

CITY OF ADELAIDE City Strategy Division



Sustainable Energy and Greenhouse Action Plan



CITY STRATEGY DIVISION

Sustainable Energy and Greenhouse Action Plan Resource Document

This document is produced by
the City of Adelaide as a participant of
the Cities for Climate Protection™
Programme

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Table of Contents

Acknowledgements

Forward

RESOURCE DOCUMENT

SECTION 1 - BACKGROUND

1.1 Potential Impacts on Australia	10
1.2 Global Warming Potential of GHG	11
1.3 International Response	12
1.4 Australian Response So Far	16
1.5 South Australian Response So Far	16
1.6 Local Government Response	17
	3

SECTION 2 - GREENHOUSE GAS EMISSIONS INVENTORY AND FORECAST

2.1 City of Adelaide <i>Community</i> GHG Emissions	21
2.2 City of Adelaide GHG Emissions	22
2.3 South Australian GHG Emissions	26
2.4 Emissions Inventory and Forecast	

CHAPTER 3 - GHG REDUCTION GOAL

Community Greenhouse Gas Reduction Goal

Corporate Greenhouse Gas Reduction Goal

SECTION 4 - CORPORATE GREENHOUSE REDUCTION STRATEGY

SECTION 5 - COMMUNITY GREENHOUSE REDUCTION STRATEGY

SECTION 6 - APPENDICES

BACKGROUND

1. CLIMATE CHANGE AND NEED FOR ACTION

The balance of scientific evidence now indicates that increasing levels of greenhouse gases emitted into the atmosphere from human activities are leading to an enhanced greenhouse effect. This enhanced greenhouse effect has the potential to lead to global warming, climate change and long-term changes to the environment, which could have a negative impact on human and other life on our planet. The basic information on Greenhouse Effect and Climate Change are included in the Appendix 1.

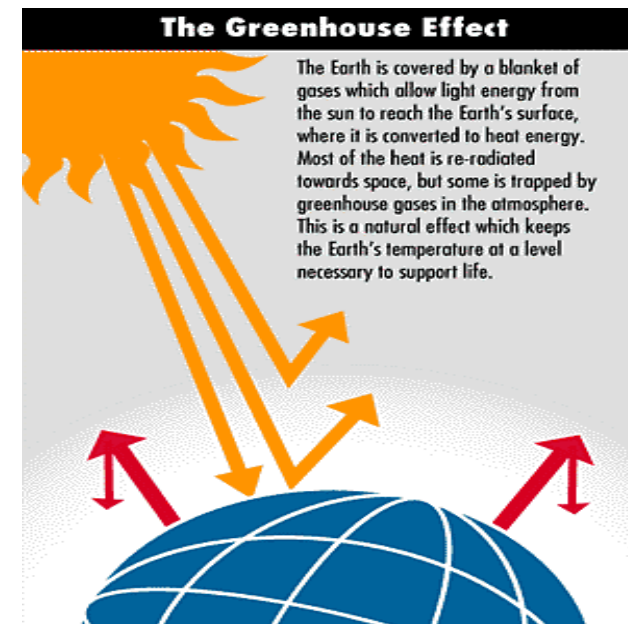
1.1 Greenhouse Effect

1.1.1 Natural Greenhouse Effect

Greenhouse gases are a natural part of the atmosphere. They trap the sun's warmth, and maintain the earth's surface at a level necessary to support life. Water vapour is the most significant greenhouse gas and accounts for about 75% of the natural greenhouse effect. Carbon dioxide is the next most significant greenhouse gas. Both of these gases are naturally occurring in the

atmosphere. Without this natural phenomenon, it is estimated that the global annual average temperature at the surface would be a chilly -18°C instead of a life supporting 15°C . On average earth surface would be 33°C cooler.

Figure 1.1.1 Natural Greenhouse Effect

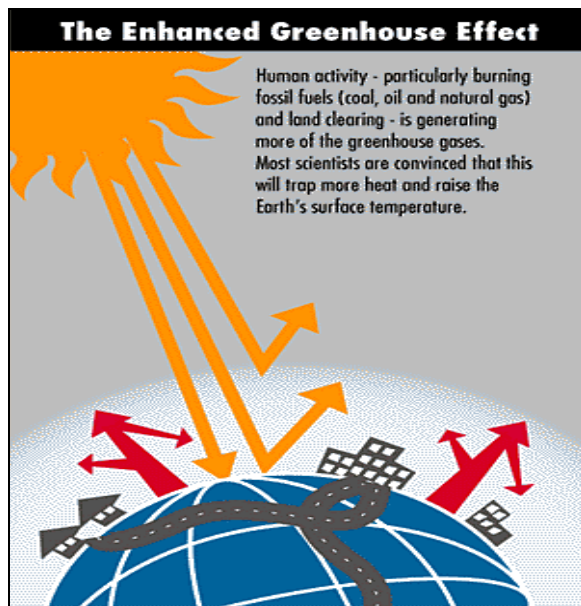


1.1.2 Enhanced Greenhouse Effect

Human activities release greenhouse gases (GHG's) into the atmosphere. Carbon dioxide is generated when fossil fuels such as coal, oil and natural gas are used including during land clearing. Methane and nitrous oxide are emitted from agricultural activities, changes in land, artificial chemicals called halo-carbons (CFCs, HFCs, PFCs) and other long lived gases such as sulphur hexafluoride (SF₆) are released by industrial processes. Rising levels of greenhouse gases are expected to cause climate change. By absorbing infrared radiation, these gases control the flow of natural energy through the climate system.

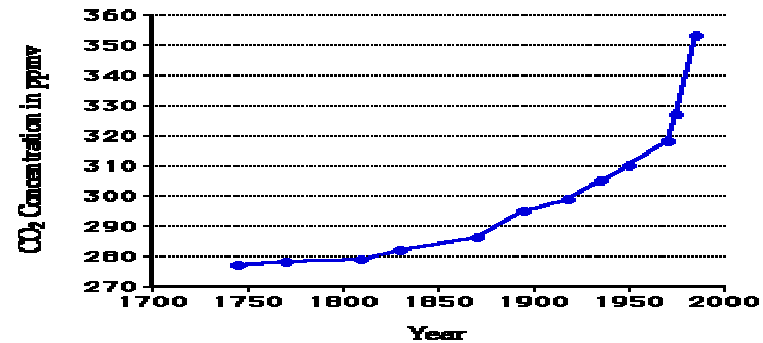
The climate must somehow adjust to the "thicker blanket" of greenhouse gases in order to maintain the balance between energy arriving from the sun and energy escaping back into the space.

Figure 1.1.2 Enhanced greenhouse effect



More than 200 years have passed since the world began burning the sequestered sunlight of fossilised plants that took millions of years to accumulate, but only recently has it become evident that the carbon those fuels produce is disrupting the Earth's radiation balance, causing the planet to warm. Fossil fuel combustion has increased atmospheric concentrations of the heat-trapping gas carbon dioxide (CO₂) by 30 per cent since pre-industrial times. CO₂ levels are now at their highest point in 160,000 years, and global temperatures at their highest since the Middle Ages. The increase in concentration of CO₂ in the atmosphere is illustrated by figure Fig 1.1.3.

Fig 1.1.3 Increase in CO₂ in Earth's Atmosphere



Source: Enquete Commission 1990

1.2 Potential Impacts

1.2.1 Potential Global Impacts

While the complexity of the Earth's climate system makes it impossible to know precisely the effects of rapid changes in the composition of the atmosphere, scientists around the world have concluded that existence of noticeable human influence on Earth's Climate. The IPCC (International Panel on Climate Change) produced a Second Assessment Report in 1995, which is regarded as representing the current, generally agreed state of

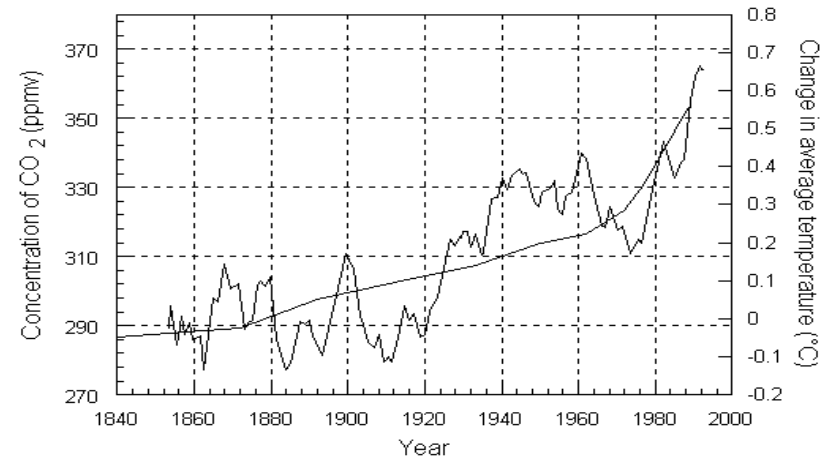
knowledge regarding greenhouse science. In this report the Intergovernmental Panel on Climate Change (IPCC) - concluded that:

*The balance of evidence suggested that there was a detectable **discernible** human influence on global climate.*

In recent years scientists have extensively documented trends—receding glaciers, rising sea levels, dying coral reefs, spreading infectious diseases, migrating plants and animals that are consistent with the projected effects of a warmer world. The extraordinary heat of 1998 was related to, but extended well beyond, an unusually strong El Niño phenomenon. This contributed to a range of extreme weather events, including droughts and rare fires in tropical and subtropical forests from Indonesia to Mexico; historic floods in China and Bangladesh and most recently in Venezuela; severe storms and epidemics in Africa and North Central, and South America; and deadly heat waves in the United States, southern Europe, and India.

In 1998, the average global temperature was 0.66°C above the long-term average, breaking the previous year's record high of 0.43°C. That year was the twentieth successive year in which the annual average exceeded the long-term mean. The increase in the average global temperature is shown by Figure 1.2.1.

Figure 1.2.1. Increase in the average global temperature



Without measures to abate such expected increase in greenhouse gas emissions over the next century, the IPCC projected that average global temperature would increase to up to 1.0-3.5°C. This would likely result in the following:

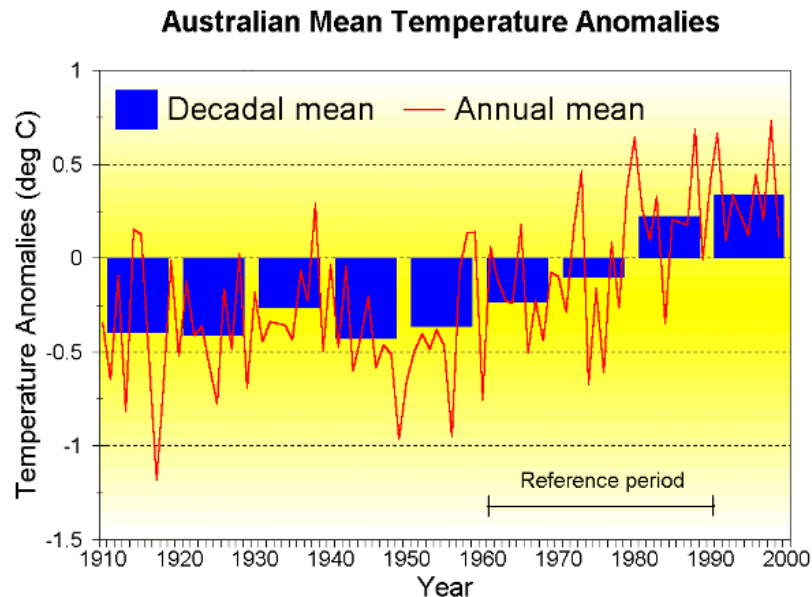
- Coastal damage from rising sea levels
- Greater frequency of severe weather events
- Shifts in agricultural growing conditions from changing weather;
- Damaged ecosystems and bio-diversity;
- Threats to human health from increased range and incidence of diseases;
- Threats to human health from increased range and incidence of diseases;
- Changes in availability of fresh water supplies;

The climate system is non-linear and has in the past switched abruptly to another equilibrium after crossing a temperature threshold. Even in the space of a few shifts potential exists to greatly disrupt both the natural world and human society.

1.2.2 The Potential Impacts of Climate Change on Australia

The 1990s were Australia's warmest decade for the ninety years for which high-quality records are available (since 1910). The Australian annual mean temperature during the 1990s was, on average, 0.33°C higher than the average for the 1961 to 1990 reference period, making the 1990s the warmest decade since at least the 1910s. Australian decadal annual temperatures are shown in Figure 1.2

Fig 1.2 The graph above shows Australian decadal and annual mean temperature since 1910.



Five years during the 1990s were amongst Australia's 10 warmest years with 1998 being the warmest on record. The next warmest decade was the 1980s with a mean temperature departure of +0.22 °C.

Recently, CSIRO's Division of Atmospheric Research has produced a general scenario describing likely changes to Australia's climate. By the year 2030, Australia's average temperatures are likely to be higher than today. Northern coastal regions may experience an increase of up to 1°C. Southern coastal regions may warm by up to 1.3°C.

The trend for drier and hotter weather is likely to continue for at least the next 80 years. It is predicted that Australia's average monthly temperatures will rise by as much as two degrees in 2050. The overall global picture for the next 50 years is one of wetter and more extreme weather.

1.3 Greenhouse Gas Emissions

1.3.1 Global Greenhouse Gas Emissions

The Global Greenhouse Gas Emissions have rising throughout the modern history. In the 1990's they well exceeded 6 Billion tonnes of carbon (22 Billion tonnes of equivalent CO₂).

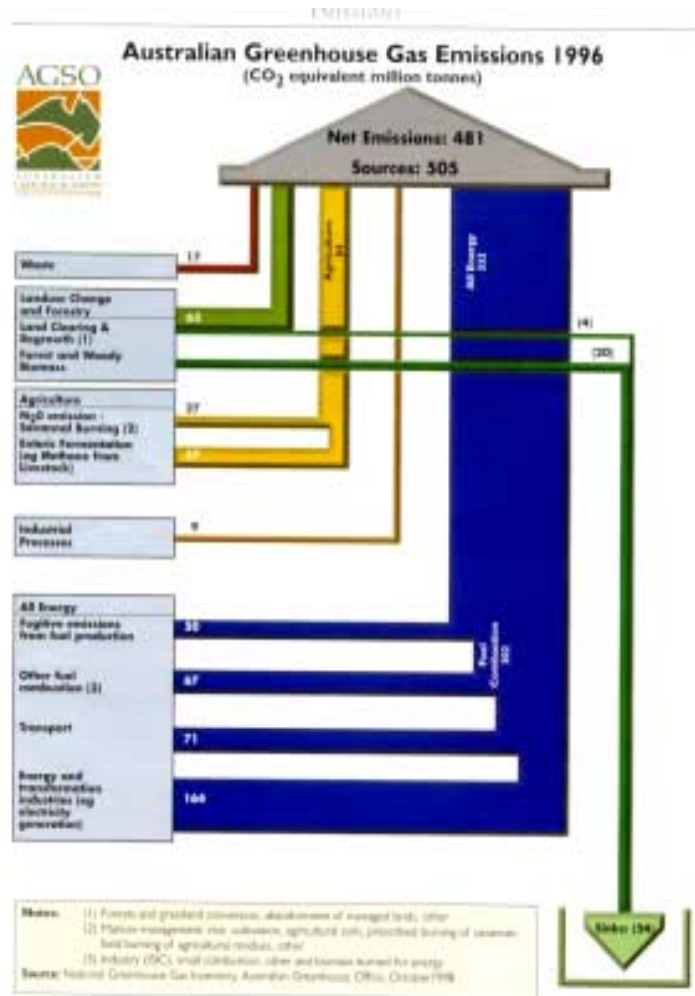
1.3.2 Australian National Greenhouse Gas Emissions

Under the Kyoto Protocol, Australia agreed to limit GHG emissions growth to 8% over 1990 levels between 2008-2012. The agreed 8% emission growth target is an ambitious target, particularly, if the current trend is taken into account. For the same period Australia's emissions growth for the energy sector on business as usual basis is projected to grow by approximately 61%.

Australia's net greenhouse gas emissions for 1997, not including land clearing, were 431 million tonnes (Mt) compared with 424 Mt in 1996 and 389 Mt in 1990. This represents a 1.6% increase in emissions since 1996 and an 11% increase during the period 1990 to 1997. In 1997 emissions per head of population were 23.3 tonnes of CO_{2-e}. This represents an 2.2% increase since 1990.

The relative contributions to total greenhouse gas emissions by individual sectors and gases tend to exhibit a similar pattern from year to year. The chart Figure 1.3.2 shows Australia's emissions pattern for the year 1996.

Figure 1.3.2 National Australian emission per sector



Emissions per dollar of Gross domestic Product (GDP) declined by nearly 9% from 1990 to 1997. Even though emissions increased at an average rate of about 1.5% during this period economic activity grew at a significantly greater average rate of 2.8%. Therefore the emissions intensity of the Australian economy declined at an average of 1.3% per annum over the period 1990 to 1997.

Figure 1.3.3.3 GHG Emissions (kg CO₂-e per \$ of GDP, 1990 to 1997)

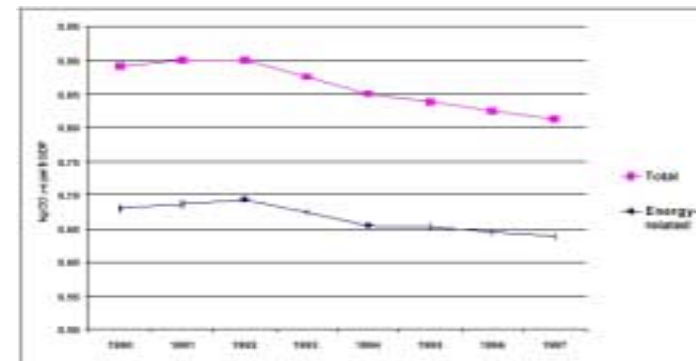
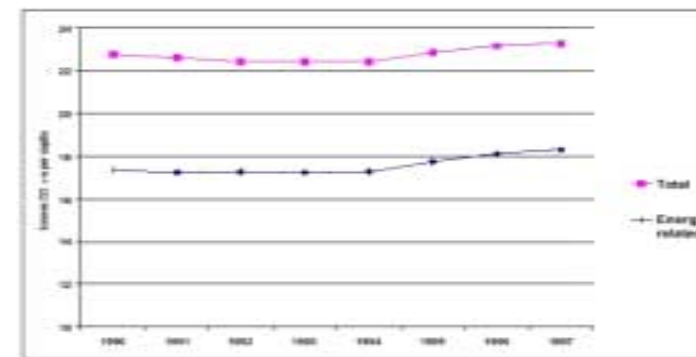


Figure 1.3.3.4 Australian GHG emissions per head of population



In 1997 emissions per head of population were 23.3 tonnes of CO₂-e. This represents an 2.2% increase since 1990.

1.3.3 South Australian Greenhouse Gas Emissions

The South Australian Centre for Economic Studies predicts that this State GHG emissions will rise from 18.9 Mt in 1996/97 (the emissions from stationary energy sector totalled 12.9 Mt) to approximately 24 Mt in 2009-10 (business as usual scenario). In terms of Kyoto commitment period (1990 to 2010), South Australia's emissions growth from energy sector (business as usual) projected to be approximately 22 percent.

1.3.4 Emissions by SA Councils Participating in the Cities for Climate Protection™ Programme

Emissions from Local Government areas administered by all eleven SA Councils participating in the Cities for Climate Protection™ programme are 12.9 million tonnes of CO_{2-e}. This constitute 68.2% of total SA emissions.

1.4 The International Response to Climate Change

In 1979, the First World Climate Conference recognised climate change as a serious problem. Since then a number of intergovernmental conferences focusing on climate change were held in 1980s and 1990s. The most recent was the United Nations Convention on Climate Change in Kyoto in December 1997, which culminated in the adoption of Kyoto Protocol. Under the Protocol adopted by consensus, the industrial countries have a legally binding commitment to reduce their collective greenhouse gas emissions by at least 5.2% compared to 1990 levels by the period 2008-2012. Within this target, individual countries have agreed to differentiate targets ranging from an eight percent reduction to a 10% increase, depending on their economic circumstances and differing capacities to make emissions reductions. Australia's target is to reduce its greenhouse gas emissions in the target period to no more than 8% above 1990 levels.

1.5 The Australian Response So Far

Although Australia only contributes approximately only 2 per cent of global greenhouse gas emissions, its per capita emissions are among the highest in the world. On current projections there is likely to be substantial growth in Australian emissions in the next decade. If no further specific actions were taken to reduce greenhouse gas emissions, Australia's emissions are expected to grow by around 28 per cent from 1990 to 2010. To achieve Australia's target under the Kyoto Protocol of an 8 per cent increase from 1990 to 2010, it is expected that Australia, on current projections, will need to achieve an average 2 per cent emissions reduction each year. Australia's emissions reflect its particular national circumstances. Fossil fuels supply most of our energy needs; our industries are energy intensive and we are a major exporter of energy intensive products. The population growth rate is relatively high; and with our widely separated and decentralised cities, transport use is relatively high.

In recognition of the importance of reducing greenhouse gas emissions, the Commonwealth Government has developed the National Greenhouse Strategy. The most recent edition of the NGS was released in November 1998. The NGS is a major policy initiative of the Commonwealth, State and Territory governments. It builds on a substantial cooperative effort of governments, and includes the Prime Minister's \$180 million package: Safeguarding the Future: Australia's Response to Climate Change. The National Greenhouse Strategy has been developed by the Commonwealth and all State and Territory Governments. The Australian Local Government Association, and industry and community consultations also have made an important contribution.

