



**CARBON NEUTRAL COMMUNITIES**

Centre for Design, RMIT University and University of South Australia

**TITLE: ENERGY EFFICIENCY POTENTIAL FOR PLAYFORD LGA**

Working Paper –Final draft

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## **ABSTRACT**

The Australian Government has predicted that energy efficiency initiatives will provide up to 55% of Australia's greenhouse gas (GHG) emission reductions by 2050. Following on from a study of energy demand and associated GHG or commonly referred to as 'carbon' emissions across the Playford Local Government Area (LGA) in South Australia, this paper focuses on the potential for energy efficiency opportunities to reduce the carbon emissions within the residential, commercial, industry and transport sectors of the Playford LGA. It presents the cost of carbon abatement related to these initiatives within each sector. The energy savings are also compared with the projected energy demand for these sectors into the future. The study concludes that energy savings of 16.5% are technologically feasible, however only 4.7% of energy savings are economic. In terms of carbon reductions, the energy savings provide a reduction of nearly 40% of carbon emissions is potentially achievable with 30% related to the energy savings that are economically feasible. These initiatives are in the industrial (manufacturing), residential and commercial sectors. The cost of carbon reduction in the transport sector is extremely high and has very long pay-back periods at least three times the life of the vehicles. The study is limited by a lack of specific data at the local level and relies heavily on assumptions and findings from state, national and international studies. Projections of increased energy use over the next two decades in all sectors show that focusing on mechanisms to reduce energy related carbon emissions and reporting progress at the local level will be important in achieving targets for carbon reduction. The study also concludes that social practices are influenced by decisions about house design and urban design that lock in high energy practices as social norms.

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## **Glossary of Terms and Acronyms**

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
AGO	Australian Greenhouse Office
ARC	Australian Research Council
CCP	Cities for Climate Protection
Climate Change	A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods
CNC	Carbon Neutral Community
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia's national science agency)
EU	European Union
GHG	Greenhouse Gases - those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation
ICLEI	International Council for Local Environmental Initiatives
IPCC	Intergovernmental Panel on Climate Change
MEPS	Mandatory Energy Performance Standards
NAEEEP	National Appliance and Equipment Energy Efficiency Program
NFEE	National Framework for Energy Efficiency
SEAV	Sustainable Energy Authority of Victoria
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
US	United States of America

# 1. INTRODUCTION

## 1.1 Context and Definitions

The issue of climate change and the need to reduce emissions of greenhouse gases (GHGs) has in recent years become a key area of concern for communities in all countries. The IPCC (2007) reported that the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations and that discernible human influences now extend to other aspects of climate, including ocean warming, increases in continental-average temperatures, temperature extremes and wind patterns. This human-induced climate change is now accepted by most scientists and governments (Jones, Watkins and Hennessy, 2005; G8 Presidency, 2005; Lowe, 2005; Flannery, 2005; Steffen, 2006; Garnaut, 2008). Governments at all levels in Australia including local government have made commitments to reduce GHGs to varying degrees and have adopted a variety of mechanisms to achieve this. There are examples of carbon trading schemes, legislation to set targets to reduce GHG emissions and various mandatory and voluntary strategies to reduce GHG emissions. The latter includes setting targets for renewable energy and committing to implementing energy efficiency initiatives.

In March 2008 the Minister for Resources and Energy in the Australian Government stated:

*'The Australian Bureau of Agricultural and Resource Economics projects that energy efficiency will contribute up to 55% to Australia's emission reduction targets by 2050. In a climate of rising energy costs, energy efficiency is also a crucial element to maintaining profitability'* (Ferguson, 2008)

According to the World Energy Council (2006) *energy efficiency* refers to the ratio between energy outputs (services such as electricity, heat and mobility) and inputs (primary energy). They go on to say that there are many sources of *energy efficiency* throughout the energy chain, specifically during exploration and production of primary sources, transmission and storage of primary energy, generation and transmission of electricity, distribution of energy and provision of services in industrial, commercial and residential activities. It is the last of these aspects of *energy efficiency* that is the focus of this paper as this is considered to be the area that the community has the greatest opportunity to influence through their choices and policy. This is supported by the Australian Government's Productivity Commission which used the following to describe energy efficiency measures (Productivity Commission, 2005):

*'Energy efficiency measures, unlike energy conservation, aim to reduce energy consumption while at the same time maintaining or increasing the level of useful output or outcome delivered. Put simply, on hot days, electricity consumption could be reduced through:*

- *an efficiency measure, for example, installing insulation (which reduces the amount (and cost) of electricity used to maintain a cool home); or*
- *a conservation measure, for example, turning up the thermostat (and tolerating a hotter house) or by turning off the air conditioner and going to the pool or the movies.'*

In exploring the difference between energy conservation and energy efficiency, Boardman (2004a) used the following example to explain energy conservation as it relates to transport:

*Say a family's use of their car is typically 500 km per week. If they want to use less energy, to conserve petrol, without changing the car, they would travel less distance. This would require behavioural changes, such as walking to work more often. This change might be involuntary because a price rise meant they could no longer afford to travel so much, or it might be a chosen lifestyle change. In the latter case, the choice is easily reversible. In the former case, it is reversible if the household gets richer and can afford the old level of consumption. The energy conservation which results from this complex set of behavioural changes, therefore, is difficult to guarantee and can demonstrate a variety of situations from hardship and deprivation to environmentally-friendly lifestyle changes and may or may not be linked to a policy intervention.*

In the context of this working paper, **energy efficiency** relates to the level of service provided, - e.g. home heating, air conditioning, refrigeration, information management, entertainment, water heating, food preparation, medical treatment, exercise, trips, waste management, lighting - or product manufactured, using electricity (a secondary energy source) or gas, petrol, diesel or another fuel (primary energy sources) within each particular sector. The **energy efficiency initiatives** discussed in this paper relate to the technical or non-technical measures employed to provide the *same level of service* using *less energy*. In this regard it is a demand side study rather than a supply side study and is consistent with the energy efficiency measures described by the Productivity Commission (Productivity Commission, 2005). However, these definitions may limit the direct comparison of the results of this study to other studies that adopt a broader definition of energy efficiency. The level of services provided are not quantified in this study and assumptions about energy use and energy savings are generalised across sectors. It is acknowledged that there will be large variations within sectors and that actual energy use and energy savings will be influenced by many factors including the potential implementation of multiple initiatives. An example may be insulating a house and replacing drapes to achieve equivalent comfort levels at reduced consumption of energy.

In the United Kingdom, energy efficiency improvements have been supported by measures comprising economic instruments and product policy (Boardman 2004b). Boardman (2004b) considers that product policy is the main delivery mechanism for energy efficiency in the residential sector. Successful policy has focused on roof insulation, wall insulation, double glazing of windows, draught-proofing and minimum performance standards for domestic appliances particularly refrigeration. In Australia, energy efficiency measures have focused on phasing in minimum energy performance standards for various appliances including mandatory labelling at point of sale; adopting building energy rating systems and establishing minimum performance standards for new residential and commercial buildings; legislation requiring mandatory reporting of energy use and energy efficiency actions by high energy consuming businesses and corporations; legislation to phase out low efficiency lighting consumables such as incandescent light bulbs; legislation to require energy

suppliers to work with consumers to identify opportunities to reduce energy consumption in dwellings and requiring energy suppliers to assist customers to implement these improvements; and providing rebates for energy efficiency improvements such as the recently announced rebate for insulation of dwellings, both owner occupied and tenanted.

The Australian Government's Department of Climate Change projects stationary energy sector related greenhouse gas emission reductions of 36 Mt CO<sub>2</sub>-e in the Kyoto period to 2012 (Commonwealth of Australia 2008a). Action on energy efficiency measures at the federal level, including Mandatory Energy Performance Standards (MEPS) for appliances, improved building standards, the phase out of incandescent light bulbs and regulation of water heaters, was estimated to contribute 12.4 Mt CO<sub>2</sub>-e or approximately one third of the stationary energy sector's expected reductions. The Greenhouse Challenge Plus program for industry was estimated to contribute 1.9 Mt CO<sub>2</sub>-e and the Energy Efficiency Opportunities program for large energy users was estimated to contribute 1.6 Mt CO<sub>2</sub>-e towards this total. Programs in various Australian States were estimated to contribute 7.4 Mt CO<sub>2</sub>-e while the expanded renewable energy target (RET) of 20% electricity to be from renewable sources by 2020 was estimated to contribute 10.5 Mt CO<sub>2</sub>-e to the total. Abatement beyond the Kyoto period to 2020 was estimated to be 83 Mt CO<sub>2</sub>-e mainly due to the RET and to action on energy efficiency measures. The Business as Usual (BAU) estimate of total greenhouse emissions in 2020 was 403 Mt CO<sub>2</sub>-e. Emissions from the stationary energy sector were estimated to be 50% of total emissions in 2005 (Commonwealth of Australia 2008a).

**Energy conservation initiatives** may also be promoted by agencies seeking to reduce total energy consumption. While, in this paper, effort is made to identify energy efficiency measures rather than energy conservation measures this is problematic as energy conservation initiatives are often included in energy efficiency measures and vice versa.

In addition some studies include energy savings that can be made by **fuel switching** (substitution with renewable energy) within energy efficiency initiatives. Effort is made in this paper to ensure that energy savings through use of renewable energy is excluded.

## 1.2 Aims and Objectives

The aims and objectives of this paper are to:

- provide a summary of the literature estimating the energy efficiency potential within various sectors of a community,
- describe a method for estimating the energy efficiency potential at the local government level,
- trial this method for assessing the potential energy efficiency for the Playford LGA in South Australia,
- discuss the results of this trial, and
- recommend an energy efficiency assessment method for the Carbon Neutral Communities: Making the Transition ARC Linkage project.

## 1.3 Layout and Approach

Section 2 provides a summary of studies and reports which assess energy efficiency potential within sectors at various levels, i.e. national, state or local. Section 2 also briefly discusses energy conservation measures which may be incorporated into

energy efficiency estimates in some studies. It concludes by describing a method for assessing the energy efficiency potential at the local government level.

Section 3 summarises the results of the assessment of energy efficiency potential for the Playford LGA in South Australia. Section 4 discusses the findings of the assessment and Section 5 makes recommendations for use of the approach to energy efficiency assessment for the CNC Project.

## **2. METHOD AND APPROACH**

### **2.1 Review of Energy Efficiency Assessment Methods**

This section commences with a review of International and Australian studies and reports that identify potential energy efficiencies for various sectors. It identifies the aspects of each sector that contribute to energy efficiency improvements. It then proceeds to discuss the assessments that have been undertaken in South Australia. The section concludes with the description of an approach which could be applied at the local government level.

#### **2.1.1 Studies of Energy Efficiency Potential**

A study of potential energy efficiency across the Conisbrough and Denaby areas of South Yorkshire in the north of England (Grant and Kellett 2002) focused on identifying energy efficiency improvements and comparing them against implementation costs. The study estimated the cost, energy demand reductions, associated carbon dioxide savings and the potential job creation for the residential, commercial, public services (including public buildings) and industrial sectors. Their findings were that a 10% overall saving was probably feasible but that this would have only a marginal impact on energy demand and carbon dioxide emissions overall. The study identified that the greatest potential to reduce carbon emissions cost effectively in the residential sector was from installing loft (roof and ceiling) and wall insulation and improving the control over heating and cooling. The study concluded that double-glazing of windows was not a cost effective measure.

Mecrow and Jack (2008) reviewed the potential for efficiency improvements through electric motors in the residential and industrial sectors. They concluded that, through the adoption of efficiency standards and technical measures such as speed control, more efficient motors and seasonal switches for electric motors for heating and cooling systems in households, energy requirements could be reduced by more than a factor of three by 2020. For industry across Europe and in the United States of America (USA), Mecrow and Jack (2008) concluded that the main opportunities for improvement related to energy savings that would result from replacing fixed-speed machines with variable-speed drives. The greatest opportunities were reported to relate to the operation of electric motors in lifts (81% when regenerative braking is included), in fans (25-30%) and in compressors (15-20%). These would be applicable to the commercial sector as well as the industrial sector.

Sanchez, Brown, Webber and Homan (2008) estimated savings made by the United States Environmental Protection Agency's (USEPA's) ENERGY STAR voluntary product labelling program which was established in 1992. Their methodology used bottom-up data wherever possible from product sales and modelling of household and business use of equipment based on audits and studies monitoring hours of operation. They concluded that 70% of the potential carbon reductions through the ENERGY

STAR program can be achieved through 6 products: monitors (41%), printers (13%), residential light fixtures (5%), televisions (4%), furnaces (4%) and computers (4%) (Sanchez et al 2008).

A number of Australian studies have been undertaken over the last decade to estimate the potential for reduction in energy use by various sectors and also the related greenhouse gas emissions. Some undertook their assessments over all sectors (i.e. residential, commercial, industrial and transport) while others confined their assessments to a particular sector such as the residential sector or transport sector. The latter are discussed under their respective sector headings in this section. Two studies in particular looked at all four sectors. An overview of each study is provided here to avoid repetition.

In 2005 the Australian Government's Productivity Commission produced its report into the private cost effectiveness of improving energy efficiency (Productivity Commission 2005). Its report summarised studies conducted by the Sustainable Energy Authority of Victoria (SEAV) which, together with other consultants, produced estimates of Australia's energy efficiency potential for the residential, commercial and industrial sectors for the National Framework for Energy Efficiency (NFEE). The summary of estimates for various sectors is provided in the subsections for each sector below. The modelling undertaken by SEAV-NFEE assumes that energy saving improvements with a pay-back rate of up to 4 years will be taken up economy wide at a rate of 50% (The Allen Consulting Group 2004).

In 2007 Australia's energy efficiency expert, Alan Pears, described future scenarios for energy use in Australia and identified potential energy efficiencies in the residential, commercial, industrial and transport sectors (Pears 2007a).

More recently McKinsey & Company have undertaken studies of greenhouse gas abatement costs for various countries, producing greenhouse abatement cost curves for a range of mechanisms including energy efficiency across all sectors. Their study for Australia (McKinsey & Company 2008) identified opportunities to reduce emissions both directly and indirectly, concluding that an average annual gross cost of AU\$290 per household would be required to reduce emissions in 2020 by 30% of the 1990 levels. This cost included mechanisms such as switching to renewable energy as well as energy efficiency improvements, but was considered to be achievable without major technological breakthroughs or lifestyle changes.

Lee and Denlay (2002) reviewed the demand for electricity and the energy efficiency that could potentially be achieved in industrial, commercial and residential sectors in South Australia over a 20 year period (to 2017). Their results for each sector are summarised under the relevant section heading.

### *Residential Sector*

Energy Efficient Strategies (EES 2008) reported that in 2006, the total number of residential households in Australia was 8,045,000 (EES 2008) and the total energy used by the residential sector was 391.7 PJ, consisting of:

- Electricity – 196.3 PJ
- Mains Gas – 134.9 PJ
- LPG – 8.3 PJ
- Wood – 52.3 PJ

Using the EES (2008) data for 2006, electricity comprised 50.1%, mains gas 34.4%, LPG 2.1% and wood 13.4% of the total energy used respectively.

EES reported the breakdown of major end uses of energy (water heating, space heating, space cooling, cooking and appliances) by energy type (electricity, gas, LPG and wood) in the residential sector in Australia in 1990 and also in 2007 (EES, 2008).

The data for 1990 and 2007 has been summarised to compare the trends over time and is presented in Table 1.

EES have conducted detailed analyses of energy efficiency data and trends in energy efficiency and usage for each of these end uses (EES 2008). This is an extremely complex area and EES have developed sophisticated models to undertake their assessment of energy use trends to 2020, based on measured data, incorporating the expected uptake of energy efficiency improvements and projecting purchases and preferences into the future. They have also attempted to model this for each Australian state.

