0.30	$10.7	$163	24.6	$887
CW/CD/DW	20%	$9.2	0.04	$1.4	$122	3.3	$118
Cooking	16%	$6.2	0.05	$1.4	$81	4.2	$114
Sub-total		***$74***	***1.5***	***$36***	***$972***	***124***	***$3,022***
Total		**$1,113**	**10.8**	**$201**	**$13,470**	**855**	**$15,933**

* Savings for the Building Shell EEI are included in the heating and cooling savings estimates. It has been assumed that building shell improvements have not been implemented for new dwellings.

6.3.2 Commercial Sector

Table 6.2 Implementation costs and savings in commercial sector, LOW EEI

Building Type / ANZSIC codes	EEIP (%)	Annual data (Year 1)			Accumulated data (Yr 1-12)		
		Capital cost ($M)	Energy saved (PJ)	Energy saved ($M)	Capital cost ($M)	Energy saved (PJ)	Energy saved ($M)
Offices (J, K, L, M)	28%	$203.2	2.20	$50.8	$2,590	178.6	$4,125
Wholesale & Retail (F, G, Q)	26%	$154.3	1.49	$38.6	$2,040	124.0	$3,211
Education (N)	28%	$13.2	0.13	$3.3	$155	9.7	$254
Accommodation & Restaurants (H)	29%	$39.1	0.38	$9.8	$510	31.1	$806
Health & Community (O)	29%	$55.5	0.70	$13.9	$685	55.4	$1,102
Cultural & Recreational (P)	28%	$29.1	0.32	$7.3	$381	26.1	$601
Total	**27.6%**	**$494**	**5.21**	**$124**	**$6,361**	**425**	**$10,099**

6.3.3 Industrial Sector

Table 6.3 Implementation costs and savings in industrial sector, LOW EEI

Division / Sub-division / ANZSIC codes	EEIP (%)	Annual data (Year 1)			Accumulated data (Yr 1-12)		
		Capital cost ($M)	Energy saved (PJ)	Energy saved ($M)	Capital cost ($M)	Energy saved (PJ)	Energy saved ($M)
A. Agriculture	20%	$18.5	0.19	$4.6	$225	15.4	$364
B. Mining	20%	$131.3	3.43	$32.8	$1,692	280.6	$2,685
C. Manufacturing	23%	$810.4	23.3	$202.6	$10,166	1,864.2	$16,276
21 Food, Beverage, etc	25%	$263.3	3.56	$65.8	$3,312	286.4	$5,298
22 Textile, Clothing, etc	25%	$21.1	0.34	$5.3	$251	26.1	$409
23 – 24 Wood, Paper & Printing	20%	$39.3	1.29	$9.8	$506	105.7	$804
252 – 6 Petroleum, Chemical	25%	$196.8	5.86	$49.2	$2,475	471.4	$3,960
26 Non-Metallic Mineral, etc	30%	$67.3	2.37	$16.8	$826	187.7	$1,333
271 Iron & steel (ex coke oven)	30%	$74.0	4.62	$18.5	$861	353.4	$1,414
272 – 273 Basic Non ferrous Metals	15%	$110.5	4.53	$27.6	$1,458	376.4	$2,296
274 – 276 Other Metal Products	20%	$11.3	0.21	$2.8	$146	17.3	$231
28 Machinery & Equipment	25%	$26.8	0.50	$6.7	$328	39.5	$529
29 Other Manufacturing	25%	$0.14	0.004	$0.03	$2	0.3	$3
E. Construction	20%	$1.5	0.03	$0.4	$18	2.7	$29
Total	**22%**	**$962**	**26.9**	**$240.4**	**$12,101**	**2,163**	**$19,353**

6.4 Summary of input data – High EEI Potential

The savings (both in energy and dollar terms) and implementation cost data for the High EEI potential for the residential, commercial and industrial sectors are summarized in the tables below, with more detailed data presented in Appendix 1.

As in Section 6.3, data is presented both in an annual form (Year 1 of the economic modelling period) and an accumulated form (over the 12-year modelling period). Note that annual data might change from year to year, for example in response to changes in the penetration of appliances or due to growth of an industry sector. Please refer to Appendix 1 for the annual data over the 12 year modelling period.

6.4.1 Residential sector

Table 6.4 Implementation costs and savings in residential sector, HIGH EEI

Description	EEIP (%)	Annual Data (Year 1)			Accumulated data (Yr 1-12)		
		Capital cost ($M)	Energy saved (PJ)	Energy Saved ($M)	Capital Cost ($M)	Energy Saved (PJ)	Energy saved ($M)
Existing dwellings							
Building shell*	50%	$2,416.7	-	-	$29,000	-	-
Heating	58%	$253.8	10.90	$94.0	$3,045	846.3	$7,304
Cooling	35%	$82.1	0.30	$12.0	$1,166	29.3	$1,059
Water heating	81%	$876.0	5.50	$127.7	$10,513	429.0	$9,957
Lighting	75%	$120.8	1.04	$37.7	$1,450	81.4	$2,940
Refrigeration	75%	$241.7	1.79	$64.8	$2,900	139.9	$5,052
Clothes washing	40%	$151.0	0.06	$2.3	$1,813	4.9	$178
Clothes drying	60%	$120.8	0.09	$3.3	$1,620	7.7	$279
Dishwashing	20%	$25.7	0.03	$1.1	$308	2.3	$85
Cooking	36%	$60.4	0.45	$11.0	$725	35.1	$857
Sub-total		***$4,349***	***20.2***	***$354***	***$52,539***	***1,576***	***$27,711***
New dwellings							
Building shell*	50%	-	-	-	-	-	-
Heating	55%	$61.6	0.86	$11.0	$813	71.4	$912
Cooling	35%	$27.7	0.16	$5.8	$366	13.4	$485
Water heating	81%	$203.4	1.28	$29.5	$2,682	106.3	$2,448
Lighting	75%	$49.3	0.23	$8.3	$650	19.2	$693
Refrigeration	75%	$49.3	0.76	$27.4	$650	63.0	$2,274
CW/CD/DW	45%	$30.8	0.09	$3.2	$406	7.4	$266
Cooking	36%	$18.5	0.11	$3.0	$244	9.3	$252
Sub-total		***$441***	***3.5***	***$88***	***$5,811***	***290***	***$7,331***
Total		**$4,790**	**24**	**$442**	**$58,350**	**1,866**	**$35,042**

* Savings for the Building Shell EEI are include in the heating and cooling savings estimates. It has been assumed that building shell improvements have not been implemented for new dwellings.

6.4.2 Commercial sector

Table 6.5 Implementation costs and savings in commercial sector, HIGH EEI

Building Type / ANZSIC codes	EEIP (%)	Annual data (Year 1)			Accumulated data (Yr 1-12)		
		Capital cost ($M)	Energy saved (PJ)	Energy saved ($M)	Capital cost ($M)	Energy saved (PJ)	Energy saved ($M)
Offices (J, K, L, M)	74%	$1,037.9	5.62	$129.7	$8,990	352.8	$8,148
Wholesale & Retail (F, G, Q)	70%	$799.0	3.86	$99.9	$7,038	244.9	$6,343
Education (N)	72%	$70.6	0.32	$8.8	$617	20.1	$558
Accommodation & Restaurants (H)	69%	$186.2	0.90	$23.3	$2,006	65.1	$1,690
Health & Community (O)	66%	$252.4	1.59	$31.6	$2,622	112.4	$2,236
Cultural & Recreational (P)	67%	$176.3	0.75	$22.0	$1,918	55.1	$1,610
Total	**71%**	**$2,522**	**13.0**	**$315**	**$23,191**	**850**	**$20,585**

6.4.3 Industrial sector

Table 6.6 Implementation costs and savings in industrial sector, HIGH EEI

Division / Sub-division / ANZSIC codes	**EEIP (%)**	**Annual data (Year 1)**			**Accumulated data (Yr 1-12)**		
		Capital cost ($M)	Energy saved (PJ)	Energy saved ($M)	Capital cost ($M)	Energy saved (PJ)	Energy saved ($M)
A. Agriculture	50%	$92.5	0.49	$11.6	$982	35.0	$831
B. Mining	50%	$637.3	8.33	$79.7	$6,117	559.9	$5,356
C. Manufacturing	46%	$3,299.9	46.5	$412.5	$36,969	3,468.1	$30,730
21 Food, Beverage, etc	55%	$1,158.4	7.83	$144.8	$12,658	573.6	$10,612
22 Textile, Clothing, etc	45%	$75.9	0.60	$9.5	$825	44.1	$693
23 – 24 Wood, Paper & Printing	45%	$176.8	2.91	$22.1	$2,024	219.8	$1,671
252 – 6 Chemical industry	45%	$708.3	10.5	$88.5	$8,108	796.7	$6,693
26 Non-Metallic Mineral, etc	50%	$224.3	3.95	$28.0	$2,508	293.8	$2,086
271 Iron & steel (ex coke oven)	55%	$271.2	8.48	$33.9	$2,816	600.4	$2,402
272 – 273 Basic Non ferrous Metals	35%	$515.6	10.57	$64.5	$6,186	824.0	$5,026
274 – 276 Other Metal Products	45%	$50.9	0.48	$6.37	$583	35.9	$481
28 Machinery & Equipment	55%	$117.8	1.10	$14.7	$1,255	79.2	$1,061
29 Other Manufacturing	50%	$0.5	0.009	$0.07	$6	0.6	$5
E. Construction	40%	$5.8	0.07	$0.7	$65	5.1	$54
Total	**46%**	**$4,036**	**55.3**	**$504**	**$44,134**	**4,068**	**$36,971**

6.5 Summary of input data

The key outputs from this study are summarized in Tables 6.7 and 6.8 below. These show the EEI potential estimates, and the estimated implementation costs and savings - for both the first year of the modelling period and accumulated over the 12-year period – for the LOW and HIGH potential estimates respectively.

Table 6.7 Implementation costs and savings, LOW EEI

Sector	**EEIP**	**Annual data (Year 1)**			**Accumulated data (Yr 1-12)**		
	(%)	Capital cost ($M)	Energy saved (PJ)	Energy saved ($M)	Capital cost ($M)	Energy saved (PJ)	Energy saved ($M)
Residential Sector							
Existing housing	34%	$1,040	9.4	$165	$12,498	731	$12,926
New housing	37%	$74	1.5	$36	$972	124.7	$3,007
Sub-total		*$1,113*	*10.8*	*$201*	*$13,470*	*855*	*$15,933*
Commercial Sector	*27.6%*	*$494*	*5.2*	*$124*	*$6,361*	*425*	*$10,099*
Industrial Sector							
Agriculture	20%	$18.5	0.19	$4.6	$225	15.4	$364
Mining	20%	$131.3	3.43	$32.8	$1,692	280.6	$2,685
Manufacturing	23%	$810.4	23.3	$202.6	$10,166	1,864.2	$16,276
Construction	20%	$1.5	0.03	$0.4	$18	2.7	$29
Sub-total		*$961.8*	*26.9*	*$240.4*	*$12,101*	*2,163*	*$19,353*
Total		**$2,569**	**42.9**	**$565.4**	**$31,932**	**3,443**	**$45,385**

Table 6.8 Implementation costs and savings, HIGH EEI

Sector	**EEIP**	**Annual data (Year 1)**			**Accumulated data (Yr 1-12)**		
	(%)	Capital cost ($M)	Energy saved (PJ)	Energy saved ($M)	Capital cost ($M)	Energy saved (PJ)	Energy saved ($M)
Residential Sector							
Existing housing	73%	$4,349	20.2	$354	$52,539	1,576	$27,711
New housing	73%	$441	3.5	$88	$5,811	290	$7,331
Sub-total		*$4,790*	*23.7*	*$442*	*$58,350*	*1,866*	*$35,042*
Commerical Sector	*70%*	*$2,522*	*13.0*	*$315.3*	*$23,191*	*850*	*$20,585*
Industrial Sector							
Agriculture	50%	$92.5	0.49	$11.6	$982	35.0	$832
Mining	50%	$637.3	8.33	$79.7	$6,117	550.9	$5,356
Manufacturing	46%	$3,299.9	46.5	$412.5	$36,969	3,468.1	$30,730
Construction	40%	$5.8	0.07	$0.7	$65	5.1	$54
Sub-total		*$4,036*	*55.3*	*$504.4*	*$44,134*	*4,068*	*$36,971*
Total		**$11,348**	**92.0**	**$1,262**	**$125675**	**6,784**	**$92,598**

As noted above, accumulating the savings for only years 1 to 12, underestimates the total lifetime energy savings that will be achieved from the capital investments required to achieve the given EEI potential. The NEEIP 12-year data was therefore used to derive an estimate of the accumulated lifetime savings, based on a 12-year life – the savings were accumulated for a total of 23 years (based on 2001 to 2023). This is presented below in Table 6.9.

Table 6.9 Accumulated capital expenditure & lifetime savings

Sector	LOW EEI Potential			HIGH EEI Potential		
	Capital ($M)	Energy Savings (PJ)	Energy Savings ($M)	Capital ($M)	Energy Savings (PJ)	Energy Savings ($M)
Existing housing	12,498	1,350	23,910	52,539	2,912	51,292
New housing	972	237	5,729	5,811	553	13,965
Residential	***13,470***	***1,587***	***29,639***	***58,350***	***3,465***	***65,257***
Commercial	***6,361***	***802***	***19,082***	***23,191***	***1,437***	***34,787***
Construction	18	5	53	65	9	97
Agriculture	225	29	676	982	62	1,474
Mining	1,692	531	5,075	6,117	959	9,176
Manufacturing	10,166	3,488	30,499	36,969	6,266	55,454
Industrial	***12,101***	***4,052***	***36,303***	***44,134***	***7,297***	***66,201***
TOTAL	**31,932**	**6,441**	**85,023**	**125,675**	**12,199**	**166,244**

When reviewing this data, it should be noted that the savings derived by the NEEIP model do not take the 'rebound effect' into account. This tends to reduce the economy-wide level of savings generated, as the energy savings lead to higher profits, disposable incomes and greater use of the energy services and economic growth, which in turn leads to higher levels of energy consumption.

This preliminary analysis suggests that, under the assumptions used in this study, implementing the LOW EEI levels will generate significantly more net benefits than the HIGH EEI levels, which require considerably higher capital investments. For this reason and because 100 per cent implementation is unrealistic, in the associated economic modelling, both 50% and 100% implementation of the LOW EEI potentials were modeled, as well as 50% implementation of the HIGH EEI levels.

7. Future work on EEI potential estimates

7.1 Introduction

As was noted in Section 1, this work is a preliminary study of energy efficiency improvement potential (savings levels, implementation costs) in Australia. It is recognised that additional work needs to be undertaken to develop more robust estimates in support of the development and on-going implementation of the NFEE.

The key limitations, which underscore the preliminary nature of the estimates provided and point to the need for further detailed work in this area, are as follows:

- due to the short timeframe available for the study, it was not possible to undertake original research, meaning that the EEI potential and cost estimates were based on a range of existing data sources in each energy end-use sector;

- estimates are based on national averages (EEI potential, implementation costs and energy prices), as adequate data was not available to take into account regional variations;

- the limitations of the available data meant that it was not possible to analyse, in the commercial and industrial sectors, detailed sub-sectoral EEI opportunities, or to analyse different types of dwellings in the residential sector;

- in most cases, it was not feasible to take into account fuel substitution (changes in the energy mix) in each sector over the study period. Nor was it possible to consider the optimal energy efficiency improvement of energy services, systems and processes;

- the EEI implementation cost estimates are based on current costs and do not take into account any cost reductions that might arise through an increased scale of implementation of higher energy efficiency technology. Also, in most cases, the extent to which the estimates used included transaction costs is not known;

- in the commercial and industrial sectors simple paybacks are used as the investment criterion to identify EEI opportunities (as this is the most commonly used criterion). Paybacks tend to under-value the return on longer life investments. In general, the paybacks are based only on the energy savings, as most available data does not quantify non-energy benefits such as overall productivity improvement. Also, energy saving cost estimates do not include any non-market environmental benefits;

- in each sector it was very difficult to estimate what EEI would take place in the absence of further measures. That is, although the basis for estimates provided is beyond business-as-usual (BAU), BAU EEI is difficult to estimate; and

- the EEI potential estimates do not take account of the “rebound effect” associated with reduced costs of energy services, although provision for this was included in the associated economic modelling.

This section sets out in more detail the work that needs to be undertaken to develop more robust EEI potential and cost and savings estimates.

The approach taken in this study was to initially develop beyond-BAU EEI potential estimates for the residential, commercial and industrial sectors, and then to use these estimates to develop (only derived in industrial and commercial sectors) implementation cost and savings estimates as input data for the chosen economic modelling period (using the NEEIP model, as described in Section 6) – in this case a 12 year period from 2001 to 2012. Additional work could be undertaken to both improve the EEI potential estimates and to refine estimates generated by the NEEIP model over a more realistic period.

7.2 Improvement of EEI potential estimates

Work can be undertaken in a number of areas to address the key limitations identified throughout this report and summarised above in Section 7.1. As an overall comment, a more realistic time period such as 2004-05 to 2016-17 needs to be analysed.

7.2.1 Increased segmentation of economic sectors

Further segmentation of the residential, commercial and industrial sectors would allow more accurate estimates to be developed for each sub-sector.

- In the residential sector, both existing and new dwellings need to be further segmented into dwelling types with similar characteristics (single homes, apartments, etc.) for each region.

- In the commercial and industrial sectors more detailed sub-sectoral analysis is required, for example, below the division (commercial) and 2-digit ANZSIC (industrial) levels. This is particularly the case for sub-sectors which make a significant contribution to overall energy consumption in the commercial and industrial sectors.

In the industrial sector, the current status of energy efficiency in individual plants is particularly important in energy intensive industries with a relatively small number of plants. Thus, in energy intensive sub-sectors which make a significant contribution to the energy consumption, detailed plant level studies would be required to develop more reliable EEI potential, cost and savings estimates. However, such detailed plant level studies may not be feasible for cost and confidentiality reasons.

The EEI analysis reported in this study was confined to energy end-use sectors, and opportunities to improve energy efficiency in the entire stationary energy system are not assessed. A more comprehensive approach would cover all energy sectors – including energy production (processing, generation, etc.) and networks (transmission, distribution) – and would need to take into account the relationship between the energy supply and end-use sectors.