The NGS provides the strategic framework for Australia's greenhouse response and is the primary mechanism through which our international commitments will be met. Also it provides a broad menu of actions some of which will be implemented by governments acting individually, some by joint intergovernmental initiatives and some through partnerships between government, various stakeholders and the community. It contains a range of measures within a "**no regrets**" framework, i.e. the measures have to have other benefits apart from reducing greenhouse gas emissions and not have net adverse economic impacts. Priority measures in the NGRS include:

- preparation of a national greenhouse gas inventory;
- micro-economic reform in the electricity and gas sectors to promote competition between suppliers and the promotion of greenhouse-friendly energy sources;
- increased energy efficiency within the residential and commercial sectors through energy labelling and minimum energy performance standards; and
- more efficient transport systems through travel demand strategies and improved fuel consumption in the national vehicle fleet.

The National Greenhouse Strategy identified the Cities for Climate Protection™ Australia Program as providing a strategic framework for action on greenhouse by Local Government.

In 1998 the Commonwealth Government established the Australian Greenhouse Office (AGO), a separate agency within the environment portfolio.

The AGO is responsible for the coordination of domestic climate change policy and the delivery of Commonwealth programs and provides a central point of contact for stakeholder groups.

In May 1999 the Prime Minister announced that the Government will commit an additional \$ 1 billion, to further assist Australia in meeting its commitments under the Kyoto Protocol to the United Nations Framework Convention on Climate Change.

New initiatives announced as part of Measures for a Better Environment include:

- **Greenhouse Gas Abatement Programme \$400 million**
- **New Renewable Energy Initiatives - \$321 Million**
- **Photovoltaic rebate Programme \$31 Million**
- **Alternative Fuel Conversion Programme - \$65 million**

All four programmes have some relevance to the City of Adelaide Greenhouse Strategy. Detail information on the above programmes is included in the Appendix 1.

1.6 South Australian Response So Far

The South Australian Government is committed to playing its part in the national and international efforts to address the issue of global warming. On 14 of July 1997 the SA Cabinet approved the establishment of Greenhouse Gas Targets for all South Australian Government agencies. This initiative aims to reduce the level of carbon dioxide emissions currently generated in public sector activities and reduce Government expenditure on energy.

The South Australian public is a large consumer of energy – expenditure on electricity and natural gas in 1996/97 was over \$70 million and resulted in the emissions of over 600,000 tonnes of carbon dioxide equivalent CO_{2-e}. Measures to improve energy efficiency in undertaking Government business are being considered as an important factor in reducing greenhouse gas emissions levels.

The South Australian Government recognises and supports the ratification by the Australian Government of the *United Nations Framework Convention on Climate Change* and its subsequent signing of *the Kyoto Protocol* to that Convention.

South Australia has developed reference groups and specialist working groups to provide to the representative on the national groups. The technical expertise from across government provided for this has predominantly been coordinated through the South Australian Greenhouse Committee. The South Australian Government has agreed to the National Greenhouse Strategy, and has prepared South Australian implementation plans for those measures considered to be the responsibility of the States and Territories.

A Greenhouse Consultative Committee comprising the SA Environment Protection Agency (EPA), Department of Environment and Heritage

(DEH), Local Government Association (LGA) and Cities for Climate Protection programme (CCP™) has been formed to facilitate liaison between SA Government and the Local Government on greenhouse issues.

1.7 Local Government Response The Cities for Climate Protection™ - Australia Programme

1.7.1 Cities for Climate Protection™ Programme

In 1997, the City of Adelaide was invited to formally participate in the Cities for Climate Protection™ Program, a program of the International Council for Local Environmental Initiatives (ICLEI) and the Australian Greenhouse Office. The Adelaide City Council approved participation in this programme in January 1998.

1.7.2 The CCP Strategic Framework Greenhouse Abatement Framework

The CCP™ is a well-structured performance based programme involving quantification of targets, timetables and reductions of greenhouse gas emissions achieved over a period of time by CCP™ participants. Quantification serves several purposes. Firstly, methods of quantification permit CCP™ participants to define GHG reduction targets based on an analysis of energy end uses and technical potential for further reductions. This in turn helps CCP™ participants to set priorities based on a solid understanding of energy end use pattern and emission sources. It also gives them the tools they need to advocate effectively in regulatory processes whose outcome will affect their ability to achieve GHG reduction targets. Secondly, quantification enables the CCP™ participants who can afford to undertake further economic analysis to assess the relative costs and benefits of further policies and measures. Finally, quantification allows the International Council for Local Environmental Initiatives (ICLEI) and other interested parties to periodically evaluate the performance of the CCP programme. The quantification process is supported by software programme, which has been recently developed, with support from US EPA and Environment Canada.

Each local government, once it become a participant, undertakes to proceed through and complete five key milestones:

Milestone 1 **Conduct an emissions inventory of current Council and community activity and a forecast of emissions growth in the future.**

Milestone 2 **Establish an emissions reduction goal**

Milestone 3 **Develop a Local Action Plan**

Milestone 4 **Implement the Local Action Plan**

Milestone 5 **Monitor and report on the implementation of the Local Action Plan**

One hundred councils, representing nearly forty percent of Australia's population have already joined the CCP™ programme.

At present 12 South Australian councils participate in this programme namely: Adelaide, Burnside, Charles Sturt Marion, Mitcham, Onkaparinga, Unley, Playford, Port Adelaide Enfield, Salisbury, and Tea Tree Gully and West Torrens.

The CCP™ Australia programme actively encourages partnerships between local governments and industry and communities at the local level and at program level with programs such as Greenhouse Challenge, Household Greenhouse Action, Bush for Greenhouse and State and Territory Government programmes.

The CCP™ is part of the Module 3 of the National Greenhouse Strategy titled: Partnerships for Greenhouse Action Governments, industry and the Community.

2.0 GHG EMISSIONS INVENTORY AND FORECAST

2.1 City of Adelaide Greenhouse Gas Emissions

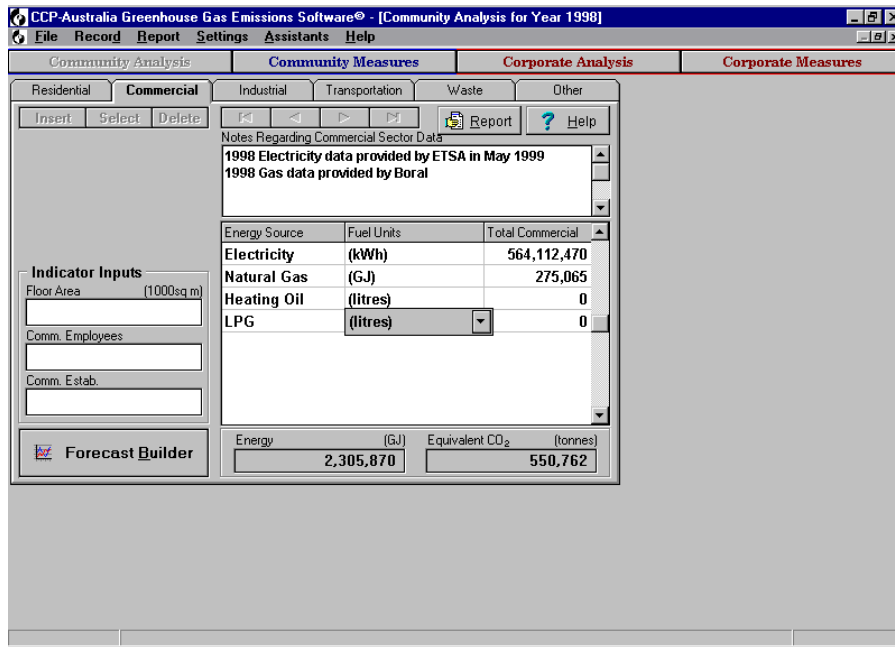
2.1.1 Methodology and Rationale

The first step in developing a plan to reduce greenhouse gas emissions is to identify sources and quantities of greenhouse gases emitted in City of Adelaide. A Greenhouse Gas Inventory was developed using methodology and computer software provided by the Cities for Climate Protection™ programme for the baseline year 1994. The purpose of the local inventory of greenhouse gas emissions is to help identify and quantify the most important sources of greenhouse gas emissions in communities and help identify, quantify the most effective opportunities for reducing those emissions. The inventory includes only carbon dioxide (CO₂) and methane (CH₄) represented as a CO₂ equivalent, or CO_{2-e}. The inventory does not cover a small subset of emissions that are not readily controlled by the local government nitrous oxide (N₂O) and perfluorocarbons (PFCs) in "carbon dioxide equivalents" (CO_{2-e}) agricultural sources.

This is then calculated by multiplying the actual mass of emissions by the appropriate coefficients for the end use combustion of that fuel type. In an end use orientated approach power plant emissions are pro-rated over kilowatt-hours of electricity use.

The inventory and forecast were compiled with the assistance of the ICLEI inventory software. The software is designed with the energy end user in mind and so it computes the emissions based on both electricity to gas use. It is focussed on the energy supply side. Net emissions are calculated with the upstream emissions (eg electricity generator) factored in.

Fig2.1 CCP Greenhouse Gas Emissions Software®



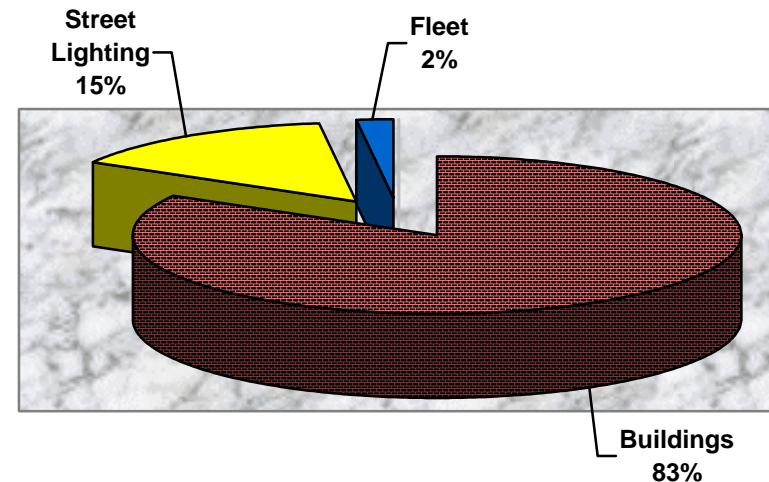
2.1.2 City of Adelaide Corporate GHG Emissions – Baseline Year 1994

The Corporate GHG Emissions Inventory comprises four major sectors such as Buildings, Street Lights, Waste and Vehicle Fleet. Work on this part of the project involved a laborious analysis of the historical energy consumption data of corporation-owned buildings including large properties such as the Central Market, Aquatic Centre and also smaller energy users such as Rowing Clubs, Toilet Blocks etc. In 1994 the Cities operations were responsible for consumption of 141,929 GJ of energy. The Corporate GHG Emission Inventory is summarised by the following table and the pie chart:

Table 2.1 City of Adelaide Corporate GHG Emissions

Sector	CO _{2-e} Emissions	Energy
	tonnes	GJ
Buildings	22,114	119,351
Street Lights	3,862	14,635
Waste		-
Vehicle Fleet	537	7,944
Total	26,513	141,929

Fig 2.2 City of Adelaide Corporate GHG Emissions



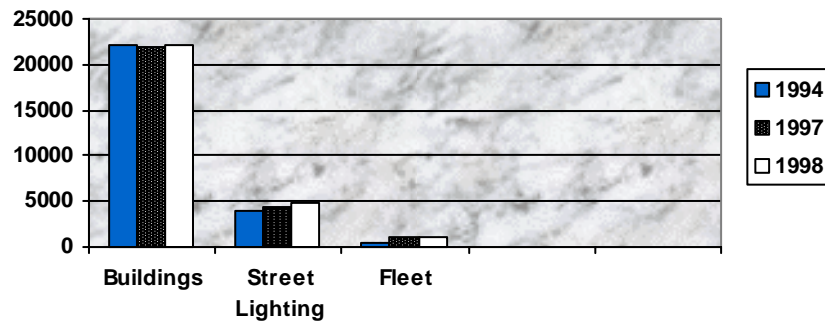
By far the biggest proportion of emissions came from electricity consumption at 86.6% per cent, with natural gas producing a further 9.5% per cent of emissions and transport fuels 3.9%.

Table 2.3 Emissions by Source

Energy Source	CO _{2-e} tonnes	CO _{2-e} %	Energy GJ	Cost \$
Electricity	23,562	86.6	89,289	2,351,000
Natural Gas	2,414	9.5	44,696	223,766
Fleet Fuel	537	3.9	7,944	341,953
Total	26,513	100	141,929	2,916,719

A greenhouse gas emissions inventory was also conducted for 1997 and 1998. In 1998 the corporate emissions were 28,149 tonnes, a 6% increase over 1994 levels.

Figure 2.3 1994-1998 Increase in Corporate GHG Emissions by Sector



2.1.4 City of Adelaide Corporate GHG Emissions Forecast

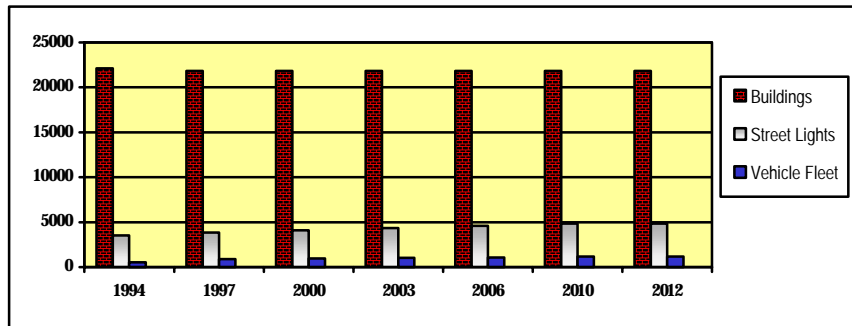
The forecast analysis for the municipal operations considered all sectors identified in the baseline year analysis and estimated any changes that are likely to occur by the target year. Emissions from Building sector are expected to remain stable. Emissions from Street Lighting are expected to increase by 25.7%. The vehicle fleet emissions are expected to increase by 118%.

Table 2.1.4 Forecast of Corporate GHG Emissions Business as Usual

Sector	(1994)	(2010)	Change
	GHG Emissions	GHG Emissions	%
	Tonnes of CO _{2-e}	Tonnes of CO _{2-e}	
Buildings	22,114	22,114	0
Street Lights	3,862	4,855	25.7
Vehicle Fleet	537	1,169	118
Total	26,513	28,138	6.1

The estimated trend of GHG emissions resulting from the municipal operations is shown on the chart below.

Fig 2.1.4 Estimated trend of GHG Emissions



2.1.5 City of Adelaide Community GHG Emissions – Baseline Year 1994

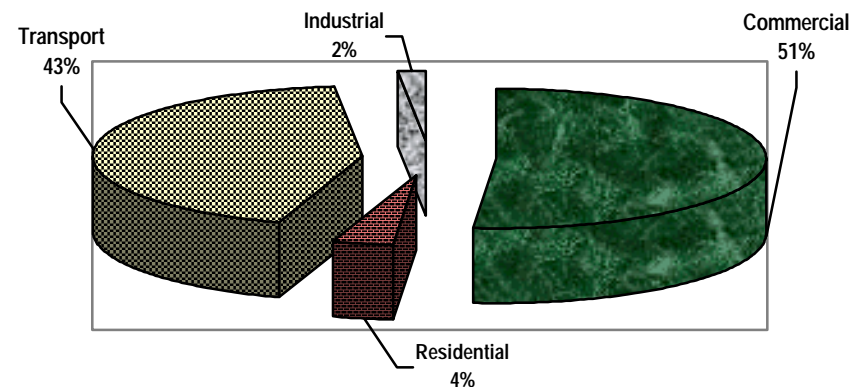
Data on total fuel and electricity sales to different sectors such as Residential, Commercial, and Industrial was used to calculate GHG emissions in the wider community. Data on volume and mix of waste being sent to landfill was used to estimate methane emissions. Transport emissions were estimated using formulae that include the number of trips, average length of trips, vehicle fuel efficiency and emissions per unit of fuel. In 1994, City of Adelaide was responsible for approximately 1,022,000 tonnes of CO_{2-e}.

The City of Adelaide Community GHG Emissions by major end use i.e. commercial residential industrial and transportation sector are summarised by the following table and the pie chart.

Table 2.1.5 City of Adelaide Community GHG Emissions

Sector	CO _{2-e} Emissions	Energy
	Tonne	GJ
Residential	36,991	194,006
Commercial*	524,318	2,158,945
Industrial	17,215	144,197
Transportation	443,318	6,696,632
Total	1,021,842	9,193,780

Fig 2.5 City of Adelaide Community GHG Emissions (%) BASELINE YEAR 1994



By far the biggest proportion of emissions came from electricity consumption at 54.6% per cent, with transport fuels producing a further 43.4% per cent of emissions natural gas producing 1.9%.

Table 2.5 Emissions by Source

Energy Source	CO _{2-e}	CO _{2-e}	Energy
	Tonnes	%	GJ
Electricity	558,287	54.6	2,115,606
Transport	443,318	43.4	6,702,348
Natural Gas	19,614	1.9	363,219
Total	1,021,615	100	9,181,173

2.1.6 Interim Year Community Emissions Inventory - 1998

A greenhouse gas emissions inventory was also conducted for 1997 and 1998. In 1998 the community emissions were 1,063,450 tonnes, a 3.8% increase over 1994 levels.

Figure 2.1.6 1994-1998 Increase in Community Greenhouse Gas Emissions by Sector

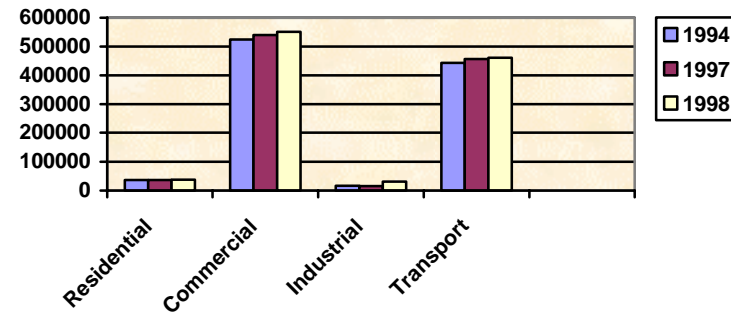
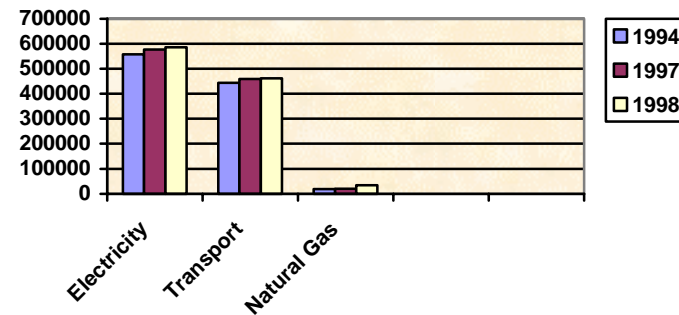


Figure 2.1.7 1994-1998 Increase in Greenhouse Gas Emissions by Source



2.1.7 Forecast of Community GHG Emissions

The forecast analysis for the community considered all sectors included in the baseline year inventory, and estimated any changes that are likely to occur by the target year. The 2010 CO_{2-e} emissions forecast is intended to reflect CO_{2-e} emissions **in the absence of any Greenhouse Gas**

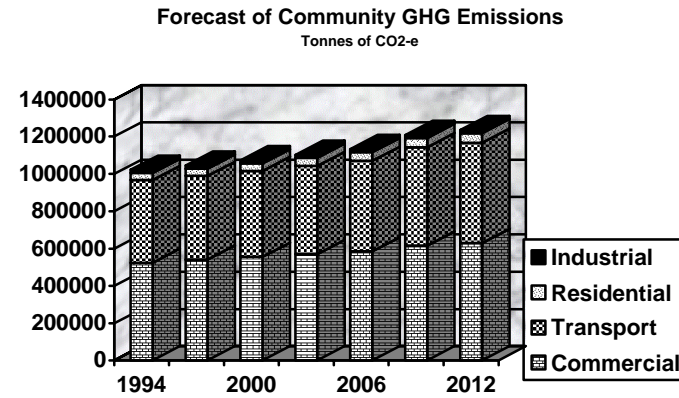
abatement measures implemented since 1994. Under this Scenario, City of Adelaide Community CO_{2-e} emissions are predicted to increase more the 17.8% from the 1994 level.

One of the sources used in the analysis was the recently published report: *'The Economic Impact of Climate Change Policy on South Australia'* prepared by the Centre for Economic Studies of Adelaide and Flinders Universities.

Table 2.1.7 1994-2010 Increase in Community Greenhouse Gas Emissions by Sector

Sector	(1994)	(2010)	Change %
	CO _{2-e} Tonnes	CO _{2-e} Tonnes	
Residential	36,991	49,197	33
Commercial	524,318	616,178	17.5
Industrial	17,215	17,215	-
Transport	443,318	520,898	17.5
Total	1,021,842	1,203,489	17.8

Figure 2.1.7 1994-2010 Increase in Community Greenhouse Gas Emissions by Sector



3 GREENHOUSE GAS EMISSIONS REDUCTION GOALS

In 1998, the City of Adelaide endorsed and committed to undertaking the 5 Milestones Cities for Climate Protection™ programme. Through joining the CCP™ City of Adelaide made a commitment to reduce greenhouse gas emission in both municipal operations and community activities.

In consultation with relevant stakeholders each CCP™ Member Council is required to establish a *Greenhouse Gas Reduction GHG Goals* for both municipal corporate operations and the community. These goals are the amounts of greenhouse gases the council and its community are committed to reducing from the forecast year. The reference for this reduction is the baseline year (1994). The goals established in this global programme vary across municipalities to take account of the different situations, changing industries, expanding populations and so on – in which they find themselves. The Cities for Climate Protection™ preferred target is a 20% reduction from the base year in greenhouse gas emissions by the year 2010. Numerous municipalities around the world and in Australia have already committed themselves to greenhouse gas reduction targets.