In a separate study, Wilkenfeld estimated the breakdown of energy by use in Australian households in 1995 (Wilkenfeld, 1998). This is presented in Table 2. This study broke down the appliances category into various sub-categories such as TV, video; refrigeration, major appliances and also included lighting as a category which was not included in the EES (2008) report. Using similar categories McNicol (2004) from SEAV presented estimates of various energy uses within the Australian residential sector for 2005. This is also included in Table 2. The trends in Table 1 reported by EES (2008) however do not appear in Table 2.

**Table 1. Proportion of household energy use by end use in Australia**

End Use (Household Energy)	Energy Use 1990	Energy Use 1990	Energy Use 2007	Energy Use 2007	Trend 1990 to 2007	Trend 1990 to 2007
	PJ	%	PJ	%	PJ	%
<b>Space Heating</b>	126.2	42	149.6	38	+23.4	-4
Wood	63.8	21	51.3	13	-12.5	-8
LPG	3.5	1	3.6	1	<0.5	<0.5
Gas	48.0	16	81.3	21	+33.3	+5
Electricity	10.9	4	13.4	3	+2.5	-1
<b>Water Heating</b>	84.1	28	90.7	23	+6.6	-5
LPG	2.9	1	2.9	1	<0.1	<0.5
Gas	33.8	11	44.7	11	+10.9	<0.5
Electricity	47.4	16	43.1	11	-4.3	-5
<b>Space Cooling</b>	3.0	1	11.9	3	+8.9	2
Electricity	3.0	1	11.9	3	+8.9	+2
<b>Cooking</b>	14.9	5	19.6	5	+4.7	<-1
LPG	1.1	<0.5	1.8	<0.5	0.7	<0.5
Gas	5.9	2	8.5	2	+2.6	<0.5
Electricity	7.9	3	9.3	2	+1.4	-1
<b>Appliances</b>	70.5	24	124.9	31	+54.4	7
Gas	1.5	<0.5	2.4	1	+0.9	+0.5
Electricity	69	24	122.5	31	+53.5	+7

(Source: EES 2008)

The energy use of a typical South Australian home by end use has been reported by Department of Transport, Energy and Infrastructure (DTEI 2008). This is also included in Table 2. A higher percentage of energy is used for heating water in the typical SA home compared to the residential sector for the whole of Australia, while the heating and cooling energy is proportionally lower in the typical SA home. The categories by which energy use is reported vary between studies and make it difficult to directly compare studies. This is particularly relevant to heating and cooling and also to appliances. It is also important to note the large increase in electricity used to power appliances that has been observed over time (see Table 1).

**Table 2. Comparison of proportion of household energy use by end use for Australia with typical home in South Australia**

End Use (Household Energy)	Energy Use 1995 (Wilkenfeld 1998) %	Energy Use 2005 (McNicol 2004) %	Energy Use SA House (DTEI 2008) %
Space Heating	40.1	42	26*
Water Heating	26.6	28	35
Space Cooling	1.2	2	
Cooking	7.8	4	
Lighting	4.1	4	5
Refrigeration	8.9	7	11
TV/Video	2.4		
Major Appliances	5.2		
Miscellaneous	3.8		
Home Electronics		4	
Other Appliances		9	18
Standby			5

\* includes cooling

The energy use by fuel type for each sector in each State of Australia has been estimated by ABARE (2006). This information is summarised in Tables A1 and A2 of Appendix A. The use of electricity in the residential sector ranges from 28.6% of the total energy use for the residential sector in Victoria to 78.4% in Queensland. The use of gas ranges from 2% (LPG) in Tasmania to 57.8% (predominantly mains gas) in Victoria. The use of wood ranges from 2.4% in the Northern Territory to 47.9% in Tasmania. Gas and wood use dominate in cooler climates (Tasmania and Victoria) where space heating is required, while electricity dominates in warmer climates of Queensland, Northern Territory and New South Wales where space cooling is required. South Australia has an annual energy use mix similar to the Australian average however it is likely to be seasonally dependent with electricity use higher in the hot summers.

Energy efficiency improvements in the residential sector focus on improving the building shell to reduce the energy required for heating and cooling, reducing the energy used for water heating, for lighting and for operating household appliances and other electrical equipment.

Some studies have tried to quantify the potential energy efficiency improvements for the residential sector. The results from a study conducted by SEAV-NFEE (reported by EES 2008) and other data reported by McNicol (2004) have been combined and are presented in Table 3. This table summarises the reduction in energy use and running costs, the increase in capital cost of these improvements and the approximate payback time in years. It is assumed that these capital costs are before any subsidies or rebates are applied.

The Department of Transport Energy and Infrastructure in South Australia (DTEI 2008) states that 15% of energy used for heating and cooling is able to be saved by sealing gaps and preventing draughts and 10% of heating and cooling costs can be saved by adjusting temperature controls by one degree Celsius (lower for winter and higher for summer). They also state that approximately 50% of energy can be saved through using a front loading washing machine rather than a top loader machine and that savings of 75% of energy used for lighting can be achieved through replacing incandescent bulbs with compact fluorescent bulbs. The percentage reductions listed in Table 3 are somewhat lower than the potential savings stated by DTEI.

Lee and Denlay used the results of a study conducted on small households in South Australia between 1993 and 1996 (Lee and Denlay, 2002:13) and the UK Energy Review reported by the UK Cabinet Office (2001) to calculate potential energy efficiency savings over a 20 year period to 2017. They used baseline energy data from South Australian Energy Flows 1998/99 provided by Energy SA (2001) in their calculations. Their study concluded that efficiencies of 25% were expected to be achieved through a number of measures including installing insulation in roof-spaces and walls; replacing inefficient appliances; replacing incandescent and halogen light-bulbs with compact fluorescent lighting; eliminating drafts in winter; increasing reliance on passive heating and cooling and natural lighting; and reducing the volume and temperature of hot water used by households. Lee and Denlay (2002) estimated that the ratio of electricity to gas contributing to the savings in the residential sector was 70:30. They calculated annual greenhouse gas emission savings and annual cost savings. These are presented in Table 4. The study also estimated capital costs of \$609M (in 2002 \$) for the initiatives in the residential sector. Lee and Denlay's report (p13) referred to *hot water improvements* such as *insulation, solar* and *controls* however it was not clear whether solar energy for heating water was included in the calculations.

The Productivity Commission concluded that relative to a business-as-usual projection for 2014/2015, whereby householders would undertake continuing improvements and future increases in mandatory efficiency standards for residential buildings and appliances would occur, additional improvements could result in energy use reductions of between 13% and 34% (Productivity Commission, 2005:72). The data in Table 3 is at the lower end of these estimates of energy efficiency improvements while the estimate of 25% used by Lee and Denlay (2002) lies within this range. The installation of insulation in dwellings could be considered to be a conservation measure, however using the definition of conservation as making a sacrifice, if insulation allows the home to be used with the same level of thermal comfort but reduced usage of heating and cooling, it then qualifies as an efficiency initiative rather than a conservation measure.

**Table 3. Estimates of potential energy efficiency improvements for the residential sector in Australia**

Energy Efficiency Measure	Reduction in energy use	Proportionate reduction in energy use	Reduction in running costs	Increase in capital costs	Payback
	PJ per annum	%	\$M	\$M	Yrs
Weather stripping & sealing	7.3	3.0	81.2	423	5.2
Increase all States to 5-Star	8.8	3.6	173.8	1132	6.5
Improve efficiency of or replace gas & solid fuel heaters	20.7	8.5	162.4	483	3.0
Improve efficiency of ducted heating and cooling systems	3.0	1.2	41.4	136	3.3
<b>Total Building shell, heating and cooling with payback &lt;6.5 yrs)</b>	<b>37.7</b>	<b>16.4</b>	<b>458.8</b>	<b>2175</b>	<b>5.0</b>
Lighting	2.7	12.4	97.6	384	3.9
Refrigeration	3.5	10.9	126.4	439	3.5
Cooking	3.9	17.7	100.4	330	3.3
Dishwashers	0.3	8.0	10.5	63	6.0
Clothes washers	0.2	13.5	8.5	35	4.1
Water heating	21.2	14.9	427.3	1038	3.1
<b>Total (all measures payback &lt;6.5 yrs)</b>	<b>69.5</b>	<b>13.0</b>	<b>1229.5</b>	<b>4464</b>	<b>3.6</b>
Insulate existing houses	3.0	1.2	34.1	639	18.8
Improve efficiency of RACs	1.2	0.5	41.9	1000	23.9
Replace electric heating with RACs	2.6	1.0	91.8	1171	12.7
<b>Total (all measures)</b>	<b>76.3</b>	<b>14.3</b>	<b>1397.3</b>	<b>7274</b>	<b>5.2</b>

(Source: EES, 2008; McNicol, 2004)

(Note: The figures in this table were relative to a business as usual projection of annual energy use and costs for 2015 for water heating or 2014 for other measures.)

**Table 4. Energy efficiency savings in South Australia's residential sector**

	Annual Energy Use	Annual Energy Saving Potential	Annual CO2e Saving Potential	Estimated Annual Cost Saving
	PJ (GWh)	PJ (GWh)	MT CO2e	\$M (in 2002 \$)
Residential Electricity	14.41 (4000)	4.55 (1264)	1.4	190
Residential Gas	8.26	1.12	0.058	13.4

(Source: Lee and Denlay, 2002)

In 2006, the Australian Institute for Social Research (AISR) at the University of Adelaide in South Australia evaluated an energy efficiency program for low income households in South Australia (Spoehr, Davidson and Wilson, 2006). One of the objectives of the program was to reduce energy use and greenhouse gas emissions. The program focused on providing a free energy audit to identify opportunities to save energy without compromising comfort, offering a retrofit kit -comprising two compact fluorescent light bulbs, a low flow (AAA rated) showerhead, and a draft excluder; and offering assistance in replacement of inefficient fridges and other appliances through interest-free loans or fridge buy-back schemes. The evaluation estimated that for the 1000 participants surveyed, the retrofit reduced annual electricity use by a total of 221,037 kWh or 795,733 MJ (average 221 kWh or 796 MJ per participant) and annual gas use by a total of 910,887 MJ (average 911 MJ per participant). The evaluation report estimated annual savings on fuel use and cost of energy for each energy efficiency action within the program. These are summarised in Table 5. A cost benefit analysis was not undertaken as the capital cost of initiatives was not included as a cost to the consumer. It should also be noted that this study did not record actual energy use before and after the actions were taken.

**Table 5. Annual energy and cost savings for each action within the low income energy efficiency program trialled in South Australia**

Annual Savings	Number	Electricity savings	Gas savings	CO2-e savings	Cost savings
Category	#	kWh	MJ	Tonnes	\$
CFLs	1	44	0	0.04	8.38
Showerheads	1	303	2168	0.45	60.03
Switch off appliances	1	18	0	0.02	3.42
Further CFLs	1	29	0	0.03	5.59
Lower hot water service thermostat and lag pipes	1	88	558	0.13	16.32
Fridge Buy-back	1	506	0	0.49	96.10
IFLS – energy efficient fridges and freezers	1	500	0	0.48	95.00

(Source: Spoehr et al 2006)

Pears (2007a) predicted improved efficiency of two thirds for the residential sector, with household total energy use declining by 55% and electricity use declining by 50% to a level of 1000 kWh/person/yr although the timeframe for this reduction was not stated. In a draft paper by the same author describing the framework and rationales for the scenarios for the residential sector, a timeframe of 2005 to 2030 was modelled (Pears, 2007b). The study incorporated energy use data from ABARE, population and new home construction data from the Australian Bureau of Statistics (ABS), adoption of new technology and standards for appliances predicted by Wilkenfeld (2002), Navigant (2003) and EES (2006) and improved energy efficiency ratings for new homes.

In 2008, CSIRO (Hatfield-Dodds and Denniss, 2008) summarised energy efficiency improvements in the residential sector from a number of previous studies (Saddler et al, 2004; EES, 2007; Batten and O'Connell, 2007; TCI, 2007). In their report, service efficiency of household electricity use was estimated to improve by 20% over ten years from 2010, while service efficiency of household natural gas use would improve by 15% over fifteen years from 2010.

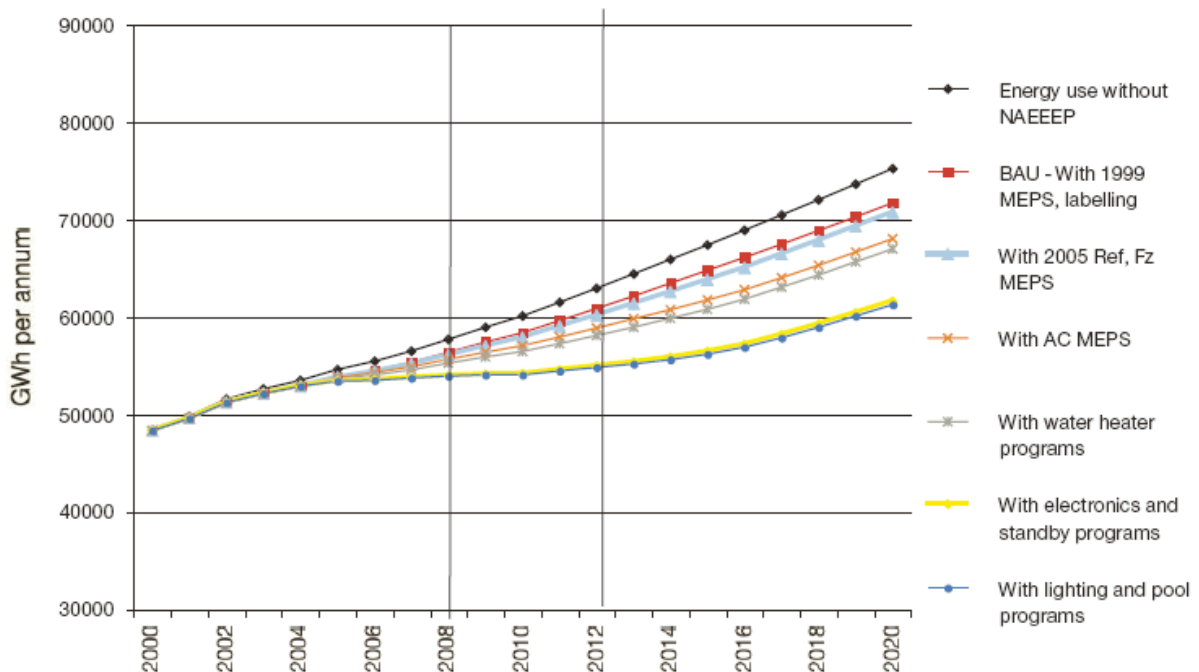
The ABS has used a study by Ipsos (2005) to report the number of items of electrical equipment in households of capital cities in each state (ABS 2006). This is summarised in Table B1 in Appendix B. The average total number of items of electrical equipment per household ranged from 21.1 for Brisbane households to 24.1 for Canberra households, with an average of 22.2 for all Australian capital city households.

Harrington, Brown and Ryan (2006) conducted intrusive surveys of 120 households to determine the actual standby power of electrical products used in households. In doing so they quantified the stock of major appliance products in these households. This is summarised in Table B2 in Appendix B. The average total number of items per household was 67.7 with an average of 18.7 items per household not plugged in at the time of the survey. The total number of 67.7 items is 3 times the average number of items per household (22.2) reported by ABS (2006) from the Ipsos (2005) study while the number of items actually plugged in at the time of the survey (49 items per household) is twice that reported by ABS. These differences highlight the limitations in attempts to quantify potential efficiency improvements across the residential sector at the local level using existing studies.

DTEI (2008) reported that, for the typical SA home, 5% of energy use was associated with equipment in standby mode. There has been significant progress in development and implementation of tighter standards for standby power consumption in recent years. These standards apply particularly to home office equipment including computers, photocopiers and printers and to home entertainment equipment (Pears, 2007a). The figures estimated by the SEAV studies as reported by the Productivity Commission (2005) do not include the efficiencies expected to be achieved by these improved standards.