This increased segmentation would considerably expand the amount of work required to develop EEI potential estimates, and ideally would focus on those sub-sectors which made the most significant contributions to energy consumption. Also, this increased segmentation would require significant upgrading of both the NEEIP model and the MMRF-GREEN economic model to handle this increased level of complexity.

7.2.2 Improved energy service information

Better data on energy services in the residential, commercial and industrial sectors, and likely trends, would allow more accurate BAU and beyond-BAU EEI potential estimates to be developed.

In the **residential sector**, data could be improved in the following areas:

New dwellings

- The mix and size of new dwellings.
- The proportions (by State) of new dwellings heated and cooled, the type and efficiencies of space conditioning equipment, and the extent (level) of space conditioning.
- The percentage of electrical and gas equipment installed in new housing for space heating, hot water (solar as well) and cooking, and likely trends.
- Current envelope efficiencies / thermal integrities (by jurisdiction), and likely future building code requirements.

Existing dwellings

- Status (levels, efficiencies) and trends (BAU levels, efficiencies) in heating, cooling and other services by jurisdiction.
- The existing thermal integrity of building shells and the rate, efficiency and costs of shell retrofit, extensions, as well as an analysis of the increased comfort impacts on energy used and EEI economics..

Existing and new dwellings

- There is little data currently available on EEI potential, penetrations, etc. for the household electronics and “other appliance” categories.
- Information is required on the status (age, efficiency, turnover rates) of heating, cooling, hot water, refrigerators, etc. equipment.
- Optimisation of envelope and equipment EEIs.

In the **commercial sector**, further work is required on the segmentation of existing and new buildings. This would make it possible to differentiate between EEI potentials for new and existing buildings, based on building shell and energy service considerations. This work would also take into account the impact of building envelope on space conditioning EEI potentials in order to optimize envelope and equipment EEI combinations, and the impact of equipment heat loads on space conditioning. The specific data gaps which have been identified in the commercial sector during this study are:

- energy service usage and efficiency levels in commercial sub-divisions (particularly office type buildings), for existing and new buildings;
- current and potential EEIs when buildings are refurbished;

- the potential for efficiency improvement in different commercial sub-divisions at different payback/rate of return (ROR) levels up to 8 year payback or ROR equivalents. Most analysis to date appears to have been conducted on the more rapid payback/higher rate of return opportunities, namely <3 year payback;
- the typical life and turnover rates for commercial equipment;
- status/trends/economics of EEI in new commercial buildings;
- fuel mix trends by commercial sub-division; and
- business-as-usual (current and planned policy settings) EEI trends.

Further segmentation of the **industrial sector**, might also allow breakdowns of energy services demanded, as energy services vary substantially between sub-sectors (in existing studies such breakdowns are generally not available). More reliable energy services breakdowns, accompanied by data from energy audits or studies of particular industrial sub-sectors, would allow more accurate EEI potential estimates to be developed for these sub-sectors. The specific data gaps which have been identified in the industrial sector during this study are:

- energy service usage, EEI status/potential of services and overall EEI for each ANZSIC 3-digit sector (2-digit not fine enough);
- paybacks/rates of return for a comprehensive range of EEI opportunities in each sub-sector as above;
- equipment life and stock turnover rates in each sub-sector[28];
- business-as-usual EEI trends for each sub-sector;
- EEIP of new equipment and processes being installed compared with potential EEI in each sub-sector and reasons for the EEI “gap” (actual EEI compared with potential EEI); and
- fuel mix trends by sub-sector (for example gas technologies versus electro technologies).

7.2.3 Sectoral growth projections

More detailed segmentation of the economic sectors could be accompanied by better estimates of growth in these sectors and sub-sectors over the chosen modelling period.

For example, in the residential sector, an average growth rate of 1.7 per cent per year, from a base of 7,250,000 dwellings in 2000 was assumed. This assumption needs to be refined through a more detailed dwelling construction analysis, ideally based on housing types in each jurisdiction. Similarly, work could be undertaken to establish more accurately the likely renovation (and demolition) rates for the existing housing stock.

---

28 If a major piece of equipment, or a process, is replaced in the analysis period the impact on EEI in the firm and its sector may be significant. For example, Orica has recently reported that a new ammonium nitrate-urea plant being installed shows an EEI of 30 per cent compared with the process it will replace.

7.2.4 Business-as-usual projections

The EEI potential estimates developed for this study are beyond-BAU estimates. In the NEEIP model used to derive the input data to the economic modelling, the BAU energy consumption levels in each sector are initially based on energy consumption in the base year (2000) for each sector, and an assumed activity growth rate for the various sub-sectors over the 12 year modelling period. For example, the average growth rate of the housing stock in the residential sector and the activity growth rates of commercial divisions and industrial sub-sectors.

Then estimates, drawn from a range of sources, are made on what EEI will be implemented over the study period in the absence of further measures.

More detailed work is required to better define the business-as-usual energy consumption in each sector as a reference point for estimating EEI implementation costs and savings for different scenarios.

7.2.5 Geographic segmentation

For the purpose of this study national averages (energy prices, energy use patterns, EEI potentials, implementation costs, etc.) were used. A more detailed analysis would require state, and even regional, breakdowns for these various parameters, to be developed as the basis for estimating EEI opportunities and implementation costs in the different sectors.

As with increased segmentation of the economic sectors, this would significantly expand the amount of work required to develop the EEI potential estimates, and also require significant disaggregation of both the NEEIP and economic models.

7.2.6 Sectoral energy mixes

In the current NEEIP model, the base year sub-sectoral energy mixes for the industrial and commercial sectors were maintained over the 12 year modelling period. However, the sectoral energy mixes changed over this period as the sub-sectors grew at different rates.

More detailed work needs to be undertaken to analyse, in each sub-sector, the shifts in energy mix (fuel substitution, etc.) that are likely to take place over the modelling period, for example in water heating, space conditioning and food processing. Such energy mix changes will be linked to relative changes in fuel prices, the expansion of the distribution networks for alternative fuels (e.g. natural gas) and the uptake of new technologies of higher energy efficiency.

7.2.7 Improved estimation of implementation costs and savings

Energy prices

A more refined analysis would require detailed analysis of energy prices, including on a regional and sub-sectoral basis, and likely price trends over the modelling period.

Also, the energy prices used in this study are based on average national market energy prices in each sector, do not account for the impacts of EEI on avoided energy supply system costs, and do not include estimates of non-market environmental costs, such as greenhouse externalities.

Investment criteria

In the commercial and industrial sectors, simple paybacks are used as the investment criterion to identify EEI opportunities in most available data sources. However, the existing energy saving and implementation cost data for these sectors is often incomplete or not in the form required for this study. There is an urgent need to develop a standardised reporting format for this data.

It has already been noted that a simple payback investment criterion ignores the return on EEI investment beyond the payback period (although the analysis did take this into account) and under-values the return from longer life investments.

Implementation/capital costs

In this study the EEI investment costs are derived (in the industrial and commercial sectors) from current estimates of the implementation costs and do not take into account potential cost reductions (which may be significant) that might arise over the study period when the scale of implementation increases and technology improvement proceeds. Further work could be undertaken to determine the likely scale of these cost reductions, especially for key technology groups.

The degree to which cost estimates used in this study include transaction costs is not known, as the data sources are seldom explicit on this point. Again, this is an area for further analysis: Note that for the economic modelling, the transaction costs for displaced energy supply investments would also need to be considered.

Savings estimates

In most cases the available data used for the analysis in this study did not include the quantification of non-energy benefits, such as overall productivity improvements which might arise as a result of implementing EEI measures.

The “rebound” effect, that is, the impact that EEI has on the demand for a service when its cost is reduced, was not taken into account in the energy savings estimates in this study. The rebound effect was, however, explicitly considered in the economic modelling analysis.

7.2.8 Sensitivity analysis

The limitations of the data used in the preliminary analysis of EEI potential in Australian stationary end-use sectors indicate that sensitivity analyses should be undertaken on the data used. The technical and economic models developed in the course of the current work could be used to conduct the sensitivity analyses at relatively low cost.

The sensitivity analysis could be undertaken by varying the EEIs and costs estimated thus far, by say +/– 20 per cent, or by conducting a Delphi Seminar (with up to 10 expert participants) to develop revised scenarios.

7.2.9 A more comprehensive approach

Longer analytical timeframes, a more detailed assessment of EEI opportunities (levels, costs), provision for more complex structural changes (for example within sub-sectors) and consideration of EEI in the entire energy system will need to be considered in future NFEE work to produce more robust estimates of EEI potentials, costs and savings and, therefore, more accurate outputs from the economic modelling.

Sections 7.2.1 to 7.2.8 have outlined a number of key areas in which work could be undertaken to develop estimates that are more robust than the preliminary estimates developed for this study. This work would require a much more comprehensive and sustained approach than was possible for this initial study.

It is evident that a substantial improvement is required in the data used to develop the EEI potential estimates if energy efficiency improvement is to be accorded a high priority in Australia.

To this end, it is recommended that consideration be given to establishing Australian Energy End-Use Data Analysis Centres (AEEDACs), similar to the successful Canadian model (CEEDACs).[29] A range of studies for Commonwealth energy agencies (eg DPIE) during the late 1990's detailed the concepts and assessed the benefits and costs of establishing AEEDACs in the residential, commercial and industrial sectors (one centre in the transport area has been established).

The work reported in this study has built on previous work, for example that undertaken for the Ecologically Sustainable Development (ESD) process during the 1980s. The work undertaken in the course of these studies was conducted in more detail over a much longer time period than was possible in this current study.

The establishment of AEEDACs, as part of the development and on-going analysis of the NFEE, would be one way of ensuring that adequate data was available for the development of more robust estimates and economic modelling, as the basis of sound policy decision making.

---

[29] Reports from CEEDACs are available: see for example www.cieedac.sfu.ca, the website of the Canadian Industrial Energy End-use Data Analysis Centre.

Abbreviations

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
AGO	Australian Greenhouse Office
ANZSIC	Australian and New Zealand Standard Industry Classifications
BAU	Business as usual
CoAG	Council of Australian Governments
E2G2	Energy Efficiency and Greenhouse Gas Working Group
EEBPP	Energy Efficiency Best Practice Program
EEI	Energy Efficiency Improvement
EEIP	Energy Efficiency Improvement Potential
GDP	Gross Domestic Product
GJ	Gigajoule
GSP	Gross State Product
HVAC	Heating, Ventilation, Air Conditioning
HWM	Hot Water Management
IRR	Internal rate of return
MCE	Ministerial Council on Energy
MEPS	Minimum energy performance standards
MWh	Megawatt hour
NFEE	National Framework for Energy Efficiency
PB	Payback (simple investment criterion)
PJ	Petajoule
ROR	Rate of Return
SCOE	Standing Committee of Officials on Energy
SEAV	Sustainable Energy Authority Victoria
SEDA	Sustainable Energy Development Authority NSW

References

In general, the reference sources used for this study have been reports published by government agencies or industry associations, and the actual author may have been a consultant. In this report, the primary reference has usually been given to the organisation which published the report, and the details of the actual author are contained in the reference, where appropriate. An abbreviated form has been used in the body of the report, eg ABARE 1999, to minimise the space taken by the reference sources in the tables in section 5.

ABARE 1999 Australian Bureau of Agricultural and Resource Economics, *Australian Energy Market Developments and Projections to 2014-15, Research Report 99.4,* ABARE, Canberra, 1999.

ABARE 2000 Australian Bureau of Agricultural and Resource Economics, *Trends in Australian Energy Intensity 1973-74 to 1997-98, Research Report 2000.13*, ABARE , Canberra, 2000.

ABARE 2001 Australian Bureau of Agricultural and Resource Economics, *Australian Energy - Projections to 2019-20, Research Report 01.11*, ABARE, Canberra, 2001.

ABARE2002a Australian Bureau of Agricultural and Resource Economics, *Energy efficiency: the potential for improvements and policy options, Industrial Sector*, presented by Hugh Saddler & Jinlang Ma, Energy Strategies to the ABARE Workshop, 11 December 2002, Canberra.

ABARE2002b Australian Bureau of Agricultural and Resource Economics, *Energy Efficiency Improvement Potential and Policies in the Commercial Sector*, presented bu Stephen Pupilli, EMET Consultants Pty. Ltd. to the ABARE Workshop, 11 December 2002, Canberra.

ABARE2002c Australian Bureau of Agricultural and Resource Economics, *Energy Statistics – Full Historical Dataset – All States 2002*, Product 12434, ABARE, Canberra, 2002.

ABARE2003a Australian Bureau of Agricultural and Resource Economics, *Australian Energy: National and State Projections to 2019/20*, Report 03.10, ABARE, June 2003.

ABARE2003b Australian Bureau of Agricultural and Resource Economics, *Trends in Australian Energy Intensity 1973/74 to 2000/01,* Report 034.09, ABARE, June 2003.

ABCB 2002 Australian Building Codes Board, *Energy Efficiency Measures, BCA – Volume 2 (Housing Provisions),* ABCB, 2002.

ABS 1993 Australian Bureau of Statistics, *Australian and New Zealand Standard Industrial Classification*, ABS, Canberra, 1993.

ABS 2000 Australian Bureau of Statistics, *Population Survey Monitor: Energy Survey Report*, ABS, 2000

ACE 2000 The Association for the Conservation of Energy, *White Collar CO_2 - Energy Consumption in the Service Sector*, ACE, London, 2000 <www.ukace.org/pubs.htm>

AESIRB 1994 Australian Electricity Supply Industry Research Board, *End-Use Energy Efficiency in Australia – A Review of Data and Estimates of Potential to 2030*, prepared by National Institute of Economic and Industry Research, AESIRB, 1994

AGA 2001 Australian Gas Association, *Gas Statistics Australia*, AGA, 2001

AGO 1999 Australian Greenhouse Office, *Baseline Study of Greenhouse Gas Emissions from the Commercial Buildings Sector with Projections to Year 2010*, report prepared by EMET Consultants Pty. Ltd. and Solarch Group, AGO, Canberra, 1999.

AGO 2000a Australian Greenhouse Office, *Efficiency Standards for Power Generators Working Group, Generator, Efficiency Standards Guidelines*, AGO, Canberra, 2000.

AGO 2000b Australian Greenhouse Office, *National Appliance & Equipment Energy Efficiency Program (NAEEP) - Projected Combined Impacts from an Extended and Enhanced Program*, report prepared by George Wilkenfeld and Associates Pty. Ltd., AGO, Canberra, 2000 (revised version published in April 2003).

AGO 2000c Australian Greenhouse Office, *CRC Lignite web page* AGO, Canberra, 2000.

AGO 2000d Australian Greenhouse Office, Motor Selector Software, version 3.1A, AGO, Canberra, < http://www.industry.gov.au/motors/>, AGO, Canberra.

AGO 2001 Australian Greenhouse Office, *Regulatory Impact Statement, Minimum Energy Performance Standards for Electricity Distribution Transformers, Draft for Public Comment*, AGO, Canberra, 2001.

AGO 2002a Australian Greenhouse Office, *Your Home, Technical Manual*, AGO, Canberra, 2002.

AGO 2002b Australian Greenhouse Office, *Ministerial Council on Energy - Money Isn't All You're Saving, Australia's Standby Power Strategy 2002 - 2012*, AGO, Canberra, 2002.

AGO 2002c Australian Greenhouse Office, *Australia's National Greenhouse Gas Inventory 1990, 1995 and 1999: End Use Allocation of Emissions (draft 3)*, report prepared by George Wilkenfeld & Associates Pty Ltd with Energy Strategies, AGO, Canberra, 2002.

AGO 2002d Australian Greenhouse Office, *Energy End Use Analysis of Australia's Greenhouse Gas Emissions, 1999 (draft 2),* report prepared by George Wilkenfeld & Associates Pty Ltd with Energy Strategies, AGO, Canberra, 2002.

AI 2002 The Australia Institute, *Long – term Greenhouse Gas Scenarios*, AI, Canberra, 2002.

ANZMEC2000 The Australian and New Zealand Minerals and Energy Council, *Energy trends - an analysis of energy supply and use in the National Energy Market 2000,* ANZMEC, Canberra, 2000.

Audin 1994 Audin, L., Houghton, D., Shepard, M., Hawthorne, W., *Lighting Technology Atlas*, E Source Inc., Boulder, Colorado, 1994.

CMC 2003 The Cast Metals Coalition, *Metal Casting Industry Profile*, 2003, <http/cmc.aticorp.org/industryprofile.html>

CAE 1996 Centre for Advanced Engineering, *Energy Efficiency, A Guide to Current and Emerging Technologies, Volume 1 Buildings and Transportation*, CAE, University of Canterbury, Christchurch, New Zealand, 1996.

DEMV 1992 Department of Energy and Minerals, Victoria, 1992. *Development of a Commercial Building Energy Code: Victorian Impact Study, Volumes 1 and 2*, DEMV, Melbourne, 1992.

DISR 2000 Department of Industry, Science and Resources, *Energy Efficiency Best Practice in the Australian Aluminium Industry,* DISR, Canberra, 2000

DISR 2001 Department of Industry, Science and Resources, *Training Notes 2001, Motor Challenge Program*, DISR, Canberra, 2001.

DITR 2003a Department of Industry, Tourism and Resources, *Motor Solutions Online*, <http://www.isr.gov.au/motors/> DITR, Canberra, 2003.

DITR 2003b Department of Industry, Tourism and Resources, Energy Efficiency Best Practice Program, DITR, Canberra, 2003. <http://www.industry.gov.au/content/controlfiles/display_details.cfm?objectid=4797DE4D-9619-4C79-A10D935C6FE25ED1&typeid=5D93D74B-E1B9-4674-8718D4A8E3A32887>

DITR 2003c Department of Industry, Tourism and Resources, Energy Efficiency Best Practice Program, *Sectoral Energy Efficiency Publications*, DITR EEBP, 2003, <www.industry.gov.au/content/controlfiles/display>

DPIE 1995 Department of Primary Industries and Energy, *Study of Energy Use and Increased Energy Efficiency in the Accommodation Industry*, report prepared by Energetics Pty. Ltd., DPIE, Canberra, 1995.

DNRE 2002 Department of Natural Resources and Environment, *Energy for Victoria – A Statement by the Minister for Energy Resources*, DNRE, Victoria, 2002.