Table 3.1 Existing Reduction Goals from Australian CCP Councils

Australian Cities	GHG Reduction Goals
City of Adelaide	20% and 10% below 1994 levels by 2010
City of Fremantle	20% below 1996 levels by 2010
City of Melbourne	20% below 1996 levels by 2010
ACT Government	Stabilise at 1990 levels by 2008
City of Darebin	20% below 1995 levels by 2010
Frankston City Council	20% below 1995 levels by 2010
Shire of Macedon Ranges	20% below 1995 levels by 2010
Mitcham City Council	20% below 1994 levels by 2010
City of Onkaparinga	20% below 1997 levels by 2010
Port Phillip City Council	20% below 1996 levels by 2010
City of Unley	20% below 1994 levels by 2010

The implementation of the Cities for Climate Protection™ programme is one of the actions identified in the Corporate Plan. The Corporate Plan contains the following action:

action 3.4.1:

Meet the milestones in the Cities for Climate Protection™ Programme – July 1999 – 2004 – including:-

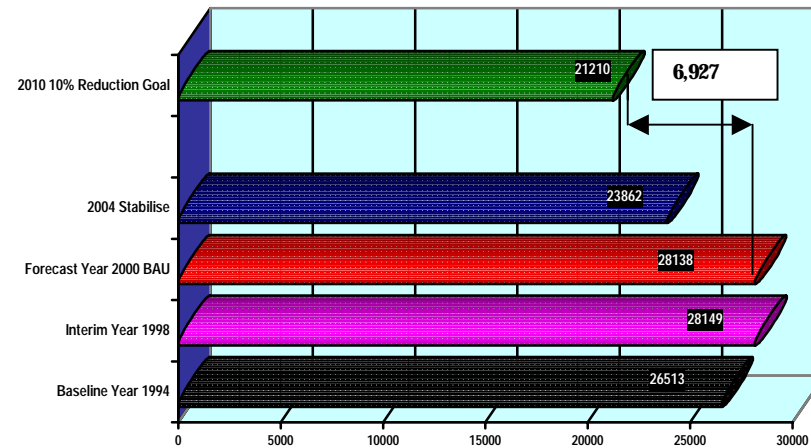
3.1 Corporate GHG reduction Goal

Following internal consultation with the relevant Departments of the City Administration, and preliminary analysis of the effectiveness of the GHG reduction actions and measures it was proposed that the City of Adelaide would adopt the following corporate greenhouse emissions reduction goal:

- **Reduce emissions from its own operations by 10% on 1994 level by 2004 leading to a 20% reduction by the year 2010.**

Such goal is generally consistent with other municipalities involved in the Cities for Climate Protection™ Programme. Due to the voluntary nature of the CCP™ Programme the GHG reduction Goal can be refined and the goal can be increased as the Local Action Plan is finalised and implemented. The Corporate GHG Emissions Reduction Scenario is illustrated by Figure 3.1.

Fig 3.1 Corporate GHG Emissions Reduction Scenario tonnes of CO_{2-e}



Greenhouse gas emissions from corporate operations are expected to reach 28,138 tonnes of CO_{2-e} under **a business as usual scenario** by 2010. The achievement of this corporate goals of 10% (2004) and 20%

(2010) would decrease greenhouse gas emissions to corporate operations to 23,863 and 21,211 tonnes of CO_{2-e} respectively.

This equals to **business as usual** adjusted 15% (4,275 tonnes of CO_{2-e}) and 24.6% (6,927 tonnes of CO_{2-e}) emissions reductions.

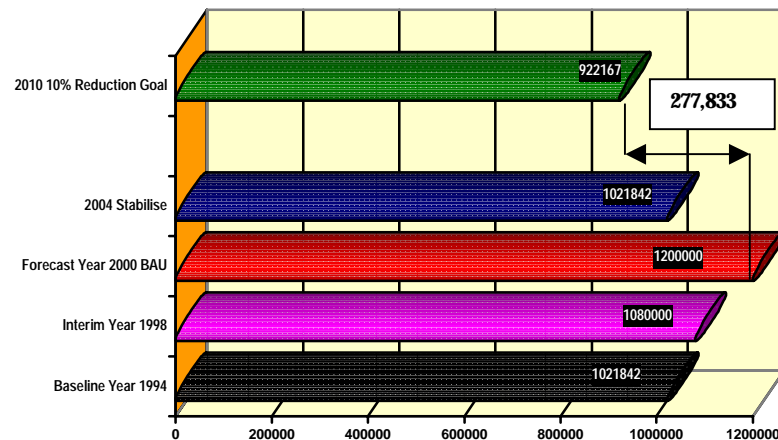
3.3 City of Adelaide Community GHG Reduction Goal

Following extensive community consultation including consultation during the Environment Management Plan review process including Environment Forum on 22/02/2000, Energy Workshops on 01/09/99 and 28/10/99 it was proposed that the City of Adelaide would adopt the following community greenhouse gas emissions reduction goal:

- **Stabilise emissions at 1994 level by 2004 leading to a 10% reduction by the year 2010**

Such a goal is generally consistent with other municipalities involved in the Cities for Climate Protection™ Programme. Due to the voluntary nature of the CCP™ Programme the GHG reduction Goal can be refined and the goal can be increased as the Local Action Plan is finalised and implemented. The Community GHG Emissions Reduction Scenario is illustrated by Figure 3.2.

Fig 3.2 Community GHG Emissions Reduction Scenario tonnes of CO₂e



Greenhouse gas emissions from City of Adelaide are expected to reach 1,200,000 tonnes under a business as usual scenario by 2010. The achievement of the community goals of 10% on 1994 baseline level (1,021,842) would decrease community greenhouse gas emissions less than 922,167 tonnes. This equals to 23% (277,833) reduction on business as usual basis. Stabilise emissions at 1994 level by 2004 equals to 7% (77,642) business as usual adjusted reduction

3.2 Adelaide City Council Endorsement

In order to qualify for Milestone 2 under the Cities for Climate Protection™ programme this goal has to be adopted by Council. The Adelaide City Council endorsed both Corporate and Community Goals on 10/04/2000.

4.0 CORPORATE GREENHOUSE GAS REDUCTION STRATEGY

Introduction

The Greenhouse gas reduction strategy is a blueprint for putting together a set of effective and practical measures to reduce the greenhouse gas emissions generated by the corporate operations. When implemented, the greenhouse reduction strategy will enable the City of Adelaide to meet the greenhouse gas reduction goals set as part of the Cities for Climate Protection™ Programme. The City of Adelaide Corporate baseline (1994) GHG emissions are over 26,513 tonnes of CO_{2-e}. They contribute 2.6% to total City of Adelaide GHG emissions. This is in line with other capital cities but significantly higher than suburban metropolitan municipalities. It is important that City of Adelaide leads the wider community by example. The sectors such as Building and Street Lighting contribute most of the emissions; 22,114 tonnes of CO_{2-e} and 3,862 tonnes of CO_{2-e} respectively. The building portfolio contribute over 83% to total corporate emissions. Clearly, in order to meet the overall Community GHG emissions reduction Goal substantial reductions from the building sector are critical.

Street and Traffic Signalling Sector is the second most significant emitter of greenhouse gases. Substantial emissions reductions have been already been achieved particularly in Traffic Signalling. Even more dramatic reductions are feasible through adoption of new technologies such as LED's (Light Emitting Diode).

Further GHG emissions reductions can be achieved through development of targeted solid waste management strategies

In summary the following main corporate technical processes have been identified:

- **Reducing energy consumption through improved energy efficiency;**
- **Increased use of renewable and less greenhouse intensive energy;**
- **Carbon sequestration;**
- **Participation in carbon trading system;**
- **Targeted solid municipal waste management.**

The Corporate GHG reduction Strategy can be illustrated by the following flow chart::

Fig 4 Corporate GHG Emissions Reduction Strategy

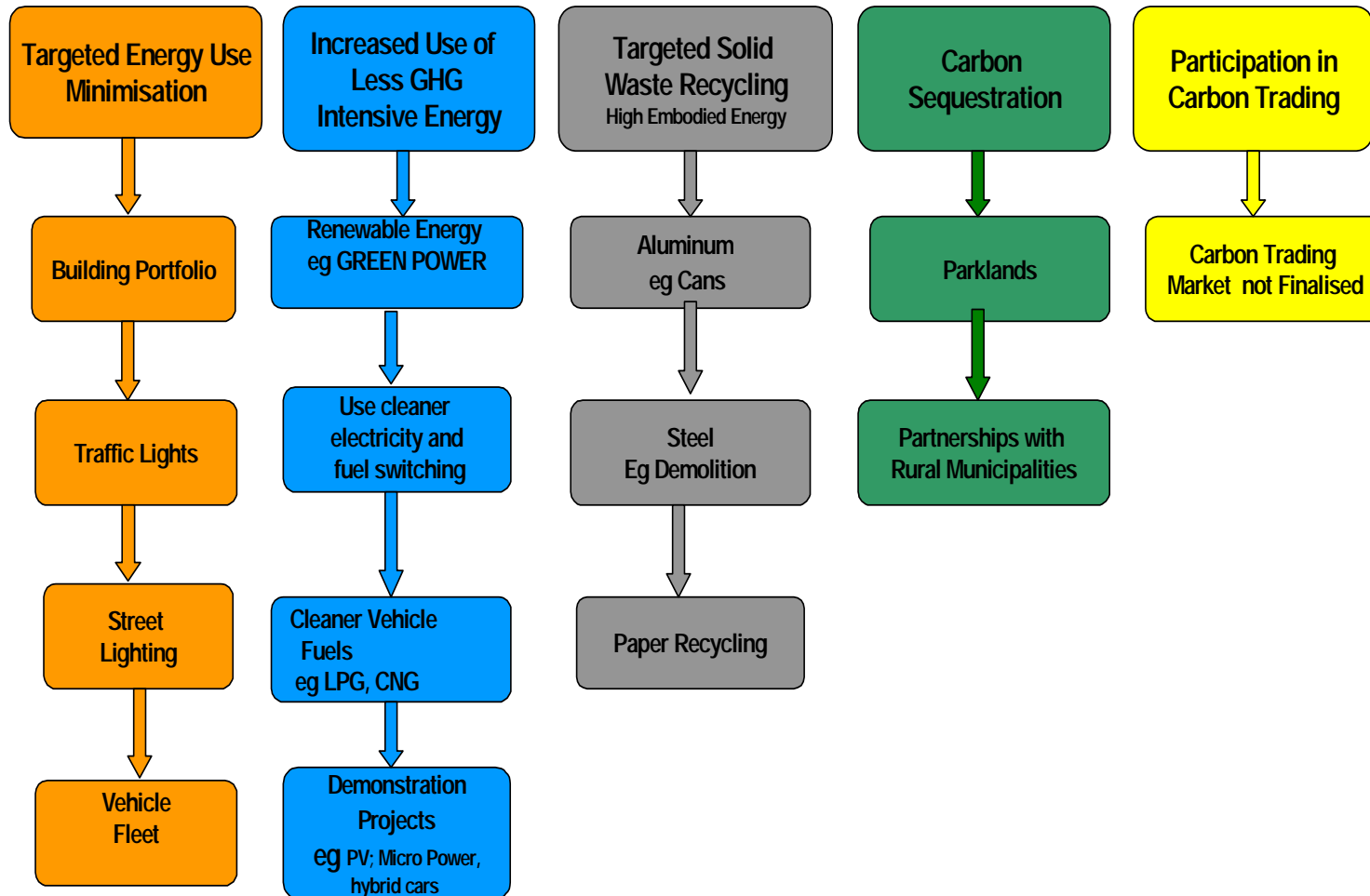
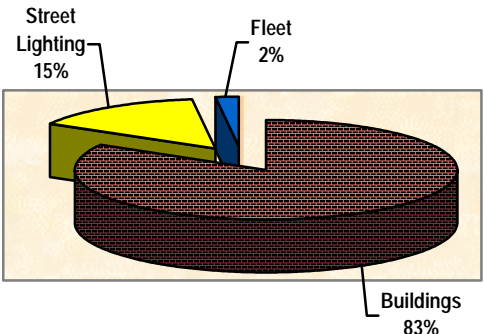
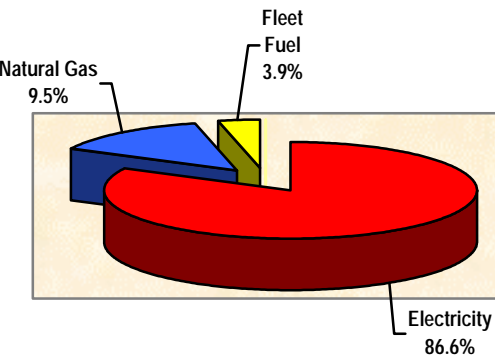
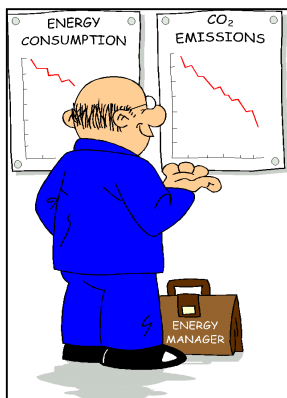


Table 4.0 Corporate GHG Emissions Reduction Measures Summary

Strategies	Reduction of GHG Tonnes CO ₂ e		Rationale Comments
	2000-2004	2004-2010	
Improve Energy Efficiency of Corporate Buildings including fuel switching	1,360	580	<p>Contribution of different sectors to the corporate GHG emissions is shown by the chart below:</p>  <p>By far the biggest proportion of emissions came from electricity consumption at 86.6% per cent, with natural gas producing a further 9.5% per cent of emissions and transport fuels 3.9%.</p> 
Improve Energy Efficiency of Traffic Signals	500	410	
Improve Energy Efficiency of Street Lighting	Stabilise	Stabilise	
Increase the use of renewable and less greenhouse gas intensive energy sources	2,300	1,500	
Reduce Emissions from Corporate Fleet	17	35	
Solid waste	100	100	
Carbon Sinks		25	
	4,277	2,650	
	6,927		

4.1 Reducing Greenhouse Gas Emissions Through Improved Energy Efficiency



Generally, greenhouse gas emissions are directly proportional to energy consumption. Measures to reduce energy consumption in undertaking business activities are an important factor in reducing GHG emissions levels. They will also substantially benefit profitability of city businesses. Different kinds of energy result in different greenhouse outcomes and appropriate targeting of energy reduction measures can further enhance their effectiveness.

The City Adelaide Operation use GJ 158,505 of Energy at annual Cost of over \$2.9 Million.

Table 4.1

Energy Source	Energy Use	Energy Cost 1998
	GJ	\$
Electricity	92,380	2,303,114
Natural Gas	49,417	261,700
Petrol & Diesel	16,707	341,953
Total	158,501	2,906,767

Considering current energy expenditure by the corporation at present the Corporation it is estimated that 10% reduction in consumption would result in \$290,000 annual savings.

4.1.1 Corporate Building Sector

Estimated CO_{2-e} Reductions in 2010	1,940 tonnes
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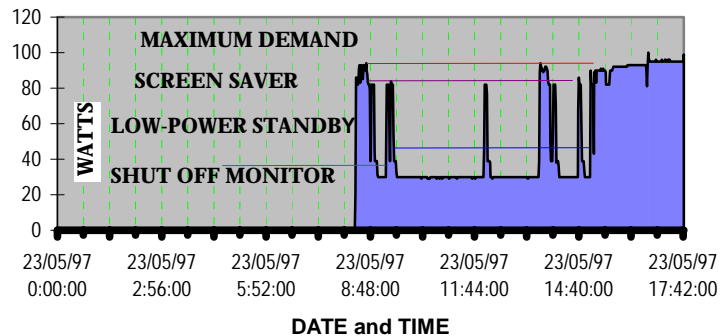
Buildings contribute 83% to overall corporate GHG emissions. In order to achieve the proposed GHG emissions reduction goals it is imperative that significant cuts are made in this sector.

4.1.1.1 Energy Star Office Equipment

Estimated CO_{2-e} Reductions in 2010	237 tonnes
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Electronic office equipment consumes electricity when it is being and also when it is idle. Some office equipment consumes more energy while in idle mode than when being utilised for its intended purpose. By using energy efficient office equipment, it is estimated that energy consumption can be reduced by as much as 75 per cent for individual products. A computer which works to the Energy Star power management system changes to low energy demand (or sleep) mode when it has not been used for a pre-set time and returns to normal operation (or wakes up) as soon as the user touches the keyboard or the mouse. However, these features only save energy when they are activated – which is usually upon installation.

Fig 4.1 An ENERGY STAR computer, monitor, photocopier or printer is designed to automatically reduce the amount of power it uses whenever it is left idle for a period of time



❑ **Computers**

Both financial savings and GHG emissions reductions to be gained through utilising power management features are significant. Without enabling the Energy Star features the 500 networked computers would had an annual energy cost of \$40,000 and over the same period produced 292 tonnes of CO_{2-e}. However, after enabling the Energy Star features on all 500 networked computers an annual energy cost would fall to \$18,279. This equals an annual saving of \$21,721 and 147 tonnes of greenhouse gases. The potential energy savings and resultant reductions in GHG emissions are summarised in table

Table 4.1.2 .The potential energy savings and resultant reductions in GHG emissions

Total Annual energy use Before Energy Star	Total Annual GHG emissions	Total Annual Energy use After Energy Star	Total Annual Energy Use Reduction After Energy Star	Total Annual GHG Emissions Reduction	Total Annual Financial Savings
kWh	Tonne of CO _{2-e}	kWh	kWh	Tonne of CO _{2-e}	\$
500*615.8 = 307,900	292.5	500*305.5= 152,750	155,150	147.4	21,721

Recommended Measure

Complete enabling of Energy Star power management controls on corporate computer network.

Estimated CO_{2-e} Reductions in 2010 147 tonnes

Significant other savings could be achieved by extending the Energy Star principles to other key pieces of office equipment which consume large amounts of energy – most notably photocopiers and printers. For example, some types of fax machines use only about 20 per cent of their maximum energy demand for transmitting and receiving faxes, and 80 per cent during stand-by periods. photocopiers often continue to draw electricity from the mains when physically switched off (typical values in an office situation: switched off 25 per cent; stand-by 75 per cent; copying 100 per cent). Electricity consumption by idle electronic office equipment can largely be avoided. By using energy efficient office equipment, it is estimated that energy consumption can be reduced by as much as 75 per cent for individual products. Currently there are 45 photocopiers being used throughout the Corporation. The annual energy costs, which can be attributed to photocopiers are estimated of \$15,807. However, after adopting

Energy Star principles the same office equipment would have an annual energy cost of \$6,481. This would provide an annual saving of \$9,718 and approximately 53 tonnes of CO_{2-e}. Some of the above savings have already been achieved as the power savings features are incorporated in some of the modern and photocopiers. Older equipment could be provided with supplementary time switches. The potential energy and financial savings are summarised in the following table:

Table 4.1.3 - The potential energy savings and resultant reductions in GHG emission

No of Items	Total Annual energy use Before Energy Star	Total Annual GHG emissions	Total Annual Energy use After Energy Star	Total Annual Energy Use Reduction After Energy Star	Total Annual GHG Emissions Reduction	Total Annual Financial Savings
	kWh	Tonne of CO _{2-e}	kWh	kWh	Tonnes of CO _{2-e}	\$
33 Medium Photocopy Machines	33*1,556.9= 53,377.7	50.7	33*671= 22,143	31,234.7	29.7	4060
12 Large Photocopy Machines	12*3,503= 42,036	39.9	12*1,463= 17,556	24,480	23.3	3182
Total	95,413	90.6		55714.7	53.0	7242

Recommended Measure

Complete enabling of Energy Star power management controls on other corporate office equipment.

Estimated CO_{2-e} Reductions in 2010 *53 tonnes*

4.1.1.2 Exit Signs

Estimated CO_{2-e} Reductions in 2010 *83 tonnes*



For the past 20 or so years, Emergency Exit luminaries have traditionally used fluorescent lamps and conventional inverters to provide indication of egress paths out of buildings. All these fittings are required, by AS 2293, to be operational 24 hours a day. Each Exit fitting not only has a maintained fluorescent tube (typically a 10-Watt tube) but also a battery charger, which provides a constant trickle charge to the battery. One current technology uses 13.6 Watts (max) in a typical operation. Older luminaries, however, use between 16 and 22 Watts of power in continuous operation. A lot of energy is simply wasted as heat from low efficiency components. The power consumed by these fittings, especially those of older technology is not insignificant. . A medium sized building with 50 Exit signs could have a 1 kW continuous operation resulting in cost of \$ 1,100. annual expenditure. In addition all 10 watt tubes have a limited life; the very best are only rated for 7000 hours (about 10 months) continuous operation. The fluorescent tubes, require regular tube changes to meet current building safety requirements.

These above problems are being addressed by exit sign manufactures through introduction of new technologies such as:

- Cold cathode tube (a cold cathode tube does not have energy- consuming filaments, it has advantages over a standard fluorescent tube in both life expectancy and energy consumption. A 3 - watt cold cathode tube produces the same amount of light as a 10 W fluorescent tube. The typical life expectancy of cold cathode tube is between 3 & 5 years. Combining this with modern charging circuitry produces a fitting that would consume significantly less energy, perhaps only half energy consumption of current technology.
- Light Emitting Diode LED technology is another technology which offer substantial reductions in energy efficiency. An LED Exit Sign

operates on less than 5 watts per face, using 50% less energy than a typical exit sign. Each year, just one LED exit sign can reduce GHG emissions by 83.2 kg of CO_{2-e}.

Recommended Measure

Progressively retrofit existing exit signs serving corporate buildings with energy efficient modern equipment



In 1999, specialist energy auditors have conducted an energy audit on several corporation's buildings. They identified a number of strategies directed to the saving of energy and reducing resultant GHG emissions such as enhanced controls of lighting and air conditioning systems. Most of these improvements are characterised by relatively short payback periods between 1 to 5 years. In order to make a substantial impact on corporate emissions, considerable effort must be directed towards upgrading of various buildings. By reducing GHG emission from their own buildings the Corporation of City of Adelaide would lead the city's business and residential community by example.