The extent of the improvements expected to be achieved by the National Appliance and Equipment Energy Efficiency Program (NAEEEP) which manages the development and implementation of standards for electrical and gas appliances and equipment were summarised in a report on the projected impacts of the program (Commonwealth of Australia, 2005). This report estimated reductions of energy use associated with the NAEEEP to be approximately 18% of that expected in a business as usual scenario for the residential sector over the period 2000 to 2017 and expected to continue to 2020. This is depicted in Figure 1. The rate of uptake of equipment which uses less energy in standby mode or in 'off' mode will influence the actual energy consumption over time.

In summary, for the residential sector, estimates of potential reductions in household energy use in either absolute terms or as a percentage of household energy use can be attributed to individual energy efficiency improvement initiatives. The cost of these initiatives and the greenhouse gas emissions related to the quantum of energy reduction can be used to prepare the greenhouse gas abatement costs for each initiative similar to the cost curves produced by Grant and Kellett (2002) and McKinsey & Company (2008). Assumptions would need to be made regarding the quantum and mix of energy used within the residential sector in each study area and the number of individual actions which a typical household would be likely to implement over time.



**Figure 1. Projected electricity consumption of residential sector in Australia with and without NAEERP measures (Source: Commonwealth of Australia, 2005)**

### Commercial Sector

For the commercial sector, the Productivity Commission concluded that reductions in energy use related to modifications to the thermal performance of the building fabric, heating, ventilation, cooling, lighting, hot water services, lifts and other services and plant and that these would potentially reach 10.4% by 2010 relative to a business as usual scenario modelled over 12 years (Productivity Commission, 2005). This is summarised for each subsector in Table 6. The payback period for each of these initiatives did not exceed 4 years and this was considered to be important for commercial enterprises.

It was reported that about half of the estimated potential energy savings were from initiatives to improve lighting and management of hot water systems and processes such as cooking and heating in the wholesale and retail sectors (Productivity Commission, 2005). However, they questioned the higher estimates of 28 to 70% being quoted by other studies (see Productivity Commission, 2005).

**Table 6. Estimates of potential energy efficiency improvements for the commercial subsectors in Australia in 2010 compared to business as usual**

Subsector	Reduction in energy use	Proportionate reduction in energy use	Reduction in running costs	Implementation costs
	PJ per annum	%	\$M	\$M
Wholesale and retail trade	15.2	11.9	920.8	846.9
Accommodation, cafes and restaurants	2.8	14.1	121.4	144.0
Communication services	0.5	7.6	25.6	27.3
Finance, insurance, property and business services	4.1	11.1	196.1	203.6
Government administration, education, health and community services	6.0	7.3	430.0	276.6
Culture and recreation, personal and other services	1.7	9.9	73.6	74.0
<b>Total</b>	<b>30.2</b>	<b>10.4</b>	<b>1767.5</b>	<b>1572.4</b>

(Source: Productivity Commission, 2005)

Estimates of the energy efficiency savings expected in one Australian Government office building were reported by the Productivity Commission (1999). This is summarised in Table 7.

Pears (2007a) predicted a reduction of 75% in energy consumption per unit of activity in the commercial sector with 60% savings in heating, ventilation and cooling for buildings feasible using existing cost-effective technologies. The timeframe for these reductions, however, was not stated.

**Table 7. Estimates of potential energy efficiency improvements for Australian Government office buildings**

Initiative	Annual Electricity Saving	Energy Saving
	GJ	\$
Installation of automatic lighting controls	0.2	3000
Control of lighting available and changes to cleaning times	0.23	3500

(Source: Productivity Commission 1999)

Lee and Denlay (2002) identified energy efficiency improvements in lighting systems; the use of more energy efficient office equipment; the replacement of inefficient refrigeration and air-conditioning; and by insulating ovens and other equipment for food preparation (Lee and Denlay 2002). The energy savings for each improvement were not provided but a summary of electricity savings and gas savings was provided and is summarised in Table 8. For the commercial sector, Lee and Denlay (2002) used data from SEDA (NSW) and the UK Energy Review. Their study concluded that energy efficiencies of 15% for the commercial sector were potentially achievable over a 20 year period. The ratio of electricity to gas contributing to these savings was estimated to be 90:10 initially for the commercial sector moving to 70:30 over time (Lee and Denlay, 2002). Their study used baseline energy data from South Australian Energy Flows 1998/99 provided by Energy SA (2001).

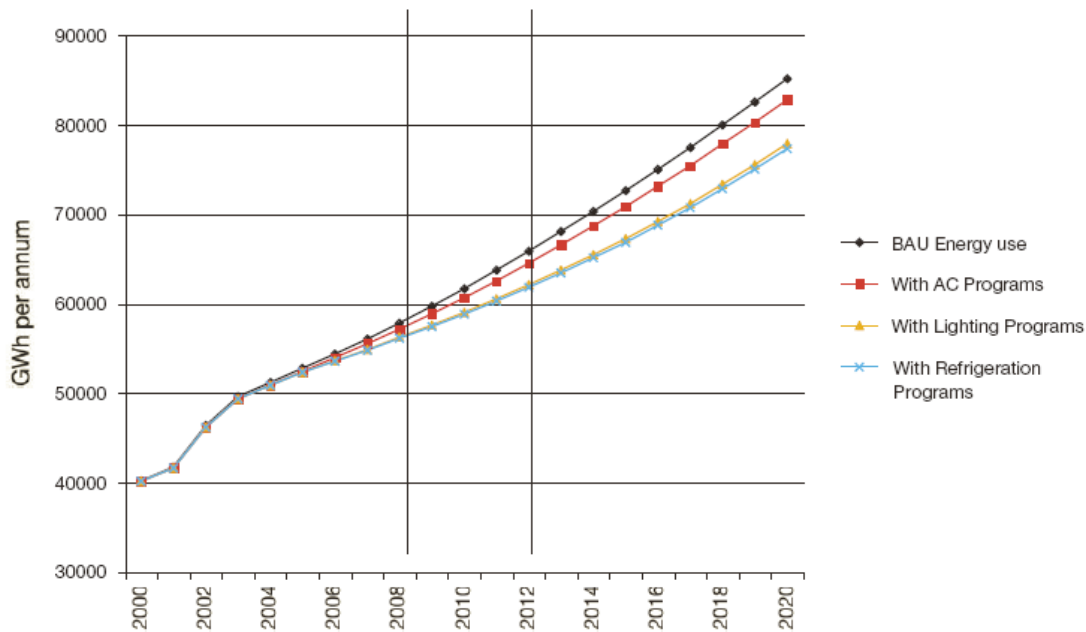
While the capital cost of initiatives was not provided, however based on the cost saving alone, the cost saving per tonne of CO<sub>2</sub>e is \$91 (in 2002 \$) for electricity and \$186 for gas.

**Table 8. Potential energy efficiency savings in South Australia's commercial sector**

	<b>Annual Energy Use</b>	<b>Annual Energy Saving Potential</b>	<b>Annual CO<sub>2</sub>e Saving Potential</b>	<b>Estimated Annual Cost Saving</b>
	<b>PJ (GWh)</b>	<b>PJ (GWh)</b>	<b>MT CO<sub>2</sub>e</b>	<b>\$M (in 2002 \$)</b>
Electricity	8.12 (2255)	1.39 (386)	0.429	39
Gas	2.06	0.13	0.007	1.3

(Source: Lee and Denlay 2002)

The improvements expected to be achieved by regulating the energy efficiency performance of equipment used in the commercial sector were estimated to reduce energy use by approximately 18% compared to that expected in a business as usual scenario to 2020 (Commonwealth of Australia 2005) This is described in Figure 2. The actual rate of uptake of equipment which uses less energy will influence the energy consumption over time.



**Figure 2. Projected electricity consumption of commercial sector in Australia with and without NAEEEP measures (Source: Commonwealth of Australia, 2005)**

### Industrial Sector

Energy use is a significant cost for industrial businesses and energy that is used without a product or service being provided is costly and a waste. The Australian Government has worked with many industry groups to identify best practice and promote awareness of improvements to processes that eliminate waste including wasted energy.

Within the industrial sector of mining and manufacturing, the Productivity Commission (2005:76) reported that the SEAV-NFEE studies estimated reduction in energy use of between 6% and nearly 9% due to energy efficiency initiatives. The estimates of the SEAV-NFEE study for all sectors as reported by the Productivity Commission (2005) are summarised in Table 9. The largest energy savings in 2011 compared to business as usual were expected to be in aluminium smelting, chemical products manufacturing, mining and iron and steel manufacturing. In this study initiatives were limited to those that had a payback period of no more than 4 years. It is not clear however whether the efficiencies relate to electricity only or to all energy sources.

Using a study by Saddler, Diesendorf and Denniss (2004) the Productivity Commission (2005) produced another set of estimates of potential energy efficiency improvements in industrial subsectors in 2040 compared to business as usual. This is reproduced as Table 10 and compares the expected energy use reductions in 2040 with that expected to be achieved in the residential and commercial sectors.

Pears (2007a) did not provide an estimate of potential energy efficiencies for the industrial sector, and was of the opinion that non-transport energy is a small input cost factor for Australian industry. The Energy Efficiency Opportunities initiative of the Australian Government, however, indicated efficiencies of 30% were potentially achievable (Commonwealth of Australia 2006). No timeframe was stated over which these efficiency improvements would occur.

It has been reported that energy use reduction associated with the NAEEEP for the industrial sector was difficult to estimate (Commonwealth of Australia, 2005) as the

equipment used in industry was often purpose built and not mass produced, with Mandatory Energy Performance Standards (MEPS) in place for electric motors only. No estimate of the improvement in terms of percentage reduction in energy use related to the use of more efficient motors was provided in that report. From the review undertaken by Mecrow and Jack (2008) described earlier (see Section 2.1.1), motor replacement has potential to be beneficial.

**Table 9. Estimates of potential energy efficiency improvements for the industrial subsectors in Australia in 2011 compared to business as usual**

<b>Subsector</b>	<b>Reduction in energy use</b>	<b>Proportionate reduction in energy use</b>	<b>Reduction in running costs</b>	<b>Implementation cost</b>
	<b>PJ per annum</b>	<b>%</b>	<b>\$m</b>	<b>\$m</b>
Mining (excluding oil, gas and bauxite)	8	8.8	100	212
Meat and Meat products	1	8.3	24.1	63.6
Dairy product manufacturing	1.7	11.9	23.9	81.8
Bakery products, flour milling and cereal products	1.5	13.5	19.2	58.1
Pulp and paper manufacturing	3.5	7.4	54.2	149.3
Chemical products manufacturing	9.3	8.9	89	211
Ceramic products manufacturing	2.1	8.6	13.2	44.8
Cement manufacturing	2.8	9.6	28.3	42.9
Iron and steel manufacturing	6.6	4	117	160
Bauxite mining and alumina refining	1	0.6	45.7	111.6
Aluminium smelting and semi-fabrication	11.4	8.8	143.7	438.2
<b>Total</b>	<b>48.9</b>	<b>6.2</b>	<b>659</b>	<b>1574</b>

(Source: Productivity Commission 2005)

**Table 10. Estimates of potential energy efficiency improvements in 2040 for the industrial subsectors in Australia compared to the commercial and residential sectors**

Industry	Reduction in energy use	
	PJ	%
Agriculture, forestry and fishing	21	20
Mining	66	16
Manufacturing	138	11
Iron and steel	17	8
Food, beverages and tobacco	86	42
Basic chemicals	12	16
Cement, lime, plaster and concrete	10	16
All other non-metallic mineral products	8	11
Non-ferrous metals	0	0
Wood, paper and printing	0	0
All other manufacturing	5	5
Construction	20	17
<b>Commercial services</b>	<b>197</b>	<b>39</b>
<b>Residential</b>	<b>148</b>	<b>27</b>
<b>Total final stationary energy consumption</b>	<b>590</b>	<b>20</b>

(Source: Productivity Commission 2005)

For the industrial sector in South Australia, Lee and Denlay (2002) reviewed data from the Sustainable Energy Development Authority (SEDA) of New South Wales, the Commonwealth Enterprise Energy Audit Program which operated between 1991 and 1997 (IPART 2002), the UK Energy Review (UK Cabinet Office 2001), US studies conducted by the Electric Power Research Institute (EPRI 1990) and the Rocky Mountain Institute (RMI 1990). Lee and Denlay (2002) concluded that energy efficiencies of 20% were potentially achievable within the industrial sector by adopting available technologies which would reduce electricity consumption and by fuel switching from electricity to gas. The savings were summarised in a table which is reproduced here as Table 11. The ratio of electricity to gas contributing to these savings was estimated to be 70:30 (Lee and Denlay, 2002) using baseline energy data from South Australian Energy Flows 1998/99 provided by Energy SA (2001). The capital cost of initiatives was not provided, however based on the annual cost saving alone, the cost saving per tonne of CO<sub>2</sub>-e is \$90 (in 2002 \$) for electricity and \$192 for gas.

**Table 11. Potential energy efficiency savings in South Australia's industrial sector**

	Annual Energy Use	Annual Energy Saving Potential	Annual CO2e Saving Potential	Estimated Annual Cost Saving
	PJ (GWh)	PJ (GWh)	MT CO2e	\$M (in 2002 \$)
Electricity	16.54 (4600)	5.22 (1450)	1.61	145
Gas	29.65	4.01	0.208	40

(Source: Lee and Denlay 2002)

### *Transport Sector*

In the transport sector, energy efficiency assessment relates to measuring and monitoring the energy used to transport passengers (passenger-km/MJ) or goods (tonne-km/MJ). Within the transport sector the **energy intensity** of different modes of transport has also been assessed (MJ-FFC/passenger-km or MJ-FFC/tonne-km). The term FFC indicates Full Fuel Cycle and incorporates energy used in production and losses in transmission.

For individual vehicles fuel efficiency relates to the volume of fuel used to travel a set distance (e.g. L/100km). Some initiatives to improve efficiency rely on reducing greenhouse gas emissions by encouraging a shift to more efficient transport modes (increasing pass-km/MJ or tonne-km/MJ). Efficiencies for various transport modes have been summarised in a report by the Australian Conservation Foundation (ACF, 2000). The ACF report states that urban car travel has an efficiency of 0.36 pass-km per MJ, electric rail 0.83 pass-km per MJ, air travel 0.37 pass-km per MJ (similar to urban car travel) and bus travel 2.04 pass-km per MJ.

Fuel efficiency and emissions for urban car travel is monitored by the Australian Government. In 2004 the Department of Transport and Regional Services, in collaboration with the Australian Greenhouse Office released the Green Vehicle Guide (GVG) (IEA 2008). The GVG provides fuel consumption data (L/100km) as well as an overall environmental star rating on each vehicle model and variant sold in Australia weighing 3.5 tonnes gross vehicle mass or less. The star rating of 0 to 5 stars reflects air pollution and greenhouse gas emission data provided for each vehicle at certification (Commonwealth of Australia, 2008b).

The Australian Bureau of Statistics (ABS) calculates fuel consumption rates using fuel used and number of kilometres travelled. In 2005 the average fuel consumption rate for the total vehicle fleet in Australia was 11.7 L/100km which was also the average fuel consumption rate for passenger vehicles (ABS, 2006).

The CSIRO study (Hatfield-Dodds and Denniss 2008) assumed that service efficiency of household transport fuel use would improve by 25% over fifteen years from 2015.

Pears (2007a) forecast that fuel efficiency for passenger vehicles has the potential to increase from approximately 11 L/100km to 3 L/100km using weight reduction and advanced engine technologies (p.265) although no timeframe was given for this transition. This equates to a 73% reduction in energy use. The newest hybrid car released in February 2009 in Japan is expected to provide an efficiency of 22 km/L or 4.5 L/100km based on tests conducted in the US (Kavanagh 2009).

## 2.2 Energy Conservation Assessment Methods

Energy conservation measures result in reduced fuel consumption and thereby reduce carbon emissions. As discussed earlier energy conservation measures and energy efficiency measures are often grouped and assessed together with the terms interchanged and poorly defined.