DNRE 2002a Department of Natural Resources and Environment, *Victorian Firewood Strategy*, DNRE, Melbourne, 2002

EA 1998 Environment Australia *Strategic Study of Household Energy and Greenhouse Issues*, prepared by Pears, A., Sustainable Solutions Pty. Ltd., for EA, 1998.

EANSW 1984 Energy Authority of NSW, *Cost Effective Energy Use in Meat Processing,* EANSW, 1984.

ECW 1994 Energy Centre of Wisconsin, *Wisconsin's Statewide Technical and Economic Potential, Report 119-1*, prepared by Wisconsin Centre for Demand-Side Research for ECW, Wisconsin, 1994.

EMRC 1991 Energy Mines and Resources, Canada, *The Economically Attractive Potential for Energy Efficiency Gains in Canada*, prepared by Peat Marwick Stevenson and Kellog and Marbek Resource Consultants (Peat Marwick/Marbek) for EMR, Canada, 1991.

ERDC 1994 Energy Research and Development Corporation, *Solar and Heat Pump Hot Water Systems: Consideration for Proposed Financing Program*, report prepared by Economic and Energy Analysis Pty. Ltd., Saddler, H. and Wilkenfeld, G., ERDC, Canberra, 1994

ESA 2002 Energy South Australia, *Demand Side Management, Energy Efficiency Potential in South Australia,* ESA, 2002.

ESAA 1992 Electricity Supply Association of Australia, Australian Electricity Supply Industry Research Board, *Greenhouse Response Mechanisms: Technological Options*, prepared by Economic Policy and Analysis P/L for ESAA/AESIRB Socio-Economic Greenhouse Study, EEA/ESAA, 1992.

ESAA 1994 Electricity Supply Association of Australia, *Socio-Economic Study: Effects of Greenhouse on the Australian Electricity Industry*, preparedy by the National Institute of Economic and Industry Research for ESAA, 1994

ESAA 2001 Electricity Supply Association of Australia, *Electricity Australia*, ESAA, 2001

ESWG 1991 Ecologically Sustainable Working Groups: Final Reports, *Energy Use and Transport*, ESD, Australian Government Publishing Service, Canberra, 1991.

GBP 2002 Green Building Partnership, *The 60L Green Building Project*, <www.60lgreenbuilding.com/oview.html>, GBP, Melbourne, 2002.

Geller 1992 Geller, Howard S, American Council for an Energy-Efficient Economy, ACEEE, *Presentation to the Workshop on Energy Technology Options for the 21st Century*, McMaster Institute for Energy Studies, Hamilton, Ontario, Canada, 7 May 1992.

GFCV 1991 Gas and Fuel Corporation of Victoria, *Potential for End Use Natural Gas Demand Management for Victorian Industry*, GFCV, Melbourne, 1991.

GFCV 1989 Gas and Fuel Corporation of Victoria, *End Use Natural Gas Demand Management for Victorian Industry*, GFCV, Melbourne, 1989.

HF 2002 Hewlett Foundation, *California's Secret Energy Surplus: the Potential for Energy Efficiency*, prepared by XENERGY Inc, Hewlett Foundation, San Francisco, 2002.

Houghton '96 Houghton, D., Cler, G., Wilson, A., Gregerson, J., Bristol, LS., Newcomb, J., Karen, LG., Shepard, M., 1996, *Space Heating Technology Atlas*, E Source Inc., Boulder, Colorado, 1996.

IEA 2001 International Energy Agency, *Energy Use in Australia in an International Perspective - comparison of trends through the mid 1990s*, IEA, Paris, 2001

IEC 2001 The Iowa Energy Centre, *The Potential for Energy Efficiency in the State of Iowa*, report prepared by Hadley, S. W., IEC, Iowa, USA, 2001.

IUA 2002 Iowa Utility Association, *Assessment of Energy and Capacity Savings Potential in Iowa,* report prepared by Global Energy Partners in association with Quantec, Lafayette, California, 2002.

Kreith 1997 Kreith, F. & West, R.E., (editors), *CRC Handbook of Energy Efficiency*, CRC Press Inc. Boca Ranton, Florida, USA, 1997.

Martin 1999 Martin, Price & Warrell, *Energy Efficiency and CO2 emissions opportunities in the US cement Industry* (P 34-35), 1999

NSWDOE '96 New South Wales Department of Energy, *Energy Use in the NSW Commercial Sector*, NSW DOE, Sydney, 1996.

PCA 2001 The Property Council of Australia, Victorian Division., *Energy Guidelines,* PCA, Melbourne, 2001.

PIU 2001 Performance and Innovation Unit, *Energy Efficiency Strategy, UK Cabinet Office, Consultation Draft,* <www.cabinet-office.gov.uk/innovation/2002/energy/report/ working%20papers/PIUc.pdf, page 6>, PIU. UK, 2001.

RCEP 1998 Royal Commission Environmental Pollution, Study on Energy and the Environment, *Prospects for Energy Saving and Reducing Demand for Energy in the UK*, prepared by Fisher, J., Blythe, W., Collings, S., Boyle, S., Wilder, J., Henderson, G.,Grubb, M., for RCEP, 1998. <(www.rcep.org.uk/studies/energy/98-6063/fisher.html>.

RMI 1994 Rocky Mountain Institute, *Greening the Building and the Bottom Line*, RMI, Snowmass, Colorado, 1994 <www.rmi.org/images/other/GDS-GBBL.pdf>

SAI 2000 Standards Australia International, *AS/NZS 1359.5:2000: Rotating electrical machines - General requirements - Three-phase cage induction motors - High efficiency and minimum energy - performance standards requirements*, SAI, Sydney, 2000.

SEAV 2000a Sustainable Energy Authority Victoria, *Energy Benchmarking of Victorian Schools*, SEAV, Melbourne, 2000.

SEAV 2000b Sustainable Energy Authority Victoria, *FirstRate House Energy Rating Software,* version 3.11a, SEAV, Melbourne, 2000.

SEAV 2001 Sustainable Energy Authority Victoria, *Infosheet on Restaurants*, SEAV, Melbourne, 2001.

SEAV 2002a Sustainable Energy Authority Victoria, *Your Guide to Energy Smart Gas Heaters*, SEAV, Melbourne, 2002.

SEAV 2002b Sustainable Energy Authority Victoria, *Your Guide to Energy Smart Air Conditioners*, SEAV, Melbourne, 2002.

SEAV 2002c Sustainable Energy Authority Victoria,*Your Guide to Energy Smart Gas Water Heaters*, SEAV, Melbourne, 2002.

SEAV 2002d Sustainable Energy Authority Victoria, *Operating Costs of Gas Appliances, SEAV*, Melbourne, 2002.

SEAV 2002e Sustainable Energy Authority Victoria, *Effect of Building Fabric Measures for Residential Sector*, SEAV, Melbourne, 2002.

SEAV 2002f Sustainable Energy Authority Victoria, *Operating Costs of Electrical Appliances*, SEAV, Melbourne, 2002.

SEAV 2002g Sustainable Energy Authority Victoria, *Energy Savings Tips Manual, Energy & Thermal Services* (unpublished Joyce, K.,), SEAV, Melbourne, 2002.

SEAV 2002h Sustainable Energy Authority Victoria, *Commercial and Industrial Energy Audits 2001 – 2002*, SEAV, Melbourne, 2002.

SEAV 2002i Sustainable Energy Authority Victoria, *How to Choose a Wood Heater*, SEAV, Melbourne, 2002.

SEAV 2002j Sustainable Energy Authority Victoria, *Comparative Cost Benefit Study of Energy Efficiency Measures for Class 1 Buildings and High Rise Apartments in Victoria*, SEAV, Melbourne, 2002.

SEAV 2002 Sustainable Energy Authority Victoria, Environmental Protection Agency Victoria, *Energy and Greenhouse Management Toolkit*, SEAV /EPA, Melbourne, 2002.

SEAV 2003 Sustainable Energy Authority Victoria., 2003. *Historical trends Analysis and Snapshot of Sectoral Energy Use*, SEAV, Melbourne, 2003.

SECV 1992 State Electricity Commission of Victoria, Energy Business Centre, *Guide to Cogeneration (Page 37 table B3)*, SECV, Melbourne, 1992.

SECV 1993 State Electricity Commission of Victoria, Energy Business Centre, *Data Summary SECV DM Program*, SECV, Melbourne, 1993.

SECV 1994 State Electricity Commission of Victoria, Energy Business Centre,*Variable Speed Drives and High Efficiency Motors Information sheet*, SECV, Melbourne, 1994.

SECV 1995a State Electricity Commission of Victoria, Energy Business Centre, *Energy Audits,* SECV, Melbourne, 1995.

SECV 1995b State Electricity Commission of Victoria, Energy Business Centre, *Opportunities by ASIC Classification*, SECV, Melbourne, 1995.

SECV 1996 State Electricity Commission of Victoria, Energy Business Centre, *Refrigeration information sheet*, SECV, Melbourne, 1996.

SEDA 2000 Sustainable Energy Development Authority), *Epping/North Ryde Demand side Management Scoping Study*, SEDA, Sydney, April 2000.

SEDA 2001 Sustainable Energy Development Authority, *Demand Side Management: Evaluating Market Potential in NSW*, SEDA, Sydney, July 2001.

Shepard 1995 Shepard, M., Gregerson, J., Houghton, DJ., Fryer, L., Elleson, J., Pattison, B., Hawthorne, W., Webster, L., Stein, J., Davia, Debbie., Parsons, S., 1995, *Commercial Space Cooling and Air Handling Technology Atlas*, E Source Inc. Boulder, Colorado.

SWEEP 2002 Southwest Energy Efficiency Project, *The New Mother Lode – The Potential for More Efficient Electricity Use in the Southwest,* SWEEP, Boulder, Colorado, 2002.

TNES 1995 Trans Net Energy Services, *Industrial Energy Data,* 1995

USDOE 2002 US Department of Energy, Office of Industrial Technologies Energy Efficiency and Renewable Energy, *Petroleum Best Practices Assessment Case Study, Martinez Refinery Completes Plant – Wide Energy Assessment*, U.S. DOE, 2002 (http://www.oit.doe.gov/bestpractices/factsheets/bp_cs_martinez.pdf)

VSEC 1990 Victoria Solar Energy Council, *Efficient Renewable Energy Scenario for Victoria*, VSEC, Melbourne, 1990.

WC 1990 The Warren Centre, *Energy Management in the Process Industry Technical Papers*, WC, University of Sydney, 1990.

WC 1999 The Warren Centre, *Perspectives on Industrial Energy Efficiency*, WC, University of Sydney, 1999.

Worrell 1997 Worrell E, Farla J, Price L, Martin N, Schaeffer R 1997. *International Energy Efficiency Comparisons and Policy Implications in the Iron and Steel Industry*, European Council for an Energy Efficient Economy, <http://www.eceee.org/library_links/proceedings/1997/pdf97/97p3-102.pdf

Appendix 1: Input data to economic model

A1.1 NEEIP Model – Inputs and Outputs

A1.1.1 LOW EEI Potentials

Residential – Existing Housing

Building Shell					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	-	Elec. ($/MWh)	-
% of stock retrofitted	80%	Gas (PJ)	-	Elec. ($/GJ)	-
Penetration at start	80%	Renewable (PJ)	-	Gas ($/GJ)	-
Penetration growth rate	1.00	Total(PJ)	-	Renewable ($/GJ)	-
EEI Potential		***Equipment Share***		Average ($/GJ)	-
Electricity	-	Electricity	-	***Capital Costs***	
Gas	-	Gas	-	Electricity	$1,500
Renewables	-	Renewables	-	Gas	-
Average	20%	Other	-	Renewables	-

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$725	$725	$725	$725	$725	$725	$725	$725	$725	$725	$725	$725
Energy savings in each year compared to BAU (PJ)											
-	-	-	-	-	-	-	-	-	-	-	-
Energy savings in each year compared to BAU ($Million)											
$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-

Space conditioning - Heating					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	7.1	Elec. ($/MWh)	130
% of stock retrofitted	60%	Gas (PJ)	73.3	Elec. ($/GJ)	36.1
Penetration at start	60%	Renewable (PJ)	81.4	Gas ($/GJ)	10
Penetration growth rate	1.00	Total(PJ)	161.8	Renewable ($/GJ)	5
EEI Potential		***Equipment Share***		Average ($/GJ)	8.6
Electricity	25%	Electricity	10%	***Capital Costs***	
Gas	20%	Gas	75%	Electricity	$200
Renewables	30%	Renewables	15%	Gas	$0
Average	25%	Other	-	Renewables	$200
Average inc. shell	37.6%				

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$18	$18	$18	$18	$18	$18	$18	$18	$18	$18	$18	$18
Energy savings in each year compared to BAU (PJ)											
4.9	9.8	14.6	19.5	24.4	29.3	34.2	39.0	43.9	48.8	53.7	58.5
Energy savings in each year compared to BAU ($Million)											
$42	$84	$126	$168	$210	$253	$295	$337	$379	$421	$463	$505

Space conditioning - Cooling					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	5.8	Elec. ($/MWh)	130
% of stock retrofitted	44%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	44%	Renewable (PJ)	-	Gas ($/GJ)	-
Penetration growth rate	1.03	Total(PJ)	-	Renewable ($/GJ)	-
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	10%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$0
Renewables	-	Renewables	-	Gas	-
Average	10%	Other	-	Renewables	-
Average inc. shell	28%				

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Energy savings in each year compared to BAU (PJ)											
0.13	0.25	0.39	0.52	0.67	0.81	0.96	1.12	1.29	1.44	1.61	1.78
Energy savings in each year compared to BAU ($Million)											
$5	$9	$14	$19	$24	$29	$35	$40	$46	$52	$58	$64

Water Heating					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	48	Elec. ($/MWh)	130
% of stock retrofitted	100%	Gas (PJ)	46.9	Elec. ($/GJ)	36.1
Penetration at start	100%	Renewable (PJ)	-2.4	Gas ($/GJ)	10
Penetration growth rate	1.00	Total(PJ)	92.5	Renewable ($/GJ)	23
EEI Potential		***Equipment Share***		Average ($/GJ)	23.2
Electricity	20%	Electricity	60%	***Capital Costs***	
Gas	20%	Gas	40%	Electricity	$50
Hot water management	20%	Renewables	-	Gas	$100
Average	36%	HW management	100%	HW management	$50

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$73	$73	$73	$73	$73	$73	$73	$73	$73	$73	$73	$73
Energy savings in each year compared to BAU (PJ)											
2.8	5.6	8.4	11.2	14.0	16.8	19.7	22.5	25.3	28.1	30.9	33.7
Energy savings in each year compared to BAU ($Million)											
$65	$130	$195	$261	$326	$391	$456	$521	$586	$652	$717	$782

Lighting					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	16.7	Elec. ($/MWh)	130
% of stock retrofitted	100%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	100%	Renewable (PJ)	-	Gas ($/GJ)	
Penetration growth rate	1.00	Total(PJ)	16.7	Renewable ($/GJ)	
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	40%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$50
Renewables	-	Renewables	-	Gas	-
Average	40%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$30	$30	$30	$30	$30	$30	$30	$30	$30	$30	$30	$30
Energy savings in each year compared to BAU (PJ)											
0.6	1.1	1.7	2.2	2.8	3.3	3.9	4.5	5.0	5.6	6.1	6.7
Energy savings in each year compared to BAU ($Million)											
$20	$40	$60	$80	$101	$121	$141	$161	$181	$201	$221	$241

Refrigeration					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	28.7	Elec. ($/MWh)	130
% of stock retrofitted	200%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	200%	Renewable (PJ)	-	Gas ($/GJ)	
Penetration growth rate	1.00	Total(PJ)	28.7	Renewable ($/GJ)	
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	30%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$50
Renewables	-	Renewables	-	Gas	-
Average	30%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$60	$60	$60	$60	$60	$60	$60	$60	$60	$60	$60	$60
Energy savings in each year compared to BAU (PJ)											
0.7	1.4	2.2	2.9	3.6	4.3	5.0	5.7	6.5	7.2	7.9	8.6
Energy savings in each year compared to BAU ($Million)											
$26	$52	$78	$104	$130	$155	$181	$207	$233	$259	$285	$310

Clothes Washer					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	1.9	Elec. ($/MWh)	130
% of stock retrofitted	100%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	100%	Renewable (PJ)	-	Gas ($/GJ)	10
Penetration growth rate	1.00	Total(PJ)	1.9	Renewable ($/GJ)	
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	20%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$125
Renewables	-	Renewables	-	Gas	-
Average	20%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$76	$76	$76	$76	$76	$76	$76	$76	$76	$76	$76	$76
Energy savings in each year compared to BAU (PJ)											
0.03	0.06	0.09	0.13	0.16	0.19	0.22	0.25	0.28	0.32	0.35	0.38
Energy savings in each year compared to BAU ($Million)											
$1.1	$2.3	$3.4	$4.6	$5.7	$6.9	$8.0	$9.2	$10.3	$11.4	$12.6	$13.7

Clothes Dryer					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	1.8	Elec. ($/MWh)	130
% of stock retrofitted	56%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	56%	Renewable (PJ)	-	Gas ($/GJ)	10
Penetration growth rate	1.02	Total(PJ)	1.8	Renewable ($/GJ)	
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	15%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$50
Renewables	-	Renewables	-	Gas	-
Average	15%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$17	$18	$18	$18	$19	$19	$19	$20	$20	$21	$21	$21
Energy savings in each year compared to BAU (PJ)											
0.02	0.05	0.07	0.09	0.12	0.14	0.17	0.20	0.22	0.25	0.28	0.31
Energy savings in each year compared to BAU ($Million)											
$0.8	$1.7	$2.5	$3.4	$4.3	$5.2	$6.2	$7.1	$8.1	$9.1	$10.1	$11.1

Dishwashing					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	1.8	Elec. ($/MWh)	130
% of stock retrofitted	34%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	34%	Renewable (PJ)	-	Gas ($/GJ)	
Penetration growth rate	1.00	Total(PJ)	1.8	Renewable ($/GJ)	
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	10%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$50
Renewables	-	Renewables	-	Gas	-
Average	10%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$10	$10	$10	$10	$10	$10	$10	$10	$10	$10	$10	$10
Energy savings in each year compared to BAU (PJ)											
0.02	0.03	0.05	0.06	0.08	0.09	0.11	0.12	0.14	0.15	0.17	0.18
Energy savings in each year compared to BAU ($Million)											
$0.5	$1.1	$1.6	$2.1	$2.7	$3.3	$3.8	$4.3	$4.9	$5.4	$6.0	$6.5

Cooking					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	8.4	Elec. ($/MWh)	130
% of stock retrofitted	100%	Gas (PJ)	6.8	Elec. ($/GJ)	36.1
Penetration at start	100%	Renewable (PJ)	-	Gas ($/GJ)	10
Penetration growth rate	1.00	Total(PJ)	15.2	Renewable ($/GJ)	
EEI Potential		***Energy Share***		Average ($/GJ)	24.4
Electricity	20%	Electricity	70%	***Capital Costs***	
Gas	10%	Gas	30%	Electricity	$50
Renewables	-	Renewables	-	Gas	$50
Average	17%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$30	$30	$30	$30	$30	$30	$30	$30	$30	$30	$30	$30
Energy savings in each year compared to BAU (PJ)											
0.20	0.39	0.59	0.79	0.98	1.18	1.38	1.57	1.77	1.97	2.16	2.36
Energy savings in each year compared to BAU ($Million)											
$4.8	$9.6	$14.4	$19.2	$24.0	$28.8	$33.6	$38.4	$43.2	$48.1	$52.9	$57.7

Residential – New Housing

Note that building shell improvements were not applied for new dwellings, when estimating the exogenous shocks (capital investment and energy savings) for the new dwellings.