- Following internal consultation it is proposed to implement the following recommendations from the Energy Audit:
 - Town Hall, Eagle, and Gladstone Chambers: lighting, HVAC; **126 tonnes of CO_{2-e}**
 - Rundle St Carpark: lighting and HVAC; **358 tonnes of CO_{2-e}**

Recommended Measure

Progressively implement recommendation of Energy Audit

Estimated CO_{2-e} Reductions in 2010 *83 tonnes*

4.1.1.3 Selective Implementation Energy Efficiency Measures

Estimated CO_{2-e} Reductions in 2010 *1,184 tonnes*

Estimated CO_{2-e} Reductions in 2010 *484 tonnes*

- Progressive Energy Efficient Retrofit of Colonel Light Centre Building



One of the potential demonstration projects which fulfil the above criteria is recently completed refurbishment of the Mezzanine Floor in Adelaide City Council Administration Centre CLC Building.

The building is undergoing a major staged retrofit with ground floor (Customer Centre) completed in 1998. The retrofit of the mezzanine floor is expected to be completed in August 2000. Energy efficiency has been identified as one of key expected outcomes. Main energy efficiency features retrofit include:

- State of the art Air-conditioning system ‘Active Chilled Beam System (ABC). Engineering analysis showed that this system is more energy efficient than variable or constant volume systems;
- New lighting system including T5 Triphosphor lamp technology 8.3 W/m²;
- Managed Lighting System control system including ultrasonic movement sensors and automatic dimming
- Improved BMS system;
- Energy efficient Exit Lights and Emergency Lighting;
- Enabled Energy Star office equipment.

The above project has a substantial greenhouse gas reduction potential through replication and as such has good chance to obtain financial support from the Australian Greenhouse Office through recently announced ***Emissions Reduction Incentive Programme (ERIP)***.

Recommended Measure

Progressively retrofit the CLC Building with energy efficient modern equipment

Estimated CO_{2-e} Reductions in 2010 700 tonnes

4.1.2 Traffic Signals and Street Lighting

Both traffic lights and street lights are second largest contributor to corporate Greenhouse gas emissions. During the baseline year 1994 the emission totalled 4,729, approximately 15% of total corporate emissions. Between 1994 and 1998 GHG emissions from traffic lights have decreased by 20%. These significant reductions have been achieved as a result progressive replacement of existing incandescent light globes with more energy efficient quartz halogen technology. The GHG emissions from street lighting have increased by over 9% during the same period. Such increase is mostly resultant of steadily increasing number of street lights throughout the city.

Table 4.1 Traffic and Street Lighting Emissions

Lighting Type	1994 GHG Emissions	Cost of Electricity	1998 GHG Emissions	Cost of Electricity
	CO _{2-e}	\$	CO _{2-e}	\$
Traffic Lights	1,193.2 (25%)	193,048	954 (-19.8%)	146,624
Street Lights	3,536 (75%)	586,725	3,862 (9.2%)	660,114
Total	4,729	779,773	4,816	806,738

4.1.2.1 Traffic Lights

Estimated CO_{2-e} Reductions in 2010 910 tonnes



The traditional lamps that are used in traffic lights are relatively powerful, incandescent lamps usually rated 65W and sometimes up to

150W depending on the application. They operate at high temperatures with frequent switching and as such require inspections replacement on a regular basis. More modern and energy efficient quartz halogen lamps are usually rated 35W. Approximately 50 % of the traffic lights have been already equipped with quartz halogen lamps resulting in reduction to corporate GHG emissions of 300 tonnes of CO_{2-e}.

Recent developments in Light Emitting Diode LED technology which has increased the brightness of diodes to a level sufficient to compete against traditional light sources such as incandescent lamps and even quartz halogen globes. This presents an opportunity for further dramatic reductions in energy consumption and resultant GHG emissions.

A comparative performance of different globe technologies is listed below:

- 67W Incandescent
- 35 W Quartz Halogen
- 10 W Light Emitting Diodes

The potential expenditure and GHG reduction potential resulting from changeover to LED fitting is illustrated by the table below:

Table 4.1.2.1 The potential expenditure and GHG reduction

Scenario	Power Demand kW	Annual Energy Use (cost)	CO _{2-e} Tonnes
Initial 107 standard incandescent sets	143.38	1,256,009 (\$193,048)	1,193.2
Present 50/50 I/QH	35,200 +73,700= 108.900	953,964 (146,624)	906
100% QH (in 5 years time)	70,400	651,744 (61,670)	610
100%	34,000	297,840 (\$29,784)	283

Along with lower energy costs, LED's are expected to last 10-15 years, many times the life expectancy of incandescent lamps in this application.

Demonstration Projects

In June 2000 the existing traffic lights serving the intersection of King William Street and North Terrace have been equipped with LED lamps on trial basis. It is envisaged that all traffic signalling lamps will be replaced with LED lights by the end of this decade resulting in GHG emissions reduction of 900 tonnes CO_{2-e}.

Recommended Measure

Progressively retrofit existing traffic lights with light emitting diode LED technology.
Estimated CO_{2-e} Reductions in 2010 *910 tonnes*

4.1.2.2 Street Lighting

Estimated CO_{2-e} Reductions / Increase in 2010 *0 tonnes*



Between 1994 and 1998 GHG emissions from traffic lights have decreased by 20%. These significant reductions have been achieved as a result progressive replacement of existing incandescent light globes with more energy efficient quartz halogen technology.

In contrast the expenditure, energy consumption ghg emissions from street lighting have increased by over 9% during the same period. Such increase is mostly a result of steady increase number of streetlights throughout the city. Refer to Table 4.1.2.2

Table 4.1.2.2 Increase in number of street lights

Area	Annual Energy Use/ Cost	GHG Emissions	Emissions Change 1994-1998
	kWh/\$	CO _{2-e} Tonnes	%
North Adelaide	1,145,208 \$179,417	1,088	12
South Adelaide	2,576,763	2,448	8
Total	3,722,071	3,536	9.6
Number of Lights	4,968		5,589 (12%)

It is envisaged that on *business as usual basis* (BAU) electricity consumption, expenditure, and greenhouse gas emission resulting from street lighting will continue to increase during this decade.

The City Lighting Strategy presents an excellent opportunity to potentially reverse the above unsatisfactory trend. The strategy could include the following recommendations:

- **Improve energy efficiency of existing and ensure energy efficiency of new street lighting systems**

A recent report '*Report on Energy Savings Opportunities in Street Lighting*' commissioned by Sustainable Energy Development Authority and Energy Efficiency Victoria recommended that the quality of street light-

ing can be significantly improved, and the energy consumption and resultant GHG emissions can be significantly reduced by a combination of:

- More efficient lamps (eg. Metal halide and compact/tubular fluorescent);
- More efficient lanterns (reflector design, less light loss in dif-fuser, more accurate light distribution without a reflector bowl);
- More efficient ballasts, especially electronic ballasts;
- More accurate control of lighting times (electronic photo-switch rather than the existing cadmium sulphide cells, to reduce lighting times by at least an hour per day

Street lighting should operate when it can make a contribution to visual amenity, and not when it can't. Street lighting control is achieved by photo-switches. The *standard* street lighting photo-switch uses a cadmium-sulphide cell. This device can be installed in the casing of a single lantern or can be used to control a group of lanterns.

The cadmium sulphide photo-switches have several disadvantages:

- they have a rated service life of only 7 years.
- they have a switch-off illuminance of three to five times the switch-on illuminance. This means that if the desired switch-on il-luminance is set correctly, the switch-off time will be significantly later than needed (adding about 15 minutes to the daily operating time).
- the switch-on setting is typically in the range 30 - 60 lux, which is much higher than the ambient illuminance at which the street light can make a contribution to vision. This unnecessarily adds about a further 20 - 30 minutes per day to burning time.
- the switch on setting drifts by about 10% per year, causing the lights to switch on even earlier and off later. By the end of the 7 year service life, the switch-on point and switch-off point will both have doubled. Again, this will add to unneeded burning time (about

another 15 minutes per day, averaged over the service life of the photo-switch).

- they consume about 2 Watts when the lights are turned off. This is not a large power draw, but it is unnecessary.

The maintenance savings alone justify the price premium of electronic photo-switches.

Assuming that replacing a photo-switch costs \$70 (\$50 for truck and labour, \$20 for call centre, purchasing and other administrative costs), the annual cost of standard and electronic photo-switches is:

Table 4.1.2.3 Cost benefits of electronic photo switches

Photo-switch type	Initial Cost	Useful Life	Total Replacement Cost	Photoswitch maintenance costs
	\$	Years	\$ each time	\$/year
Standard cadmium sulphide	9	6	79	13.17
Electronic	15	12	85	7.08

So electronic photo-switches are justified even without considering the benefits of energy savings and increased lamp life. An electronic photo-switch will reduce lantern burning time by an hour per day, and so will increase the interval between lamp replacement by about 10%.

The following is a comparison of the costs and benefits of a standard 80 Watt mercury vapour street lantern and the proposed 35 Watt metal halide light:

Table 4.1.2.3 Cost benefits of street lighting retrofits

Item	Units	Before	After
Fitting Type		B2224	Urban Minor
Lamp Type		Mercury vapour	Metal halide
Capital Cost		65	\$80
Photo- switch upgrade		0	\$6
Total Capital Cost		65	\$86
Power Input			
Lamp	Watts	80	35
	Watts	16	8
	Watts	96	43
Energy Use			
Burning Time	hours/year	4335	4000
Lantern	kWh/year	416	172
Photo-switch	kWh/year	9	0
Total	kWh/year	425	172
Reduction in energy use	%	n/a	60%
Annual Energy Cost	\$/annum	\$34	\$13.76
	\$/annum	n/a	20.24
Maintenance			
Initial cost premium			\$15
Annual return on initial premium	% pa		74%

Note 1 A medium term electricity price (weighted average peak and off-peak) of 8 cents/ kWh, including energy and DUOS and NUOS charges was used for these calculations.

The benefit of longer effective lamp life has not been included. The mercury lamp has a shorter *effective* life than a metal halide lamp, because it will reach an unacceptably low efficacy sooner. Of course, the mercury

lamp could be left in service for longer than a metal halide lamp, as it will often last many years without fading completely. However, its light output at that time will be unacceptably low and the quality of street lighting unacceptably poor.

□ **Use of Green Power and less greenhouse intensive electricity**

Under Green Power schemes, electricity customers can pay a small premium on their bill to have their electricity use offset by an equal amount of 'green' electricity. The 'green' electricity is sourced from clean renewable sources like solar, wind and hydro and is considered free of GHG emissions

In accordance with the latest advice from the South Australian Office of Energy Policy the Green Power Scheme will be operational in SA before the end of 2000 calendar Year. Sourcing of electricity with lower greenhouse intensity eg Wingfield landfill could also be worthwhile. This measure appears to be the most practical and cost effective way to reduce GHG emissions resulting from street lighting.

Although energy efficiency/greenhouse gas emissions issue is only one of many issues, which need to be taken into account. Identifying both environmental opportunities and potential pressures early will ensure an overall superior final outcome.

□ **Demonstration Projects**

The following renewable electricity generation projects have been identified in the 1999-2004 corporate plan action :

3.4.5 Undertake key demonstration projects:

- Powering Victoria square by solar power of an appropriate design from July 2000;

- Solar lights in parklands from September 2001.

Recommended Measure

Progressively improve energy efficiency of Street Lighting
Estimated CO_{2-e} Reductions/ Increase in 2010 *0 tonnes*

Note: Greenhouse gas emissions reductions resulting from utilising of Green Power are included in the total figure (4.2)

4.2 Less Greenhouse Intensive Electricity Sources

Estimated CO_{2-e} Reductions in 2010 *3,800 tonnes*

4.2.1 General

In 1998 the corporate operations including buildings, traffic lights and street lights used 127,746 GJ of energy. The table below shows contribution from electricity and natural gas and their respective greenhouse impact:

Table 4.2.1 Percentages of electricity and natural gas based energy used by the Corporate Operations

Energy Source	CO _{2-e}	CO _{2-e}	Energy	Energy
	tonnes	%	GJ	%
Electricity	20,670	88.6	78,329	61.3

Natural Gas	2,669	11.4	49,417	38.7
Total	23,339	100	127,746	100

Figure: 4.2.2 Percentages of electricity and natural gas based energy used by the corporate operations

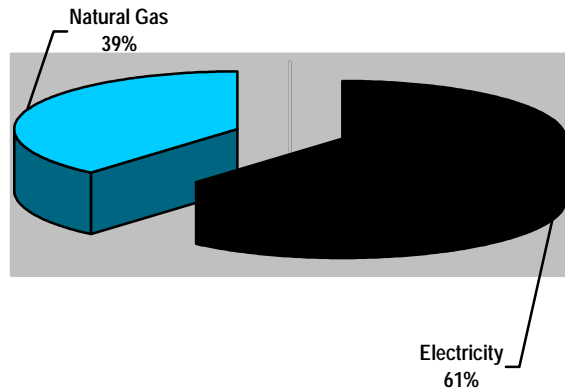
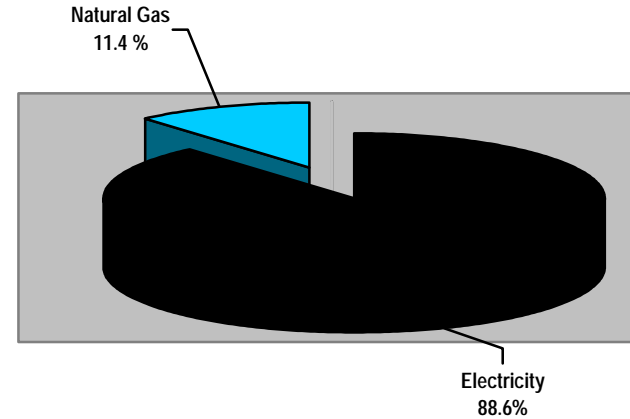


Fig 4.2.3. Greenhouse Gas Impact of Electricity and Natural Gas

The above pie charts demonstrate disproportionately high greenhouse impact of electricity in comparison with natural gas.

The reason for this is comparatively high greenhouse intensity of the existing electricity sources. The relative greenhouse intensity of electricity generation varies as follows:

Table 4.2.3 The relative greenhouse intensity of electricity generation

<i>Type of Power Station</i>	<i>Emission Coefficient</i>
	<i>kg CO₂/kWh</i>
Brown coal fired Port Augusta	1.1-1.2
Black coal fired	0.9-1.0
Gas fire single cycle (eg Torrens Island)	0.5-0.6
Electricity in SA (Used in Calculations)	0.95
Gas fired combined cycle (Pelican Point)	0.3
Cogeneration gas fired (eg Osborne)	0.2-0.4

Fuel Cell	0.2-0.4
Renewable Energy (eg wind, solar etc)	0

Clearly substantial gains can be achieved in working towards reducing the greenhouse intensity of the existing electricity supply. Realising this change is likely to be facilitated by ongoing transformation of electricity industry. The future electricity generation industry is likely to operate in the new changed environment

Stationary energy in 1997 accounted for 55% of net emissions and had increased by 2% above 1996 level and 15 % above those recorded in 1990. Electricity generation accounts for 90% of stationary energy. As such reducing the greenhouse intensity of electricity generation is potentially the most important issue in meeting the national greenhouse emissions targets. One of existing energy sources, which can have a substantial impact on emissions, is natural gas. Modern gas turbines are highly efficient, need little maintenance, and produce significantly lower carbon dioxide emissions. Gas, suits smaller decentralised electricity generation and its use can be extended as a micro-scale turbine technology (below 50 kW). One of the applications for gas is in urban-based cogeneration units. Like conventional industrial cogeneration, micro cogeneration modules produce electricity plus heat in the form of high or low temperature hot water, steam or warm air, and even cooling by means of indirect abortion, which can supply the individual house. Direct use of gas could provide greenhouse reduction of up to 470% over coal – fired electricity. Gas can also be used in fuel cells technology as a new source of cleaner energy generation

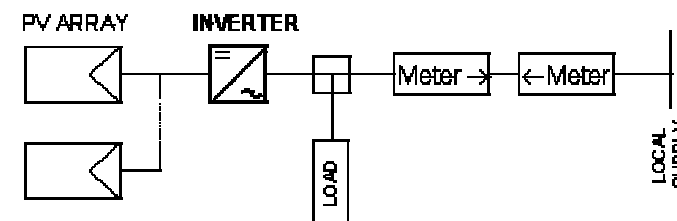
The greenhouse intensity of energy used by the corporate can be reduced by:

- Generating own renewable and low greenhouse intensive energy;
- Purchasing renewable and low greenhouse intensive energy.

4.2.3 Generation

Photovoltaic cells, known commonly as solar cells, convert the energy from sunlight into electricity. A range of cell technologies is available such as (eg monocrystalline, polycrystalline, amorphous) and has been technically proven over many years. A grid connected photovoltaic systems work by converting the energy from sunlight into direct current (d.c.) electricity. An inverter then converts this direct current to alternating current (a.c.), to make it compatible with grid electricity. As the system is always grid connected, batteries are not required to store energy for use when the sun is not shining. Photovoltaics (PV) offer added advantages over other renewable energy sources in that they give off no noise and require practically no maintenance. A simple schematic of a grid connected PV system is shown below:

Fig 1 A simple schematic of a grid connected PV system



The PV technology is the type of renewable electricity technology that can be mass deployed in both commercial and residential urban environment. Adelaide is one of the best locations in the world for photovoltaic installations. As a result of a relatively high solar flux, an identical photovoltaic cells array installed in Adelaide would generate twice as much electricity as compared with eg in Berlin.

Australia is a world leader in PV research and production. Two principal PV manufactures such as BP Solar and Solarex, have production facilities in

Australia. Together they manufacture around six megawatts of cells a year. Half are exported.

From 1 July 2000 the Commonwealth Government Photovoltaic Rebate Programme PVRP provides rebates for PV systems installed on certain community use buildings. Special requirements are to apply. Community use PVRP applications will be subject to an assessment of the educational and interpretative merits of the proposal. Applicants will need to specify, in detail, how they intend to satisfy these important criteria. Assessment of educational merit will be based on: the type or form of educational activity; the frequency of the activity and the numbers of people who will take part in activities. A standardised, weighted scoring system will be utilised to score applications and determine eligibility for rebate.

The PVRP programme for the community buildings has a minimum system size of 450-watt peak output.. Initially the rebates were capped at \$27,500 but due to unprecedented demand as from 1 October 2000, the rebates are payable at a rate of \$5.00 per peak watt, but generally capped at \$10,000 (2kW) unless exceptional circumstances apply.

The following renewable electricity generation projects have been identified in the 1999-2004 corporate plan:

4.2.2 Undertake key demonstration projects:

- *Wind and solar power generators at London Road Depot to contribute more to the electricity grid from December 2000;*

On 26 June 2000 Adelaide City Council has endorsed a proposal for a 5 kW solar photovoltaic system to be integrated into high profile corporation owned building within the City of Adelaide. It was postponed during council review on 6 June 2000. This proposal was based on PVRP rebate of \$27,500 which was available at that time. Due to unprecedented demand as from 1 October 2000, the rebates are payable at a rate of \$5.00 per peak watt, but generally capped at \$10,000 (2kW) unless exceptional circumstances apply. As a result this proposal is likely to be scaled down. Numer-

ous councils are already taking advantage of this opportunity including City of Burnside and City of Unley.

- *Powering Victoria square by solar power of an appropriate design from July 2000;*
- *Solar lights in parklands from September 2000;*

Two above proposal are being included in the City of Adelaide Lighting Strategy.

- *Solar panel art sculpture by July 2002*

Recommended Measure

<i>Progressively implement the renewable energy projects Identified in the City of Adelaide Corporate Plan</i>	
<i>Estimated CO_{2-e} Reductions/ Increase in 2010</i>	<i>20 tonnes</i>

4.2.4 Purchasing Green Power

Green power is a program that can effectively reduce greenhouse gas emissions. Under green power schemes, electricity customers can pay a small premium on their bill to have their electricity use offset by an equal amount of 'green' electricity. The 'green' electricity is sourced from clean renewable sources like solar, wind and hydro. This electricity from renewable sources replaces electricity that would otherwise have been generated by conventional means like fossil fuel fired power stations.

Already, Green Power accredited programs are available to 73 per cent of the Australian population and all residents of NSW, Victoria, Queensland and the ACT. At present an accredited Green Power program is not available in South Australia. South Australia is currently participating in the development of nationally consistent accreditation guidelines. A national accreditation scheme would allow retailers to offer the same green product in several States and would encourage large companies to sign up to green power products. In accordance with the latest advise the South

Australian Office of Energy Policy the Green Power Scheme will be operational in SA before the end of 2000 calendar Year.

It is envisaged that the City of Adelaide will source a part of its electricity demand as a Green Power. This would be a cost effective way of reducing greenhouse gas reductions. It would also provide a leadership to other large corporate greenhouse gas emitters located in the City of Adelaide.

Cost effectiveness of Green power in reducing corporate GHG emissions is illustrated by Table 4.2.4.

Table 4.2.4 Effectiveness of Green Power

Total Electricity Consumption	Total CO _{2-e} Emissions	Expenditure on electricity	Amount of Electricity Sourced as Green Power	Additional Cost of Green Power 4c/kWh	GHG Emissions Reductions CO _{2-e}	Cost of GHG Emissions Reductions
kWh	tonnes	\$	kWh	\$	tonnes	\$/tonne
24,802,500	23,562	2,303,114	2,480,500 (10%)	99,220	2,356	42.1
24,802,500	23,562	2,303,114	4,961,000 (20%)	198,440	4,712	42.1

24,802,500	23,562	2,303,114	3,684,953 (15%)	147,398	3,500	42.1
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The Green Power is a very cost effective greenhouse gas reduction tool. The average cost of emissions reduction varies between \$40-50 per tonne of CO_{2-e}. This compares very favourably with reductions achieved using eg solar photovoltaic technology costing \$6,900-8300 per tonne of CO_{2-e}.