According to the CSIRO Energy Centre (CSIRO, 2008), energy conservation measures for buildings may be active or passive and may include:

- building orientation and layout – maximising natural light and allowing for temperature control throughout seasons
- building insulation – reducing heating and cooling loads
- opening windows – allowing for natural ventilation
- window glass selection – minimising heat build up and maintaining natural light
- energy efficient air-conditioning system – designed for separate and specific uses in laboratories and office areas
- outside air economy cycle – making use of outside air for cooling
- automatic lighting control system – only lights areas that are in use
- building management system – minimising energy use and maximising efficiency.

Some are energy efficiency measures as the same level of service is provided using less energy. True conservation may involve turning off an air-conditioner in the home and visiting a shopping centre which is air-conditioned.

Energy conservation measures relating to transport focus on using less energy by reducing the number of trips made, the length of trips or changing the mode of travel. This requires behaviour change and conscious choice. Initiatives to reduce the number of trips made or length of trips can be by working from home, working closer to home, teleworking, trip-chaining or using home delivery services. Changing the mode of travel may take place by using mass transit rather than a personal vehicle, or walking or cycling rather than using a motor vehicle. Western Australia has implemented a TravelSmart program aimed at achieving a 12-16 per cent reduction in vehicle kilometres travelled across the target population of more than 218,500 in metropolitan Perth. This program is tailoring information to the target audience and addressing motivation (Commonwealth of Australia, 2008c)

The Australian Government has also funded the National Travel Behaviour Change Project in other States (Queensland, Victoria, South Australia and the Australian Capital Territory). This project aims to reduce impacts of car use by utilising a variety of measures to facilitate a voluntary change in behaviour towards more sustainable modes of travel. These include walking, cycling, public transport and ride-sharing (Commonwealth of Australia, 2008c). The project information estimates the total greenhouse gas emissions expected to be saved between 2008 and 2012 but does not identify the proportion expected to be achieved by each State or by each efficiency improvements.

No effort is made in this working paper to separate the energy saved due to conservation initiatives in the transport sector as distinct from energy efficiency. However it should be noted that all transport including walking or cycling, requires a source of energy. It should also be noted that transport energy may be conserved by working from home but an increase in residential energy use may take place to heat or cool the home and operate equipment. Similarly energy may be conserved by cycling to work but energy and water to provide shower facilities at the workplace may

reduce some of the energy savings made. The combined impact of various energy conservation and energy efficiency initiatives warrants further research but is beyond the scope of this working paper.

## 2.3 Method for Assessing Energy Efficiency Potential for Playford LGA

This section outlines a method that could be used to assess the energy efficiency potential for a local government area.

### 2.3.1 Proposed Method

The method that is proposed to be used to assess the energy efficiency potential for a local government area involves the following:

- Identify the energy efficiency initiatives relevant to each sector in the study area;
- Estimate the energy efficiency improvement expected based on the studies undertaken in Australia and if possible at the State or local level;
- Estimate the cost savings in operational energy;
- Estimate the associated greenhouse gas emissions saved;
- Estimate the capital investment and life of the initiative;
- Calculate an annual cost per tonne of GHG emissions saved;
- Plot the GHG abatement cost curve ( the cost per tonne of GHG saved against the total GHG emissions saved)
- Summarise the technologically feasible and economically feasible energy and GHG savings potentially achievable through implementing energy efficiency initiatives

### 2.3.2 Availability of data and assumptions made

This method requires baseline data for energy use to be available at the local government level. Methods for estimating the carbon profile of a local government area were reviewed and assessed by Hamilton, Kellett and Yuan (2008). The average of the energy use determined using the three methods from that study have been used as the baseline for the energy efficiency assessment of Playford LGA.

The residential baseline energy demand for 2006 was estimated to be somewhere between 1 and 1.63 PJ per year with an average of 1.24 PJ/yr. The industrial sector baseline energy demand for 2006 was estimated to be between 3.85 and 5.25 PJ/yr of energy with an average of 4.59 PJ/yr and the commercial sector energy demand for 2006 estimated to be between 0.38 and 0.82 PJ/yr with an average of 0.57 PJ/yr. The energy use in the transport sector was estimated to be between 2.98 and 4.12 PJ/yr with an average of 3.38 PJ/yr. The use of electricity and gas in the residential sector was estimated as part of the baseline assessment undertaken by Hamilton et al (2008). The average energy use for each sector is summarised in Table 12.

**Table 12. Average baseline energy use for Playford LGA in 2006**

Sector	Average Baseline Energy Use Playford LGA PJ/yr
<b>Residential</b> (Electricity) (Gas)	1.24 (0.52) (0.53)
<b>Industrial</b>	4.59
<b>Commercial</b>	0.57
<b>Transport</b>	3.38

(\* Average of three methods – Source: Hamilton, Kellett & Yuan 2008)

Assumptions regarding the uptake of energy efficiency initiatives in each sector are required in order to calculate the energy efficiency savings potential.

#### *Residential Sector - Assumptions*

In the residential sector the following assumptions and additional sources of data are used:

- Total energy use in residential sector was estimated to be an average of 1.24 PJ/yr in 2006 (Hamilton et al 2008). Of this, electricity use across the residential sector for Playford LGA was estimated to be within a range of 0.458 to 0.61 PJ/yr (Hamilton et al 2008) or an average of 0.52 PJ/yr which was based on a study of South Australian households by Oliphant (2003) - a range of 4650 – 6200 kWh/yr or an average of 5425 kWh/yr. Using the same study by Oliphant (2003) household use of natural gas was estimated to be in the range 16.8 – 22.5 GJ/yr or an average of 19.6 GJ/yr. The estimated gas use across the residential sector for Playford LGA ranges between 0.46 and 0.62 PJ/yr with an average of 0.53 PJ/yr (Hamilton et al 2008).
- The greenhouse gas (GHG) emissions associated with energy used in the residential sector were estimated by Hamilton et al (2008) to range between 0.96 and 1.19 Mt CO<sub>2</sub>-e/yr with an average of 1.07 Mt CO<sub>2</sub>-e/yr. This was estimated to be between 18 and 24% of the total GHG emissions for all sectors in the Playford LGA.
- ABS 2006 Census data provides number of households in study area
- A minimum of 4 Compact Fluorescent Light Bulbs will be installed in each house in Playford at a cost of \$5 per CFL – baseline is currently 50% have 4 or more CFLs/dwelling in metro Adelaide (ABS 2008)
- 10% of households will update their fridge each year– assume life of fridge is 10 years – ABS survey shows 10% households in SA purchased new fridge in previous 12 months and that 70% have a fridge that is less than 10 years old (ABS 2008) – cost is a low of \$400 premium to purchase an energy efficient fridge or a high of \$1500 to purchase
- 30% of households will retire their second fridge and recoup up to \$250 if retired through a buy-back scheme – ABS survey shows 30% of SA households have a second fridge and that 50% of these second fridges are 10 years or more in age (ABS 2008)
- All households will install a low flow showerhead at a cost of \$30/showerhead – ABS survey shows 50% already have water efficient showerhead in SA (ABS 2007)
- 50% of households will reduce the temperature of their hot water heater and lag the pipes at a cost of \$50/household
- 50% of households will actively switch off one appliance when not in use at a saving of 18 kWh/household/yr (Spoehr et al 2006)

- All houses will install roof insulation at a cost of between \$1000 (low) to \$2000 (high) - 77% of dwellings in SA already have roof insulation (ABS 2009) – lower end of efficiency improvement of 25% of heating and cooling energy used. This could be considered to be a conservation measure as less heating and cooling may be used due to greater thermal efficiency, however as the level of service is maintained it has been included here as an efficiency initiative.
- All houses will retrofit energy efficient glass at a premium of \$1620 / house of average 21 squares (approximately 195 sq m) – reduce heating cost by 25-32% based on Canberra data (Standards Australia 2009) – lower end of efficiency improvement of 25% of heating and cooling energy used. This could be considered to be a conservation measure as less heating and cooling may be used due to greater thermal efficiency, however as the level of service is maintained it has been included here as an efficiency initiative.
- Retail price for electricity = \$49.52/GJ
- Retail price for gas = \$34.78/GJ (calculated using operating cost of gas storage hot water system)
- The energy savings for CFLs, showerheads (electricity and gas), switching off appliances, lowering hot water service thermostat (electricity and gas), the fridge buy-back and purchasing an energy efficient fridge/freezer are the same as those used by Spoehr et al (2006) – see Table 13.
- All capital costs are before rebates are applied
- 300 new houses are completed each year to 5 star rating and are not included in the assessment

The assumptions used in estimating the energy efficiency savings, capital investment and payback period for the residential sector are summarised in Table 13.

**Table 13. Assumed annual savings from energy efficiency initiatives in residential sector, and estimate of capital investment required**

Efficiency initiative	Number/ household	Electricity savings/ household	Gas savings/ household	Capital Investment/ household	Life of initiative
Category	#	kWh	MJ	\$	Yrs
CFLs	4	176	0	20	8
Showerhead (AAA)	1	303	2168	30	10
Switch off appliances	1	18		0	na
Lower hot water service thermostat and lag pipes	1	88	558	50	10
Fridge Buy-back	1	506	0	-250	na
Purchase Energy efficient fridge/freezer	1	500	0	400-1500	10
Energy efficient windows	Upgrade each house	324	38	1620	30
Insulation (R3.5)	Whole house	324	38	1000-2000	30
<b>Total</b>					

na=not applicable

### *Commercial Sector - Assumptions*

In the commercial sector the following assumptions are used:

- National energy reduction estimates from the Productivity Commission (2005) for each subsector
- Energy use reductions are on a per employee basis for each subsector – based on employee numbers at State and Local level (from ABS data)
- All energy savings are in electricity

### *Industrial Sector - Assumptions*

In the industrial sector the following assumptions are used:

- National energy reduction estimates from the Productivity Commission (2005) for each subsector
- Energy use reductions are on a per employee basis for each subsector – based on employee numbers at State and Local level (from ABS data)
- Transport and storage industry subsector is included in this sector
- Electricity and gas savings are calculated and aggregated

### *Transport Sector - Assumptions*

In the transport sector, the following assumptions are used:

- Number of vehicles in Playford in 2006 from ABS data
- Average distance travelled for passenger vehicles is 12,100 km/yr and for light commercial vehicles is 17,100 km/yr (metropolitan) (ABS data)
- Average fuel efficiency of passenger vehicle fleet in SA is 11.7 L/100km
- Potential energy efficiency improvements if all passenger vehicles were to be petrol/hybrid and reach 4.5 L/100km; or all were to be a 4 cylinder petrol vehicle at 7.5 L/100km
- Potential energy efficiency improvements if
  - all fleet were upgraded to diesel light commercial vehicles to achieve 8.2 L/100km (Ford Transit Van);
  - all diesel light commercial vehicles were upgraded to achieve 8.2 L/100km (Ford Transit Van) and all petrol light commercial vehicles were upgraded to achieve 11.6 L/100km (Toyota HiAce)
- 29 ML of Petrol has 1 PJ energy; 25.88 ML Diesel has 1 PJ energy.

## **3. RESULTS**

This section summarises the results of the energy efficiency assessment across the residential, commercial, industrial and transport sectors of the Playford LGA using the method outlined in Section 2.3.

### **3.1 Residential Sector**

The potential annual energy savings (the resource) and associated GHG emissions for Playford LGA if all efficiency initiatives were to be implemented are summarised in Table 14. The estimated total savings in electricity and gas if all of these initiatives

were to be implemented is between \$5.3 and \$5.4 million annually. This is an average of almost \$210 per household per year.

**Table 14. Estimate of annual energy savings from energy efficiency initiatives in residential sector in Playford, and estimate of costs of GHG abatement**

Efficiency initiative	Number of households	Annual Electricity savings	Annual Gas savings	CO2e savings total	Energy cost savings total	GHG abatement costs total*
Category	#	kWh	MJ	Tonnes/yr	\$/yr	\$/T CO2-e
CFLs	12,939	2,277,264	0	1,970	\$405,970	-\$190
Showerhead (AAA)	12,939	3,920,517	28,051,752	4,842	\$1,674,560	-\$340
Switch off an appliance	12,939	232,902		201	\$41,520	-\$210
Lower hot water service thermostat and lag pipes	12,939	1,138,632	7,219,962	1,358	\$454,100	-\$290
Fridge Buy-back	7,703	3,897,718	0	3,372	\$694,850	-\$210
Purchase Energy efficient fridge/freezer	2,,568	1,284,000	0	1,111	\$228,900	-\$110 to +\$140
Energy efficient windows	25,678	8,319,672	996,306	7,248	\$1,517,820	-\$20
Roof Insulation (R3.5)	5,906	1,913,544	229,153	1,667	\$349,100	-\$90 to +\$25
<b>Total</b>				<b>21,768</b>	<b>\$5,366,820</b>	

\*Using zero discount rate

The capital investment for each initiative and estimated annual savings in electricity and gas use for the residential sector for Playford LGA, together with the payback period for each initiative is summarised in Table 15. The average cost per household of the investment required across Playford LGA for these initiatives is approximately \$2000 with a payback of approximately 10 years.

The percentage reduction in electricity and gas use for Playford LGA are summarised in Table 16. If all initiatives were implemented, it is estimated that savings of 16% of electricity and 7% of gas are possible.

**Table 15. Estimate of energy cost savings, capital investment required and payback period for energy efficiency improvements for Playford residential sector**

Efficiency initiative	Number of households	Energy cost savings total	Capital Investment	Payback
Category	#	\$/yr	\$m	Yr
CFLs	12,939	\$405,970	\$0.26	0.64
Showerhead (AAA)	12,939	\$1,674,560	\$0.39	0.23
Switch off an appliance	12,939	\$41,520	nil	na
Lower hot water service thermostat and lag pipes	12,939	\$454,100	\$0.65	1.42
Fridge Buy-back	7,703	\$694,850	-\$1.93	na
Purchase Energy efficient fridge/ freezer*	2,568	\$228,900	\$1.03 to \$3.85	4.49 to 16.83
Energy efficient windows	25,678	\$1,517,820	\$41.60	27.41
Roof Insulation (R3.5)**	5,906	\$349,100	\$5.91 to \$11.81	16.92 to 33.84
<b>Total</b>		<b>\$5,366,820</b>	<b>\$50.72 to \$53.81</b>	<b>9.45 to 10.03</b>

\*low cost is extra premium of \$400 on top of normal price while high is full price of new fridge of \$1500

\*\*low cost is \$1000 to insulate house while high cost is \$2000 to insulate a house

**Table 16. Estimates of energy use within the residential sector in Playford LGA after efficiency improvements**

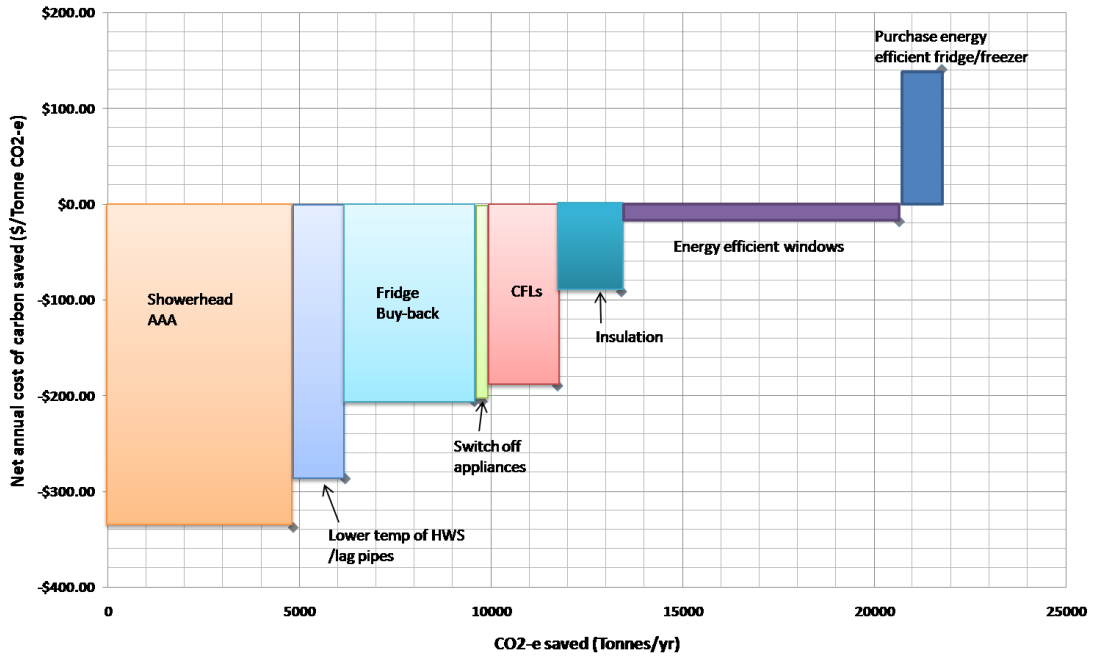
Residential Sector	Average energy use* PJ/yr	Energy resource savings in efficiency initiatives PJ/yr	Percent of average energy use %
Electricity	0.52	0.083	16
Gas	0.53	0.036	7
Total	1.24 (includes all fuels)	0.119	9.6

(\* Average of three methods using 2006 data – Source: Hamilton et al 2008)

A portion of the energy resource savings can be achieved economically. To calculate this portion, the cost of greenhouse gas abatement needs to be determined. The annual capital cost was determined using a zero discount rate as it is not appropriate to bring forward future benefits. The costs of the initiatives will need to be met at the time of implementation. Combining this with the annual cost savings in reduced energy, the cost curves for CO<sub>2</sub>-e abatement have been prepared. This is shown in Figures 3 and 4, with the differences between the two figures relating to the capital cost of purchasing an energy efficient fridge/freezer and the cost of insulating a house. Negative abatement costs indicate economic feasibility of initiatives.