Space conditioning - Heating					
Sector data		**Energy use – base data**		**Energy Prices**	
Base houses (Million)	0.123	Electricity (PJ)	0.24	Elec. ($/MWh)	130
Housing growth rate	1.7%	Gas (PJ)	1.51	Elec. ($/GJ)	36.1
Penetration at start	80%	Renewable (PJ)	0.20	Gas ($/GJ)	10
Penetration growth rate	1.0	Total(PJ)	1.95	Renewable ($/GJ)	5
EEI Potential		***Equipment Share***		Average ($/GJ)	12.8
Electricity	25%	Electricity	25%	***Capital Costs***	
Gas	20%	Gas	70%	Electricity	$200
Renewables	30%	Renewables	5%	Gas	$0
Average	21.8%	Other	-	Renewables	$200
Average inc. shell	21.8%				

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$5.9	$6.0	$6.1	$6.2	$6.3	$6.4	$6.5	$6.7	$6.8	$6.9	$7.0	$7.1
Energy savings in each year compared to BAU (PJ)											
0.34	0.69	1.04	1.40	1.76	2.14	2.51	2.90	3.29	3.68	4.09	4.50
Energy savings in each year compared to BAU ($Million)											
$4.4	$8.8	$13.3	$17.9	$22.5	$27.3	$32.1	$37.0	$42.0	$47.0	$52.2	$57.4

Space conditioning - Cooling					
Sector data		**Energy use – base data**		**Energy Prices**	
Base houses (Million)	0.123	Electricity (PJ)	0.61	Elec. ($/MWh)	130
Housing growth rate	1.7%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	75%	Renewable (PJ)	-	Gas ($/GJ)	-
Penetration growth rate	1.0	Total(PJ)	0.61	Renewable ($/GJ)	-
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	10%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$0
Renewables	-	Renewables	-	Gas	-
Average	10%	Other	-	Renewables	-
Average inc. shell	10%				

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Energy savings in each year compared to BAU (PJ)											
0.05	0.09	0.14	0.19	0.24	0.29	0.34	0.39	0.45	0.50	0.55	0.61
Energy savings in each year compared to BAU ($Million)											
$1.7	$3.4	$5.1	$6.9	$8.6	$10.5	$12.3	$14.2	$16.1	$18.0	$20.0	$22.0

Water Heating					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	0.123	Electricity (PJ)	0.66	Elec. ($/MWh)	130
Housing growth rate	1.7%	Gas (PJ)	0.99	Elec. ($/GJ)	36.1
Penetration at start	100%	Renewable (PJ)	-	Gas ($/GJ)	10
Penetration growth rate	1.0	Total(PJ)	1.65	Renewable ($/GJ)	23
EEI Potential		***Equipment Share***		Average ($/GJ)	20.4
Electricity	20%	Electricity	50%	***Capital Costs***	
Gas	20%	Gas	50%	Electricity	$50
Hot water management	20%	Renewables		Gas	$100
Average	36%	HW management	100%	HW management	$50

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$15.4	$15.7	$15.9	$16.2	$16.5	$16.8	$17.0	$17.3	$17.6	$17.9	$18.2	$18.5
Energy savings in each year compared to BAU (PJ)											
0.60	1.21	1.83	2.46	3.10	3.73	4.41	5.09	5.77	6.47	7.18	7.90
Energy savings in each year compared to BAU ($Million)											
$12.3	$24.7	$37.4	$50.2	$63.4	$76.7	$90.2	$104	$118	$132	$147	$162

Lighting					
Sector data		**Energy use – base data**		**Energy Prices**	
Base houses (Million)	0.123	Electricity (PJ)	0.31	Elec. ($/MWh)	130
Housing growth rate	1.7%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	100%	Renewable (PJ)	-	Gas ($/GJ)	
Penetration growth rate	1.0	Total(PJ)	0.31	Renewable ($/GJ)	
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	40%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$200
Renewables	-	Renewables	-	Gas	-
Average	40%	Other	-	Renewables	-

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$24.7	$25.1	$25.5	$25.9	$26.4	$26.8	$27.3	$27.7	$28.2	$28.7	$29.2	$29.7
Energy savings in each year compared to BAU (PJ)											
0.12	0.25	0.38	0.51	0.64	0.77	0.91	1.05	1.19	1.33	1.48	1.63
Energy savings in each year compared to BAU ($Million)											
$4.5	$9.0	$13.6	$18.3	$23.0	$27.9	$32.8	$37.8	$42.9	$48.1	$53.3	$58.7

Refrigeration					
Sector data		**Energy use – base data**		**Energy Prices**	
Base houses (Million)	0.123	Electricity (PJ)	0.49	Elec. ($/MWh)	130
Housing growth rate	1.7%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	200%	Renewable (PJ)	-	Gas ($/GJ)	
Penetration growth rate	1.0	Total(PJ)	0.49	Renewable ($/GJ)	
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	30%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$50 x 2
Renewables	-	Renewables	-	Gas	-
Average	30%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$12.3	$12.5	$12.7	$13.0	$13.2	$13.4	$13.6	$13.9	$14.1	$14.3	$14.6	$14.8
Energy savings in each year compared to BAU (PJ)											
0.30	0.60	0.90	1.21	1.53	1.85	2.18	2.51	2.85	3.19	3.54	3.90
Energy savings in each year compared to BAU ($Million)											
$10.7	$21.5	$32.6	$43.8	$55.3	$66.9	$78.7	$90.7	$103	$115	$128	$141

Clothes Washer / Dryer / Dishwasher					
Sector data		**Energy use – base data**		**Energy Prices**	
Base houses (Million)	0.123	Electricity (PJ)	0.20	Elec. ($/MWh)	130
Housing growth rate	1.7%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	100%	Renewable (PJ)	-	Gas ($/GJ)	
Penetration growth rate	1.0	Total(PJ)	0.20	Renewable ($/GJ)	
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	20%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$75
Renewables	-	Renewables	-	Gas	-
Average	20%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$9.2	$9.4	$9.6	$9.7	$9.9	$10.1	$10.2	$10.4	$10.6	$10.8	$10.9	$11.1
Energy savings in each year compared to BAU (PJ)											
0.04	0.08	0.12	0.16	0.20	0.25	0.29	0.33	0.38	0.43	0.47	0.52
Energy savings in each year compared to BAU ($Million)											
$1.4	$2.9	$4.4	$5.8	$7.4	$8.9	$10.5	$12.1	$13.7	$15.4	$17.1	$18.8

Cooking					
Sector data		**Energy use – base data**		**Energy Prices**	
Base houses (Million)	0.123	Electricity (PJ)	0.20	Elec. ($/MWh)	130
Housing growth rate	1.7%	Gas (PJ)	0.11	Elec. ($/GJ)	36.1
Penetration at start	100%	Renewable (PJ)	-	Gas ($/GJ)	10
Penetration growth rate	1.0	Total(PJ)	0.31	Renewable ($/GJ)	
EEI Potential		***Equipment Share***		Average ($/GJ)	27.0
Electricity	20%	Electricity	80%	***Capital Costs***	
Gas	10%	Gas	20%	Electricity	$50
Renewables	-	Renewables	-	Gas	$50
Average	18%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$6.2	$6.3	$6.4	$6.5	$6.6	$6.7	$6.8	$6.9	$7.1	$7.2	$7.3	$7.4
Energy savings in each year compared to BAU (PJ)											
0.05	0.10	0.16	0.21	0.26	0.32	0.37	0.43	0.49	0.55	0.61	0.67
Energy savings in each year compared to BAU ($Million)											
$1.4	$2.8	$4.2	$5.6	$7.1	$8.6	$10.1	$11.7	$13.2	$14.8	$16.4	$18.1

Commercial

Offices				ANZSIC Code	J, K, L, M
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.035	Electricity (PJ)	67.3	Elec. ($/MWh)	100
EEIP estimate	28%	Gas (PJ)	18.5	Elec. ($/GJ)	28
Savings rate / yr	2.3%	Coal (PJ)	-	Gas ($/GJ)	9
No of years	12	Petroleum (PJ)	5.3	Coal ($/GJ)	
Base energy use (PJ)	91.1	Biomass (PJ)	-	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	23.1

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$203	$205	$208	$210	$212	$215	$217	$219	$222	$224	$226	$229
Energy savings compared to BAU (PJ)											
2.2	4.4	6.7	8.9	11.2	13.6	15.9	18.3	20.7	23.1	25.6	28.0
Energy savings compared to BAU ($Million)											
$51	$102	$154	$207	$260	$313	$368	$422	$478	$534	$590	$647

Wholesale & Retail				ANZSIC Code	F, G, Q
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.04	Electricity (PJ)	45.7	Elec. ($/MWh)	120
EEIP estimate	26%	Gas (PJ)	16.1	Elec. ($/GJ)	33
Savings rate / yr	2.2%	Coal (PJ)	-	Gas ($/GJ)	10
No of years	12	Petroleum (PJ)	4.3	Coal ($/GJ)	
Base energy use (PJ)	66.1	Biomass (PJ)	-	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	25.9

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$154	$157	$160	$163	$165	$168	$171	$174	$177	$180	$183	$187
Energy savings compared to BAU (PJ)											
1.5	3.0	4.5	6.1	7.7	9.3	11.0	12.7	14.4	16.1	17.9	19.7
Energy savings compared to BAU ($Million)											
$39	$78	$118	$158	$200	$242	$285	$328	$373	$418	$463	$510

Education				ANZSIC Code	N
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.02	Electricity (PJ)	3.3	Elec. ($/MWh)	130
EEIP estimate	28%	Gas (PJ)	1.5	Elec. ($/GJ)	36
Savings rate / yr	2.3%	Coal (PJ)	-	Gas ($/GJ)	10
No of years	12	Petroleum (PJ)	0.5	Coal ($/GJ)	
Base energy use (PJ)	5.3	Biomass (PJ)	-	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	26.2

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13
Energy savings compared to BAU (PJ)											
0.13	0.25	0.38	0.50	0.63	0.75	0.87	1.00	1.12	1.24	1.36	1.48
Energy savings compared to BAU ($Million)											
$3.3	$6.6	$9.9	$13.1	$16.4	$19.6	$22.9	$26.1	$29.3	$32.5	$35.7	$38.8

Accommodation & Restaurants				ANZSIC Code	H
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.04	Electricity (PJ)	9.2	Elec. ($/MWh)	130
EEIP estimate	29%	Gas (PJ)	4.5	Elec. ($/GJ)	36
Savings rate / yr	2.4%	Coal (PJ)	-	Gas ($/GJ)	10
No of years	12	Petroleum (PJ)	1.3	Coal ($/GJ)	
Base energy use (PJ)	15	Biomass (PJ)	-	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	25.9

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$39	$40	$40	$41	$42	$42	$43	$43	$44	$45	$45	$46
Energy savings in each year compared to BAU (PJ)											
0.38	0.76	1.15	1.54	1.94	2.35	2.76	3.18	3.60	4.03	4.47	4.91
Energy savings in each year compared to BAU ($Million)											
$10	$20	$30	$40	$50	$61	$72	$83	$94	$105	$116	$128

Health & Community				ANZSIC Code	O
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	16.4	Elec. ($/MWh)	100
EEIP estimate	29%	Gas (PJ)	9.1	Elec. ($/GJ)	28
Savings rate / yr	2.4%	Coal (PJ)	-	Gas ($/GJ)	8
No of years	12	Petroleum (PJ)	2.5	Coal ($/GJ)	
Base energy use (PJ)	28	Biomass (PJ)	-	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	$19.9

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$55	$56	$56	$56	$57	$57	$57	$57	$58	$58	$58	$59
Energy savings compared to BAU (PJ)											
0.70	1.40	2.10	2.81	3.52	4.24	4.95	5.68	6.40	7.13	7.87	8.60
Energy savings compared to BAU ($Million)											
$14	$28	$42	$56	$70	$84	$99	$113	$127	$142	$157	$171

Cultural & Recreation				ANZSIC Code	P
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.04	Electricity (PJ)	7.7	Elec. ($/MWh)	120
EEIP estimate	28%	Gas (PJ)	4.3	Elec. ($/GJ)	33
Savings rate / yr	2.3%	Coal (PJ)		Gas ($/GJ)	8
No of years	12	Petroleum (PJ)	1.1	Coal ($/GJ)	
Base energy use (PJ)	13	Biomass (PJ)		Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	23

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$29	$30	$30	$30	$31	$31	$32	$32	$33	$33	$34	$35
Energy savings compared to BAU (PJ)											
0.32	0.64	0.96	1.29	1.63	1.97	2.32	2.67	3.02	3.39	3.76	4.13
Energy savings compared to BAU ($Million)											
$7	$15	$22	$30	$38	$45	$53	$61	$70	$78	$87	$95

Industrial

Agriculture (Non-Mobile)				ANZSIC Code	None
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.02	Electricity (PJ)	10.5	Elec. ($/MWh)	90
EEIP estimate	20%	Gas (PJ)		Elec. ($/GJ)	25
Savings rate / yr	1.7%	Coal (PJ)		Gas ($/GJ)	
No of years	12	Petroleum (PJ)	0.96	Coal ($/GJ)	
Base energy use (PJ)	11.5	Biomass (PJ)		Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	23.7

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$18	$19	$19	$19	$19	$19	$19	$19	$19	$19	$19	$19
Energy savings in each year compared to BAU (PJ)											
0.19	0.39	0.59	0.78	0.98	1.18	1.38	1.57	1.77	1.97	2.17	2.38
Energy savings in each year compared to BAU ($Million)											
$5	$9	$14	$19	$23	$28	$33	$37	$42	$47	$52	$56

Mining (Non-Mobile)				ANZSIC Code	None
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	48.1	Elec. ($/MWh)	80
EEIP estimate	20%	Gas (PJ)	137.6	Elec. ($/GJ)	22
Savings rate / yr	1.7%	Coal (PJ)	14.2	Gas ($/GJ)	6
No of years	12	Petroleum (PJ)	-	Coal ($/GJ)	2
Base energy use (PJ)	199.9	Biomass (PJ)	-	Petroleum ($/GJ)	
				Biomass ($/GJ)	
				Average ($/GJ)	9.6

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$131	$133	$135	$136	$138	$140	$142	$144	$145	$147	$149	$151
Energy savings in each year compared to BAU (PJ)											
3.4	6.9	10.4	14.0	17.6	21.3	25.0	28.7	32.5	36.4	40.3	44.2
Energy savings in each year compared to BAU ($Million)											
$33	$66	$100	$134	$168	$203	$239	$275	$311	$348	$385	$423

Food & Beverage				ANZSIC Code	21
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	17.6	Elec. ($/MWh)	100
EEIP estimate	25%	Gas (PJ)	29.2	Elec. ($/GJ)	28
Savings rate / yr	2.1%	Coal (PJ)	12	Gas ($/GJ)	8
No of years	12	Petroleum (PJ)	6.3	Coal ($/GJ)	5
Base energy use (PJ)	165.8	Biomass (PJ)	100.7	Petroleum ($/GJ)	10
				Biomass ($/GJ)	22
				Average ($/GJ)	18.5

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$263	$266	$268	$270	$272	$275	$277	$279	$282	$284	$287	$289
Energy savings in each year compared to BAU (PJ)											
3.6	7.1	10.8	14.4	18.1	21.8	25.6	29.3	33.1	37.0	40.9	44.8
Energy savings in each year compared to BAU ($Million)											
$66	$132	$199	$267	$335	$403	$473	$543	$613	$684	$756	$828

Textiles, Clothing and Footwear				ANZSIC Code	22
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.02	Electricity (PJ)	7.5	Elec. ($/MWh)	90
EEIP estimate	25%	Gas (PJ)	6.4	Elec. ($/GJ)	25
Savings rate / yr	2.1%	Coal (PJ)	0.5	Gas ($/GJ)	8
No of years	12	Petroleum (PJ)	0.9	Coal ($/GJ)	2
Base energy use (PJ)	15.8	Biomass (PJ)	0.5	Petroleum ($/GJ)	10
				Biomass ($/GJ)	0
				Average ($/GJ)	15.7

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$21	$21	$21	$21	$21	$21	$21	$21	$21	$21	$21	$21
Energy savings in each year compared to BAU (PJ)											
0.34	0.67	1.01	1.34	1.67	2.01	2.34	2.67	3.01	3.34	3.67	4.00
Energy savings in each year compared to BAU ($Million)											
$5	$11	$16	$21	$26	$32	$37	$42	$47	$52	$58	$63

Wood, Paper & Printing				ANZSIC Code	23-24
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	19.5	Elec. ($/MWh)	70
EEIP estimate	20%	Gas (PJ)	25.7	Elec. ($/GJ)	19
Savings rate / yr	1.7%	Coal (PJ)	7.8	Gas ($/GJ)	6
No of years	12	Petroleum (PJ)	2.9	Coal ($/GJ)	2
Base energy use (PJ)	75.3	Biomass (PJ)	19.4	Petroleum ($/GJ)	10
				Biomass ($/GJ)	0
				Average ($/GJ)	7.6