City of Adelaide is already indirectly involved in generation of clean electricity at the Wingfield Landfill. The 16 GWh of electricity generated at Wingfield could satisfy more than 50% of corporate electricity needs.

Recommended Measure

Source part of corporate energy requirements as renewable and low greenhouse intensive electricity

Estimated CO_{2-e} Reductions/ Increase in 2010 3,800 tonnes

4.3 Vehicle Fleet

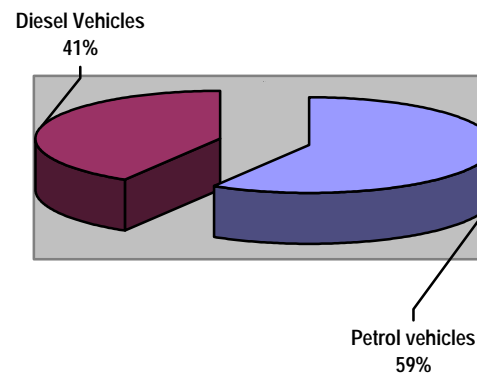
4.3.1 Strategy Rationale

The City of Adelaide greenhouse gas emissions from Corporate Fleet totalled 527 tonnes of CO_{2-e} in baseline year 1994. They have increased to 1,013 tonnes of CO_{2-e} in 1998. The significant increase in emissions was generally due to major plant and equipment upgrade/changeover as a result of moving Council Depot to from Halifax St to London Rd Mile End. The GHG emissions are forecasted to grow 1,430 tonnes of CO_{2-e} under a business as usual (BAU) scenario by 2010. The achievement of the 20% corporate reduction goal in this sector would require reducing ghg emissions to 422 tonnes of CO_{2-e} by 2010. This equates to 70 % reduction on (BAU) basis. Clearly such a goal does not appear to be realistic. Considering that vehicle fleet contribute only a relatively small percentage to total corporate ghg 1.6% a significant investment in this sector would not be cost effective. However several worthwhile and cost effective opportunities exist which

offer both ghg emissions reductions and financial savings. would show leadership to the wider community.

The existing corporate fleet includes both petrol and diesel engine driven vehicles and equipment. Passenger vehicles, some vans and motorcycles are fuelled by petrol. Heavy trucks, specialised heavy equipment, light trucks are fuelled by diesel.

Table 4.3 and figure 4.3 shows GHG contributions from different fuels. Petrol based emission contribute largest share of to vehicle emissions 58.7% followed by diesel 41.3%.



There are many approaches that may be taken to reduce the emission of greenhouse gases from corporate vehicles. The main two options include:

- **Replacing petrol and diesel with other fuels; and**
- **Substituting large vehicles with smaller, more efficient ones.**

Other approaches include:

- A reduction in total vehicle kilometres travelled (particularly the use of vehicles for short trips;
- Use of bicycles by field staff e.g. Compliance Department staff
- A reduction in the total number of vehicles in the corporate fleet;
- The implementation of staff car pooling schemes;
- An increase in vehicle fuel efficiency through driver education or improved maintenance.

Table 4.3 GHG contributions from different fuels

Type of vehicle/plant	GHG emission	Energy	Cost
	CO _{2-e}	GJ	\$
Petrol Vehicles	647	9,805	200,690
Diesel Vehicles	456	6,902	1
Total	1,103	16,707	341,953

Fig 4.3 GHG contributions from different fuels in %

4.3.2 Conversion of Petrol and Diesel Driven Passenger Vehicles to alternative fuels and technologies

Estimated CO_{2-e} Reductions in 2010 50 tonnes

Alternative fuels and technologies can be classified under two categories (NRMA,1998a)

- Current Cleaner Fuel and technology options, such as Liquefied Petroleum Gas (LPG), Compressed Natural Gas (CNG), ethanol and methanol;
- Future Ultra Clean Fuel and Technology Options, such as electric vehicles, hybrid electric vehicles, and solar power

Two most established and mature technologies in Australian technologies include LPG (Liquid Petroleum Gas) and CNG (Compressed Natural Gas)

4.3.2.1 Current Cleaner Fuel and technology options

4.3.2.1.1 Liquefied Petroleum Gas (LPG)



Liquefied Petroleum Gas (LPG) is the general name given to mixes of hydrocarbons, predominantly propane and butane, which enter a liquid state when compressed to about 8 times atmospheric pressure. The use of LPG instead of petrol offers some potential to reduce greenhouse gas emissions from passenger vehicles. LPG is environmentally friendlier, with up to 20% lower global warming potential, 15% lower carbon dioxide emissions. Other environmental benefits include 20% lower ozone (smog) forming potential, and 80% less harmful air toxic emissions compared to petrol.

The estimated ghg emissions reduction resulting from conversion of executive corporate vehicles from petrol to LPG are shown in Table 4.3.2.1.

Table 4.3.2.1 Potential greenhouse gas emission reductions (kg CO_{2-e}) due to converting executive corporate vehicles to LPG

Vehicle Model	Fuel Source		Reduction
	Petrol	LPG	

	Use	GHG emissions	Use	GHG emissions	
	L	Tonnes of CO _{2-e}	L	Tonnes of CO _{2-e}	Tonnes of CO _{2-e}
^{25x} Ford Falcon dedicated LPG	57,500	150	75,000	120	30

(i) Based of travel distance of 20,000 km

(ii) Most of emission would occur outside of the city boundary

(iii) Based on a US Dept of Energy Study of LPG lifecycle emissions. Global Warming Potential (GWP) considers all greenhouse gases emitted through the production and use of a fuel and considers their global warming potency as well as their life in the atmosphere. Results are expressed as CO₂ equivalents. This study indicates that LPG offers 20% reduction in GWP versus petrol.

Based on Green fleet estimate that 17 trees planted will absorb 4.33 tonnes of CO₂ during their lifetime.

An LPG fuelled engine increases the capital cost but the residual value of the vehicle is not affected by the conversion. Until recently the capital cost increase for factory fitted dual fuel vehicle was approximately \$ 2,200. This additional cost was considered as a major disincentive against choosing the LPG option. In a case of recently introduced **dedicated** LPG vehicles, the increase in capital cost has been reduced to approximately \$800. Consequently, the financial benefits available from opting for LPG vehicles are more evident. Table 4.3.2.2 demonstrates the reduction in fuel costs, which is possible through changing fuel source.

Table 4.3.2.2 Potential fuel cost savings (kg CO_{2-e}) due to converting larger executive corporate vehicles from petrol to LPG

Vehicle Model	Fuel Source				Annual Fuel Cost Savings	Payback
	Petrol		LPG			
	Fuel Cost per vehicle	Fuel Cost for 25 vehicles	Fuel Cost per vehicle	Fuel Cost for 25 vehicles	S	Months (Km)
6 cylinder vehicle dedicated LPG	2,208	55,200	75,000	120	24,450	10 (16,319)

Information provided in this table should be used as an approximate guide to the cost recovery of the LPG options. LPG option cost recovery will vary with accordance to fuel consumption, fuel cost vari-

ances and change in cost of LPG options.

Figures for Dual Fuel system assume vehicle is running solely on LPG.

^ Fuel consumption figures based on AS2877 tests for Falcon Forté 6-cyl auto sedan. Actual fuel consumption will depend on many factors, including your driving habits, the prevailing conditions and your vehicle's equipment, condition and use.

Results are based on the following prices: **96c/L for petrol and 41c/L for LPG.**

Approximately \$3000 per vehicle (\$75,000 per 25 vehicles) could be saved during the recently introduced 3 year changeover period.

Other perceived and anecdotal technical disincentives historically causing resistance to change have also been overcome. Some of them are summarised in Table 4.3.2.3

Table 4.3.2.3 Anecdotal technical disincentives

Alleged Problems	
Warranty	Factory fitted LPG options is currently offered by in Australia by Holden and Falcon where the supplied equipment is covered by the same warranty as the of the vehicle.
Operating vehicle on LPG results in lower level of power to that obtained using petrol.	This may have been true for older vehicles with an engine designed for petrol carburettors, but modern with electronic fuel injection engine management systems have addressed this deficiency. Modern LPG equipment has been designed to be compatible with the vehicle's engine management system so there is hardly any difference in performance
LPG vehicles have compromised boot space .	In a dedicated LPG vehicle the gas storage unit replaces the petrol tank. As a result the spare wheel is mounted in the boot. This allows the Dedicated LPG sedans to have more space than a Dual Fuel Sedan. Also the convenience of split fold rear seat is retained.



Higher Maintenance Costs.	As the LPG is release into the engine the pressure drops and the fuel vaporises again so that enters the engine as gas. This prevents it washing the lubricating oil from the inside of the cylinders, so that an engine that runs on LPG can expect a longer service life and reduced long term maintenance costs.

Progressive replacement of petrol driven executive vehicles with equivalent dedicated LPG vehicles would have the following benefits:

- Reduce corporate GHG emissions
- Demonstrate Council commitment and leadership to reduction of greenhouse gas and other emissions;
- Result in worthwhile financial savings;
- A changeover of executive vehicles (every 2-3 years) would boost number of LPG vehicles wider community.

Recommended Measures

Progressively replace larger executive corporate vehicles with LPG dedicated vehicles.

Estimated CO_{2-e} reductions in 2010

30 tonnes

4.3.2.1.1 Compressed Natural Gas CNG

□ Passenger Petrol Vehicles

Compressed natural gas (CNG) has been used overseas for automotive purposes but, despite having considerable reserves of natural gas, Australia has been slow to develop engines capable of running on CNG and the infrastructure to support them. Factory fitted fuel systems for CNG are not generally offered by passenger vehicle manufacturers in Australia. Several companies do so overseas, including Honda, Ford and Volvo. At the end of 1998, Australia had 1766 natural gas vehicles-half of them forklifts and only 437 passenger vehicles. The use of CNG instead of petrol offers good potential to reduce greenhouse gas emissions from passenger vehicles by

approximately 30%. Higher ghg emissions reductions (up to 47%) can be achieved with engines specifically designed to operate on CNG. Potential greenhouse gas emission reductions (kg CO_{2-e}) due to converting larger corporate vehicles from petrol to CNG.

Table 4.3.2.1.1 Potential greenhouse gas emission reductions (kg CO_{2-e}) due to converting corporate executive vehicles from petrol to CNG.

Vehicle Model	Fuel Source				Reduction
	Petrol		CNG		
	Consumption	GHG emissions	Consumption	GHG emissions	
	L	Tonnes of CO _{2-e}	L	Tonnes of CO _{2-e}	
25 x Holden VT Commodore	57,500	130	270,500	91	39

It is envisaged that the petrol to CNG technology will continue its progress in line with improvement in of the infrastructure (refuelling stations)..

Recommended Measures

Monitor progress petrol to CNG technology and improvements in infrastructure.

❑ **Conversions from Diesel to CNG**

Diesel engines are generally amenable to conversions to natural gas, in either dual or spark ignition mode. It is worth noting that several manufactures are committing to engines specifically designed for natural gas. These include: Daimler Chrysler, MAN, Mack-Renault, Scania, Detroit Diesel, Caterpillar and Cummins.

There are several fleets of heavy vehicles in Australia which currently operate on CNG:

- Sydney Buses currently operates 104 Scania CNG buses, is taking delivery of further 150 and has an option for an additional 150 CNG buses from Daimler Chrysler;
- South Australian public transport currently operates 110 MAN CNG buses and is having an additional 53 built by MAN;
- Cities of Unley in SA and Waverley in NSW have been trailing the use of CNG in Municipal Solid Waste collection trucks.

Compared to their diesel counterpart, natural gas engines emit much less pollutants from their exhaust. Some of the natural gas engines already meet the strictest emissions standards being proposed in the US and Europe.

The Table 4.3.2.1.2 shows CNG engine emissions reductions in comparison with a diesel engine.

Table 4.3.2.1.2 - CNG engine emissions reductions in comparison with a diesel engine.

Emissions type	Emissions Reduction
NO _x Nitrogen Oxides	65% less
CO carbon monoxide	45% less
NMHC non Methane Hydrocarbons.	60% less
PM Particulate Matter.	75% less
SO ₂ Sulphur Dioxide	95% less
Carbon Dioxide	10% less

Particulate Matter of <10µm (PM10) can be inhaled deeply into the lungs and has been linked to pneumonia, loss of lung function, asthma and other respiratory problems

At present the Corporation uses 200,000 L of Diesel which generate 456 tonnes of CO_{2-e}. Most of diesel is used is being used by 100 diesel engine powered vehicles. There are 26 vehicles weighting 3.5 tonnes and over.

Table 4.3.2.1.2 Potential greenhouse gas emission reductions (kg CO_{2-e}) due to converting of diesel fuelled vehicles to CNG

Vehicle Model	Fuel Source				Reduction
	Diesel		CNG		
	Consumption	GHG emissions	Consumption	GHG emissions	
	L	Tonnes of CO _{2-e}	L	Tonnes of CO _{2-e}	
All diesel vehicles	200,000	450	270,500	315	45

(i)Based on 10% CO_{2-e} reduction

Recently, a viability of conversions CNG of larger vehicles weighing 3.5 tonnes gross vehicle mass (GVM) or more has been substantially enhanced by the Commonwealth Government Alternative Fuel Conversion Programme.

This program commenced in January 2000. Commercial on-road vehicles and buses weighing 3.5 tonnes gross vehicle mass (GVM) or more are potentially eligible for grants under this program. The program focuses on the conversion, purchase or fuel systems upgrade of vehicles operating on compressed natural gas (CNG) or liquefied petroleum gas (LPG); Subject to environmental conditions, the program provides either:

- up to a 50 per cent grant to purchasers for the difference in the purchase price between new original equipment manufacture (OEM) vehicles and their conventionally fuelled equivalents;

- up to a 50 per cent grant towards the cost of converting vehicles to CNG or LPG; and
- up to a 50 per cent grant towards the cost of upgrading the fuel systems of vehicles already operating on CNG or LPG where a reduction of greenhouse gas emissions can be demonstrated.

\$15 million has been allocated to the program up to June 2001 and \$20 million in the subsequent three financial years.

Consequently an average payback period for conversions from Diesel to CNG has been reduced to less than two years. With current price differential between diesel and CNG substantial ongoing savings could be realised by taking advantage of this Federal Government initiative.

The Corporation of Adelaide in unique position of having CNG refuelling station in close proximity of it's London Rd Depot. An example confirming financial attractiveness of Diesel to CNG Conversion is included in Appendix 9.

□ Ethanol, Methanol Biodiesel

Other alternative fuel such as Ethanol, Methanol Biodiesel also offer potential ghg emissions reduction. They are not considered a viable options due to lack of appropriate infrastructure.

Recommended Measures

Monitor other alternative fuel options

4.3.4 Vehicle substitution

The substitution of a large engine capacity by one with smaller engine capacity, with associated savings in fuel consumption, will have obvious benefits in reducing greenhouse gas emissions. This measure should be directed towards smaller vehicles where factory fitted LPG/CNG are not available. Substituting the vehicles in the corporate fleet for, more fuel efficient vehicles is one of effective means of reducing the greenhouse gas emissions arising from corporate fleet operation. In order to maximise the benefits, in economic terms and on a lifecycle basis, vehicles should only be substituted when the vehicles are next due to be replaced. Table 4.3.4 rates the most popular models in each passenger vehicle class using information derived from ABARE Research Report 97.2. Vehicles have been ranked initially on the basis of greenhouse gas emissions which operating costs differentiate between vehicles with equivalent emissions. Greenhouse ranking of most popular models by greenhouse gas emission and running cost. It is expected that fuel efficiency of vehicles will continue to increase. Similar reductions are available by carefully choosing the heavy vehicles used in corporate operations.

Table 4.3.4 Greenhouse Ranking of Vehicles

Make/Model/Capacity	Fuel Use	Running Cost c/km	GHG emission Tonnes/year	Overall Ranking
Toyota Starlet Life, 1.3L	7.2	31.19	3.25	1
Mitsubishi Mirage 1.5 L	7.6	32.76	3.43	2
Mitsubishi Lancer Gli, 1.5L	7.6	40.52	3.43	3
Ford Festiva, 1.5L	8.0	31.74	3.61	4
Toyota Corolla 1.8L 8.5	42.30	42.30	3.84	5
Holden Vectra GL, 2.2L	9.5	44.0	4.29	6
Toyota Camry Csi,2.2L	10.0	45.92	4.51	7
Mitsubishi TH Magna Exec, 3.0L	10.5	49.41	4.74	8

Mitsubishi Verada Xi, 3.5L	11.0	68	4.96	9
Toyota Camry Csi V6, 3.0L	11.5	49.8	5.19	10
Ford AU Falcon, 4.0L	11.5	51	5.19	11
Holden VT Commodore Exec, 3.8L	11.5	51	5.19	11
Holden Calais VT 3.8L	11.5	69	5.19	13
Ford AU Fairmont Gia, 4.0L	12.5	68	5.64	14

(i) Running costs based on previous model, where necessary
(ii) Annual greenhouse emissions based on 20,000 km travelled

Recommended Measures

Include in the purchasing of vehicles the fuel/greenhouse efficiency criterion. Estimated CO_{2-e} reductions in 2010 5 tonnes

It should be kept in mind that the local action plan includes measure that will be current for at least 10 years. Many new vehicle models and fuel technologies will inevitably become available during that time, so it is important that the measures are revised frequently to ensure that the ultimate target is reached. In particular, the efficiency of CNG engines in Australia is certain to improve markedly in the coming years (based on overseas experience) so this option should be reviewed during entire life of the LAP.

4.4.1 Future Ultra Clean Technologies

The future ultra clean technologies include:

- **Electric**



The electrical vehicle technology is advancing rapidly as the vehicle manufactures seek to comply with the US Clean Air Act. General Motors, Honda and Ford have all recently released electric vehicles with performance that is equivalent to petrol models, although the range of such

vehicles is limited to 200-300 km before requiring recharging. Even with this range, electric vehicles are a viable alternative for movement of staff and materials between Council properties. The need to have the vehicle stationary for up to 8 hours during recharging is still one of the greatest impediments to broad market acceptance of electric vehicles. The use of electricity also causes greenhouse gas emissions at the point of power production, although a clear advantage of electric vehicles is that the emissions are not in urban areas or at the street level. There is potential for emissions to be reduced by using photovoltaic cells placed on the roofs of garages and other buildings. Green power could also be used for this purpose.

□ **Hybrid electric vehicles,**



A hybrid electric vehicle combines some of the advantages of an internal combustion engine with those of an electric motor, thus improving efficiency. Under urban conditions, with frequent stops and starts, a hybrid vehicle uses mainly electric power. The battery is recharged when the petrol engine starts automatically during stretches of uninterrupted driving. The use of a hybrid electric /petrol power eliminates the need to keep the vehicle stationary when recharging batteries. Overall petrol consumption and emissions are approximately halved due to the vehicle utilising electric power for most urban driving. The benefits of such hybrid systems have been recognised by several major car manufacturers, including Toyota, Ford, General Motors, Daimler Chrysler and others. First electric hybrid vehicles are available on the market overseas. Toyota Prius is expected to sell in Australia for approximately \$50,000. It is envisaged that competitively priced hybrid vehicles will be increasingly available later this decade. This will present an opportunity for corporations to include such vehicles in the corporate fleet.

□ **Solar Power**



Solar-powered cars are electric cars that use solar energy through photovoltaic (PV) cells. PV cells convert solar energy into electricity, which is used directly to power an electric motor or is stored in batteries. PV cells only produce electricity when the sun is shining so without sun, the solar-powered car must depend on the electricity stored in its batteries. The major impediment to the development of solar-powered vehicles remains the efficiency of the photovoltaic cells used to generate electricity. It is possible to build a one-seat vehicle out of lightweight materials which is capable of speeds equal to those of petrol-fuelled vehicles - but only at prohibitive cost. There are several ways in which solar power may be utilised other than directly powering a vehicle. The photovoltaic cells can generate power for sale into the grid and then recharging vehicles' batteries overnight using off-peak rates.

□ **Hydrogen vehicles**



Hydrogen vehicles which utilise hydrogen, generated by renewable energy, as an electricity source are effectively zero GHG emissions, with only steam and possibly, very small amounts of nitrogen oxide emitted from the exhaust pipe. Hydrogen can be used as a fuel source in different ways. It is possible to use the gas directly in a dedicated internal combustion engine or it can be used in an on-board fuel cell used to drive an electric motor. The use of fuel cells has been progressing rapidly to the stage where vehicles are expected to be available by 2004. Hydrogen has a substantially higher energy efficiency than either petrol or diesel, whether it is used directly or indirectly.

Recommended Measures

*Monitor availability of ultra clean technology
Trial a vehicle as high profile demonstration project
Estimated CO_{2-e} reductions in 2010 5 tonnes*

4.5 Waste Management

Rationale

The existing Solid Municipal management practices already contribute to net GHG emissions reduction through methane recovery and tree planting at the Wingfield Landfill. In accordance with the latest methodology solid municipal waste recycling programmes targeting materials with high embodied energy content could be developed to contribute to overall reduction of GHG emissions.

A brief summary of the summary of the US EPA is contained in the Appendix

What does municipal solid waste have to do with rising sea level, higher temperatures, and GHG emissions? For many wastes, the materials disposed by the community represent what is left over after a long series of steps including:

- Extraction and processing of raw materials;
- Manufacture of products;
- Transportation of materials and products to markets;
- Use by consumers; and
- Waste management

At virtually every step along this “life cycle” the potential exists for GHG impacts. Waste management affects GHGs by affecting one or more of the following:

- **Energy consumption** (specifically, combustion of fossil fuels) associated with making, transporting, using and disposing the product or material that becomes a waste.
- **Non-energy related manufacturing emissions**, such as carbon dioxide released when limestone is converted to lime (which is needed for aluminium and steel manufacturing)
- Methane emissions from landfills where the waste is disposed;
- **Carbon Sequestration**, which refers to natural or man-made processes that remove carbon from the atmosphere and store it for long time periods or permanently. A store of sequestered carbon (eg., a forest or coal deposit) is known as a carbon sink.