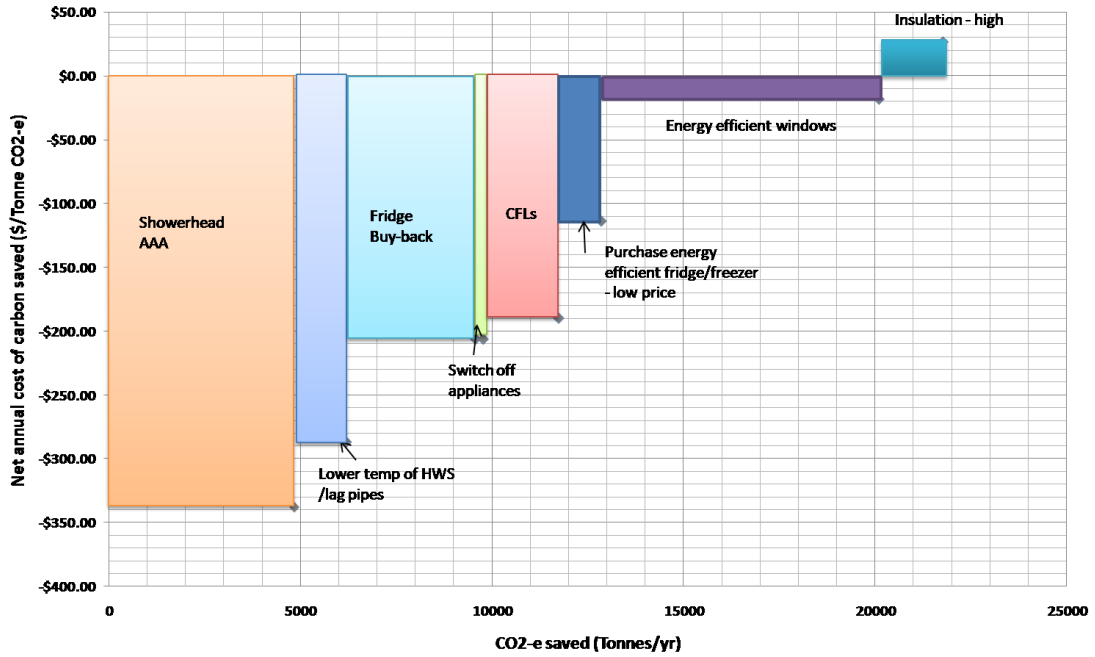
The GHG emission savings in the residential sector, if all initiatives were implemented, total 21,768 T CO<sub>2</sub>-e/yr. This is 2% of the total emissions for all sectors in Playford LGA and approximately 10% of the total emissions of the residential sector of Playford LGA.

**CO2-e abatement curve for energy efficient initiatives - Playford Residential**



**Figure 3. CO2-e abatement cost curves for the residential sector – High cost for fridge/freezer and low cost for roof insulation – zero discount rate**

**CO2-e abatement curve for energy efficient initiatives - Playford Residential**



**Figure 4. CO2-e abatement cost curves for the residential sector – Low cost for fridge/freezer (premium only) and high cost for roof insulation – zero discount rate**

### 3.2 Commercial Sector

For the commercial sector of Playford, energy use in 2006 was estimated to be 0.38 PJ/yr using the pro rata energy per employee estimate method (Hamilton et al, 2008). Energy savings due to efficiency improvements in each subsector were estimated from the Australian commercial subsector estimates made by SEAV-NFEE (Productivity Commission 2005) using pro rata employee numbers from Hamilton et al (2008). This is summarised in Table 17. Assuming that the total savings is electricity, cost savings associated with the reduced energy consumption, estimated capital cost, payback period, estimates of GHG emissions saved and GHG abatement costs are summarised in Table 18. The carbon abatement cost curve is presented as Figure 5. From this analysis savings in energy use totalling 0.037 PJ/yr and GHG emission reductions of nearly 9,000 T CO<sub>2</sub>-e/yr are possible. The potential energy savings are approximately 10 per cent of estimated energy use by this sector. The negative abatement costs indicate that these initiatives are economically feasible.

**Table 17. Estimates of energy reduction related to energy efficiency initiatives in the commercial sector of Playford**

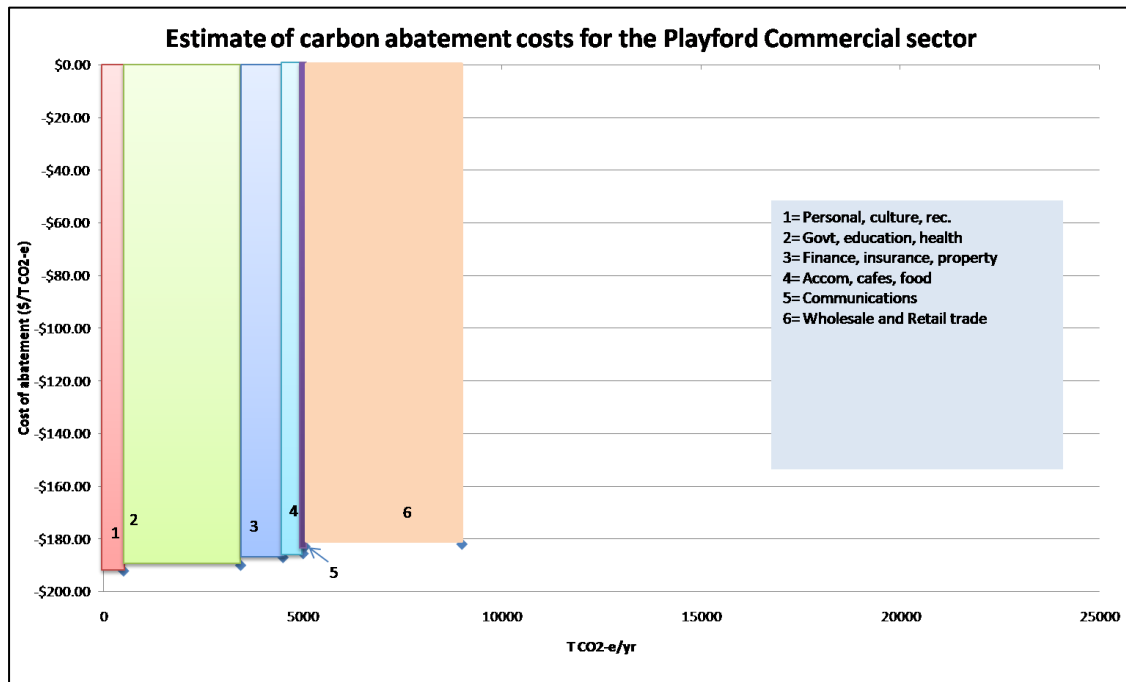
Subsector	Employees in Playford	Energy Use	Energy resource savings	Energy savings as a % of energy use
	#	PJ/yr	PJ/yr	%
Wholesale and retail trade	3,945	0.138	0.016	11.6
Accommodation, cafes and restaurants	430	0.015	0.002	13.3
Communication services	71	0.002	<0.001	nd
Finance, insurance, property and business services	1,142	0.040	0.004	10
Government administration, education, health and community services	4,797	0.167	0.012	7.2
Culture and recreation, personal and other services	602	0.021	0.002	9.5
<b>Total</b>	<b>10,987</b>	<b>0.383</b>	<b>0.037</b>	<b>9.7</b>

(Source: based on employee numbers used by Hamilton et al 2008)

**Table 18. Estimates of energy cost savings, capital investment required and payback period for energy efficiency improvements for Playford commercial sector**

Subsector	Cost savings	Implementation cost	Payback	GHG emissions saved	GHG abatement costs total*
	\$/yr	\$m	yr	T CO2-e/yr	\$/T CO2-e
Wholesale and retail trade	\$898,830	\$0.91	1.0	3,937	-\$180
Accommodation, cafes and restaurants	\$116,080	\$0.11	0.9	508	-\$185
Communication services	\$10,330	\$0.01	1.0	45	-\$180
Finance, insurance, property and business services	\$242,700	\$0.22	0.9	1,063	-\$185
Government administration, education, health and community services	\$670,470	\$0.56	0.8	2,937	-\$190
Culture and recreation, personal and other services	\$114,110	\$0.09	0.8	500	-\$190
<b>Total</b>	<b>\$2,052,530</b>	<b>\$1.95</b>	<b>0.9</b>	<b>8,990</b>	

\*Using zero discount rate



**Figure 5. CO2-e abatement cost curve for the commercial sector – zero discount rate used**

### 3.3 Industrial Sector

The baseline energy demand of the industrial sector in Playford LGA was estimated to be between 3.85 and 5.25 PJ/yr of energy with an average of 4.59 PJ/yr (Hamilton et al, 2008). This did not include the Transportation and Storage subsector which was included in the Transport section of the baseline energy assessment and the Agriculture, forestry and fishing subsector which was reported separately. Table 19 summarises the industry subsectors operating within the Playford LGA, the number of employees, the estimate of the energy used and the estimate of the electricity and gas savings possible using energy efficiency initiatives reported by SEAV-NFEE (Productivity Commission 2005) and Saddler, Diesendorf and Denniss (2004). The majority of employees (76%) were engaged by the manufacturing subsector. The estimated energy use of this subsector (4.42 PJ/yr) dominates and the reduction in electricity and gas use related to energy efficiency in this subsector is critical to overall estimates for the industrial sector.

Table 20 summarises the estimates of cost savings, implementation costs, payback period, GHG emission savings and GHG abatement costs for the various subsectors. The carbon reduction of 0.28 MT CO<sub>2</sub>-e/yr only relates to savings in electricity and gas from implementing energy efficiency initiatives in these subsectors. Fuel mix will affect the actual GHG emission savings. It should be noted that many assumptions were made in estimating these costs and savings and that industry subsectors vary considerably in the type of equipment that is used, the work that is undertaken, the goods produced and the fuel used.

Figure 6 shows the carbon abatement cost curve for the various industry subsectors. It is clear that annual savings in reduced electricity and gas use exceed estimates of annual costs over the life of the energy efficiency initiatives.

**Table 19. Estimates of electricity and gas use reductions related to energy efficiency initiatives in the industrial sector of Playford**

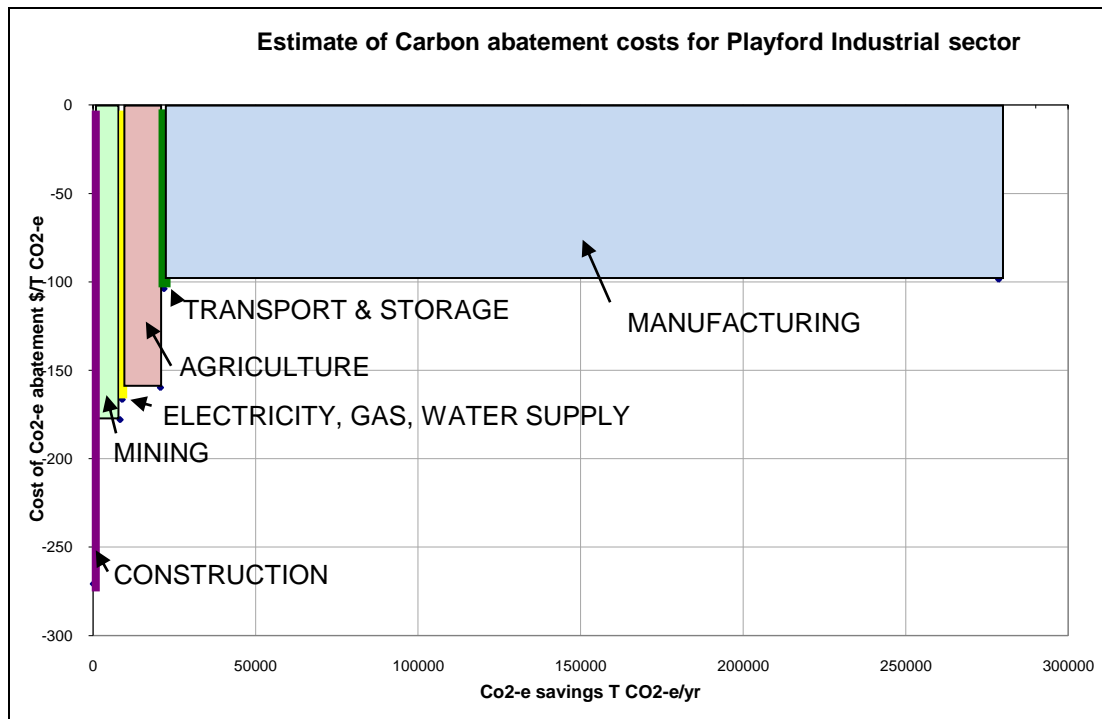
Subsector	Employees in Playford	Total Energy Use	Energy resource savings	Energy savings as a % of energy use
	#	PJ/yr	PJ/yr	%
<b>Manufacturing</b>	6,413	4.42	0.281	6.4
<b>Construction</b>	497	0.02	0.001	5.6
<b>Transportation &amp; Storage</b>	433	0.45	0.002	0.4
<b>Agriculture, forestry, fishing</b>	965	0.24	0.004	1.6
<b>Electricity, gas &amp; water supply</b>	46	0.01	0.000	4.8
<b>Mining</b>	70	0.22	0.030	13.8
<b>Total (total excluding transport &amp; storage)</b>		5.36 (4.91)	0.318 (0.316)	5.9 (6.4)

**Table 20. Estimates of energy cost savings, capital investment required and payback period for energy efficiency improvements for Playford industrial sector**

Subsector	Cost savings	Implementation cost**	Payback**	GHG emissions saved	GHG abatement costs total*
	\$/yr	\$m	yr	T CO2-e/yr	\$/T CO2-e
<b>Manufacturing</b>	\$63,309,400	\$189.93	3	256,763.50	-\$100
<b>Construction</b>	\$39,600	\$0.12	3	58.55	-\$270
<b>Transportation &amp; Storage</b>	\$282,400	\$0.85	3	1,086.85	-\$100
<b>Agriculture, forestry, fishing</b>	\$2,686,900	\$8.01	3	11,768.05	-\$160
<b>Electricity, gas &amp; water supply</b>	\$153,700	\$0.46	3	646.13	-\$165
<b>Mining</b>	\$2,528,600	\$5.31	2.1	8,240.04	-\$180
<b>Total (total excluding transport &amp; storage)</b>	<b>\$69,000,700 (\$68,718,300)</b>	<b>\$204.73 (\$203.88)</b>		<b>278,563.13 (277,476.28)</b>	

\*Using zero discount rate; life of initiatives implemented is assumed to be between 5 and 10 years

\*\*Implementation costs calculated by assuming Payback periods to be the same as calculated from the implementation costs and savings reported by SEAV-NFEE studies of manufacturing and mining subsectors; other subsectors assume payback period of 3 years.