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$39	$40	$40	$41	$41	$42	$42	$43	$44	$44	$45	$45
Energy savings in each year compared to BAU (PJ)											
1.3	2.6	3.9	5.3	6.6	8.0	9.4	10.8	12.3	13.7	15.2	16.7
Energy savings in each year compared to BAU ($Million)											
$10	$20	$30	$40	$50	$61	$72	$82	$93	$104	$115	$127

Petroleum, Coal & Chemicals				ANZSIC Code	25
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	24.2	Elec. ($/MWh)	60
EEIP estimate	25%	Gas (PJ)	96.3	Elec. ($/GJ)	17
Savings rate / yr	2.1%	Coal (PJ)	2.4	Gas ($/GJ)	5
No of years	12	Petroleum (PJ)	140.4	Coal ($/GJ)	2
Base energy use (PJ)	272.9	Biomass (PJ)	9.6	Petroleum ($/GJ)	10
				Biomass ($/GJ)	0
				Average ($/GJ)	8.4

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$197	$198	$200	$202	$204	$205	$207	$209	$211	$212	$214	$216
Energy savings in each year compared to BAU (PJ)											
5.9	11.8	17.7	23.7	29.8	35.9	42.1	48.3	54.5	60.9	67.2	73.7
Energy savings in each year compared to BAU ($Million)											
$49	$99	$149	$199	$250	$302	$353	$406	$458	$511	$565	$619

Non-Metallic Minerals				ANZSIC Code	26
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	13.3	Elec. ($/MWh)	70
EEIP estimate	30%	Gas (PJ)	51.3	Elec. ($/GJ)	19
Savings rate / yr	2.5%	Coal (PJ)	20.6	Gas ($/GJ)	6
No of years	12	Petroleum (PJ)	5.5	Coal ($/GJ)	2
Base energy use (PJ)	92	Biomass (PJ)	1.3	Petroleum ($/GJ)	10
				Biomass ($/GJ)	0
				Average ($/GJ)	7.1

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$67	$68	$68	$68	$68	$69	$69	$69	$70	$70	$70	$70
Energy savings in each year compared to BAU (PJ)											
2.4	4.7	7.1	9.5	11.9	14.4	16.8	19.2	21.7	24.1	26.6	29.1
Energy savings in each year compared to BAU ($Million)											
$17	$34	$51	$68	$85	$102	$119	$137	$154	$172	$189	$207

Iron & Steel				ANZSIC Code	271
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.02	Electricity (PJ)	20.8	Elec. ($/MWh)	50
EEIP estimate	30%	Gas (PJ)	46.6	Elec. ($/GJ)	14
Savings rate / yr	2.5%	Coal (PJ)	134.2	Gas ($/GJ)	4
No of years	12	Petroleum (PJ)	2.4	Coal ($/GJ)	2
Base energy use (PJ)	181.3	Biomass (PJ)	-	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	4

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$74	$74	$73	$73	$72	$72	$72	$71	$71	$70	$70	$70
Energy savings in each year compared to BAU (PJ)											
4.6	9.2	13.8	18.3	22.9	27.4	31.8	36.3	40.7	45.1	49.5	53.8
Energy savings in each year compared to BAU ($Million)											
$19	$37	$55	$73	$92	$109	$127	$145	$163	$180	$198	$215

Basic Non-Ferrous Metals				ANZSIC Code	272-273
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	124.2	Elec. ($/MWh)	30
EEIP estimate	15%	Gas (PJ)	120.9	Elec. ($/GJ)	8
Savings rate / yr	1.3%	Coal (PJ)	54	Gas ($/GJ)	5
No of years	12	Petroleum (PJ)	44.8	Coal ($/GJ)	2
Base energy use (PJ)	351.7	Biomass (PJ)	7.8	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	$6.1

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$110	$112	$114	$116	$118	$120	$122	$124	$127	$129	$131	$133
Energy savings in each year compared to BAU (PJ)											
4.5	9.1	13.8	18.6	23.4	28.4	33.4	38.5	43.7	48.9	54.3	59.8
Energy savings in each year compared to BAU ($Million)											
$28	$56	$84	$113	$143	$173	$204	$235	$266	$299	$331	$365

Other Metal Products				ANZSIC Code	274-276
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	5.4	Elec. ($/MWh)	80
EEIP estimate	20%	Gas (PJ)	5.6	Elec. ($/GJ)	22
Savings rate / yr	1.7%	Coal (PJ)	-	Gas ($/GJ)	6
No of years	12	Petroleum (PJ)	1.3	Coal ($/GJ)	2
Base energy use (PJ)	12.3	Biomass (PJ)	-	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	13.4

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$11	$11	$12	$12	$12	$12	$12	$12	$13	$13	$13	$13
Energy savings in each year compared to BAU (PJ)											
0.21	0.43	0.64	0.86	1.08	1.31	1.54	1.77	2.00	2.24	2.48	2.72
Energy savings in each year compared to BAU ($Million)											
$3	$6	$9	$12	$15	$18	$21	$24	$27	$30	$33	$37

Machinery & Equipment				ANZSIC Code	28
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.025	Electricity (PJ)	13	Elec. ($/MWh)	70
EEIP estimate	25%	Gas (PJ)	9.2	Elec. ($/GJ)	19
Savings rate / yr	2.1%	Coal (PJ)	-	Gas ($/GJ)	6
No of years	12	Petroleum (PJ)	1.2	Coal ($/GJ)	2
Base energy use (PJ)	23.4	Biomass (PJ)	-	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	13.4

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$27	$27	$27	$27	$27	$27	$27	$27	$28	$28	$28	$28
Energy savings in each year compared to BAU (PJ)											
0.50	1.00	1.50	2.01	2.52	3.03	3.54	4.05	4.56	5.08	5.60	6.12
Energy savings in each year compared to BAU ($Million)											
$7	$13	$20	$27	$34	$41	$47	$54	$61	$68	$75	$82

Other Manufacturing				ANZSIC Code	29
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	-	Elec. ($/MWh)	90
EEIP estimate	25%	Gas (PJ)	0.2	Elec. ($/GJ)	25
Savings rate / yr	2.1%	Coal (PJ)	-	Gas ($/GJ)	8
No of years	12	Petroleum (PJ)	-	Coal ($/GJ)	
Base energy use (PJ)	0.2	Biomass (PJ)	-	Petroleum ($/GJ)	
				Biomass ($/GJ)	
				Average ($/GJ)	8

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.2
Energy savings in each year compared to BAU (PJ)											
0.004	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.05	0.05
Energy savings in each year compared to BAU ($Million)											
$0.0	$0.1	$0.1	$0.1	$0.2	$0.2	$0.2	$0.3	$0.3	$0.4	$0.4	$0.4

Construction (Non-Mobile)				ANZSIC Code	E
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.02	Electricity (PJ)	0.3	Elec. ($/MWh)	90
EEIP estimate	20%	Gas (PJ)	1.74	Elec. ($/GJ)	25
Savings rate / yr	1.7%	Coal (PJ)	-	Gas ($/GJ)	8
No of years	12	Petroleum (PJ)	-	Coal ($/GJ)	
Base energy use (PJ)	2.04	Biomass (PJ)	-	Petroleum ($/GJ)	
				Biomass ($/GJ)	
				Average ($/GJ)	10.5

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$1.5	$1.5	$1.5	$1.5	$1.5	$1.5	$1.5	$1.5	$1.5	$1.5	$1.5	$1.5
Energy savings in each year compared to BAU (PJ)											
0.03	0.07	0.10	0.14	0.17	0.21	0.24	0.28	0.32	0.35	0.39	0.42
Energy savings in each year compared to BAU ($Million)											
$0.4	$0.7	$1.1	$1.5	$1.8	$2.2	$2.6	$2.9	$3.3	$3.7	$4.1	$4.4

A1.1.2 HIGH EEI Potentials

Residential – Existing Housing

Building Shell					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	-	Elec. ($/MWh)	-
% of stock retrofitted	80%	Gas (PJ)	-	Elec. ($/GJ)	-
Penetration at start	80%	Renewable (PJ)	-	Gas ($/GJ)	-
Penetration growth rate	1.00	Total(PJ)	-	Renewable ($/GJ)	-
EEI Potential		***Equipment Share***		Average ($/GJ)	-
Electricity	-	Electricity	-	***Capital Costs***	
Gas	-	Gas	-	Electricity	$5,000
Renewables	-	Renewables	-	Gas	-
Average	50%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$2417	$2417	$2417	$2417	$2417	$2417	$2417	$2417	$2417	$2417	$2417	$2417
Energy savings in each year compared to BAU (PJ)											
-	-	-	-	-	-	-	-	-	-	-	-
Energy savings in each year compared to BAU ($Million)											
$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-

Space conditioning - Heating					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	7.1	Elec. ($/MWh)	130
% of stock retrofitted	60%	Gas (PJ)	73.3	Elec. ($/GJ)	36.1
Penetration at start	60%	Renewable (PJ)	81.4	Gas ($/GJ)	10
Penetration growth rate	1.00	Total(PJ)	161.8	Renewable ($/GJ)	5
EEI Potential		***Equipment Share***		Average ($/GJ)	8.6
Electricity	70%	Electricity	10%	***Capital Costs***	
Gas	50%	Gas	75%	Electricity	$1000
Renewables	70%	Renewables	15%	Gas	$500
Average	58%	Other	-	Renewables	$1500
Average inc. shell	77.5%				

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$254	$254	$254	$254	$254	$254	$254	$254	$254	$254	$254	$254
Energy savings in each year compared to BAU (PJ)											
10.9	21.7	32.5	43.4	54.3	65.1	75.9	86.8	97.7	108.5	119.3	130.2
Energy savings in each year compared to BAU ($Million)											
$94	$187	$281	$374	$469	$561	$656	$749	$843	$936	$1030	$1124

Space conditioning - Cooling					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	5.8	Elec. ($/MWh)	130
% of stock retrofitted	44%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	44%	Renewable (PJ)	-	Gas ($/GJ)	-
Penetration growth rate	1.03	Total(PJ)	-	Renewable ($/GJ)	-
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	35%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$300
Renewables	-	Renewables	-	Gas	-
Average	35%	Other	-	Renewables	-
Average inc. shell	67.5%				

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$82	$85	$87	$90	$92	$95	$98	$101	$104	$107	$110	$114
Energy savings in each year compared to BAU (PJ)											
0.3	0.7	1.1	1.4	1.7	2.2	2.6	3.0	3.4	3.8	4.4	4.7
Energy savings in each year compared to BAU ($Million)											
$12	$25	$37	$51	$64	$79	$93	$108	$123	$139	$156	$172

Water Heating					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	48	Elec. ($/MWh)	130
% of stock retrofitted	100%	Gas (PJ)	46.9	Elec. ($/GJ)	36.1
Penetration at start	100%	Renewable (PJ)	-2.4	Gas ($/GJ)	10
Penetration growth rate	1.00	Total(PJ)	92.5	Renewable ($/GJ)	23
EEI Potential		***Equipment Share***		Average ($/GJ)	23.2
Electricity	80%	Electricity	25%	***Capital Costs***	
Gas	25%	Gas	25%	Electricity	$1,500
Renewables - solar	75%	Renewables - solar	50%	Gas	$300
Hot water management	40%	HW management	100%	Renewables - solar	$2,000
Average	81%			HW Management	$200

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$876	$876	$876	$876	$876	$876	$876	$876	$876	$876	$876	$876
Energy savings in each year compared to BAU (PJ)											
5.5	11.0	16.5	22.0	27.5	33.0	38.5	44.0	49.5	55.0	60.5	66.0
Energy savings in each year compared to BAU ($Million)											
$128	$255	$383	$511	$638	$766	$894	$1021	$1149	$1277	$1404	$1532

Lighting					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	16.7	Elec. ($/MWh)	130
% of stock retrofitted	100%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	100%	Renewable (PJ)	-	Gas ($/GJ)	
Penetration growth rate	1.00	Total(PJ)	16.7	Renewable ($/GJ)	
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	75%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$200
Renewables	-	Renewables	-	Gas	-
Average	75%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$121	$121	$121	$121	$121	$121	$121	$121	$121	$121	$121	$121
Energy savings in each year compared to BAU (PJ)											
1.0	2.1	3.1	4.2	5.2	6.3	7.3	8.4	9.4	10.4	11.5	12.5
Energy savings in each year compared to BAU ($Million)											
$38	$75	$113	$151	$188	$226	$264	$302	$339	$377	$415	$452

Refrigeration					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	28.7	Elec. ($/MWh)	130
% of stock retrofitted	200%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	200%	Renewable (PJ)	-	Gas ($/GJ)	
Penetration growth rate	1.00	Total(PJ)	28.7	Renewable ($/GJ)	
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	75%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$200 x 2
Renewables	-	Renewables	-	Gas	-
Average	75%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$242	$242	$242	$242	$242	$242	$242	$242	$242	$242	$242	$242
Energy savings in each year compared to BAU (PJ)											
1.8	3.6	5.4	7.2	9.0	10.8	12.6	14.4	16.1	17.9	19.7	21.5
Energy savings in each year compared to BAU ($Million)											
$65	$130	$194	$259	$324	$389	$453	$518	$583	$648	$713	$777

Clothes Washer					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	1.9	Elec. ($/MWh)	130
% of stock retrofitted	100%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	100%	Renewable (PJ)	-	Gas ($/GJ)	10
Penetration growth rate	1.00	Total(PJ)	1.9	Renewable ($/GJ)	
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	40%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$250
Renewables	-	Renewables	-	Gas	-
Average	40%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$151	$151	$151	$151	$151	$151	$151	$151	$151	$151	$151	$151
Energy savings in each year compared to BAU (PJ)											
0.06	0.13	0.19	0.25	0.32	0.38	0.44	0.51	0.57	0.63	0.70	0.76
Energy savings in each year compared to BAU ($Million)											
$2.3	$4.6	$6.9	$9.2	$11.4	$13.7	$16.0	$18.3	$20.6	$22.9	$25.2	$27.4

Clothes Dryer					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	1.8	Elec. ($/MWh)	130
% of stock retrofitted	56%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	56%	Renewable (PJ)	-	Gas ($/GJ)	10
Penetration growth rate	1.02	Total(PJ)	1.8	Renewable ($/GJ)	
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	60%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$350
Renewables	-	Renewables	-	Gas	-
Average	60%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$121	$123	$126	$128	$131	$133	$136	$139	$142	$144	$147	$150
Energy savings in each year compared to BAU (PJ)											
0.09	0.19	0.28	0.38	0.48	0.58	0.68	0.79	0.90	1.01	1.12	1.23
Energy savings in each year compared to BAU ($Million)											
$3.3	$6.7	$10.2	$13.7	$17.3	$20.9	$24.6	$28.5	$32.3	$36.3	$40.3	$44.5

Dishwashing					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	1.8	Elec. ($/MWh)	130
% of stock retrofitted	34%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	34%	Renewable (PJ)	-	Gas ($/GJ)	
Penetration growth rate	1.00	Total(PJ)	1.8	Renewable ($/GJ)	
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	20%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$125
Renewables	-	Renewables	-	Gas	-
Average	20%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$26	$26	$26	$26	$26	$26	$26	$26	$26	$26	$26	$26
Energy savings in each year compared to BAU (PJ)											
0.03	0.06	0.09	0.12	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.36
Energy savings in each year compared to BAU ($Million)											
$1.1	$2.2	$3.3	$4.3	$5.4	$6.5	$7.6	$8.7	$9.8	$10.8	$11.9	$13.0

Cooking					
Sector data		**Energy use – base data**		**Energy Prices**	
Housing stock (Million)	7.25	Electricity (PJ)	8.4	Elec. ($/MWh)	130
% of stock retrofitted	100%	Gas (PJ)	6.8	Elec. ($/GJ)	36.1
Penetration at start	100%	Renewable (PJ)	-	Gas ($/GJ)	10
Penetration growth rate	1.00	Total(PJ)	15.2	Renewable ($/GJ)	
EEI Potential		***Energy Share***		Average ($/GJ)	24.4
Electricity	40%	Electricity	70%	***Capital Costs***	
Gas	30%	Gas	30%	Electricity	$100
Renewables	-	Renewables	-	Gas	$100
Average	37%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$60	$60	$60	$60	$60	$60	$60	$60	$60	$60	$60	$60
Energy savings in each year compared to BAU (PJ)											
0.5	0.9	1.4	1.8	2.3	2.7	3.2	3.6	4.1	4.5	5.0	5.4
Energy savings in each year compared to BAU ($Million)											
$11	$22	$33	$44	$55	$66	$77	$88	$99	$110	$121	$132

<u>Residential – New Housing</u>

Note that building shell improvements were not applied for new dwellings, when estimating the exogenous shocks (capital investment and energy savings) for the new dwellings.