Management of municipal solid waste presents many opportunities for GHG emissions reduction. Source reduction and recycling can reduce GHG emissions at the manufacturing stage, increase forest carbon storage, and avoid landfill methane emissions. When waste is combusted, energy recovery displaces fossil fuel-generated electricity from utilities (thus reducing GHG emissions from the energy sector), and landfill methane emissions are avoided. Landfill methane emissions can be reduced by using gas recovery systems and by diverting organic materials from the landfill.

The United States Environmental Protection Agency published a report titled “ Greenhouse Gas Emissions from Management of Selected Materials in Municipal Waste. The findings of this report are discussed briefly below:

- **Sources reductions**, generally speaking represents an opportunity to reduce GHG emissions in a significant way. The reduction in energy – related from raw materials acquisition and manufacturing process, and the absence of emissions from waste management, combine to reduce GHG emissions more than all other options. On a per –tonne basis, the metals (eg aluminium cans and steel cans) have greatest emission reduction potential, due to primarily to reductions in energy use in the raw material acquisition and manufacturing step.

- **Recycling** generally has the second lowest GHG emissions. For most materials recycling reduces energy – related CO_{2-e} emissions in the manufacturing process (although not as dramatically as source reduction) and avoids emissions from waste management. Emissions reductions associated with recycling are due to several factors, including avoided waste management emissions and reduced process energy emissions. In addition, emission reductions from recycling paper products (when measured at the point of waste generation) are due in part to the forest carbon sequestration benefits of recycling paper.
- The net GHG emissions from combustion and landfilling are similar for mixed MSW. Because, in practice, combustors and landfills manage a mixed waste stream, net emissions are determined more by technology factors (e.g. landfill gas collection system efficiency, combustion energy conversion efficiency) than by material specificity.
- **Composting** is a management option for food scraps and plant debris. The net GHG emissions from composting are lower than land filling for food scraps (composting avoids methane emissions), and higher than land filling for plant debris (land filling is credited with the carbon storage that results from failure of certain yard trimmings to degrade fully in landfills). Overall, given the uncertainty in the analysis, the emission factors for composting or combusting these materials are similar. Because plant debris has a relatively low methane generation in landfills and a relatively high carbon sequestration coefficient, the net effect on greenhouse gas emissions of diverting it from landfill is a relatively small amount of methane emissions are avoided and a relatively large amount of CO₂ is release that would have been sequestered.

The potential effectiveness of greenhouse friendly Municipal Waste Management can be illustrated by the following examples:

- At an enterprise level, targeted recycling programs can reduce GHGs. For example, an enterprise that moves from baseline practice of landfilling to recycling 50 tonnes of office paper

and 2 tonnes of aluminium cans can reduce GHG emissions by over 100MTC

If the business implements an office paper recycling program, and annually diverts 10 tonnes of office paper (that would otherwise be land filled) to recycling, the GHG emissions are 13.5 MTCE/yr

Recommended Measure

*Solid Municipal Waste Strategy
Estimated CO_{2-e} reductions in 2010*

4.6 Carbon Sequestration – Sinks for CO₂

Greenhouse gas concentrations in the atmosphere can be limited by reducing the amount released to the atmosphere, and/or removing (or sequestering) greenhouse gases from the atmosphere. Sequestration projects often focus on increasing the amount of carbon stored in vegetation and soils. It is useful to distinguish between ‘sinks’, whereby carbon is actively removed from the atmosphere, and ‘reservoirs’ or ‘pools’, in which carbon is held or stored. Sequestration implies both removal and storage. Sequestering atmospheric carbon through vegetation management is important component of a long - term to the global climate change problem, but it will not prove sufficient without other measures. This is because there is a limit to how much carbon can be stored in vegetation on any given site and because areas available for renegotiation are substantial but finite.

Quantifying carbon stocks (the mass of carbon present in various compounds) in vegetation and soils is a technical undertaking, which requires a good deal of technical and scientific expertise, and commitment of resources. Nonetheless, the ability to measure and manage greenhouse emission will be increasingly important in the future. It may be of benefit to

commence building of understanding of issues involved, and building capacity to estimate carbon flows.

While no definitive guidance can be provided at this stage, it seems likely that a forestation and reforestation projects, undertaken since 1990, and involving land which has been under a different land use for an extended period, will produce sequestration which is countable during the first commitment period, provided that methodologies used for counting emissions and sequestration are not contrary to future relevant Conference of Parties or domestic decisions.

Emissions and sequestration relevant to management of existing forests, or plantations established before 1990, are currently not countable under the Kyoto Protocol.

Recommended Measure

Investigate opportunities and options for:

- *Planting trees in parklands to offset corporate emissions;*
- *Buying credits from rural SA.*

4.7 Carbon Trading

The Federal Government has not made a decision on the establishment of a national emissions trading system and the potential incorporation of carbon credits in such a system. There is consequently no official system currently in place that provides carbon credits to owners of businesses, forest plantations etc,

which could potentially be sold or banked in an emissions trading system. Internationally key decisions on these matters are expected to be taken at the sixth session of the Conference of Parties to the United Nations Framework Convention on Climate Change in the Hague in November 2000.

Emissions trading, if introduced, would be based on an emission permit - a tradeable instrument - that provided the holder with authorisation to emit a specified amount of greenhouse gas - most likely expressed as one tonne of CO_{2-e}. Carbon sinks could be incorporated into a national emissions trading system by issuing a 'carbon credit' for each tonne of CO_{2-e} sequestered in a Kyoto forest. Such credits would be tradeable instruments, and could be used interchangeably with emission permits in any emissions trading system. Participation in a carbon credit trading system could be voluntary - in terms of registering to be incorporated into the system for the crediting of sequestered carbon - and based on whether it was viable given the individual's particular set of circumstances. The Commonwealth Government could issue a carbon credit to the owners of sequestered carbon equal to the change in the carbon stock that is verifiable as having been sequestered in the years of the commitment period, 2008 to 2012 for Kyoto forests.

Uncertainty about the rules that will apply with regard to international trading of emission allowances, sequestration and the clean development mechanism couple with the general uncertainties associated with forecasting the future to make the prediction of probable permit prices a difficult task. Some emission permit price predictions have arisen from studies that employ various mathematical models. They do however tend to overstate the potential permit prices (given the assumptions they employ) suggesting a range of permit price predictions, from \$10/tonne to \$50/tonne CO₂). Carbon credits would have to be below the permit price for them to be an attractive alternative strategy.

Corporation is a relatively small emitter on its own but through its participation in CCP™ it is well positioned to take an advantage of partnership with other Local Government and private sector emitters.

Globally, private companies have already begun to engage in emissions trading. These private companies are proceeding regardless of the risk that some traded emissions may not be credited under currently emerging emissions trading schemes. Their main current interest is in reducing emissions early and promoting the development of the emissions trading mechanism.

Several examples of recent trades are listed in the table 4.7.

	system of group-wide emissions trading as a central tool to deliver its GHG target (made in September 1998). According to BP Amoco, emissions trading offers the incentive and the opportunity to fulfil the obligation in a commercial and efficient manner.	tonnes of CO ₂ total were traded internally	
Consortio Noruego and the Government of Costa Rica	This Norwegian Consortium, named Consortio Noruego, is collaborating with the state-owned power utility in Costa Rica in planning the construction of a small hydropower plant on the Virilla river near the country's capital. Electricity from the plant will replace that currently produced by diesel-fuelled plants and therefore contribute to a reduction in CO ₂ emissions.	4 million tonnes of CO ₂ over a 20 year period	1999
Sumitomo	This Japanese trading house announced that it would help a Russian power generation group, the United Energy System, reduce its emissions in 28 power plants. Sumitomo agreed to provide natural gas plants to replace the current coal-burning stations, starting from 2000. This is to reduce CO ₂ by 10 million tonnes per year.	Reduction of CO ₂ by 10 million tonnes per year	1998
Pacific Power	On June 18, 1998, Pacific Power's trade with State Forest of New South Wales will result in almost a quarter of a million tonnes of carbon dioxide emissions from the atmosphere over a 10-year period.	25 million tonnes CO ₂ over a 10-year period	1998

Recommended Measures

Monitor progress, on development of both national and international carbon trading sytem.

Table 4.7. Examples of recent trades in carbon credits

Company	Description	Traded	Year
BP Amoco	Starting January 1st 2000, BP Amoco launched a	49,000	2000

5.0 COMMUNITY GREENHOUSE GAS REDUCTION STRATEGY

Introduction

The greenhouse gas emissions reduction strategy is a blueprint for putting together a set of effective and practical measures to reduce the greenhouse gas emissions generated by the City of Adelaide community. When implemented, the greenhouse emissions reduction strategy will enable City of Adelaide to meet the greenhouse gas reduction goals set as part of the Cities for Climate Protection™ Programme.

The City of Adelaide Community emissions totalled 1,021,615 tonnes of CO_{2-e}. The Building and Transport Sectors contribute most of the emissions; 578,524 tonnes of CO_{2-e} and 443,318 tonnes of CO_{2-e} respectively.

In accordance with the Cities for Climate Protection™ methodology buildings are grouped into three categories Commercial Residential and Industrial. The commercial buildings contribute over 50% to total city emissions and 90% of overall building sector emissions. Clearly, in order

to meet the overall Community GHG emissions reduction Goal substantial reductions from the commercial part of the building sector are critical.

There are however worthwhile reduction opportunities available in two remaining building sub-sectors, particularly within the Residential Building Sector.

Transport Sector is the second most significant emitter of greenhouse gases. At present time some opportunities exist to reduce GHG emissions this sector. It envisaged that as a result of technological progress

more opportunities will become available in the second part of this decade (i.e. low emissions and no emissions vehicles).

The existing Solid Municipal management practices already contribute to net GHG emissions reduction through methane recovery and tree planting at the Wingfield Landfill. In accordance with the latest methodology solid municipal waste recycling programmes targeting materials with high embodied energy content could be develop to contribute to overall reduction of GHG emissions.

Fig 5.0 Community GHG Emissions Reduction Strategy

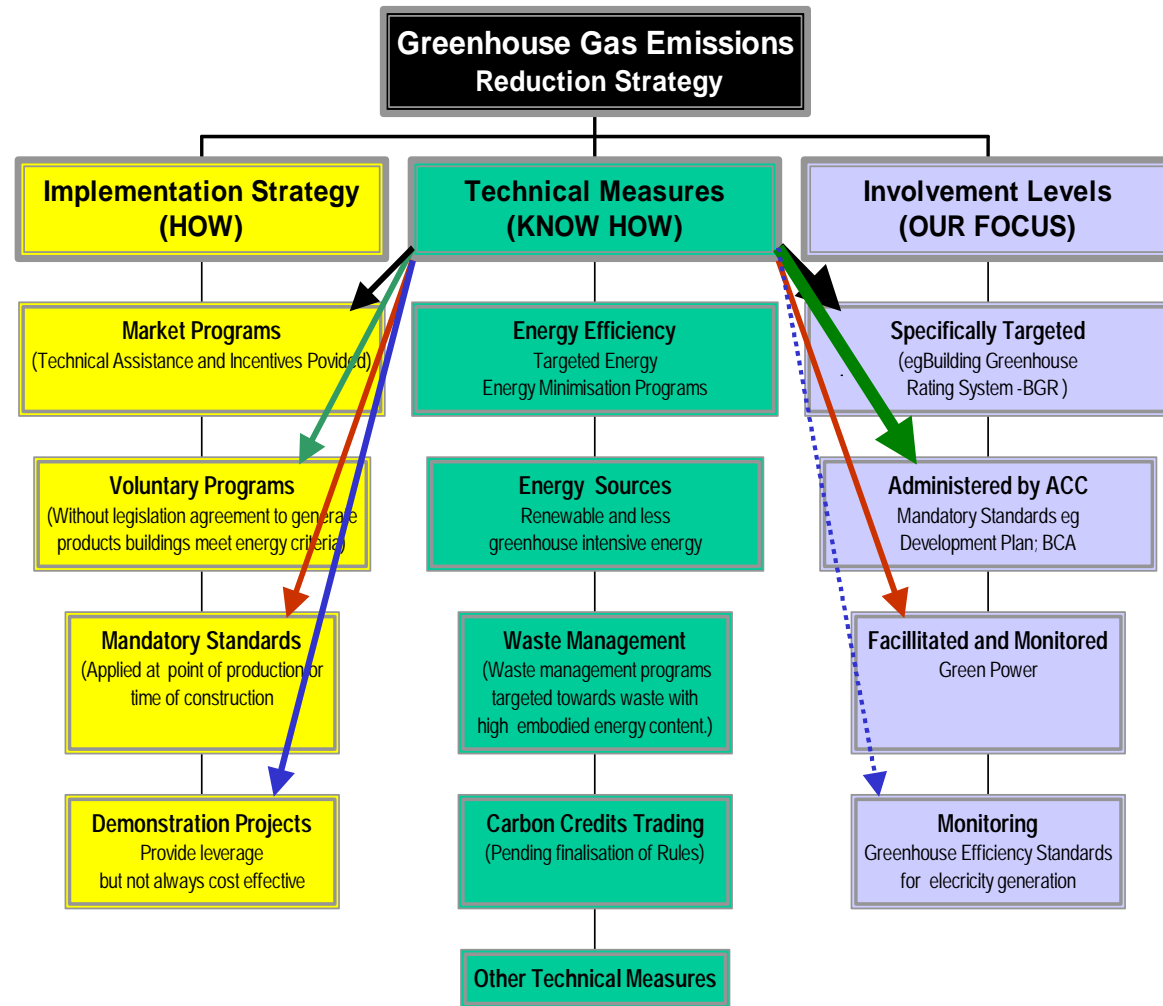


Table 5.0 provides a broad sectoral summary of estimated GHG emissions reductions.

Table 5.1 Community GHG Emissions Reduction Measures Summary

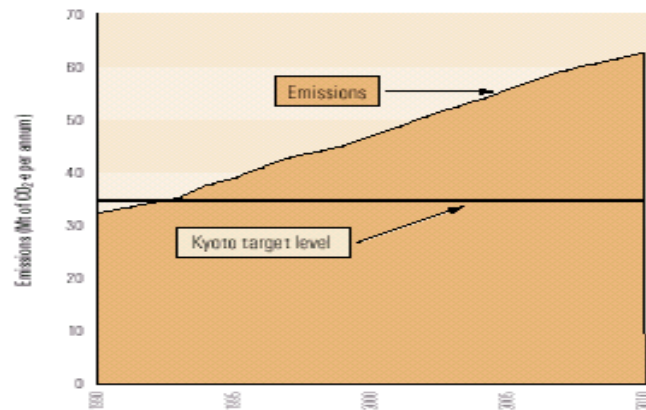
Action/Measures	Reduction of GHG Tonnes CO _{2-e}		Rationale/Comments
	2000-2004	2004-2010	
Commercial Building Sector	70,642	184,191	<p style="text-align: center;">%</p> <p><i>Space cooling (28%), ventilation (22%) and lighting (21%) are the three most significant causes of emissions, together accounting for 71% of the total. Also Office and Other Use contribute 12% to total emissions. In order to achieve the best Greenhouse Gas abatement outcomes energy reduction strategies should focus.</i></p>
Residential Building Sector	2,000	3,500	<p><i>In terms of end use share, electrical appliances and equipment dominate greenhouse gas emissions in 1999, accounting for some 55% of the total. Water heating is the next most significant with 29% followed by space heating (7%) cooking (5%) and space cooling (4%). The above data indicates that the greenhouse abatement measures directed towards domestic appliances and hot water generation are of primary importance</i></p>

Transport	5,000	12,500	<p>Passenger vehicles contribute the far largest share of transport emissions 86.5% followed by light commercial vehicles 11.2%. Contributions from trucks and public transport is insignificant by comparison.</p>
	77,642	200,191	
Total	277,833		

5.1 GHG Emission Reduction Strategy from Commercial Building Sector - Rationale

Australian commercial buildings consume about \$4 billion a year in lighting, air conditioning and power and are responsible for producing about 47 million tonnes of CO_{2-e} annually. By the year 2010 the greenhouse gas emissions from commercial buildings are expected to increase to 62.8 million of tonnes of CO_{2-e} annually. This presents 94% increase from the Kyoto Protocol baseline year of 1990 emissions of 32.2 million of tonnes of CO_{2-e}. The forecast of National GHG Emissions from Commercial Building Sector is illustrated by Chart Figure 5.1.

Fig 5.1 Forecast of National GHG Emissions from Commercial Building Sector



The GHG emissions from City's of Adelaide commercial building sector are expected to grow at a slower rate and reach 620,000 tonnes of CO_{2-e} under a business as usual (BAU) scenario by the target year 2010. The achievement of the 10% community reduction goal in this sector would result in 471,886 tonnes of CO_{2-e} emissions by 2010. This equates to 23.9 % reduction on (BAU) basis. Even a more significant reduction in this sector is likely to be required if the nominated GHG reduction goal is to be achieved.

The attainment of the Community goal will necessitate considerable GHG emissions reductions from all three commercial buildings sub sectors:

- **Private commercial buildings;**
- **Government and institutional buildings; and**
- **The City of Adelaide property portfolio.**

Two broad technical greenhouse gas abatement strategies have been identified:

- **Reducing energy consumption in existing and new buildings;**
- **Increased use of renewable and less greenhouse intensive energy sources.**

5.1.1 Targeted energy use minimisation in existing and new buildings

The commercial building sector is a large consumer of energy. In 1998 the consumption including electricity and natural gas exceeded 2,860,000 GJ .This energy consumption resulted in emissions of 524,318 tonnes of CO_{2-e}. Considering that at present city businesses spend approximately \$80 million Dollars on electricity and gas, it is estimated that reducing energy expenditure within the City by 20% would result in the annual efficiency dividend of 16 Million Dollars.

The building sector is characterised by a diverse array of energy end users and varying sizes and types of building shells. Numerous technologies and measures have been developed nationally and internationally especially over the past two decades, which can lead to significant GHG emissions reductions. They can be classified into three main groups:

- Deployment of efficiency technologies aimed at reducing energy use in **building equipment** (appliances, cooling and heating systems, lighting and all plug loads including office equipment);
- Reducing cooling and heating losses through improvements in building **thermal integrity**; and
- Urban design and land-use planning that facilitates lower energy use patterns and reduce **urban heat island**.

5.1.1.1 Energy Use and GHG Emissions from Building Equipment

Figures 5.2 and 5.3 show the proportions of energy use and greenhouse gas emissions respectively caused by energy applications within the commercial building sector.

Fig 5.1.1 Commercial building energy share by end use (EMET 1999)

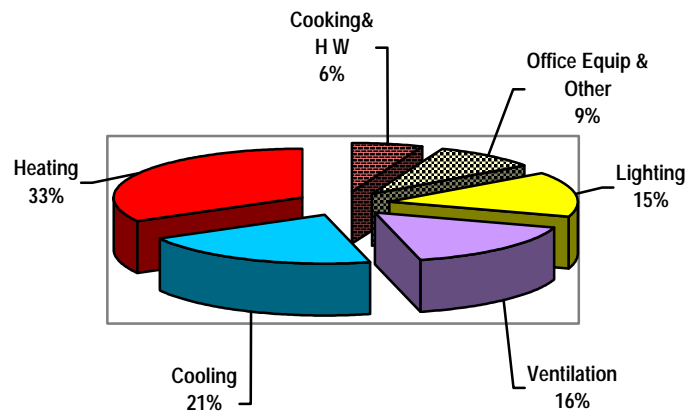
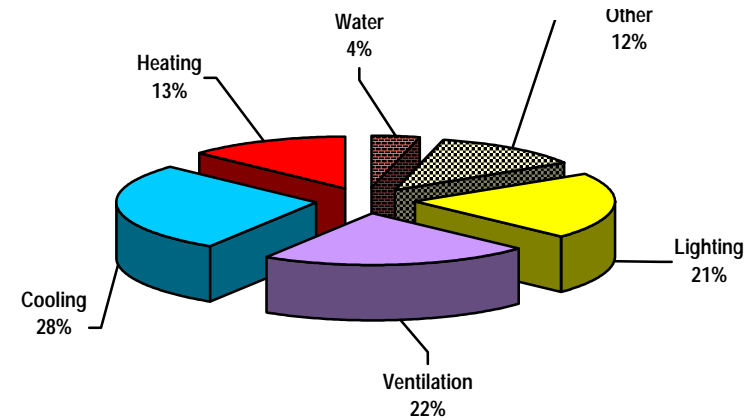


Fig 5.1.2 Commercial building GHG emission share by end use (EMET 1999)



In greenhouse gas emissions terms *cooling (28%), ventilation (22%) and lighting (21%)* are the three most significant causes of emissions, together accounting for 71% of the total. Also *Office and Other Use* contribute 12% to total emissions.

In order to achieve the best Greenhouse Gas abatement outcomes energy reduction strategies should focus on these areas in the first instance.

5.1.1.2 Building Thermal Integrity

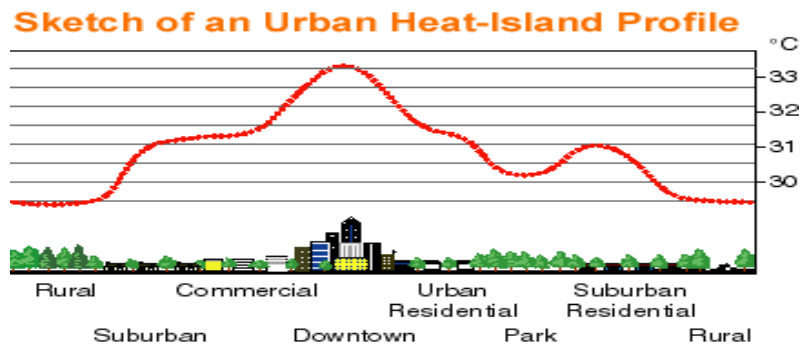
Although commercial buildings tend to be internal – load dominated, important energy savings opportunities exist in the design of the building envelope. Considerably larger energy savings opportunities are possible for new buildings than for the existing ones.