**Figure 6. CO2-e abatement cost curves for the industrial sector – zero discount rate used**

### 3.4 Transportation Sector

The transport sector across Playford LGA including the transport and storage industry was estimated to use between 2.98 and 4.12 PJ/yr (Hamilton et al, 2008) with an average of 3.5 PJ/yr. Energy efficiency opportunities for the transport and storage industry subsector were summarised in the previous section and will not be considered here.

For the estimates of energy efficiency potential for the transportation sector for Playford LGA, the scenario of replacing the existing fleet with more fuel efficient vehicles was explored. This study used the number of vehicles registered in Playford LGA from ABS (2006), estimates of energy use from Hamilton et al (2008), potential energy savings based on fuel efficient passenger vehicles and light commercial vehicles reported by the Commonwealth Government's Green Vehicle Guide (Commonwealth of Australia 2008b) and costs of new vehicles including dealer delivery.

Table 21 summarises the estimate of energy reduction achievable if all petrol passenger vehicles were replaced with hybrid electric vehicles capable of achieving an efficiency of 4.5 L/100km, or with a 4 cylinder petrol vehicle capable of achieving 7.5 L/100km. It also summarises the improved efficiency for light commercial vehicles if all petrol vehicles were replaced with more fuel efficient vans and similarly with the diesel vehicles. Replacing all passenger vehicles with petrol/hybrid vehicles results in a 60% reduction in energy required to deliver the same level of transport service. If the passenger vehicle fleet were all upgraded to a more efficient 4 cylinder vehicle at 7.5 L/100km, the saving in energy would be 34%. For light commercial vehicles, approximately half of which are diesel, the greatest efficiency improvement is to upgrade the existing diesel fleet to achieve 8.2 L/100km efficiency. This will result in a 37% energy saving. If all of the fleet were upgraded to diesel, the efficiency improvement would be greater still.

The main efficiency improvements for heavy vehicles carrying freight appear to relate to shifting greater volumes and/or weight using extended trailer configurations which is reliant on appropriate road infrastructure. The complexity of this assessment was beyond this study. The industry have reported that the life of heavy transport vehicles is 5 years and new vehicles would be compliant with all recent standards for fuel efficiency and emission management.

Table 22 summarises the cost savings, implementation costs, payback period and cost of GHG emissions saved for these initiatives. It also includes the cost and savings differences between the two hybrid/petrol vehicles assessed and the petrol 4 cylinder vehicle. It is clear that the capital cost of upgrading/replacing vehicles is high with pay-back periods well beyond the life of the vehicle. However owners change their vehicles regularly and may not keep a vehicle for its whole life, so the use of pay-back periods is not appropriate in this instance. It is worth noting that, compared to energy efficiency initiatives in other sectors, the GHG abatement costs for upgrading a vehicle to a more fuel efficient vehicle are very high.

**Table 21. Estimates of fuel reductions related to energy efficiency initiatives in the transportation sector of Playford LGA**

Vehicle category	Vehicles in Playford LGA*	Total Energy Use	Energy resource savings	Energy savings as a % of energy use
	#	PJ/yr	PJ/yr	%
<b>Passenger vehicles</b>	37,864	1.80		
Honda Insight Petrol/Hybrid**	37,864	0.71	1.09	60
Toyota Prius Petrol/Hybrid**	37,864	0.71	1.09	60
Toyota Corolla Petrol 4 cylinder***	37,864	1.18	0.61	34
Difference between Toyota Prius and Toyota Corolla		-0.47	0.47	26
Difference between Honda Insight and Toyota Corolla		-0.47	0.47	26
<b>Light Commercial</b>	3,714	0.29		
Upgrade Diesel fleet to Ford Transit - Diesel	1,857	0.08	0.05	37
Upgrade Petrol fleet to Toyota HiAce - Petrol	1,700	0.11	0.02	17
Upgrade all fleet to Ford Transit - Diesel	3,714	0.20	0.09	30
<b>Rigid Trucks</b>	752	0.14	Not assessed	
<b>Articulated vehicles</b>	139	0.29	Not assessed	
<b>Buses</b>	71	0.02	Not assessed	

(Source: Hamilton et al 2008)

\*vehicles registered in Playford;

\*\*Assumes all passenger vehicles are upgraded to petrol hybrid at 4.5L/100km

\*\*\* Assumes all passenger vehicles are upgraded to petrol 4 cylinder achieving 7.5 L/100km

**Table 22. Estimates of energy cost savings, capital investment required and payback period for energy efficiency improvements for Playford transport sector**

Vehicle Category	Cost savings*	Implementation cost	Payback	GHG emissions saved	GHG abatement costs total
	\$/yr	\$m	yr	T CO2-e/yr	\$/T CO2-e
<b>Passenger vehicles**</b>					
Honda Insight Petrol/Hybrid	\$43,405,600	\$1,325	30.5	76,183.83	\$1,170
Toyota Prius Petrol/Hybrid	\$43,405,600	\$1,529	35.2	76,183.83	\$1,440
Toyota Corolla Petrol 4 cyl	\$25,262,700	\$757	36.8	42,920.89	\$1,175
Difference between Toyota Prius and Toyota Corolla	\$18,142,900	\$772	42.6	33,262.94	\$1,775
Difference between Honda Insight and Toyota Corolla	\$18,142,900	\$568	36.8	33,262.94	\$1,160
<b>Light Commercial</b>					
Upgrade diesel fleet to Ford Transit Diesel	\$1,698,200	\$71	41.7	3,321.5	\$1,620
Upgrade petrol fleet to Toyota HiAce Petrol	\$869,300	\$56	64.7	1,580.2	\$3,010
Upgrade all fleet to Ford Transit - Diesel	\$4,115,500	\$142	34.4	5,957.68	\$1,680

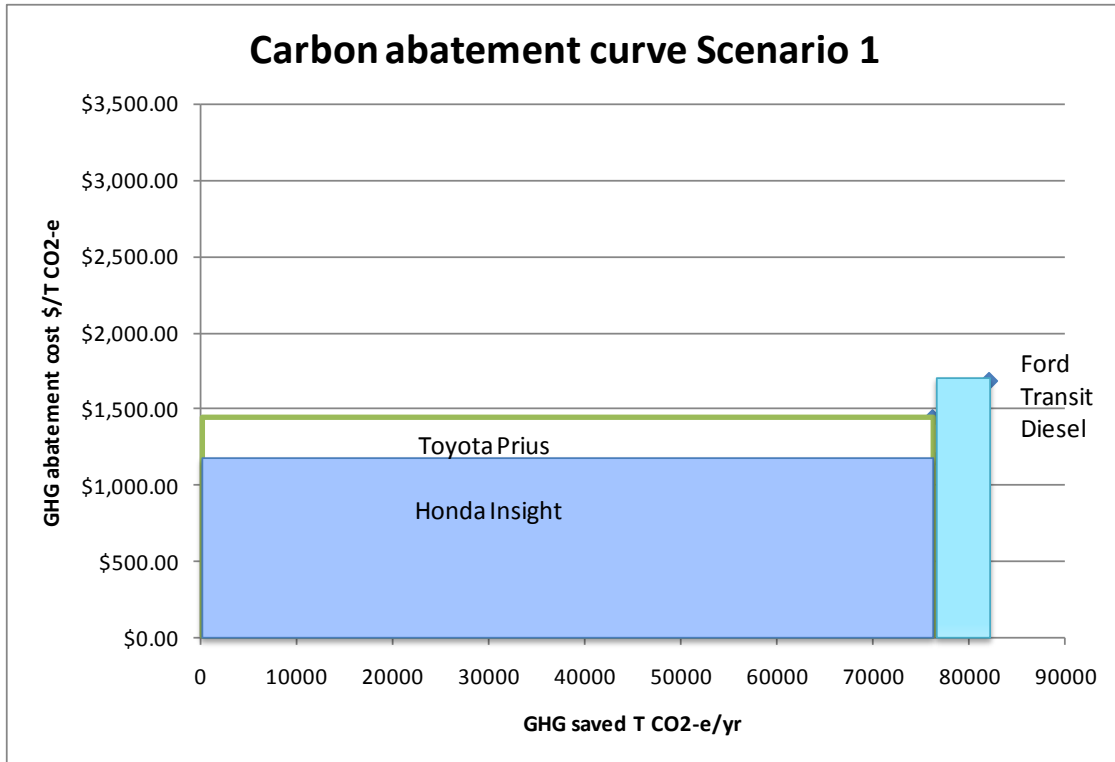
\*Fuel savings at \$1.32/L unleaded – Adelaide price in Sept qtr 2006; Fuel saving at \$1.38/L diesel – SA price in 2006

\*\*Using zero discount rate; life of initiative implemented is assumed to be vehicle life for cars of 10 years. Note average for SA is 11.3 years (in 2003, ABS 2008) but this is reducing.

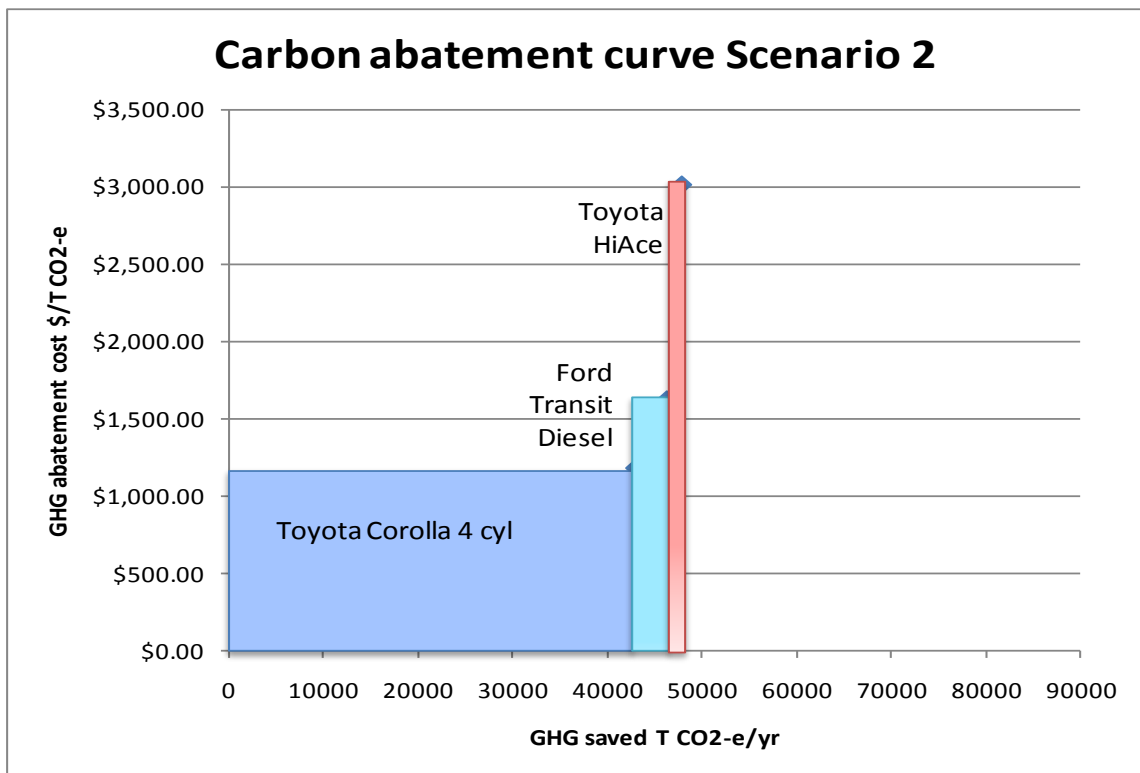
Carbon abatement cost curves have been prepared for two Scenarios and a comparison between upgrading to 4 cylinder petrol passenger vehicles and upgrading to hybrid electric/petrol passenger vehicles. The Scenarios are:

- Scenario 1 The passenger vehicle fleet upgraded to hybrid electric/petrol vehicles – Toyota Prius or Honda Insight and the Light Commercial vehicle fleet upgraded to Ford Transit Van diesel.
- Scenario 2 The passenger vehicle fleet upgraded to 4 cylinder petrol vehicles, diesel light commercials upgraded to Ford Transit diesel and the petrol light commercial fleet upgraded to Toyota HiAce petrol vehicles.

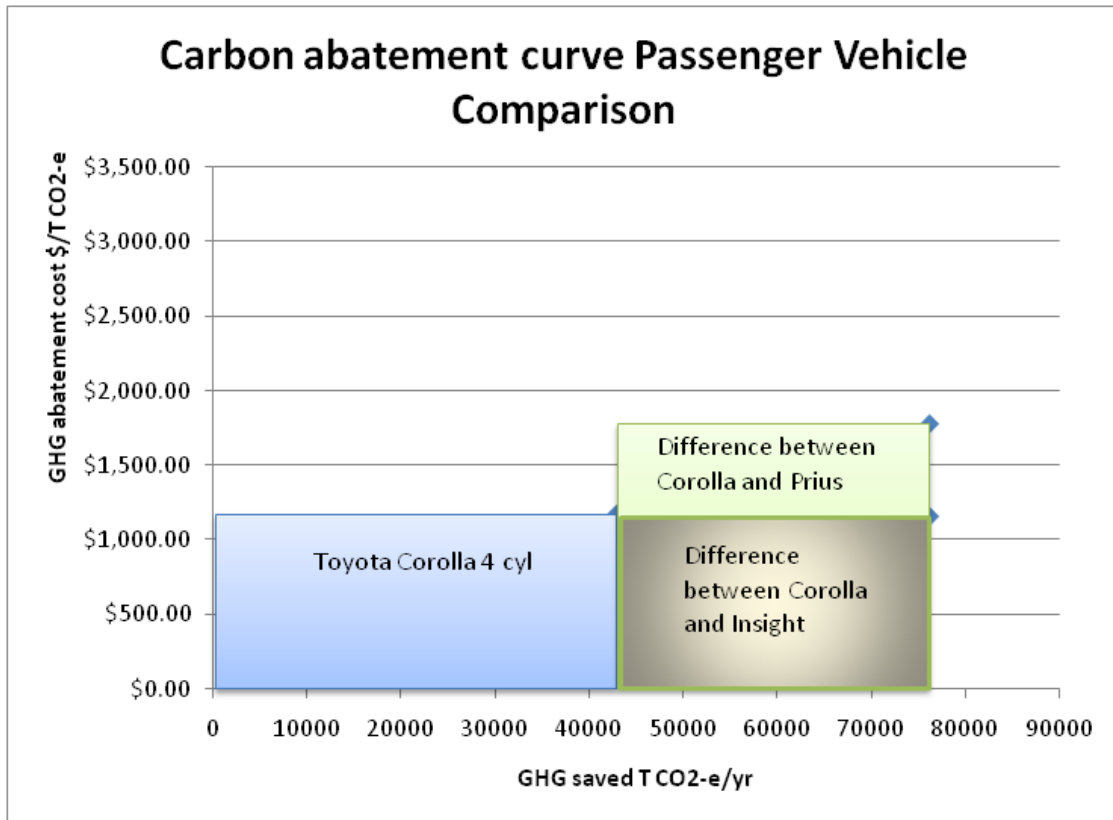
The carbon abatement cost curves for the Scenarios are presented in Figures 7 and 8, while the comparison between the carbon abatement costs for the 4 cylinder petrol option and the upgrade to the two different hybrid electric/petrol vehicles is presented in Figure 9.