Space conditioning - Heating					
Sector data		**Energy use – base data**		**Energy Prices**	
Base houses (Million)	0.123	Electricity (PJ)	0.24	Elec. ($/MWh)	130
Housing growth rate	1.7%	Gas (PJ)	1.51	Elec. ($/GJ)	36.1
Penetration at start	80%	Renewable (PJ)	0.20	Gas ($/GJ)	10
Penetration growth rate	1.0	Total(PJ)	1.95	Renewable ($/GJ)	5
EEI Potential		***Equipment Share***		Average ($/GJ)	12.8
Electricity	70%	Electricity	25%	***Capital Costs***	
Gas	50%	Gas	70%	Electricity	$1000
Renewables	70%	Renewables	5%	Gas	$500
Average	56%	Other	-	Renewables	$500
Average inc. shell	56%				

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$61.6	$62.7	$63.7	$64.8	$65.9	$67.0	$68.2	$69.3	$70.5	$71.7	$72.9	$74.2
Energy savings in each year compared to BAU (PJ)											
0.86	1.73	2.62	3.53	4.45	5.38	6.33	7.30	8.29	9.29	10.3	11.3
Energy savings in each year compared to BAU ($Million)											
$11.0	$22.1	$33.5	$45.0	$56.8	$68.7	$80.9	$93.2	$106	$119	$132	$145

Space conditioning - Cooling

Sector data		Energy use – base data		Energy Prices	
Base houses (Million)	0.123	Electricity (PJ)	0.61	Elec. ($/MWh)	130
Housing growth rate	1.7%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	75%	Renewable (PJ)	-	Gas ($/GJ)	-
Penetration growth rate	1.0	Total(PJ)	0.61	Renewable ($/GJ)	-
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	35%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$300
Renewables	-	Renewables	-	Gas	-
Average	35%	Other	-	Renewables	-
Average inc. shell	35%				

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$27.7	$28.2	$28.7	$29.2	$29.7	$30.2	$30.7	$31.2	$31.7	$32.3	$32.8	$33.4
Energy savings in each year compared to BAU (PJ)											
0.16	0.33	0.49	0.66	0.84	1.01	1.19	1.37	1.56	1.75	1.94	2.13
Energy savings in each year compared to BAU ($Million)											
$5.8	$11.8	$17.8	$24.0	$30.2	$36.6	$43.0	$49.6	$56.3	$63.1	$70.0	$77.0

Water Heating

Sector data		Energy use – base data		Energy Prices	
Base houses (Million)	0.123	Electricity (PJ)	0.49	Elec. ($/MWh)	130
Housing growth rate	1.7%	Gas (PJ)	0.49	Elec. ($/GJ)	36.1
Penetration at start	100%	Renewable (PJ)	0.66	Gas ($/GJ)	10
Penetration growth rate	1.0	Total(PJ)	1.65	Renewable ($/GJ)	23
EEI Potential		***Equipment Share***		Average ($/GJ)	23.0
Electricity	80%	Electricity	25%	***Capital Costs***	
Gas	25%	Gas	25%	Electricity	$1500
Renewables - solar	75%	Renewables - solar	50%	Gas	$300
Hot water management	40%	HW management	100%	Renewables - solar	$2000
Average	81%			HW management	$200

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$203	$207	$210	$214	$218	$221	$225	$229	$233	$237	$241	$245
Energy savings in each year compared to BAU (PJ)											
1.28	2.58	3.90	5.25	6.62	8.01	9.43	10.9	12.3	13.8	15.3	16.9
Energy savings in each year compared to BAU ($Million)											
$29	$59	$90	$121	$152	$185	$217	$250	$284	$318	$353	$389

Lighting

Sector data		Energy use – base data		Energy Prices	
Base houses (Million)	0.123	Electricity (PJ)	0.31	Elec. ($/MWh)	130
Housing growth rate	1.7%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	100%	Renewable (PJ)	-	Gas ($/GJ)	
Penetration growth rate	1.0	Total(PJ)	0.31	Renewable ($/GJ)	
EEI Potential		***Energy Share***		Average ($/GJ)	36.1
Electricity	75%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$400
Renewables	-	Renewables	-	Gas	-
Average	75%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$49.3	$50.1	$51.0	$51.9	$52.7	$53.6	$54.6	$55.5	$56.4	$57.4	$58.4	$59.3
Energy savings in each year compared to BAU (PJ)											
0.23	0.47	0.71	0.95	1.20	1.45	1.70	1.96	2.23	2.50	2.77	3.05
Energy savings in each year compared to BAU ($Million)											
$8.4	$16.8	$25.5	$34.2	$43.2	$52.3	$61.5	$70.9	$80.4	$90.1	$100	$110

Refrigeration					
Sector data		**Energy use – base data**		**Energy Prices**	
Base houses (Million)	0.123	Electricity (PJ)	0.49	Elec. ($/MWh)	130
Housing growth rate	1.7%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	200%	Renewable (PJ)	-	Gas ($/GJ)	
Penetration growth rate	1.0	Total(PJ)	0.49	Renewable ($/GJ)	
EEI Potential		***Energy Share***		Average ($/GJ)	36.1
Electricity	75%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$200 x 2
Renewables	-	Renewables	-	Gas	-
Average	75%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$49.3	$50.1	$51.0	$51.9	$52.7	$53.6	$54.5	$55.5	$56.4	$57.4	$58.4	$59.3
Energy savings in each year compared to BAU (PJ)											
0.76	1.53	2.31	3.11	3.92	4.75	5.58	6.44	7.30	8.19	9.08	10.0
Energy savings in each year compared to BAU ($Million)											
$27.4	$55.2	$83.5	$112	$142	$171	$202	$232	$264	$296	$328	$361

Clothes Washer / Dryer / Dishwasher					
Sector data		**Energy use – base data**		**Energy Prices**	
Base houses (Million)	0.123	Electricity (PJ)	0.20	Elec. ($/MWh)	130
Housing growth rate	1.7%	Gas (PJ)	-	Elec. ($/GJ)	36.1
Penetration at start	100%	Renewable (PJ)	-	Gas ($/GJ)	
Penetration growth rate	1.0	Total(PJ)	0.20	Renewable ($/GJ)	
EEI Potential		***Equipment Share***		Average ($/GJ)	36.1
Electricity	45%	Electricity	100%	***Capital Costs***	
Gas	-	Gas	-	Electricity	$250
Renewables	-	Renewables	-	Gas	-
Average	45%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$30.8	$31.3	$31.9	$32.4	$33.0	$33.5	$34.1	$34.7	$35.3	$35.9	$36.5	$37.1
Energy savings in each year compared to BAU (PJ)											
0.09	0.18	0.27	0.36	0.46	0.56	0.65	0.75	0.86	0.96	1.06	1.17
Energy savings in each year compared to BAU ($Million)											
$3.2	$6.5	$9.8	$13.2	$16.6	$20.1	$23.6	$27.2	$30.9	$34.6	$38.4	$42.3

Cooking					
Sector data		**Energy use – base data**		**Energy Prices**	
Base houses (Million)	0.123	Electricity (PJ)	0.20	Elec. ($/MWh)	130
Housing growth rate	1.7%	Gas (PJ)	0.11	Elec. ($/GJ)	36.1
Penetration at start	100%	Renewable (PJ)	-	Gas ($/GJ)	10
Penetration growth rate	1.0	Total(PJ)	0.31	Renewable ($/GJ)	
EEI Potential		***Equipment Share***		Average ($/GJ)	27.0
Electricity	40%	Electricity	80%	***Capital Costs***	
Gas	30%	Gas	20%	Electricity	$150
Renewables	-	Renewables	-	Gas	$150
Average	38%	Other	-	Renewables	-

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$18.5	$18.8	$19.1	$19.4	$19.8	$20.1	$20.5	$20.8	$21.2	$21.5	$21.9	$22.3
Energy savings in each year compared to BAU (PJ)											
0.11	0.23	0.34	0.46	0.58	0.70	0.83	0.96	1.08	1.21	1.35	1.48
Energy savings in each year compared to BAU ($Million)											
$3.0	$6.1	$9.3	$12.5	$15.7	$19.0	$22.4	$25.8	$29.2	$32.8	$36.4	$40.1

Commercial

Offices				ANZSIC Code	J, K, L, M
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.035	Electricity (PJ)	67.3	Elec. ($/MWh)	100
EEIP estimate	74%	Gas (PJ)	18.5	Elec. ($/GJ)	28
Savings rate / yr	6.2%	Coal (PJ)	-	Gas ($/GJ)	9
No of years	12	Petroleum (PJ)	5.3	Coal ($/GJ)	
Base energy use (PJ)	91.1	Biomass (PJ)	-	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	23.1

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$1038	$974	$914	$858	$805	$755	$708	$665	$624	$585	$549	$515
Energy savings compared to BAU (PJ)											
5.6	10.9	15.8	20.5	24.8	28.9	32.8	36.4	39.7	42.9	45.9	48.7
Energy savings compared to BAU ($Million)											
$130	$251	$366	$473	$573	$668	$756	$840	$917	$991	$1059	$1124

Wholesale & Retail				ANZSIC Code	F, G, Q
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.04	Electricity (PJ)	45.7	Elec. ($/MWh)	120
EEIP estimate	70%	Gas (PJ)	16.1	Elec. ($/GJ)	33
Savings rate / yr	5.8%	Coal (PJ)	-	Gas ($/GJ)	10
No of years	12	Petroleum (PJ)	4.3	Coal ($/GJ)	
Base energy use (PJ)	66.1	Biomass (PJ)	-	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	25.9

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$799	$752	$708	$667	$628	$592	$557	$525	$494	$465	$438	$412
Energy savings compared to BAU (PJ)											
3.9	7.5	10.9	14.1	17.2	20.0	22.7	25.2	27.6	29.9	32.0	34.0
Energy savings compared to BAU ($Million)											
$100	$194	$282	$366	$444	$518	$588	$654	$715	$773	$828	$880

Education				ANZSIC Code	N
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.02	Electricity (PJ)	3.3	Elec. ($/MWh)	130
EEIP estimate	72%	Gas (PJ)	1.5	Elec. ($/GJ)	36
Savings rate / yr	6%	Coal (PJ)	-	Gas ($/GJ)	10
No of years	12	Petroleum (PJ)	0.5	Coal ($/GJ)	
Base energy use (PJ)	5.3	Biomass (PJ)	-	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	27.8

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$71	$66	$62	$59	$55	$52	$49	$46	$43	$40	$38	$36
Energy savings compared to BAU (PJ)											
0.32	0.62	0.90	1.16	1.41	1.64	1.86	2.07	2.26	2.45	2.62	2.78
Energy savings compared to BAU ($Million)											
$9	$17	$25	$32	$39	$46	$52	$57	$63	$68	$73	$77

Accommodation & Restaurants				ANZSIC Code	H
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.04	Electricity (PJ)	9.2	Elec. ($/MWh)	130
EEIP estimate	69%	Gas (PJ)	4.5	Elec. ($/GJ)	36
Savings rate / yr	5.8%	Coal (PJ)	-	Gas ($/GJ)	10
No of years	12	Petroleum (PJ)	1.3	Coal ($/GJ)	
Base energy use (PJ)	15	Biomass (PJ)	-	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	25.9

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$186	$183	$179	$175	$172	$168	$165	$162	$159	$156	$152	$149
Energy savings in each year compared to BAU (PJ)											
0.9	1.8	2.6	3.5	4.3	5.1	5.9	6.7	7.5	8.2	8.9	9.7
Energy savings in each year compared to BAU ($Million)											
$23	$46	$68	$90	$112	$133	$154	$174	$194	$213	$232	$251

Health & Community				ANZSIC Code	O
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	16.4	Elec. ($/MWh)	100
EEIP estimate	66%	Gas (PJ)	9.1	Elec. ($/GJ)	28
Savings rate / yr	5.5%	Coal (PJ)	-	Gas ($/GJ)	8
No of years	12	Petroleum (PJ)	2.5	Coal ($/GJ)	
Base energy use (PJ)	28	Biomass (PJ)	-	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	$19.9

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$252	$246	$239	$233	$227	$221	$215	$209	$203	$198	$193	$188
Energy savings compared to BAU (PJ)											
1.6	3.1	4.6	6.1	7.5	8.9	10.3	11.6	12.8	14.1	15.3	16.5
Energy savings compared to BAU ($Million)											
$32	$62	$92	$121	$150	$177	$204	$230	$256	$280	$304	$328

Cultural & Recreation				ANZSIC Code	P
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.04	Electricity (PJ)	11	Elec. ($/MWh)	120
EEIP estimate	67%	Gas (PJ)	2	Elec. ($/GJ)	33
Savings rate / yr	5.6%	Coal (PJ)		Gas ($/GJ)	8
No of years	12	Petroleum (PJ)		Coal ($/GJ)	
Base energy use (PJ)	13	Biomass (PJ)		Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	$29.2

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$176	$173	$170	$167	$164	$161	$158	$155	$152	$150	$147	$144
Energy savings compared to BAU (PJ)											
0.8	1.5	2.2	2.9	3.6	4.3	5.0	5.7	6.3	7.0	7.6	8.2
Energy savings compared to BAU ($Million)											
$22	$44	$65	$86	$106	$126	$146	$166	$185	$203	$222	$240

Industrial

Agriculture (Non-Mobile)				ANZSIC Code	None
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.02	Electricity (PJ)	10.5	Elec. ($/MWh)	90
EEIP estimate	50%	Gas (PJ)		Elec. ($/GJ)	25
Savings rate / yr	4.2%	Coal (PJ)		Gas ($/GJ)	
No of years	12	Petroleum (PJ)	0.96	Coal ($/GJ)	
Base energy use (PJ)	11.5	Biomass (PJ)		Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	23.7

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$93	$90	$88	$86	$84	$83	$81	$79	$77	$75	$74	$72
Energy savings in each year compared to BAU (PJ)											
0.5	1.0	1.4	1.9	2.3	2.8	3.2	3.6	4.0	4.4	4.8	5.2
Energy savings in each year compared to BAU ($Million)											
$12	$23	$34	$45	$55	$66	$76	$86	$95	$105	$114	$123

Mining (Non-Mobile)				ANZSIC Code	None
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	48.1	Elec. ($/MWh)	80
EEIP estimate	50%	Gas (PJ)	137.6	Elec. ($/GJ)	22
Savings rate / yr	4.2%	Coal (PJ)	14.2	Gas ($/GJ)	6
No of years	12	Petroleum (PJ)	-	Coal ($/GJ)	2
Base energy use (PJ)	199.9	Biomass (PJ)	-	Petroleum ($/GJ)	
				Biomass ($/GJ)	
				Average ($/GJ)	9.6

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$637	$611	$585	$561	$538	$515	$494	$473	$453	$435	$416	$399
Energy savings in each year compared to BAU (PJ)											
8.3	16.3	24.0	31.3	38.3	45.0	51.5	57.7	63.6	69.3	74.7	79.9
Energy savings in each year compared to BAU ($Million)											
$80	$156	$229	$299	$366	$431	$493	$552	$608	$663	$715	$765

Food & Beverage				ANZSIC Code	21
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	17.6	Elec. ($/MWh)	100
EEIP estimate	55%	Gas (PJ)	29.2	Elec. ($/GJ)	28
Savings rate / yr	4.6%	Coal (PJ)	12	Gas ($/GJ)	8
No of years	12	Petroleum (PJ)	6.3	Coal ($/GJ)	5
Base energy use (PJ)	165.8	Biomass (PJ)	100.7	Petroleum ($/GJ)	10
				Biomass ($/GJ)	22
				Average ($/GJ)	18.5

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$1158	$1138	$1119	$1100	$1081	$1062	$1044	$1026	$1008	$991	$974	$957
Energy savings in each year compared to BAU (PJ)											
7.8	15.5	23.1	30.5	37.8	45.0	52.0	59.0	65.8	72.5	79.1	85.5
Energy savings in each year compared to BAU ($Million)											
$145	$287	$427	$564	$700	$832	$963	$1091	$1217	$1341	$1463	$1582

Textiles, Clothing and Footwear				ANZSIC Code	22
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.02	Electricity (PJ)	7.5	Elec. ($/MWh)	90
EEIP estimate	45%	Gas (PJ)	6.4	Elec. ($/GJ)	25
Savings rate / yr	3.8%	Coal (PJ)	0.5	Gas ($/GJ)	8
No of years	12	Petroleum (PJ)	0.9	Coal ($/GJ)	2
Base energy use (PJ)	15.8	Biomass (PJ)	0.5	Petroleum ($/GJ)	10
				Biomass ($/GJ)	0
				Average ($/GJ)	15.7

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$76	$75	$73	$72	$71	$69	$68	$67	$66	$64	$63	$62
Energy savings in each year compared to BAU (PJ)											
0.6	1.2	1.8	2.4	2.9	3.5	4.0	4.5	5.1	5.6	6.1	6.6
Energy savings in each year compared to BAU ($Million)											
$9	$19	$28	$37	$46	$54	$63	$71	$79	$87	$95	$103

Wood, Paper & Printing				ANZSIC Code	23-24
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	19.5	Elec. ($/MWh)	70
EEIP estimate	45%	Gas (PJ)	25.7	Elec. ($/GJ)	19
Savings rate / yr	3.8%	Coal (PJ)	7.8	Gas ($/GJ)	6
No of years	12	Petroleum (PJ)	2.9	Coal ($/GJ)	2
Base energy use (PJ)	75.3	Biomass (PJ)	19.4	Petroleum ($/GJ)	10
				Biomass ($/GJ)	0
				Average ($/GJ)	7.6

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$177	$175	$174	$172	$171	$169	$168	$166	$165	$164	$162	$161
Energy savings in each year compared to BAU (PJ)											
2.9	5.8	8.7	11.5	14.3	17.1	19.8	22.6	25.3	28.0	30.6	33.3
Energy savings in each year compared to BAU ($Million)											
$22	$44	$66	$87	$109	$130	$151	$172	$192	$213	$233	$253

Petroleum, Coal & Chemicals				ANZSIC Code	25
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	24.2	Elec. ($/MWh)	60
EEIP estimate	45%	Gas (PJ)	96.3	Elec. ($/GJ)	17
Savings rate / yr	3.8%	Coal (PJ)	2.4	Gas ($/GJ)	5
No of years	12	Petroleum (PJ)	140.4	Coal ($/GJ)	2
Base energy use (PJ)	272.9	Biomass (PJ)	9.6	Petroleum ($/GJ)	10
				Biomass ($/GJ)	0
				Average ($/GJ)	8.4

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$708	$702	$696	$690	$684	$678	$672	$667	$661	$655	$650	$644
Energy savings in each year compared to BAU (PJ)											
10.5	21.0	31.4	41.6	51.8	61.9	71.9	81.8	91.7	101.4	111.1	120.7
Energy savings in each year compared to BAU ($Million)											
$89	$176	$263	$350	$435	$520	$604	$687	$770	$852	$933	$1014

Non-Metallic Minerals				ANZSIC Code	26
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	13.3	Elec. ($/MWh)	70
EEIP estimate	50%	Gas (PJ)	51.3	Elec. ($/GJ)	19
Savings rate / yr	4.2%	Coal (PJ)	20.6	Gas ($/GJ)	6
No of years	12	Petroleum (PJ)	5.5	Coal ($/GJ)	2
Base energy use (PJ)	92	Biomass (PJ)	1.3	Petroleum ($/GJ)	10
				Biomass ($/GJ)	0
				Average ($/GJ)	7.1

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$224	$221	$219	$216	$213	$210	$207	$205	$202	$200	$197	$194
Energy savings in each year compared to BAU (PJ)											
3.9	7.8	11.7	15.5	19.2	22.9	26.6	30.2	33.8	37.3	40.7	44.2
Energy savings in each year compared to BAU ($Million)											
$28	$56	$83	$110	$137	$163	$189	$214	$240	$265	$289	$313