5.1.1.3 Urban Heat Island.

Higher temperatures in urban heat islands bring with them increased energy use, mostly due to a greater demand for air conditioning. As power plants burn more fossil fuels, they increase

both the pollution level and energy costs. Reducing Urban Heat Island (UHI) effect within the city boundaries will assist in overall reductions of greenhouse gas emissions.

Fig 5.2.3 Urban Heat Island Effect



5.2.2 Energy Use Minimisation Measures

<i>Estimated CO₂e Reductions in 2010</i>	<i>,000 tonnes</i>
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A myriad of measures have been developed and some implemented over the past two decades both nationally and internationally with the goal of putting into practice energy efficiency in the building sector. The general policy measures can be grouped into four main categories:

- **market based programmes** in which equipment manufacturers building owners/tenants/managers are provided with technical support and /or incentives;
- **voluntary energy standards** where manufacturers and builders agree (without government -mandated legislation) to generate products or construct buildings that meet defined energy use criteria. (Can serve as a precursor or alternative to mandatory standards;

- **mandatory energy efficiency standards** applied at the point of manufacture or at the time of construction; and
- **development and demonstration programmes** for the development of more efficient practices, products.

5.2.2.1 Market Based Programmes

<i>Estimated CO₂e Reductions in 2010</i>	<i>9,500 tonnes</i>
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Market-based programmes, which provide incentives to promote increased use of energy-efficient technologies and practices are estimated to result in global carbon emissions reductions of about 5% of projected building emissions by 2010, and 5-10% by 2020. Some of these market based programmes are already available and it is envisaged that more will come on stream. A number of energy efficiency programmes exists nationally and internationally. They are supported by both government and private sector agencies. Partnering in such programme will leverage ability of City of Adelaide to achieve its GHG reduction goals. Three of such programmes are described in some details.

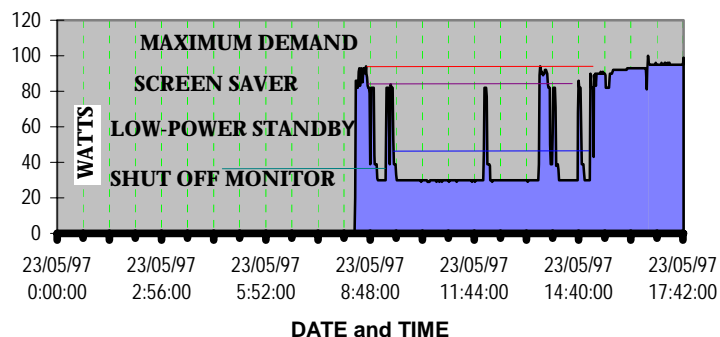
An excellent example of a market based programme is the **National ENERGY STAR Programme**



The National ENERGY STAR Programme is a co-operative energy efficiency program between State, Territory and Federal government agencies in Australia to promote the use and purchase of ENERGY STAR office equipment.

An ENERGY STAR (ES) computer, monitor, fax machine, photocopier or printer is designed to automatically reduce the amount of power it uses whenever it is left idle for a period of time. The Fig 5.2.4 illustrates operation of ENERGY STAR enabled personal computer.

Fig 5.2.4 An ENERGY STAR computer, monitor, fax machine, photocopier or printer is designed to automatically reduce the amount of energy it uses whenever it is left idle for a period of time



It has been estimated that if all the compatible computers in Australia were ENERGY STAR enabled it would reduce greenhouse gas emissions by over 2 million tonnes of CO_{2-e} and save companies and households more than \$200 million in energy costs per year.

There are approximately 90,000 people working in Adelaide CBD. Say if only 10,000 compatible computers in Adelaide were ENERGY STAR enabled it would reduce greenhouse gas emissions by over 3,000 tonnes of CO_{2-e} and save businesses over \$600,000 per annum.

The cost of achieving ENERGY STAR efficiency levels is estimated by the manufacturers to be negligible, while the cumulative direct cost of funding the ENERGY STAR Program is also relatively low. This measure therefore would save the community worthwhile amounts of energy with negligible expenditure.

The City of Adelaide has already been recognised as a leader within the local government implementation of Energy Star programme on its corporate computer network. It has been estimated that when fully

implemented this would reduce GHG emissions by 200 tonnes of CO_{2-e} and electricity costs by \$30,000. The City of Adelaide is in an excellent position to become a partner of the National ENERGY STAR programme and facilitate its implementation throughout its the city of Adelaide business community.

Recommended Measure and Estimated Outcome

Become a partner of the National ENERGY STAR programme and facilitate its implementation throughout its the city of Adelaide business community.

Estimated CO_{2-e} Reductions in 2010 *6,000 tonnes*

□ **Standby Power Losses Minimisation**

Standby power is the minimum power used by a device while connected to the mains power supply, or alternatively is the energy used by an appliance when plugged in but not performing its principal function. Electricity used by appliances in standby mode accounts for approximately 8% of domestic household electricity usage in Australia. This equates to of electricity each year generating \$400m worth around 4 million tonnes of carbon dioxide. This is equivalent to the greenhouse impact of approximately one million cars.

Reduction in standby power losses results in a win-win situation - greenhouse gases are reduced while consumers reduce their electricity costs.

The amount of electricity consumed by some appliances in standby mode is often startling. For example, some compact stereos use about 40 watts while playing a tape, yet use 27 watts in standby mode. Some of the newer technology, such as television set-top boxes used for pay TV, use only marginally less power in off mode than in on.

Australia's response to standby power consumption is coordinated jointly by Commonwealth, State and Territory Governments. Australian governments have recently adopted a one-watt standby target for all products. Consequently, policies are designed that ensure that the maximum standby power consumption of all appliances manufactured in or imported into Australia is one watt.

The standby power losses minimization measures are primarily directed towards domestic sector, substantial reductions are available in commercial buildings with high domestic appliance densities such as hotels.

Recommended Measure and Estimated Outcome

Become a partner of the National Stand By Power programme and facilitate it's implementation throughout the City of Adelaide commercial building sector.

Estimated CO_{2-e} Reductions in 2010 *1,500 tonnes*

□ **Energy Efficient Exit Signs**



Another example of a market based programme which can achieve city wide reductions in energy use is through **Retrofitting of existing buildings with new generation energy efficient exit signs.** For the past 20 or so years, Emergency Exit luminaries have traditionally used fluorescent lamps and conventional inverters to provide indication of egress paths out of buildings. All these fittings are required, by AS 2293, to be operational 24 hours a day. Each Exit fitting not only has a maintained fluorescent tube (typically a 10-Watt tube) but also a battery charger, which provides a constant trickle charge to the battery. One current technology uses 13.6 Watts (max) in a typical operation. Older luminaries, however, use between 16 and 22 Watts of power in continuous operation. A lot of energy is simply wasted as heat from low efficiency components. The power consumed by these fittings, especially those of

older technologies is not insignificant.. A medium sized building with 50 Exit signs could have a 1 kW continuous operation resulting in cost of \$ 1,100 annual expenditure. In addition all 10 watt tubes have a limited life; the very best are only rated for 7000 hours (about 10 months) continuous operation. The fluorescent tubes, require regular tube changes to meet current building safety requirements. These above problems are being are being addressed by exit sign manufactures through introduction of new technologies such as:

- Cold cathode tube technology

A cold cathode tube does not have energy consuming filaments, it has advantages over a standard fluorescent tube in both life expectancy and energy consumption. A 3 - watt cold cathode tube produces the same amount of light as a 10 W fluorescent tube. The typical life expectancy of cold cathode tube is between 3 & 5 years. Combining this with modern charging circuitry produces a fitting that would consume significantly less energy, perhaps only half energy consumption of current technology.

- Light Emitting Diode LED technology

An LED Exit Sign operates on less than 5 watts per face, using 50% less energy than a typical exit sign. Each year, just one LED exit sign can reduce GHG emissions by 83.2 kg of CO_{2-e} and save about \$10-\$15 in electricity costs when compared with the typical signs.

Recommended Measure and Estimated Outcome

Facilitate introduction and become a partner of the Energy Efficient Exit Signs programme and facilitate it's implementation throughout it's the City of Adelaide business community

Estimated CO_{2-e} Reductions in 2010 *1,000 tonnes*

❑ **Other Market Programmes**

Recommended Measure and Estimated Outcome

Monitor, assist introduction, and become a partner in suitable energy efficient programmes and facilitate their implementation throughout it's the city of Adelaide business community.

Estimated CO₂e Reductions in 2010 *2,000 tonnes*

5.1.2.2 Voluntary Standards

Estimated CO₂e Reductions in 2010 *35,000 + tonnes*

Voluntary energy-efficiency standards, where manufactures, building owners or developers agree (without government mandated legislation) to generate products or construct buildings that meet defined energy use criteria. They can serve as a precursor alternative or supplementary to mandatory standards. Based on expert estimate global greenhouse gas emissions reduction could range from 10-50% (or even more if combined with strong incentives) of reductions from mandatory standards. Voluntary measures have the potential to produce worthwhile levels of GHG abatement. They need to be accompanied by programmes of awareness and education. It has been estimated that nationally voluntary measures in commercial building sector can achieve greenhouse gas reductions up to 12 Million tonnes of CO₂e.

An excellent example of a voluntary programme tailored for commercial building sector is the recently launched:

❑ **Building Greenhouse Rating Scheme**

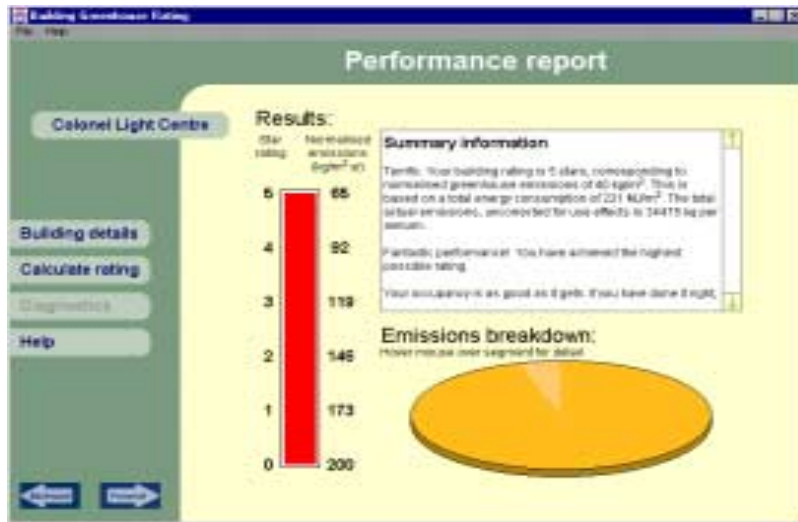


The Building Greenhouse Rating System (BGR) is a voluntary greenhouse star rating scheme designed to harness opportunities for greenhouse gas reduction in the Commercial Building Sector. The 'Building Greenhouse Rating Scheme' has been developed by Exergy Group and BRANZ for the Sustainable Energy Development Authority of NSW (SEDA). It enables an accurate assessment of building's 'greenhouse' performance and benchmarking against other buildings. The Building Greenhouse Rating (BGR) provides an accredited comparison between the greenhouse intensity of commercial buildings, by awarding a star rating on a scale of zero to five.

A building with a good star rating is energy efficient and therefore emits low levels of greenhouse gases. It has a competitive advantage in the real estate market because of ongoing cost savings for building owners and tenants. With the star rating prospective buyers and tenants of commercial buildings can identify and compare the greenhouse performance and saving potential of commercial buildings.

The BGR recognises and rewards property owners and managers that meet higher greenhouse rating, through the incorporation of energy efficiency features in the construction, or refurbishment of commercial buildings. The BGR rating is assessed on simple readily available information and the BGR scheme is supported by specially designed software tool, which makes the rating process relatively straightforward. The software also includes a diagnostic to help identify which areas of a building could be improved to enhance energy performance and subsequent BGR rating. This rating software is free, and can be used by building owners, managers, tenants or designers to self assess any building's energy performance and potential rating. For a formal BGR rating and licensed use of the BGR logo a building owner would need to have building rating checked by a appropriately accredited assessor.

Fig 5.1.2.2 Building Greenhouse Rating Scheme Software



Recommended Measure and Estimated Outcome

Facilitate introduction and become a partner of the Building Greenhouse Rating Scheme and facilitate its implementation throughout its the City of Adelaide business community.

- Facilitate introduction of the BGR to South Australia
- Provide the BGR software on ACC Website
- Utilise ACC GIS to promote BGR
- Consider rebates for high performing buildings
- Rate Corporation Buildings using BGR system
- Commitment to adding one star to on corporate buildings

Estimated CO_{2-e} Reductions in 2010 30,000 tonnes

It is envisaged that other voluntary programmes will become available in the future eg programmes developed and supported by the Australian Building Energy Council (ABEC)

Recommended Measure and Estimated Outcome

Facilitate introduction and become a partner of the : and facilitate its implementation of other effective voluntary programmes throughout its the Adelaide property sector.

Estimated CO_{2-e} Reductions in 2010 5,000 tonnes

5.1.2.3 Regulatory Measures

Estimated CO_{2-e} Reductions in 2010 20,000 tonnes

Mandatory energy efficiency standards implemented through appropriate levels of government enact specific requirements that all buildings constructed and products manufactured meet defined energy use criteria. These are an important regulatory option for commercial buildings and such standards have the potential to yield the largest reductions in this sector. The major advantage of regulation over a voluntary regime is that it provides for greater certainty of outcome and can ensure comprehensive coverage (avoiding any potential “free-riding” problems). Internationally, the regulatory measures proved to be 2-10 times more effective than the voluntary standards in reducing energy use and the resulting GHG emissions.

The cooling and heating equipment have lifetimes of 15-30 years while appliances are replaced over slightly shorter time periods of 10-20 years. These quick turnover rates mean that inefficient equipment can be relatively rapidly replaced with more efficient equipment that meets established new standards. Buildings however more typically last between 50 and 100 years. Depending on the stringency of the standard levels it has

been estimated internationally that mandatory standards applied to energy using equipment in buildings and building envelopes could result in global greenhouse gas reductions of 5-10 % of projected buildings-related emissions by 2010. and about 10-15% by 2020 and about 10-30% by 2050.

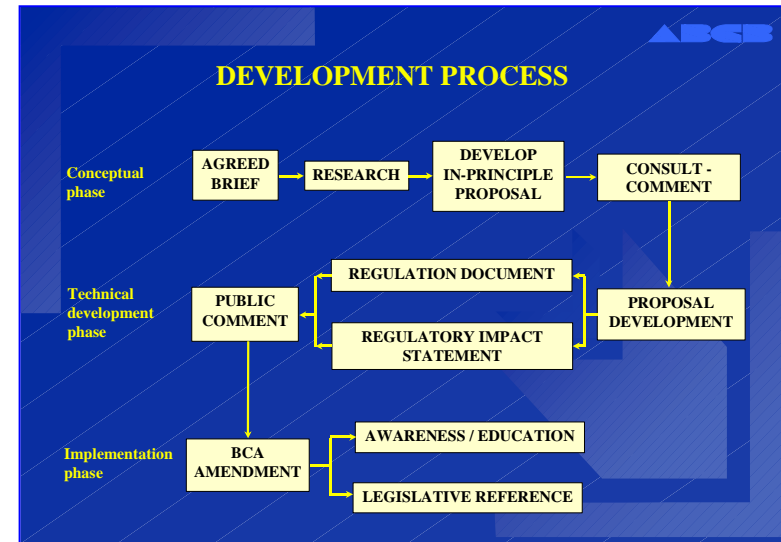
At present there are no mandatory energy performance standards for commercial buildings in Australia. In March 1999 the Ministerial Council on Greenhouse and the building sector agreed upon a comprehensive strategy to make Australia's buildings more energy efficient.

The recently published *Scoping Study of 'Minimum Energy Performance Standards for Incorporation in the Building Code of Australia'* made the following recommendations:

- The nationally recognised document, the Building Code of Australia is the natural place for minimum energy performance requirements of new buildings and major requirements;
- It is feasible to introduce minimum energy performance requirements into the BCA; and
- The minimum energy performance of all buildings of Classes 2-9 should be specified except for some building types in Classes 7 and 8.

The Federal Government and the States and Territories have lately agreed to found introduction of the energy efficiency requirements into the Building Code of Australia (total cost \$3 - 4 M over 5 years). The Development Process is illustrated by the flowchart below:

Figure 5.1.2 BCA Energy Efficiency Requirements development Flow Chart



A directions paper for the development of the project for both types of buildings will be published in April 2001. Priority will be given to the housing sector due to the various State variations that exist at present. It is intended that a Regulatory Document (RD) and Regulatory Impact Statement (RIS) will be circulated within 12 months following the directions paper (April 2002). Amendment to the Volume Two of the BCA Housing provisions is expected to take a further 12 months (April 2003) with amendments to Volume One of the BCA relating to commercial buildings 18 months later (October 2004).

It has been estimated that the changes to the BCA could produce an annual ghg emissions reduction of 3 Mt of CO_{2-e} nationally. This translates to 5,000 between 2005-2010 in Adelaide CBD scenario. More significant impact of BCA provisions is expected in decades beyond 2010.

It is envisaged that upgrading of existing buildings will remain voluntary and that the Building Greenhouse Rating BRG or similar will be an appropriate tool in making progress in this area.

Recommended Measure and Estimated Outcome

Facilitate introduction of the energy efficiency provisions into the BCA and become one of the approving authorities of thee and facilitate it's implementation throughout it's the City of Adelaide business community.

Estimated CO_{2-e} Reductions in 2010 *5,000 tonnes*

Assuming successful incorporation of the 'Minimum Energy Performance Standards for in the Building Code of Australia' by middle of this decade, the expected GHG emissions reductions by the year 2010 are estimated at 20,000 tonnes of CO_{2-e}

5.1.2.4 Demonstration Projects

Worthwhile medium to long term benefits can be expected from demonstration projects involving advanced technologies. Although not always cost competitive, demonstration projects can show a leadership, increase market share educate a community and contribute to GHG reduction objectives.

It would be prudent if the demonstration projects were directed toward the most significant causes of GHG emission in the commercial building sector together accounting for 71% of the total namely:

- *Space cooling (28%),*
- *ventilation (22%) and*
- *lighting (21%)*

Particularly lighting has been identified as the most significant area of application for greenhouse gas emissions abatement initiatives with an reduction potential of up to 70%.

One of the potential demonstration projects which fulfil the above criteria is recently completed (August 2000) refurbishment of the Mezzanine Floor in Adelaide City Council Administration Centre CLC Building. Main energy efficiency features in this retrofit include:



- Innovative air-conditioning system 'Active Chilled Beam System (ABC). Engineering analysis showed that this system is more energy efficient than variable or constant volume systems;
- State of the art lighting system including T5 Triphosphor lamp technology 8.3 W/m² (previous system 24 W/m²);
- Managed Lighting System control system including ultrasonic movement sensors and automatic dimming;
- Improved BMS system;
- Energy efficient Exit Lights and Emergency Lighting.
- Enabled Energy Star office equipment

Preliminary assessment of the performance of newly installed systems indicate that GHG emissions reductions in excess of 50% are feasible.

It is envisaged that the very successful energy efficient retrofit of the mezzanine floor will provide will be used as template in retrofitting of remaining floors of the CLC building.

The above project has a substantial greenhouse gas reduction potential through replication throughout Adelaide CBD and as such should stand a good chance to obtain a financial support from the Australian Greenhouse

Office through recently announced *Emissions Reduction Incentive Module (ERIM)*.

Recommended Measure and Estimated Outcome

Complete Energy Efficient Retrofit of the Colonel Light Building.	
Estimated CO_{2-e} Reductions in 2010	1,000 tonnes

5.1.2 Increase use of Renewable and Less Greenhouse Intensive Energy Sources - Rationale

In 1998 *Stationary energy* contributed 56.8% of national emissions in 1998 compared with 53.4% in 1990. This sub sector includes emissions from electricity generation, energy produced by the manufacturing, construction and industrial sectors, and emissions from other sources like domestic heating. Australian stationary energy accounted for 56.8% of net emissions and had increased by 2% above 1997 level and 17 % above those recorded in 1990. Electricity generation accounts for 90% of stationary energy. *Electricity generation* accounted for most of the stationary energy emissions at 168.6 Mt. This was 37.0% of national emissions. Emissions from electricity generation increased by 30.6% between 1990 and 1998 with the greatest increase of 10.3% between 1997 and 1998. The amount of *electricity generated* nationally increased by 6.1% from 1997 to 1998. In the same period, the amount generated by power stations using brown coal increased by 11.5%.

The emission intensity emissions produced per unit of electricity for brown coal is about 5% higher than for black coal and 83% generated) of higher than for natural gas.

As such reducing *the greenhouse intensity* of electricity generation is potentially the most important issue in meeting the national and local greenhouse emissions targets.