**Figure 7. CO<sub>2</sub>-e abatement cost curves for the transport sector – Scenario 1 – maximum GHG emission reduction using energy efficiency**



**Figure 8. CO<sub>2</sub>-e abatement cost curves for the transport sector – Scenario 2 – moderate GHG emission reduction using energy efficiency**



**Figure 9. CO<sub>2</sub>-e abatement cost comparison for the passenger vehicle selection for the two Scenarios**

The greatest carbon abatement benefit at least cost arises from upgrading all passenger vehicles to the lower cost Honda Insight hybrid electric/petrol option and all light commercial vehicles to the Ford Transit diesel option. While the cost of carbon abatement is very high compared to other energy efficiency initiatives in the residential, commercial and industrial sectors, owners don't usually wait until the end of life to change over a vehicle. It is more applicable to use the difference in cost between the two types of vehicles rather than the total cost in any assessment of the cost of carbon abatement due to vehicle fuel efficiency.

### 3.5 Summary for Playford LGA

The potential energy and GHG emission savings from energy efficiency initiatives within the residential, commercial, industrial and transport sectors of Playford LGA are summarised in Table 23. Apart from insulating homes (high cost scenario); replacing fridges (high cost scenario) and upgrading the vehicle fleet, these initiatives are all economically feasible. A reduction of nearly 310,000 T CO<sub>2</sub>-e is potentially achievable from economically feasible energy efficiency initiatives. This is approximately 30 per cent of 1.07 MT CO<sub>2</sub>-e, the average total GHG emissions for Playford LGA estimated by Hamilton et al (2008).

**Table 23. Summary of energy savings and GHG emission reductions across sectors of Playford LGA through implementing energy efficiency initiatives**

Sector	Average energy use*	Energy resource savings in potential efficiency initiatives	Percent of average energy use	GHG savings
	PJ/yr	PJ/yr	%	T CO <sub>2</sub> -e/yr
Residential	1.24 (includes all fuels)	0.119 (electricity and gas)	9.6	21,768
Commercial	0.38	0.037 (electricity)	9.7	8,990
Industrial**	4.91	0.316 (electricity and gas)	6.4	277,476
Transport	3.38	1.18	33.7	83,228
-transport and storage industry	0.45	0.002	0.4	1,087
-vehicles	2.54	1.18	46.5	82,141
<b>Total</b>	<b>9.91</b>	<b>1.65</b>	<b>16.5</b>	<b>391,462</b>
<b>Economically feasible</b>		<b>0.47</b>	<b>4.7</b>	<b>309,321</b>

\*from Hamilton et al 2008 unless stated otherwise

\*\*calculated from employee numbers in industry subsectors, not the average from Hamilton et al 2008

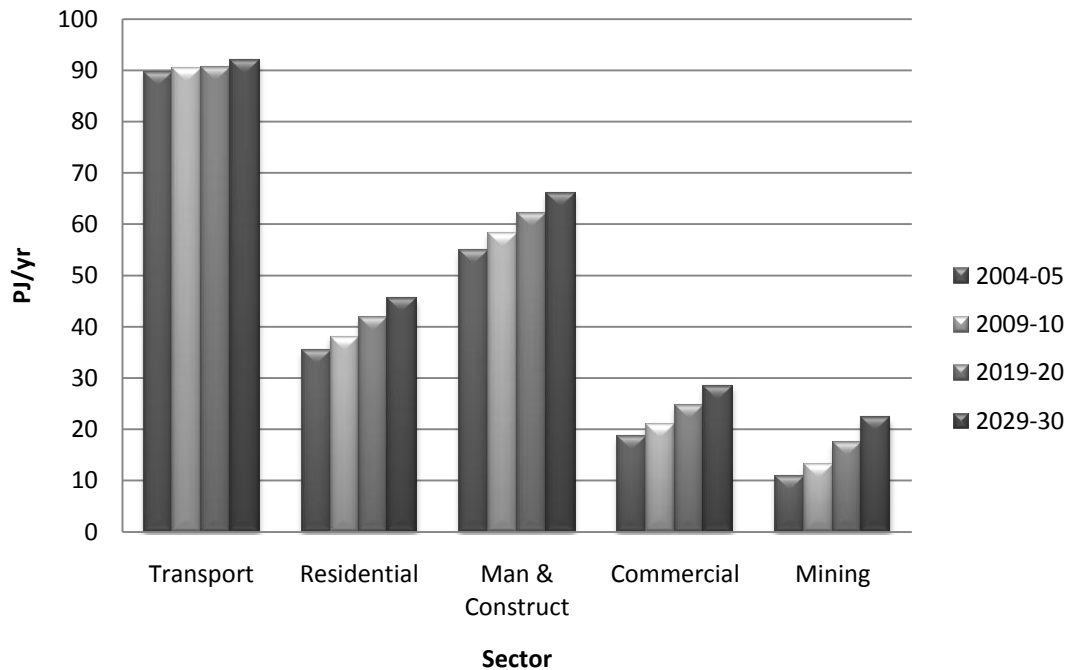
#### 4. DISCUSSION

The results of this analysis demonstrate that, in theory, a significant reduction in energy use (16.5%) and carbon emissions (39%) is possible through energy efficiency measures without a loss of service or changes in behaviour. The economic feasibility of these initiatives however reduces the estimated reductions to 4.7% of energy use and 30% of carbon emissions. The largest potential reductions are due to energy efficiencies in the industrial sector, with manufacturing providing the main opportunities for carbon reduction. There are also opportunities in the commercial sector, although these are relatively small and in the transport and residential sectors.

In the residential sector the greatest opportunity arises from the retrofit of energy efficient windows, although the payback period of 27 years is significant. The retrofit of the remaining stock of houses with low-flow shower-heads has significant opportunity to reduce carbon emissions arising from heating water and to save money as the payback period is less than one year. No-cost or low-cost initiatives with short pay-back periods include retrofitting compact fluorescent light-bulbs (CFLs), lagging hot water pipes and participating in a 'fridge buy-back scheme'. Longer payback periods relate to the replacement of energy efficient fridges and the insulation of houses. The energy savings due to insulation of houses is dependent on whether the roof is insulated alone or whether both the roof and walls are insulated. Further work is required to assess the energy efficiency improvement related to both roof and wall insulation and the effect this may have on heating and cooling costs as thermal comfort improves. Recently the Federal Government announced rebates to assist with roof insulation of dwellings including tenanted dwellings as part of its Energy Efficient Homes Package as part of its economic stimulus package (Rudd and Garrett 2009). It is not known whether the high proportion of households with roof insulation is an actual reflection of the state of housing in Playford LGA. This matter could be researched further. The introduction of a fridge buy-back scheme in the Playford area

could be explored as well as opportunities to retrofit energy efficient windows, although it may be more appropriate for the latter to be incorporated into designs for new dwellings and refurbishment of existing housing stock.

Energy use in the residential, commercial, industrial (manufacturing and construction, and mining) and transport sectors of South Australia have been projected to 2029/30 by ABARE (Cuevas-Cubria and Riwoe 2006). This is reproduced here as Figure 10.



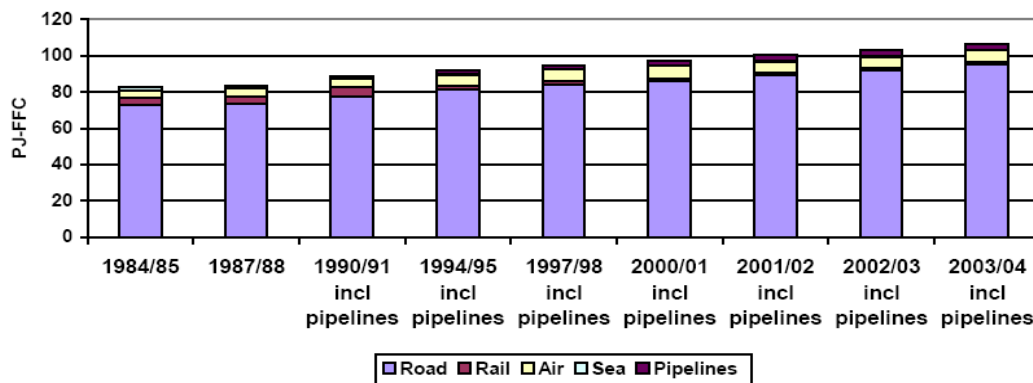
**Figure 10. Energy use in South Australia by sector 2004/05 to 2029/30**  
(Source: Cuevas-Cubria and Riwoe, 2006)

ABARE (Cuevas-Cubria and Riwoe 2006) forecast that energy used by the residential sector in South Australia will increase by 18% from 2004/05 to 2019/20. This equates to an average increase of 1.2% per year. This is after an efficiency improvement of 0.5% per year was deducted which was assumed in their model (Cuevas-Cubria and Riwoe 2006). Total energy used in the residential sector in Australia has increased significantly from 299 PJ in 1990 to 397 PJ in 2007 (EES 2008). This equates to an average increase in total energy consumption in the residential sector in Australia of 5.8% per year, significantly greater than the ABARE forecast. The study for Playford estimates a potential energy efficiency improvement of almost 10% of average annual energy use in the residential sector if all initiatives were to be implemented. If the increase in energy use estimated by EES or ABARE takes place, the overall benefit of a 10% efficiency improvement is substantially reduced by the forecast increase in energy use. The arguments for energy conservation, for passive heating and cooling systems and for renewable energy resources then become increasingly important.

In the transport sector, transitioning to smaller 4 cylinder passenger vehicles has the potential to triple the GHG savings from energy efficiencies that could be achieved within the residential sector alone. A move to hybrid electric/petrol vehicles increases the GHG savings to five times that from the residential sector alone. The analysis in this study looked at replacing all vehicles with more efficient vehicles. In reality this is likely to take place only as vehicles are replaced or reach the end of their useful life and then only if the customer is motivated to purchase a smaller, more efficient vehicle. Vehicle life in South Australia has reduced over the years - in 2003 it was

estimated to be 11.3 years and in 2008 this was projected to be 11.0 years (ABS 2008).

Total energy consumed by all modes of domestic transport in South Australia has increased steadily since 1984/85 according to Apelbaum Consulting Group (2006). This is summarised in Figure 11. They predict that given expected trends in transport activity, the likely introduction of contemporary vehicle technology and productivity enhancements, energy consumed by road transport in Australia is projected to grow by 21.2 per cent or 261.3 PJ FFC to 1,495.3 PJ FFC by 2013/14. ABARE (Cuevas-Cubria and Riwoe 2006) predict smaller growth in South Australia compared to other sectors although energy use in the Transport sector is higher than any other sector (see Figure 10).



**Note:**

(1) Excludes pipelines unless specified.

**Source:**

Apelbaum Consulting Group.

**Figure 11. Energy use by domestic transport by mode in South Australia 1984/85 to 2003/04**

While the industrial, commercial and most residential sector savings are economically feasible, the carbon reductions achieved by vehicle replacements in the passenger and light commercial transport sector come at a significant cost per tonne of carbon (ranging from \$1,162 to \$3,009 /T CO<sub>2</sub>-e) and extremely long payback periods (ranging from 30.5 to 64.7 yrs). In comparison to other efficiency initiatives, motivating purchasers to pay more for a vehicle which has lower carbon emissions may be a challenge if this were the only reason to motivate the change. This is complicated also by a trend in recent years towards heavier and higher performance vehicles, and rising energy use for vehicle air-conditioning, power steering, entertainment systems, safety and information systems (Moriarty and Honnery 2007). Moriarty and Honnery (2007) referred to a recent study in the United Kingdom (UK) by Cousins, Garcia-Bueno and Palomares-Coronado (2007) which examined data from the European Union (EU), finding that attempts to improve vehicle efficiency over the past 50 years had achieved very little in terms of overall fuel consumption and greenhouse gas emissions. Cousins et al (2007) found that the power rating of the average car increased over time and that driver behaviour related to the level of power of the vehicle. They observed that driving a higher powered vehicle resulted in increases in the average vehicle speed and acceleration and concluded that greater distances would be travelled within the time budget particularly outside of urban areas when driving at increased speed (Cousins et al 2007).

While the average age of the passenger vehicle fleet in South Australia is about 11 years, owners may change their vehicles before this time. If an owner changes a vehicle before its life is over, the actual cost of changeover is the difference between the cost of a new(er) vehicle and what they gain by selling their old(er) vehicle. Further research would be needed to ascertain the carbon reductions or increases through vehicle changeovers and whether vehicle purchase decisions are being made with vehicle fuel efficiency as a key factor. Further study of the costs and benefits of different mechanisms to reduce carbon emissions from transport at the local level could be pursued. Mechanisms to reduce emissions could include modifying the urban form, increasing the use of public transport, providing improved infrastructure for non-motorised vehicles such as bicycles or scooters and providing improved facilities to promote walking. The presence of an automotive manufacturing facility within the Playford area and the 1950s "Garden City" car oriented urban layout of Elizabeth as well as the poor public transport links to townships and infrequent after-hours public transport services in Playford LGA has raised the importance of motor vehicle ownership or the reliance on vehicular transport modes other than public transport.

The manufacturing subsector is extremely important to the industrial and local economy within Playford LGA. The ABARE projections for energy use for the manufacturing, construction and mining sectors (see Figure 10) show significant increases over time. However, in Australia generally, manufacturing is in decline due to competition within the global economy. Many manufacturers in Australia have chosen to move production off-shore and the major automotive manufacturer within Playford has chosen to change their product to better suit a carbon constrained future society – in Australia and overseas. The GM Holden facility in Elizabeth has recently announced plans to produce a 4-cylinder vehicle by the end of 2010 instead of the larger 6-cylinder family cars and V8 high performance vehicles it has been manufacturing since the 1970s. The GM Holden facility has also very recently announced a reduction from two shifts per day to a single shift per day. A focus on cost minimisation within industry tends to drive business to reduce operational energy use and adopt innovation to retain competitive advantage. Federal Government initiatives such as the Greenhouse Challenge Program and Greenhouse Challenge Plus Program previously and the current Energy Efficiency Opportunities (EEO) program have mandated reporting of energy use and carbon emissions by large energy users (Commonwealth of Australia 2006). The EEO program requires large energy users to plan for carbon reductions through implementing energy efficiency initiatives. For the manufacturing industry in South Australia, ABARE (Cuevas-Cubria and Riwoe 2006) forecast an increase of 13.3% in energy use from 2004/05 to 2019/20 equating to 0.9% per year. These estimates assumed energy efficiency improvements of only 0.5% per year.

Small efficiency gains together with a relentless increase in energy consumption forecast in all sectors pose a dilemma for policy makers. Ryan (2008) observed that visible action such as new technology attracts considerably more attention and government investment than energy efficiency initiatives which cannot be seen and may not be as politically popular. Most states have recently introduced legislation which mandates energy providers to assist customers to adopt energy efficiency measures, providing energy audits and assistance to retrofit more energy efficient equipment. Some, such as South Australia are focusing on the residential sector while others, such as New South Wales and Victoria, are also requiring energy providers to assist small commercial and industrial customers as well as residential customers to implement energy efficiency initiatives. More attention, however, needs to focus on the social practices of households and small business operators. In particular, study should be undertaken on how these are changing over time and are being locked in by inappropriate designs of housing and buildings for the climate. Air conditioning of homes has replaced the use of wide eaves, verandas and fresh air flows (Shove

2007). With the increasing trends in the occurrence of very hot days in summer in South Australia, the reliance on air conditioning is likely to increase rather than decrease if recent design trends of houses continue. A focus on increasing energy efficiency may legitimise the use of air conditioners rather than demand improvements in house design to reduce the need for air conditioning. Greater reliance on technology to provide socially accepted norms of comfort is accompanied by the cost of providing energy and the consequent carbon emissions when generated by non-renewable sources. The challenge is how to reverse these trends. As the housing stock in Playford is replaced or refurbished an opportunity exists to influence the underlying social practices by mandating lower energy housing. This, together with a focus on lowering transport energy demand, should over time assist in reversing the trends of rising energy use and consequent carbon emissions.