Iron & Steel				ANZSIC Code	271
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.02	Electricity (PJ)	20.8	Elec. ($/MWh)	50
EEIP estimate	55%	Gas (PJ)	46.6	Elec. ($/GJ)	14
Savings rate / yr	4.6%	Coal (PJ)	134.2	Gas ($/GJ)	4
No of years	12	Petroleum (PJ)	2.4	Coal ($/GJ)	2
Base energy use (PJ)	181.3	Biomass (PJ)	-	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	4

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$271	$264	$257	$250	$243	$237	$231	$224	$218	$212	$207	$201
Energy savings in each year compared to BAU (PJ)											
8.5	16.7	24.8	32.6	40.2	47.6	54.8	61.8	68.6	75.2	81.7	88.0
Energy savings in each year compared to BAU ($Million)											
$34	$67	$99	$130	$161	$190	$219	$247	$274	$301	$327	$352

Basic Non-Ferrous Metals				ANZSIC Code	272-273
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	124.2	Elec. ($/MWh)	30
EEIP estimate	35%	Gas (PJ)	120.9	Elec. ($/GJ)	8
Savings rate / yr	2.9%	Coal (PJ)	54	Gas ($/GJ)	5
No of years	12	Petroleum (PJ)	44.8	Coal ($/GJ)	2
Base energy use (PJ)	351.7	Biomass (PJ)	7.8	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	$6.1

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$516	$516	$516	$516	$516	$515	$515	$515	$515	$515	$515	$515
Energy savings in each year compared to BAU (PJ)											
10.6	21.1	31.7	42.3	52.8	63.4	74.0	84.5	95.1	105.6	116.2	126.8
Energy savings in each year compared to BAU ($Million)											
$64	$129	$193	$258	$322	$387	$451	$516	$580	$644	$709	$773

Other Metal Products				ANZSIC Code	274-276
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	5.4	Elec. ($/MWh)	80
EEIP estimate	45%	Gas (PJ)	5.6	Elec. ($/GJ)	22
Savings rate / yr	3.8%	Coal (PJ)	-	Gas ($/GJ)	6
No of years	12	Petroleum (PJ)	1.3	Coal ($/GJ)	2
Base energy use (PJ)	12.3	Biomass (PJ)	-	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	13.4

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$51	$50	$50	$50	$49	$49	$48	$48	$48	$47	$47	$46
Energy savings in each year compared to BAU (PJ)											
0.48	0.95	1.41	1.88	2.33	2.79	3.24	3.69	4.13	4.57	5.01	5.44
Energy savings in each year compared to BAU ($Million)											
$6	$13	$19	$25	$31	$37	$43	$49	$55	$61	$67	$73

Machinery & Equipment				ANZSIC Code	28
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.025	Electricity (PJ)	13	Elec. ($/MWh)	70
EEIP estimate	55%	Gas (PJ)	9.2	Elec. ($/GJ)	19
Savings rate / yr	4.6%	Coal (PJ)	-	Gas ($/GJ)	6
No of years	12	Petroleum (PJ)	1.2	Coal ($/GJ)	2
Base energy use (PJ)	23.4	Biomass (PJ)	-	Petroleum ($/GJ)	10
				Biomass ($/GJ)	
				Average ($/GJ)	13.4

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$118	$115	$113	$110	$108	$105	$103	$101	$99	$96	$94	$92
Energy savings in each year compared to BAU (PJ)											
1.1	2.2	3.2	4.3	5.3	6.2	7.2	8.1	9.1	10.0	10.8	11.7
Energy savings in each year compared to BAU ($Million)											
$15	$29	$43	$57	$70	$84	$97	$109	$121	$134	$145	$157

Other Manufacturing				ANZSIC Code	29
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.03	Electricity (PJ)	-	Elec. ($/MWh)	90
EEIP estimate	50%	Gas (PJ)	0.2	Elec. ($/GJ)	25
Savings rate / yr	4.2%	Coal (PJ)	-	Gas ($/GJ)	8
No of years	12	Petroleum (PJ)	-	Coal ($/GJ)	
Base energy use (PJ)	0.2	Biomass (PJ)	-	Petroleum ($/GJ)	
				Biomass ($/GJ)	
				Average ($/GJ)	8

Yr 1	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**	**Yr 11**	**Yr 12**
Capital investment in each year ($Million)											
$0.5	$0.5	$0.5	$0.5	$0.5	$0.5	$0.5	$0.5	$0.5	$0.5	$0.5	$0.5
Energy savings in each year compared to BAU (PJ)											
0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.07	0.08	0.09	0.10
Energy savings in each year compared to BAU ($Million)											
$0.1	$0.1	$0.2	$0.3	$0.3	$0.4	$0.5	$0.5	$0.6	$0.7	$0.8	$0.8

Construction (Non-Mobile)				ANZSIC Code	E
Sector data		**Energy use data**		**Energy Prices**	
1+Growth rate	1.02	Electricity (PJ)	0.3	Elec. ($/MWh)	90
EEIP estimate	40%	Gas (PJ)	1.74	Elec. ($/GJ)	25
Savings rate / yr	3.3%	Coal (PJ)	-	Gas ($/GJ)	8
No of years	12	Petroleum (PJ)	-	Coal ($/GJ)	
Base energy use (PJ)	2.04	Biomass (PJ)	-	Petroleum ($/GJ)	
				Biomass ($/GJ)	
				Average ($/GJ)	10.5

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
Capital investment in each year ($Million)											
$6	$6	$6	$6	$6	$5	$5	$5	$5	$5	$5	$5
Energy savings in each year compared to BAU (PJ)											
0.07	0.14	0.21	0.27	0.34	0.40	0.47	0.53	0.59	0.65	0.71	0.77
Energy savings in each year compared to BAU ($Million)											
$0.7	$1.4	$2.2	$2.9	$3.5	$4.2	$4.9	$5.5	$6.2	$6.8	$7.5	$8.1

A1.2 Exogenous Shock Tables

Tables A1 to A3 provide the exogenous shock data for the LOW EEI potential estimates, and cover the 12-year economic modelling period. Tables are shown for capital expenditure ($ Million), energy savings (in PJs), and energy savings ($ Million). The economic model uses only the dollar value of energy savings for the exogenous shock.

Tables A4 to A6 provide the exogenous shock data for the HIGH EEI potential estimates.

The data has been presented in the same format as that used by the economic model.

Note that in the economic modelling three different scenarios were modeled: (1) 50% penetration of the LOW EEI potential; (2) 100% penetration of the LOW EEI potential, and (3) 50% penetration of the HIGH EEI potential. To obtain the exogenous shock data for the 50% LOW and HIGH scenarios, it is necessary to multiply the given data by 0.5.

Table A1 – LOW EEI Potential, Capital Expenditure ($Million)

Sector	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
A Agriculture (Non-Mobile)	**$18.5**	**$18.5**	**$18.6**	**$18.6**	**$18.7**	**$18.7**	**$18.8**	**$18.9**	**$18.9**	**$19.0**	**$19.0**	**$19.1**
B. Mining (Non-Mobile)	**$131.3**	**$133.0**	**$134.7**	**$136.4**	**$138.2**	**$139.9**	**$141.7**	**$143.5**	**$145.4**	**$147.3**	**$149.1**	**$151.1**
Food and Beverage	$263.3	$265.5	$267.8	$270.1	$272.4	$274.7	$277.1	$279.4	$281.8	$284.2	$286.6	$289.1
Textile, Clothing & Footwear	$21.1	$21.1	$21.0	$21.0	$21.0	$21.0	$20.9	$20.9	$20.9	$20.8	$20.8	$20.8
Wood Paper Printing	$39.3	$39.8	$40.3	$40.8	$41.4	$41.9	$42.4	$43.0	$43.5	$44.1	$44.6	$45.2
Petroleum Coal Chemicals	$196.8	$198.4	$200.1	$201.8	$203.6	$205.3	$207.1	$208.8	$210.6	$212.4	$214.2	$216.1
Non Metallic Minerals	$67.3	$67.6	$67.9	$68.1	$68.4	$68.7	$69.0	$69.3	$69.6	$69.9	$70.2	$70.5
Iron & Steel	$74.0	$73.6	$73.2	$72.8	$72.4	$72.0	$71.6	$71.2	$70.8	$70.4	$70.0	$69.6
Basic Non-Ferrous Metals	$110.5	$112.4	$114.3	$116.3	$118.3	$120.3	$122.3	$124.4	$126.6	$128.7	$130.9	$133.2
Other Metal Products	$11.3	$11.5	$11.6	$11.8	$11.9	$12.1	$12.2	$12.4	$12.5	$12.7	$12.9	$13.0
Machinery and Equipment	$26.8	$26.9	$27.0	$27.1	$27.2	$27.3	$27.4	$27.5	$27.6	$27.7	$27.8	$27.9
Other Manufacturing	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.2
C. Manufacturing	**$810.5**	**$816.8**	**$823.3**	**$829.9**	**$836.6**	**$843.3**	**$850.1**	**$857.0**	**$864.0**	**$871.1**	**$878.3**	**$885.5**
D. Construction (Non Mobile)	**$1.5**	**$1.5**	**$1.5**	**$1.5**	**$1.5**	**$1.5**	**$1.5**	**$1.5**	**$1.5**	**$1.5**	**$1.5**	**$1.5**
Total Industrial	**$961.6**	**$969.8**	**$978.0**	**$986.4**	**$994.9**	**$1,003**	**$1,012**	**$1,021**	**$1,030**	**$1,039**	**$1,048**	**$1,057**
Accomodation and Restaurants	$39.1	$39.7	$40.3	$40.9	$41.5	$42.1	$42.8	$43.4	$44.0	$44.7	$45.3	$46.0
Wholesale & Retail	$154.3	$157.0	$159.8	$162.5	$165.4	$168.3	$171.2	$174.2	$177.2	$180.3	$183.5	$186.7
Offices	$203.2	$205.4	$207.7	$209.9	$212.2	$214.5	$216.8	$219.2	$221.6	$224.0	$226.4	$228.9
Education	$13.2	$13.2	$13.1	$13.1	$13.0	$13.0	$12.9	$12.9	$12.8	$12.8	$12.7	$12.7
Health and community	$55.5	$55.7	$56.0	$56.3	$56.6	$56.9	$57.2	$57.5	$57.8	$58.1	$58.4	$58.7
Cultural and Recreation	$29.1	$29.5	$30.0	$30.5	$30.9	$31.4	$31.9	$32.4	$32.9	$33.5	$34.0	$34.5
Total Commercial	**$494.4**	**$500.6**	**$506.9**	**$513.2**	**$519.7**	**$526.2**	**$532.8**	**$539.5**	**$546.4**	**$553.3**	**$560.3**	**$567.4**
Total Industrial & Comm.	**$1,456**	**$1,470**	**$1,485**	**$1,500**	**$1,515**	**$1,530**	**$1,545**	**$1,561**	**$1,576**	**$1,592**	**$1,608**	**$1,625**
Existing housing	$1,039.5	$1,039.9	$1,040.2	$1,040.6	$1,040.9	$1,041.3	$1,041.7	$1,042.1	$1,042.5	$1,042.9	$1,043.3	$1,043.7
New Housing	$73.7	$75.0	$76.2	$77.5	$78.8	$80.2	$81.5	$82.9	$84.3	$85.8	$87.2	$88.7
Total Residential	**$1,113**	**$1,115**	**$1,116**	**$1,118**	**$1,120**	**$1,122**	**$1,123**	**$1,125**	**$1,127**	**$1,129**	**$1,131**	**$1,132**

Table A2 – LOW EEI Potential, Energy Savings vs BAU (PJ)

Sector	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
A. Agriculture (Non-Mobile)	**0.19**	**0.39**	**0.59**	**0.78**	**0.98**	**1.18**	**1.38**	**1.57**	**1.77**	**1.97**	**2.17**	**2.38**
B. Non iron-ore - Mining (Non-Mobile)	**3.43**	**6.91**	**10.43**	**13.99**	**17.60**	**21.26**	**24.96**	**28.71**	**32.51**	**36.36**	**40.26**	**44.21**
Food and Beverage	3.56	7.15	10.76	14.41	18.10	21.81	25.55	29.33	33.14	36.98	40.85	44.76
Textile, Clothing & Footwear	0.34	0.67	1.01	1.34	1.67	2.01	2.34	2.67	3.01	3.34	3.67	4.00
Wood Paper Printing	1.29	2.60	3.93	5.27	6.63	8.01	9.40	10.82	12.25	13.70	15.17	16.65
Petroleum Coal Chemicals	5.86	11.76	17.72	23.73	29.78	35.89	42.06	48.27	54.54	60.86	67.24	73.67
Non Metallic Minerals	2.37	4.75	7.14	9.54	11.95	14.37	16.80	19.24	21.69	24.15	26.62	29.10
Iron & Steel	4.62	9.22	13.79	18.34	22.86	27.36	31.83	36.28	40.70	45.10	49.48	53.83
Basic Non-Ferrous Metals	4.53	9.13	13.82	18.58	23.43	28.36	33.37	38.47	43.66	48.94	54.30	59.76
Other Metal Products	0.21	0.43	0.64	0.86	1.08	1.31	1.54	1.77	2.00	2.24	2.48	2.72
Machinery and Equipment	0.50	1.00	1.50	2.01	2.52	3.03	3.54	4.05	4.56	5.08	5.60	6.12
Other Manufacturing	0.004	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.05	0.05
C. Manufacturing	**23.28**	**46.72**	**70.33**	**94.10**	**118.05**	**142.17**	**166.46**	**190.93**	**215.59**	**240.43**	**265.45**	**290.67**
D. Construction (Non Mobile)	**0.03**	**0.07**	**0.10**	**0.14**	**0.17**	**0.21**	**0.24**	**0.28**	**0.32**	**0.35**	**0.39**	**0.42**
Total industrial	**26.9**	**54.1**	**81.4**	**109.0**	**136.8**	**164.8**	**193.0**	**221.5**	**250.2**	**279.1**	**308.3**	**337.7**
Accomodation and Restaurants	0.38	0.76	1.15	1.54	1.94	2.35	2.76	3.18	3.60	4.03	4.47	4.91
Wholesale & Retail	1.49	3.00	4.55	6.12	7.71	9.34	10.99	12.67	14.38	16.12	17.89	19.69
Offices	2.20	4.42	6.67	8.94	11.24	13.56	15.91	18.28	20.68	23.11	25.56	28.03
Education	0.13	0.25	0.38	0.50	0.63	0.75	0.87	1.00	1.12	1.24	1.36	1.48
Health and community	0.70	1.40	2.10	2.81	3.52	4.24	4.95	5.68	6.40	7.13	7.87	8.60
Cultural and Recreation	0.32	0.64	0.96	1.29	1.63	1.97	2.32	2.67	3.02	3.39	3.76	4.13
Total commercial	**5.2**	**10.5**	**15.8**	**21.2**	**26.7**	**32.2**	**37.8**	**43.5**	**49.2**	**55.0**	**60.9**	**66.9**
Total Industrial & Comm.	**32.1**	**64.6**	**97.2**	**130.2**	**163.5**	**197.0**	**230.8**	**265.0**	**299.4**	**334.1**	**369.2**	**404.5**
Existing housing	9.4	18.7	28.1	37.4	46.8	56.2	65.6	74.9	84.3	93.7	103.1	112.5
New Housing	1.5	3.0	4.6	6.1	7.7	9.4	11.0	12.7	14.4	16.2	17.9	19.7
Total Residential	**10.8**	**21.7**	**32.6**	**43.6**	**54.5**	**65.5**	**76.6**	**87.6**	**98.7**	**109.9**	**121.0**	**132.2**

Table A3 – LOW EEI Potential, Energy Savings vs BAU ($ Million)

Sector	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
A. Agriculture (Non-Mobile)	**$4.6**	**$9.2**	**$13.9**	**$18.5**	**$23.2**	**$27.9**	**$32.6**	**$37.3**	**$42.0**	**$46.8**	**$51.5**	**$56.3**
B. Non iron-ore - Mining (Non-Mobile)	**$32.8**	**$66.1**	**$99.7**	**$133.8**	**$168.4**	**$203.4**	**$238.8**	**$274.7**	**$311.0**	**$347.8**	**$385.1**	**$422.9**
Food and Beverage	$65.8	$132.2	$199.1	$266.7	$334.8	$403.4	$472.7	$542.6	$613.0	$684.1	$755.7	$828.0
Textile, Clothing & Footwear	$5.3	$10.5	$15.8	$21.0	$26.3	$31.5	$36.8	$42.0	$47.2	$52.4	$57.6	$62.8
Wood Paper Printing	$9.8	$19.8	$29.9	$40.1	$50.4	$60.9	$71.5	$82.2	$93.1	$104.1	$115.3	$126.6
Petroleum Coal Chemicals	$49.2	$98.8	$148.8	$199.3	$250.2	$301.5	$353.3	$405.5	$458.1	$511.2	$564.8	$618.8
Non Metallic Minerals	$16.8	$33.7	$50.7	$67.7	$84.8	$102.0	$119.3	$136.6	$154.0	$171.5	$189.0	$206.6
Iron & Steel	$18.5	$36.9	$55.2	$73.4	$91.5	$109.4	$127.3	$145.1	$162.8	$180.4	$197.9	$215.3
Basic Non-Ferrous Metals	$27.6	$55.7	$84.3	$113.4	$142.9	$173.0	$203.6	$234.7	$266.3	$298.5	$331.2	$364.5
Other Metal Products	$2.8	$5.7	$8.6	$11.5	$14.5	$17.5	$20.6	$23.7	$26.8	$30.0	$33.2	$36.5
Machinery and Equipment	$6.7	$13.4	$20.2	$26.9	$33.7	$40.5	$47.4	$54.3	$61.1	$68.1	$75.0	$82.0
Other Manufacturing	$0.0	$0.1	$0.1	$0.1	$0.2	$0.2	$0.2	$0.3	$0.3	$0.4	$0.4	$0.4
C. Manufacturing	**$203**	**$407**	**$613**	**$820**	**$1,029**	**$1,240**	**$1,453**	**$1,667**	**$1,883**	**$2,101**	**$2,320**	**$2,542**
D. Construction (Non Mobile)	**$0.4**	**$0.7**	**$1.1**	**$1.5**	**$1.8**	**$2.2**	**$2.6**	**$2.9**	**$3.3**	**$3.7**	**$4.1**	**$4.4**
Total Industrial	**$240**	**$483**	**$727**	**$974**	**$1,223**	**$1,474**	**$1,727**	**$1,982**	**$2,239**	**$2,499**	**$2,761**	**$3,025**
Accomodation and Restaurants	$9.8	$19.7	$29.8	$40.0	$50.4	$60.9	$71.6	$82.5	$93.5	$104.6	$116.0	$127.5
Wholesale & Retail	$38.6	$77.8	$117.8	$158.4	$199.8	$241.8	$284.6	$328.2	$372.5	$417.6	$463.4	$510.1
Offices	$50.8	$102.2	$154.1	$206.6	$259.6	$313.2	$367.5	$422.2	$477.6	$533.6	$590.2	$647.4
Education	$3.3	$6.6	$9.9	$13.1	$16.4	$19.6	$22.9	$26.1	$29.3	$32.5	$35.7	$38.8
Health and community	$13.9	$27.8	$41.8	$55.9	$70.0	$84.3	$98.6	$112.9	$127.4	$141.9	$156.5	$171.1
Cultural and Recreation	$7.3	$14.7	$22.1	$29.8	$37.5	$45.4	$53.3	$61.4	$69.7	$78.0	$86.5	$95.2
Total Commercial	**$124**	**$249**	**$375**	**$504**	**$634**	**$765**	**$898**	**$1,033**	**$1,170**	**$1,308**	**$1,448**	**$1,590**
Total Industrial & Comm.	**$364**	**$732**	**$1,103**	**$1,478**	**$1,856**	**$2,239**	**$2,625**	**$3,015**	**$3,409**	**$3,807**	**$4,209**	**$4,615**
Existing housing	$165.1	$330.4	$495.9	$661.4	$827.2	$993.1	$1,159	$1,326	$1,492	$1,659	$1,826	$1,993
New Housing	$36.2	$73.0	$110.4	$148.5	$187.2	$226.6	$266.7	$307.4	$348.8	$391.0	$433.8	$477.4
Total Residential	**$201**	**$403**	**$606**	**$810**	**$1,014**	**$1,220**	**$1,426**	**$1,633**	**$1,841**	**$2,050**	**$2,259**	**$2,470**

Table A4 – HIGH EEI Potential, Capital Expenditure ($ Million)

Sector	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
A. Agriculture (Non-Mobile)	**$92.5**	**$90.4**	**$88.4**	**$86.4**	**$84.5**	**$82.6**	**$80.7**	**$78.9**	**$77.1**	**$75.4**	**$73.7**	**$72.0**
B. Non iron-ore - Mining (Non-Mobile)	**$637.3**	**$610.8**	**$585.3**	**$560.9**	**$537.6**	**$515.2**	**$493.7**	**$473.1**	**$453.4**	**$434.5**	**$416.4**	**$399.1**
Food and Beverage	$1,158.4	$1,138.5	$1,118.9	$1,099.6	$1,080.7	$1,062.1	$1,043.8	$1,025.9	$1,008.2	$990.9	$973.8	$957.1
Textile, Clothing & Footwear	$75.9	$74.5	$73.2	$71.8	$70.5	$69.2	$68.0	$66.7	$65.5	$64.3	$63.1	$62.0
Wood Paper Printing	$176.8	$175.3	$173.8	$172.3	$170.8	$169.3	$167.9	$166.4	$165.0	$163.6	$162.2	$160.8
Petroleum Coal Chemicals	$708.3	$702.2	$696.2	$690.2	$684.2	$678.3	$672.5	$666.7	$660.9	$655.2	$649.6	$644.0
Metallic Minerals	$224.3	$221.4	$218.5	$215.7	$212.9	$210.2	$207.4	$204.8	$202.1	$199.5	$196.9	$194.4
Iron & Steel	$271.2	$264.0	$256.9	$250.0	$243.3	$236.8	$230.5	$224.3	$218.3	$212.5	$206.8	$201.3
Basic Non-Ferrous Metals	$515.6	$515.6	$515.6	$515.5	$515.5	$515.5	$515.5	$515.5	$515.4	$515.4	$515.4	$515.4
Other Metal Products	$50.9	$50.5	$50.1	$49.6	$49.2	$48.8	$48.3	$47.9	$47.5	$47.1	$46.7	$46.3
Machinery and Equipment	$117.8	$115.3	$112.7	$110.2	$107.8	$105.5	$103.1	$100.9	$98.7	$96.5	$94.4	$92.3
Other Manufacturing	$0.5	$0.5	$0.5	$0.5	$0.5	$0.5	$0.5	$0.5	$0.5	$0.5	$0.5	$0.5
C. Manufacturing	**$3,300**	**$3,258**	**$3,216**	**$3,176**	**$3,136**	**$3,096**	**$3,058**	**$3,020**	**$2,982**	**$2,945**	**$2,909**	**$2,874**
D. Construction (Non Mobile)	**$5.8**	**$5.7**	**$5.7**	**$5.6**	**$5.5**	**$5.4**	**$5.4**	**$5.3**	**$5.2**	**$5.1**	**$5.1**	**$5.0**
Total Industrial	**$4,036**	**$3,965**	**$3,896**	**$3,828**	**$3,763**	**$3,699**	**$3,637**	**$3,577**	**$3,518**	**$3,460**	**$3,405**	**$3,350**
Accomodation and Restaurants	$186.2	$182.5	$178.9	$175.4	$171.9	$168.5	$165.1	$161.9	$158.7	$155.5	$152.4	$149.4
Wholesale & Retail	$799.0	$752.4	$708.5	$667.2	$628.2	$591.6	$557.1	$524.6	$494.0	$465.2	$438.0	$412.5
Offices	$1,037.9	$973.9	$913.9	$857.5	$804.6	$755.0	$708.4	$664.8	$623.8	$585.3	$549.2	$515.3
Education	$70.6	$66.4	$62.4	$58.7	$55.1	$51.8	$48.7	$45.8	$43.0	$40.5	$38.0	$35.8
Health and community	$252.4	$245.7	$239.2	$232.8	$226.6	$220.5	$214.7	$208.9	$203.4	$198.0	$192.7	$187.5
Cultural and Recreation	$176.3	$173.2	$170.0	$167.0	$163.9	$161.0	$158.1	$155.2	$152.4	$149.7	$146.9	$144.3
Total commercial	**$2,522**	**$2,394**	**$2,273**	**$2,158**	**$2,050**	**$1,948**	**$1,852**	**$1,761**	**$1,675**	**$1,594**	**$1,517**	**$1,445**
Total Industrial & comm.	**$6,558**	**$6,359**	**$6,168**	**$5,987**	**$5,813**	**$5,648**	**$5,489**	**$5,338**	**$5,193**	**$5,055**	**$4,922**	**$4,795**
Existing housing	$4,349	$4,354	$4,359	$4,364	$4,369	$4,375	$4,380	$4,386	$4,392	$4,398	$4,404	$4,410
New Housing	$440.6	$448.1	$455.7	$463.5	$471.4	$479.4	$487.5	$495.8	$504.2	$512.8	$521.5	$530.4
Total Residential	**$4,790**	**$4,802**	**$4,815**	**$4,828**	**$4,841**	**$4,854**	**$4,868**	**$4,882**	**$4,896**	**$4,910**	**$4,925**	**$4,940**

Table A5 – HIGH EEI Potential, Energy Savings vs BAU (PJ)

Sector	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
A. Agriculture (Non-Mobile)	**0.49**	**0.96**	**1.43**	**1.88**	**2.33**	**2.76**	**3.19**	**3.60**	**4.01**	**4.40**	**4.79**	**5.17**
B. Non iron-ore - Mining (Non-Mobile)	**8.33**	**16.31**	**23.96**	**31.29**	**38.31**	**45.04**	**51.49**	**57.67**	**63.60**	**69.28**	**74.72**	**79.93**
Food and Beverage	7.83	15.52	23.08	30.51	37.81	44.99	52.04	58.97	65.79	72.48	79.06	85.53
Textile, Clothing & Footwear	0.60	1.20	1.78	2.35	2.91	3.46	4.01	4.54	5.06	5.57	6.07	6.57
Wood Paper Printing	2.91	5.79	8.65	11.48	14.29	17.08	19.84	22.58	25.29	27.98	30.65	33.29
Petroleum Coal Chemicals	10.54	20.99	31.35	41.62	51.80	61.90	71.90	81.82	91.66	101.41	111.08	120.66
Non Metallic Minerals	3.95	7.85	11.69	15.49	19.24	22.94	26.59	30.19	33.75	37.27	40.73	44.15
Iron & Steel	8.48	16.72	24.75	32.57	40.17	47.57	54.78	61.79	68.61	75.25	81.71	88.00
Basic Non-Ferrous Metals	10.57	21.13	31.70	42.26	52.82	63.39	73.95	84.51	95.08	105.64	116.20	126.76
Other Metal Products	0.48	0.95	1.41	1.88	2.33	2.79	3.24	3.69	4.13	4.57	5.01	5.44
Machinery and Equipment	1.10	2.17	3.23	4.25	5.26	6.24	7.21	8.15	9.07	9.97	10.85	11.71
Other Manufacturing	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.07	0.08	0.09	0.10
C. Manufacturing	**46.45**	**92.34**	**137.67**	**182.45**	**226.69**	**270.41**	**313.61**	**356.31**	**398.50**	**440.21**	**481.44**	**522.20**
D. Construction (Non Mobile)	**0.07**	**0.14**	**0.21**	**0.27**	**0.34**	**0.40**	**0.47**	**0.53**	**0.59**	**0.65**	**0.71**	**0.77**
Total Industrial	**55.3**	**109.7**	**163.3**	**215.9**	**267.7**	**318.6**	**368.8**	**418.1**	**466.7**	**514.5**	**561.7**	**608.1**
Accomodation and Restaurants	0.90	1.78	2.64	3.48	4.31	5.12	5.92	6.70	7.46	8.21	8.95	9.67
Wholesale& Retail	3.86	7.49	10.91	14.13	17.16	20.01	22.70	25.23	27.62	29.86	31.98	33.97
Offices	5.62	10.89	15.84	20.48	24.83	28.92	32.75	36.35	39.73	42.90	45.87	48.66
Education	0.32	0.62	0.90	1.16	1.41	1.64	1.86	2.07	2.26	2.45	2.62	2.78
Health and community	1.59	3.13	4.63	6.10	7.52	8.91	10.25	11.57	12.84	14.09	15.30	16.48
Cultural and Recreation	0.75	1.50	2.22	2.94	3.64	4.33	5.01	5.67	6.32	6.96	7.59	8.21
Total commercial	**13.0**	**25.4**	**37.1**	**48.3**	**58.9**	**68.9**	**78.5**	**87.6**	**96.2**	**104.5**	**112.3**	**119.8**
Total Industrial & comm.	**68.4**	**135.1**	**200.4**	**264.2**	**326.5**	**387.5**	**447.2**	**505.7**	**562.9**	**619.0**	**674.0**	**727.8**
Existing housing	20.17	40.35	60.52	80.70	100.88	121.16	141.35	161.63	181.92	202.11	222.50	242.70
New Housing	3.49	7.04	10.65	14.33	18.06	21.86	25.72	29.65	33.65	37.71	41.84	46.04
Total Residential	**23.7**	**47.4**	**71.2**	**95.0**	**118.9**	**143.0**	**167.1**	**191.3**	**215.6**	**239.8**	**264.3**	**288.7**

Table A6 – HIGH EEI Potential, Energy Savings vs BAU ($ Million)

Sector	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12
A. Agriculture (Non-Mobile)	**$11.6**	**$22.9**	**$33.9**	**$44.7**	**$55.3**	**$65.6**	**$75.7**	**$85.5**	**$95.2**	**$104.6**	**$113.8**	**$122.8**
B. Non iron-ore - Mining (Non-Mobile)	**$79.7**	**$156.0**	**$229.2**	**$299.3**	**$366.5**	**$430.9**	**$492.6**	**$551.7**	**$608.4**	**$662.7**	**$714.8**	**$764.7**
Food and Beverage	$144.8	$287.1	$427.0	$564.4	$699.5	$832.3	$962.8	$1,091.0	$1,217.0	$1,340.9	$1,462.6	$1,582.2
Textile, Clothing & Footwear	$9.5	$18.8	$27.9	$36.9	$45.7	$54.4	$62.9	$71.2	$79.4	$87.5	$95.4	$103.1
Wood Paper Printing	$22.1	$44.0	$65.7	$87.3	$108.6	$129.8	$150.8	$171.6	$192.2	$212.7	$232.9	$253.0
Petroleum Coal Chemicals	$88.5	$176.3	$263.3	$349.6	$435.1	$519.9	$604.0	$687.3	$769.9	$851.8	$933.0	$1,013.5
Non Metallic Minerals	$28.0	$55.7	$83.0	$110.0	$136.6	$162.9	$188.8	$214.4	$239.6	$264.6	$289.2	$313.5
Iron & Steel	$33.9	$66.9	$99.0	$130.3	$160.7	$190.3	$219.1	$247.1	$274.4	$301.0	$326.9	$352.0
Basic Non-Ferrous Metals	$64.5	$128.9	$193.3	$257.8	$322.2	$386.7	$451.1	$515.5	$580.0	$644.4	$708.8	$773.2
Other Metal Products	$6.4	$12.7	$18.9	$25.1	$31.3	$37.4	$43.4	$49.4	$55.4	$61.2	$67.1	$72.9
Machinery and Equipment	$14.7	$29.1	$43.2	$57.0	$70.5	$83.7	$96.6	$109.2	$121.5	$133.6	$145.4	$156.9
Other Manufacturing	$0.1	$0.1	$0.2	$0.3	$0.3	$0.4	$0.5	$0.5	$0.6	$0.6	$0.7	$0.8
C. Manufacturing	**$412**	**$820**	**$1,222**	**$1,619**	**$2,011**	**$2,398**	**$2,780**	**$3,157**	**$3,530**	**$3,898**	**$4,262**	**$4,621**
D. Construction (Non Mobile)	**$0.7**	**$1.4**	**$2.2**	**$2.9**	**$3.5**	**$4.2**	**$4.9**	**$5.5**	**$6.2**	**$6.8**	**$7.5**	**$8.1**
Total Industrial	**$504**	**$1,000**	**$1,487**	**$1,966**	**$2,436**	**$2,898**	**$3,353**	**$3,800**	**$4,240**	**$4,672**	**$5,098**	**$5,517**
Accomodation and Restaurants	$23.3	$46.1	$68.4	$90.4	$111.9	$132.9	$153.6	$173.8	$193.6	$213.1	$232.1	$250.8
Wholesale/Retail	$99.9	$193.9	$282.5	$365.9	$444.4	$518.4	$588.0	$653.6	$715.3	$773.5	$828.2	$879.8
Offices	$129.7	$251.5	$365.7	$472.9	$573.5	$667.9	$756.4	$839.5	$917.5	$990.6	$1,059.3	$1,123.7
Education	$8.8	$17.1	$24.9	$32.3	$39.2	$45.6	$51.7	$57.4	$62.8	$67.9	$72.6	$77.1
Health and community	$31.6	$62.3	$92.2	$121.3	$149.6	$177.1	$204.0	$230.1	$255.5	$280.3	$304.4	$327.8
Cultural and Recreation	$22.0	$43.7	$64.9	$85.8	$106.3	$126.4	$146.2	$165.6	$184.6	$203.3	$221.7	$239.7
Total commercial	**$315**	**$615**	**$899**	**$1,168**	**$1,425**	**$1,668**	**$1,900**	**$2,120**	**$2,329**	**$2,529**	**$2,718**	**$2,899**
Total Industrial & comm.	**$820**	**$1,615**	**$2,386**	**$3,134**	**$3,861**	**$4,567**	**$5,253**	**$5,920**	**$6,569**	**$7,201**	**$7,816**	**$8,416**
Existing housing	$353.8	$707.7	$1,061.6	$1,416.6	$1,772.7	$2,127.8	$2,485.1	$2,841.3	$3,198.7	$3,556.2	$3,915.7	$4,274.3
New Housing	$88.2	$178.0	$269.3	$362.1	$456.5	$552.5	$650.1	$749.4	$850.4	$953.1	$1,057.5	$1,163.7
Total Residential	**$442**	**$886**	**$1,331**	**$1,779**	**$2,229**	**$2,680**	**$3,135**	**$3,591**	**$4,049**	**$4,509**	**$4,973**	**$5,438**

Appendix 2 - Approaches to energy efficiency analysis

Three end-use activity approaches have been suggested for energy efficiency analysis (potential, costs, etc) and policy development (promotion, strategy, measures, etc): sectoral (food and beverage, etc), cross-sectoral (electric drives, lighting, heat management etc) and firm/site (XYZ Manufacturing, etc).

These three approaches are briefly described below.

Sectoral

Processes and the business environment tend to be similar for firms in the same sector, the similarity increasing as the sectoral specificity (eg ANZIC 2, 3 and 4 digit) increases.

This approach is valuable for identifying energy efficiency opportunities and constraints for pursuing energy efficiency in priority areas for action and for enlisting the support and commitment of sectoral associations. The approach may however, mask specific opportunities, energy efficiency levels and priorities.

Cross-sectoral

Technologies and the potential change agents are similar when particular energy services – found in a range of sectors – form the focus for analysis and initiatives.

In the electric drive area techniques for improving the efficiency of particular service elements (motors, couplings, controls, etc) may be technically and commercially analysed and cooperation sought with users, manufacturers, retailers, wholesalers and standards organisations involved with specific energy services.

A cross-sectoral focus may, however, tend to ignore the place of the cross-sectoral energy service in overall operations from a sector and firm/sites within it.

Firm/site

Each firm, indeed each operations site (plant, unit operations), has particular technological and commercial characteristics. These characteristics must be taken into account if energy efficiency performance is to be effectively addressed.

This individual firm/site approach forms the core energy efficiency concerns of firms, the energy management industry and programs such as the Greenhouse Challenge.

The advantages of this approach are that it addresses site/firm specific energy efficiency situations: by comparison a cross-sectoral approach may lead to partial energy management, and a sectoral approach is too broad for analysis of specific site circumstances.

However, to apply this approach on an economy-wide basis would be very expensive and it may fail to capture the benefits from understanding sectoral energy use patterns and information exchange among and between sectoral entities, and the significant benefits that may accrue from analysis of, and action on, particular cross-sectoral energy services.

On the other hand, the site-specific approach would, ideally, be the basis for effective action on realizing the potential for energy efficiency improvement.

Concluding comments

The approaches are not mutually exclusive; each deserves attention by government and the private sector.