## 5. CONCLUSIONS

While a reduction of nearly 40% of carbon emissions is potentially achievable, only 30% is economically feasible, with more than 80% of this related to carbon reduction in the manufacturing subsector. Initiatives in the industrial, residential and commercial sectors are generally economically feasible although some initiatives such as energy efficient windows, insulation and replacement of fridges have longer payback periods. The cost of carbon reduction in the transport sector is relatively high compared to efficiency initiatives in other sectors. Promotion of transport mode shifts to less carbon intensive public transport, cycling and walking should be explored as well as adoption of renewable energy and energy conservation within all sectors. Opportunities should be explored to promote rebates for insulation, to assist in retrofitting low-flow showerheads in dwellings, to insulate hot water pipes and to establish a fridge buy-back scheme in Playford. The study was limited by a lack of specific data at the local level and relied heavily on assumptions and findings from state, national and international studies. Projections of increased energy use over the next two decades in all sectors show that focusing on mechanisms to reduce energy use and associated carbon emissions and reporting at the local level will be important in achieving targets for carbon reduction that are being proposed or legislated for all sectors. The social practices of the Playford community should not be overlooked. A study of energy use practices, house design features and urban design features should be undertaken to provide better local data for reducing carbon emissions in the Playford community. Policy should also be developed to ensure that new houses, new buildings and refurbishments and additions to existing dwellings and buildings result in lower energy use within the community.

## References

ABS (2006) *Australia's Environment, Issues and Trends*. Cat No. 4613.0, Australian Bureau of Statistics, Canberra.

ABS (2007a) *Environmental Issues: People's Views and Practices*, Cat No. 4602.0, March 2007, Australian Bureau of Statistics, Canberra.

ABS (2007b) *Australia's Environment, Issues and Trends*. Cat No. 4613.0 December 2007, Australian Bureau of Statistics, Canberra.

ABS (2008) *Environmental Issues, Energy Use and Conservation*, Cat No. 4602.0.55.001, November 2008, Australian Bureau of Statistics, Canberra.

ABS (2009)

AGO (2006) *Tracking to the Kyoto Target 2006*. Australian Greenhouse Office. Commonwealth of Australia. Canberra.

AGO (2007) *Your Home Technical Manual*. Australian Greenhouse Office. Commonwealth of Australia. Canberra. accessed at <http://www.yourhome.gov.au/technical/fs10.htm>

Apelbaum Consulting Group (2006) *South Australian Transport Facts, 2003*. Clayton, Victoria.

Apelbaum Consulting Group (2008) *South Australian Transport Facts, 2006*. Clayton, Victoria.

Boardman B (2004a) Achieving energy efficiency through product policy: the UK experience. *Environmental Science & Policy*, 7, pp165-176.

Boardman (2004b) New directions for household energy efficiency: evidence from the UK. *Energy Policy*, 32, pp1921-1933

Commonwealth of Australia (2005) *National Appliance & Equipment Energy Efficiency Program: When you keep measuring it, you know even more about it! Project Impacts 2005-2020*. Report No. 2005/05. Australian Greenhouse Office. Department of the Environment and Heritage. Canberra.

Commonwealth of Australia (2006) *Energy Efficiency Opportunities*. PowerPoint presentation last accessed at <http://www.energyefficiencyopportunities.gov.au/index.cfm?event=object.showContent&objectid=CB304960-D56D-2C65-A4C8FF92CD5CAF44> June 2007.

Commonwealth of Australia (2008a) *Stationary Energy Sector Greenhouse Gas Emissions Projections 2007*. Department of Climate Change, Canberra.

Commonwealth of Australia (2008b) *Information on Green Vehicle Guide Ratings and Measurement*. From URL <http://www.greenvehicleguide.gov.au/GVGPublicUI/StaticContent/ratings.aspx> accessed on 18 July 2008

Commonwealth of Australia (2008c) *Western Australia TravelSmart Households* URL: <http://www.environment.gov.au/settlements/industry/ggap/wath.html> last accessed 15 July 2008.

Cousins S, Garcia-Bueno J, Palomares-Coronado O. (2007) Powering or depowering future vehicles to reach low carbon outcomes: the long view 1930 to 2020. *Journal of Cleaner Production* 15 (11e12):1022e31.

CSIRO (2008) *Newcastle (NSW) CSIRO Energy Centre* <http://www.csiro.au/places/pps66.html> accessed 3 July 2008.

Cuevas-Cubria, C. and Riwoe, D. (2006) *Australian Energy: National and State Projections to 2029-30*, ABARE Research Report 06.26 Prepared for the Australian Government Department of Industry, Tourism and Resources, Canberra.

DTEI (2008) *Saving Energy*. Department of Transport Energy and Infrastructure accessed at [http://www.dtei.sa.gov.au/energy/energy\\_action/household/saving\\_energy.html](http://www.dtei.sa.gov.au/energy/energy_action/household/saving_energy.html) 10 June 2008.

EES (2008) *Energy use in the Australian residential sector 1986-2020*. Report prepared by Energy Efficient Strategies for the Department of Energy, Water, Heritage and the Arts. Commonwealth of Australia, Canberra.

- Ferguson M (2008) *Newsletter Number 10- Welcome Statement by Minister for Resources and Energy* Commonwealth of Australia, Canberra  
<http://www.energyefficiencyopportunities.gov.au/index.cfm?event=object.showContent&objectID=CE3B0C63-9365-E429-34D01A2415CDA579> accessed 31 March 2008.
- Flannery T. (2005) *The Weather Makers: The history & future impact of climate change*, Text Publishing, Melbourne.
- G8 Presidency (2005) *Gleneagles Plan of Action: Climate Change, Clean Energy and Sustainable Development* Source: URL <http://www.number-10.gov.uk/output/Page7882.asp> accessed 19 October 2005.
- Garnaut R (2008) *Climate Change Review – Draft Report*. June 2008. Commonwealth of Australia. Canberra.
- Government of South Australia (2008) *South Australian Residential Energy Efficiency Scheme: Consultation Paper*. Department for Transport Energy and Infrastructure, Adelaide.
- Grant J and Kellett J (2002) *Energy Efficiency Assessment for Conisbrough and Denaby*. Report No 19/2 for the Conisbrough and Denaby Renewable Energy (CADRE) Project, Resources Research Unit, School of Environment and Development, Sheffield Hallam University, Sheffield.
- Greening L, Greene D and Difligio C (2000) Energy efficiency and consumption – the rebound effect – a survey. *Energy Policy*, 28, pp389-401.
- Hamilton C (2008) *Renewable energy resource assessment methods and methodologies for assessment at LGA scale – a study of the City of Playford*. Working Paper for the Carbon Neutral Communities – Making the Transition Project. RMIT University and University of South Australia. Last accessed on 3 March 2009 at <http://mams.rmit.edu.au/djp8scpzgy82.pdf>.
- Hamilton C, Kellett J, and Yuan X (2008) Carbon profiling: An analysis of methods for establishing the local emissions baseline. In *Proceedings of the 3<sup>rd</sup> International Solar Cities Congress*. 17-21 February 2008, pp331-340, Adelaide.
- Harrington L, Brown and Ryan (2006) *Quantification of Standby in Australia and Trends in Standby for New Products* presented at EEDAL, London, June 2006. Last accessed on 3 March 2009 from <http://www.energyrating.gov.au/library/pubs/2006-eedal-paper-harrington.pdf>
- Hatfield-Dodds S, and Denniss R (2008) *Energy Affordability, Living Standards and Emissions Trading: Assessing the social impacts of achieving deep cuts in Australian greenhouse emissions*. Report to The Climate Institute, June 2008. CSIRO Sustainable Ecosystems, Canberra.
- IEA (2008) *Green Vehicle Guide 2004*. Last accessed at <http://www.iea.org/Textbase/pm/?mode=pm&action=detail&id=1970> on 15 July 2008.
- IPCC (2007) *Climate Change 2007: Mitigation of Climate Change. Summary for Policymakers*. Fourth Assessment Report, Working Group III. Intergovernmental Panel on Climate Change. Geneva.
- Ipsos (2005) *Household Electrical and Electronic Waste Survey* prepared for the Department of Environment and Conservation (NSW).
- Jones D, Watkins A, Hennessy K. (2005). Humans do contribute to global warming. September 2005. *Engineers Australia*. pp44-47.
- Kavanagh J (2009) *The differences are more than skin deep*. On-line article at Edmunds Inside Line, Last accessed 20 February 2009 at <http://www.edmunds.com/insideline/do/Drives/Comparos/articleId=139686>.

- Lee R and Denlay J (2002) *Energy efficiency potential in South Australia*. Energy SA, Adelaide.
- Lowe, I. (2005) *The Big Fix*, Black Inc, Melbourne.
- McKinsey & Company (2008) *An Australian Cost Curve for Greenhouse Gas Reduction*. McKinsey & Company, February 2008, Sydney.
- McNicol I (2004) *Residential Sector EEI Potential*. Sustainable Energy Authority, Victoria. Presentation to NFEE Modelling Workshop, April 2004. Last accessed 3 March 2009 at [http://www.ret.gov.au/Documents/mce/energy-eff/nfee/documents/mwp\\_07\\_ian\\_min.pdf](http://www.ret.gov.au/Documents/mce/energy-eff/nfee/documents/mwp_07_ian_min.pdf).
- Mecrow B and Jack A (2008) Efficiency trends in electric machines and drives. *Energy Policy*, 36, pp4336-4341.
- Moriarty P and Honnery D, (2007) The prospects for global green car mobility, *J Clean Prod* doi:10.1016/j.jclepro.2007.10.025. In press.
- Oliphant M (2003) *South Australian Residential Sector Baseline Study of Energy Consumption*. Final Report to State Energy Research Advisory Committee. Sustainable Energy Centre University of South Australia. January 2003.
- Pears A (2007a) Imagining Australia's energy services futures. *Futures*, 39, pp253-271.
- Pears A (2007b) *Residential sector energy efficiency scenario – Background, Framework and Rationales*. Draft 5. February 2007.
- Productivity Commission (2005) The private cost effectiveness of improving energy efficiency. Productivity Inquiry Report No. 36, Canberra.
- Rudd K and Garrett P (2009) Rudd Government fast-tracks free ceiling insulation. Joint media release. 26 February 2009. Australian Government. Canberra. Last accessed at <http://www.environment.gov.au/minister/garrett/2009/mr20090226.html>.
- Ryan W (2008) Energy efficiencies – A practical contribution to reducing global warming. In *Proc 3<sup>rd</sup> International Solar Cities Congress*. Adelaide.
- Saddler H, Diesendorf M and Denniss R (2004) *A Clean Energy Future for Australia*. Clean Energy Australia Group.
- Sanchez M, Brown R, Webber C and Homan G (2008) Savings estimates for the United States Environmental Protection Agency's ENERGY STAR voluntary product labelling program. *Energy Policy*, 36, pp2098-2108.
- Shove E (2007) Unpublished Presentation to Seminar at RMIT University, Melbourne. July 2007.
- Spoehr J, Davidson K and Wilson L (2006) *An evaluation of the energy efficiency program for low income households*. Report prepared by Australian Institute for Social Research, University of Adelaide for Energy Division, Department for Transport, Energy and Infrastructure, Feb 2006. Adelaide.
- Standards Australia (2009) *Rylock Victoria Series Window*, Application to Australian International Design Awards last accessed on 3 March 2009 at [http://www.designawards.com.au/application\\_detail.jsp?applicationID=3765](http://www.designawards.com.au/application_detail.jsp?applicationID=3765).
- Steffen W. (2006) *Stronger evidence but new challenges: Climate Change Science 2001-2005*. Department of the Environment and Heritage Australian Greenhouse Office. Commonwealth of Australia, Canberra.
- SEAV-NFEE (2004)

The Allen Consulting Group (2004) *Economic Impact Analysis of Improved Energy Efficiency*. Phase 2 Report for the Sustainable Energy Authority Victoria.

Wilkenfeld G (1998) *Household energy use in Australia: End uses, greenhouse gas emissions and energy efficiency program coverage*, George Wilkinson and Associates for the Energy Labelling Group, National Appliance and Equipment Energy Efficiency Committee, March 1998.

World Energy Council (2006) *Energy Efficiencies: Pipe dream or reality?* WEC Statement.

**APPENDIX A**

**Energy Use by Energy Type for each State (ABARE 2004/05 data)**

**Table A1. ABARE Estimates of energy use by energy type for each state – 2004/05**

Energy Source	SA	Victoria	NSW (Includes ACT)	Qld	Tas	NT	WA	Aust
	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ
<b>Electricity</b>	17.14	46.73	83.95	44.25	8.6	1.78	16.9	219.3
<b>Mains Gas</b>	10.23	92.12	21.49	2.45	0	0.01	9.1	135.4
<b>LPG/Town Gas</b>	1.78	2.53	2.88	2.35	0.35	0.45	1.53	11.9
<b>Wood</b>	5.74	21.53	12.87	6.20	8.51	0.06	5.27	60.2
<b>Other (Solar)</b>	0.44 (0.18)	0.74 (0.14)	1.20 (0.59)	1.17 (0.40)	0.27 (0.02)	0.21 (0.09)	1.44 (1.06)	5.5 (2.5)
<b>Total</b>	35.33	163.66	122.39	56.41	17.75	2.50	34.24	432.3

**Table A2. Percentages of energy used by energy type for each State – based on ABARE 2004/05 estimates in Table A1**

Energy Source	SA	Victoria	NSW (Includes ACT)	Qld	Tas	NT	WA	Aust
	%	%	%	%	%	%	%	%
<b>Electricity</b>	49.2	28.6	68.6	78.4	48.5	71.2	49.4	50.7
<b>Mains Gas</b>	28.9	56.3	17.6	4.3	0	0.4	26.6	31.3
<b>LPG/Town Gas</b>	5.0	1.5	2.4	4.2	2.0	18.0	4.5	2.8
<b>Wood</b>	16.2	13.2	10.5	11.0	47.9	2.4	15.4	13.9
<b>Other (Solar)</b>	1.2 (0.6)	0.4 (0.1)	1.0 (0.5)	2.1 (0.7)	1.5 (<0.1)	8.4 (3.6)	4.2 (3.1)	1.3 (0.6)

## **APPENDIX B**

### **Electrical equipment in households**

**Table B1. Electrical equipment types by State Capital City (ABS, 2006)**

Items per household	Sydney	Melbourne	Brisbane	Perth	Adelaide	Canberra	Total
Number of households	1.4M	1.2M	0.6M	0.5M	0.4M	0.1M	4.2M
Total items	30.4M	27.1M	12.4M	11.1M	8.9M	2.7M	92.5M
Total items per household	22.2	22.7	21.1	22.4	21.2	24.1	22.2
Big ticket items*	16.1M	14.4M	6.6M	5.8M	4.8M	1.4M	49.2M
Big ticket items* per household	11.8	12.1	11.2	11.8	11.5	13.0	11.8
Other items**	14.3M	12.7M	5.8M	5.3M	4.1M	1.2M	43.3M
Other items** per household	10.4	10.6	9.9	10.6	9.7	11.1	10.4

\* Includes TVs, videos, DVDs, radios, stereos, CD and cassette players, portable electronics, computer monitors, box units and laptops.

\*\* Includes miscellaneous computer equipment and cordless appliances.

**Table B2. Average number of items of electrical equipment in households**

Product Group	Number of Items per Household
Major appliances	8.5
Telephones and other office equipment	2.0
Other home entertainment	5.0
Set-top boxes	0.3
Televisions	1.7
Computers and peripherals	5.4
Monitoring and continuous appliances	7.6
External power supplies	4.7
Other items with a standby mode	9.7
Products unplugged	18.7
Products with no standby mode	3.1
<b>Total</b>	<b>67.7</b>

ABS (2008) survey indicates

- 89% of households with TVs switched on
- 71% of households with Video Recorders switched on
- 75% of households with DVD Players switched on
- 85% of households with microwaves switched on
- 65% of households with stereo systems switched on
- 70% of households with surround sound systems switched on
- 71% of households with desktop computers switched on
- 35% of households with laptop computers switched on
- 59% of households with printers /scanners switched on
- 41% of households with games consoles switched on