Stationary energy contributed 58.3 of City of Adelaide Community emissions compared with 56.6% in 1994. In 1998 the City of Adelaide Community used 2,218,763 GJ of electricity and 641, 168 GJ of natural gas. This can be translated to 585,509 (94.4%) and 34,623 (5.6%) tonnes of CO_{2-e}. The following table and charts below show contribution from electricity and natural gas and their respective greenhouse impact:

Table 5.1.2 Electricity and natural gas supplied to the City of Adelaide and their Greenhouse impact

<i>Energy Source</i>	<i>CO_{2-e}</i>	<i>CO_{2-e}</i>	<i>Energy</i>	<i>Energy</i>
	<i>tonnes</i>	<i>%</i>	<i>GJ</i>	<i>%</i>
Electricity	585,509	94.4	2,218,763	77.6
Natural Gas	34,623	5.6	641,168	22.4
Total	620,132	100	2,859,931	100

Fig 5.1.2 Share of electricity and natural gas supplied to the City of Adelaide

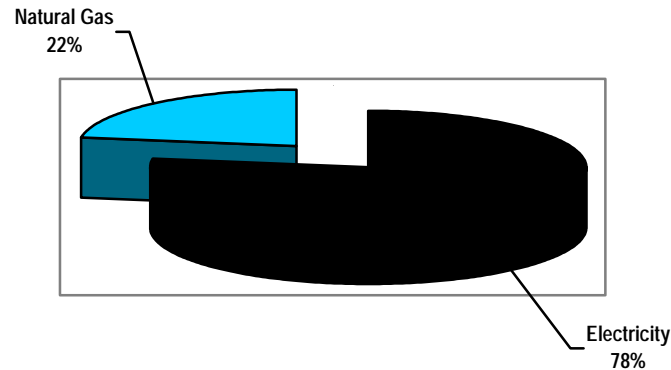
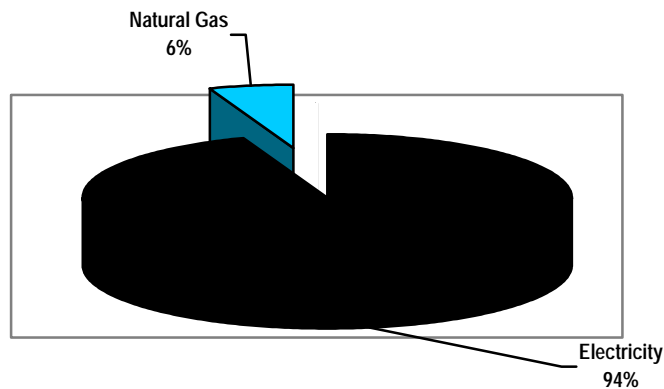


Fig 5.1.3 Greenhouse Gas Impact of Electricity and Natural Gas



The above pie charts demonstrate disproportionately high greenhouse influence of electricity in comparison with natural gas. The reason for this is comparatively high greenhouse intensity of the existing electricity

sources. The relative greenhouse intensity of electricity generation in South Australia varies as follows:

<i>Type of Power Station</i>	<i>Emission Coefficient</i>
	<i>kg CO₂/kWh</i>
Brown coal fired Port Augusta	1.1-1.2
Black coal fired	0.9-1.0
Gas fire single cycle (e.g. Torrens Island)	0.5-0.6
Cogeneration gas fired (eg Osborne)	0.2-0.4
Pelican Point Power Station (dual cycle)	0.3
Electricity in South Australia (Used in CCP™ Inventory Calculations)	0.95
Fuel Cell	0.2-0.4
Renewable Energy (eg wind solar)	0

Clearly substantial gains can be achieved in working towards reducing the greenhouse intensity of the stationary energy used in by the Adelaide Community.

A strategy aimed at reducing carbon intensity of energy used within the City of Adelaide will focus on three main areas:

- Supply of renewable and less greenhouse intensive electricity into the City;
- Generation of less greenhouse intensive electricity within the City itself including natural gas and renewable energy using. (Decentralising electricity generation);
- Encouraging substitution of electrical energy with other direct energy sources eg natural gas. Direct use of gas could provide greenhouse reduction of up to 470% over electricity generated in coal fired power stations (eg Gas hot water versus electric hot water).

Realising this change is likely to be assisted by ongoing transformation of electricity industry both globally and nationally. The future electricity generation industry is likely to operate in the new changed environment:

Traditional electricity supply system can be described as centrally managed supply system, reliant on a large scale coal-fired and hydro generation. Regulatory and legislative impediments discriminate against independent power producers and provide no incentive for end use efficiency. Environmental impact is high, the financial condition of the system is often uncertain and supply is unreliable. Conventional generation technologies reach maturity and are unable to deliver further cost reductions.

The direction in which electricity generation is moving in many parts of the world is highly decentralised system with virtually all electricity sourced from either old hydro plants or distributed generators, using a wide array of different low greenhouse intensive technologies, some reliant on natural gas (fuel cells, combined cycle generating turbines, cogeneration) and some renewable. Energy retailers are becoming energy service companies, supplying customers with electricity, gas and high efficiency equipment for both fuels. Several large coal-fired and nuclear power stations are likely to become unused and unwanted.

The ongoing transformation of electricity industry is expected to create numerous opportunities to enhance environmental performance of electricity generators.

5.1.2.2 Greenhouse Intensity Minimisation - Policy Measures

<i>Estimated CO_{2-e} Reductions in 2010</i>	<i>216,000 tonnes</i>
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The general policy measures can again be grouped into four main categories:

- **market based programmes;**
- **voluntary energy standards;**
- **mandatory energy efficiency standards;**
- **development and demonstration programmes.**

5.1.2.2.1 Market Based Programmes

<i>Estimated CO_{2-e} Reductions in 2010</i>	<i>195,100 tonnes</i>
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-  An excellent example of a market based programme is the **Green Power programme**

Green Power is a programme that can effectively reduce greenhouse gas emissions. Under green power schemes, electricity customers can pay a small premium on their bill to have their electricity use offset by an equal amount of 'green' electricity. The 'green' electricity is sourced from clean renewable sources like solar, wind and hydro etc. This electricity from renewable sources replaces electricity that would otherwise have been generated by conventional means like fossil fuel fired power stations. Green Power has been widely available in NSW since April 1997. Green Power accredited programs are available to 73 per cent of the Australian population and all residents of NSW, Victoria, Queensland and the ACT. Under the National Green Power Accreditation Program a green Power generator is defined as 'an electricity generator that results in greenhouse gas emissions reduction, net environmental benefits and is based primarily

emissions reduction, net environmental benefits and is based primarily on a renewable energy resource. The major renewable electricity generation types include:

- Solar Photovoltaic and Solar Thermal Electric Systems
- Wind Turbines
- Wave and Tidal Power Stations
- Geothermal Power Stations
- Hydro-Electric Power Stations
- Biomass-Fired Generators

At present an accredited Green Power program is not available in South Australia. The South Australian Government is committed to It is envisaged that the large corporate private sector and government greenhouse gas emitters located within the City of Adelaide boundaries will follow lead of their interstate counterparts. South Australia is currently participating in the development of nationally consistent accreditation guidelines. A national accreditation scheme would allow retailers to offer the same green product in several States and would encourage large companies to sign up to green power products. Already the introduction of the national electricity market means that some customers can choose from a range of retailers. In accordance with the latest advise the South Australian Office of Energy Policy the Green Power Scheme will be operational in SA before the end of 2000 calendar Year. More information on Green Power Scheme is included in the Appendix.

Recommended Measure and Estimated Outcome

<i>Facilitate introduction and encourage participation by the City of Adelaide Business sector in Green Power market.</i>	
<i>Estimated CO_{2-e} Reductions in 2010</i>	<i>160,000 tonnes</i>

- Less greenhouse intensive electricity

Similar program based on low carbon intensity electricity generation (eg combined cycle natural gas could also developed in collaboration with utilities).

The availability of lower greenhouse intensity electricity in South Australia will be enhanced by the following very significant low greenhouse intensive energy projects:

- Pelican Point - Stage 1 and Stage 2 (487 MW combined cycle gas turbine plant scheduled for completion in March 2001.
- Ladbroke Grove Power Station (40MW gas fired unit is scheduled to come on line early in 2000).
- Osborne 2 (440 MW gas fired power station is in planning stage);
- Re-powering of the existing Torrens Island Power Station is expected to create 390 MW combined cycle gas turbine Power Station is planned for completion in September 2004.;
- The developer of the Pelican point Power Station National Power is evaluating additional 300 MW station Pelican Point 2.

Considering that the installed capacity in South Australia is 2,589 MW the above new developments have potential to lower significantly greenhouse intensity of electricity generated in this State. It is also feasible that electricity products with specific greenhouse emissions coefficient will be provided by electricity retailers.

<i>Facilitate introduction and encourage participation by the City of Adelaide Business sector in Clean Power market.</i>	
<i>Estimated CO_{2-e} Reductions in 2010</i>	<i>35,000 tonnes</i>

5.1.2.2.2 Voluntary Standards

<i>Estimated CO_{2-e} Reductions in 2010</i>	<i>10,000 tonnes</i>
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- **Electricity Labelling**

- **Renewable Energy**

Solar photovoltaic (PV) power is a simple, reliable and commercially proven technology; which converts sunlight directly into clean electricity. Solar photovoltaic's is the only renewable electricity technology that can be mass deployed in the urban environment. Most of the building electricity is used between 9am to 5pm and there is an excellent correlation between the electricity produced by solar photovoltaics and a building's electricity demand. Solar powered buildings are usually connected to the electricity grid so that surplus solar electricity can be exported and any deficit in supply can be imported from the grid. Solar photovoltaic panels can be substituted for existing building materials such as facades, glass roofing, parapets and incorporated into new or existing buildings.

The objectives of the project would be to demonstrate the future possibilities for grid-connected installations to obtain performance data for the Adelaide CBD area and to gain competitive advantage in this emerging industry. The installation of a grid-connected PV system within the Adelaide CBD would highlight the potential of photovoltaics to form an important part of the Cities energy mix. It will also demonstrate the ease at which such systems can be established on the unused 'solar platforms' provided by the huge areas of roof space in the central business districts in most major cities.

Funding support could be sought from the Federal Government Rebate Program Photovoltaic Systems on Community Use Buildings

It is envisaged that prices of photovoltaic will continue their decline and efficiency will keep on increasing. In this scenario it may be more cost effective to intensify PV cells in the second part of this decade.

- **Low Greenhouse Intensive Energy**

One of the existing energy sources, which can have a substantial impact on greenhouse gas emissions in medium term is natural gas. Modern gas turbines are highly efficient, need little maintenance, and produce signifi-

cantly lower carbon dioxide emissions. Gas, suits smaller decentralised electricity generation and its use can be extended as a micro-scale turbine technology (below 50 kW). Like conventional industrial cogeneration, micro cogeneration modules produce electricity grid connected electricity plus heat in the form of high or low temperature hot water, steam or warm air, and even cooling by means of indirect absorption, which can supply the individual house.

Gas can also be used in fuel cells technology as a new source of clean energy generation. Once the exclusive high tech domain of NASA scientists, fuel cells are set to become a common energy technology. Operating quietly and extremely efficiently, fuel cells have no moving parts as they chemically convert a variety of fuels including natural gas, hydrogen and methane among others - into electricity and heat without any actual combustion.

Because of their flexibility with fuel, their very low emissions, high efficiency and their modular nature, fuel cells are going to be able to deliver energy services in places and at times when simply nothing else can.

A large number of researchers believe that the real opportunity for integrating fuel cells into non-polluting energy systems of the next century will involve using hydrogen to produce electricity on demand. Exhaust from the process would be useful heat, steam, small amounts of water and relatively very low levels of carbon dioxide.

At present cost of a 200kW fuel cell system is \$5000 per kW. Installing such system in lieu of diesel stand by generator is likely to make it more cost effective.

A financial support may be available through the Australian Greenhouse Office Abatement programme.

Recommended Measure and Estimated Outcome

*Develop partnerships with between property owners, manufactures and utilities to facilitate installation of fuel cell technology.
Expected outcome 1,000 tonnes of CO_{2-e}*

5.1.3 The Embodied Energy

of a material is the energy consumed, directly or indirectly, to produce that material. The embodied energy represents a significant proportion of a

building's total life cycle energy consumption and hence its contribution to greenhouse gas emissions. In two recent studies, embodied energy emissions were found to be approximately 8% to 10 % total lifecycle emissions of commercial buildings. This was the proportion found in studies of four actual buildings assuming a 40 year lifespan. This proportion would vary substantially for different building types, and for those using less operation energy eg schools, warehouses. Furthermore, it is possible to envisage situations where the introduction of a feature that saves operating energy will increase the embodied energy, so that the net outcome in terms of life cycle energy or greenhouse gas emissions is not as clear cut as might at first appear. Thus a complete assessment of the greenhouse gas impact of buildings must ultimately include embodied and operating energy on a life cycle basis. Research in embodied energy is ongoing and suitable tools for assessing its contribution to a building's life cycle energy are not yet available.

5.2 GHG Emission Reduction Strategy From Residential Building Sector - Rationale

Australian residential buildings consume about \$5billion a year in energy costs. As a result residential buildings are responsible for producing about 50 million tonnes of CO_{2-e} annually. The greenhouse gas emissions from residential buildings are expected to increase to 56.7 million of tonnes of CO_{2-e} annually by the year 2010. This presents 17% increase from the Kyoto Protocol baseline year of 1990 emissions of 48.6. million of tonnes of CO_{2-e}.

The City of Adelaide greenhouse gas emissions from Residential Building Sector are expected to grow at a faster rate and reach 49,197 tonnes of CO_{2-e} under a business as usual (BAU) scenario by 2010. This presents 33% increase from the baseline year of 1990 emissions of 36,991 of tonnes of CO_{2-e}. The achievement of the 10% community reduction goal in this sector would result in 33,2911 tonnes of CO_{2-e} emissions by 2010. This equates to 47.8 % reduction on (BAU) basis. It is worth noting that currently the residential building sector contributes only 3.6% to overall emissions and its share is predicted to increase to only to 4% by the year 2010. However there are worthwhile greenhouse gas reduction opportunities within this sector which can assist in achieving of the overall GHG reduction Goal. The following types of buildings are included in this sector:

- Detached and attached dwellings;
- Flats and apartments

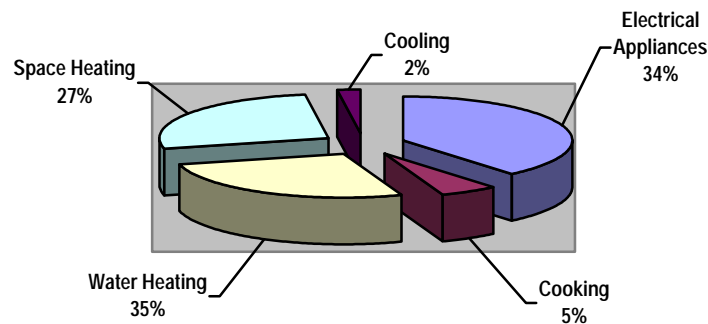
Two main strategic greenhouse gas abatement strategic approaches are the same as in commercial building sector and include:

- Reducing energy use by existing and new buildings;
- Increased use of renewable and less greenhouse intensive energy sources.

5.2.1 Reducing energy consumption by existing and new buildings

Figures 5.2.1 and 5.2.2 show the proportions of energy use and greenhouse gas emissions respectively caused by energy applications within the residential building sector.

Fig 5.2.1 Residential buildings energy share by end use (SAOEP 2000)

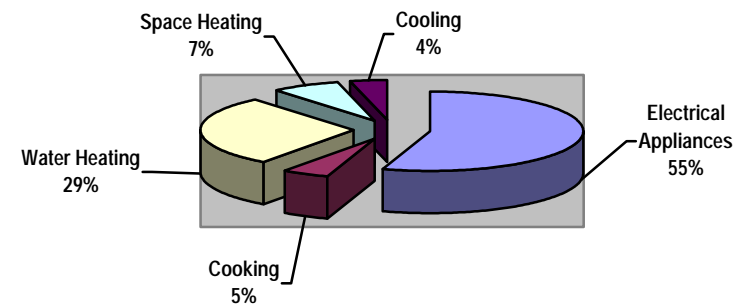


In energy terms, water heating is the largest single end use in the residential buildings sector at 35% followed by Electrical Appliances and Equipment 34%. In terms of GHG emissions Electrical Appliances and equipment accounts for 55% share followed by Hot Water 29%. Relatively low carbon intensive combustion of natural gas is used for hot heating is used widely in residential buildings.

In terms of end use, electrical appliances and equipment and water heating are responsible for 34% and 35% of energy consumption in residential buildings respectively. Space heating is the next biggest end use accounting for 27% of energy consumption followed by 5% for cooking and only 2% for space cooling.

By far, electricity is the major source of greenhouse gas emissions in South Australia accounting for about 87% of residential emissions. This high figure is the combined result of a high energy consumption share (52%) combined with the high greenhouse gas intensity of electricity generated in South Australia. Natural Gas is the only other significant contributor to greenhouse gas emissions. Whilst natural gas accounts for 33% of energy use, it only accounts for a further 12% of greenhouse gas emissions in SA.

Fig 5.2.2 Residential buildings greenhouse gas emission share by end use (SAOEP 2000)



In terms of end use share, electrical appliances and equipment dominate greenhouse gas emissions in 1999, accounting for some 55% of the total. Water heating is the next most significant with 29% followed by space heating (7%) cooking (5%) and space cooling (4%).

The above data indicates that the greenhouse abatement measures directed towards domestic appliances and hot water generation are of primary importance.

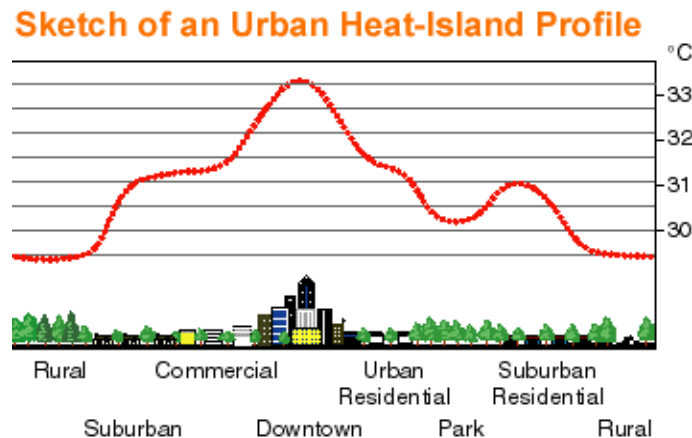
5.2.1.1 Building Thermal Integrity

Whilst prescriptive measures are relatively easy to implement, by their nature they tend to be unsophisticated and their use often results in lost opportunities especially in respect of the principals of passive solar design. In Victoria, for example, there are numerous houses that, despite meeting the mandatory insulation requirements, exhibit poor thermal performance due to poor orientation, lack of shading and or lack of winter solar access, all design aspects that often represent a zero incremental cost in most cases. The higher the overall thermal performance standard desired, the more likely a performance based measure will produce the most cost effective outcome for the consumer.

5.2.1.2 Urban Heat Island.

Higher temperatures in urban heat islands bring with them increased energy use, mostly due to a greater demand for air conditioning. As power plants burn more fossil fuels, they increase both the pollution level and energy costs. Reducing Urban Heat Island (UHI) effect within the city boundaries will assist in overall reductions of greenhouse gas emissions.

Fig Urban Heat Island Effect



According to studies conducted by the US Department of Energy at Lawrence Berkeley National Laboratories in Berkeley, California, mitigation strategies for the reduction of urban heat island conditions could save five to ten billion dollars in energy costs annually within the United States.

5.2.2 Energy Use Reduction Policy Measures

<i>Estimated CO_{2-e} Reductions in 2010</i>	<i>5,000 tonnes</i>
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The general policy measures can be grouped into four main categories:

- Market based programmes in which householders, building owners, manufacturers, developers are provided with technical support and/or incentives;
- Voluntary energy standards;
- Mandatory energy efficiency standards applied at the point of manufacture or at the time of construction; and
- Development and demonstration programmes for the development of more efficient practices, products.

5.2.2.1 Market Based Programmes

<i>Estimated CO_{2-e} Reductions in 2010</i>	<i>2,500 tonnes</i>
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Some of these market based programmes are already available and it is envisaged that more will come on stream.

Develop Market Based Programme aimed at Solar Hot Water

<i>Estimated CO_{2-e} Reductions in 2010</i>	<i>100 tonnes of CO_{2-e}</i>
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Stand by Power Losses

Actions/Recommendations

Develop and/or Monitor

5.2.2.2 Voluntary Standards

<i>Estimated CO_{2-e} Reductions in 2010</i>	<i>200 tonnes</i>
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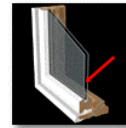
An excellent example of a Voluntary Standards programme is the



Windows Energy Rating Scheme:

The Window Energy Rating Scheme (WERS) is an excellent example of government and industry working in partnership to address the greenhouse problem. Up to 40% of energy is lost through windows in typical Australian home. W.E.R.S. rates the energy impact of residential windows in housing anywhere in Australia.. It will inform the consumer about the suitability of a window product for their particular climate and the location of their home. W.E.R.S. is a new window energy rating scheme that is being implemented by the Australasian Window Council with the support of the Australian Greenhouse Office. The Window Energy Rating Scheme is independent of any one manufacturer. W.E.R.S is a fair, rigorous and credible system for rating the thermal (energy) performance of windows.

The energy rating of a window will be displayed on an energy label. The label will be placed on the window product to be visible at point of sale. The label will rate the window on a scale of one to five stars assessing the product for cooling in summer and heating in winter. WERS will bring Australian window practices up to an international standards. In California for example, more than 90% of all residential windows, are double-glazed because US legislation requires that all windows have minimum thermal performance.



The window that will receive a five star rating under the WERS scheme will consist of double glazing, low emissivity coating and will use thermally insulating gas such as argon. For frames, timber, PVC, or thermally broken aluminium (with the moulding inside the frame to retard heat transfer) are the optimal choices for energy efficiency.

The aim of the scheme is to help consumers evaluate the relative performance of different types of windows and enable consumers to make an informed decision to purchase a window suitable for their needs.

While energy efficient windows will be more costly, it is envisaged that WERS scheme will create a domino effect-as the benefits of energy efficient windows become clear, their popularity will increase and prices will drop.

Recommended Measure and Estimated Outcome

<i>Expected outcome 000 tonnes of CO_{2-e}</i>
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Voluntary Appliances Standards

A potential exists for voluntary programs as an effective means to facilitate the supply and purchase of energy efficient appliances in certain circumstances. For example, the importance of promotional activities to support both regulated and voluntary programs, such as appliance energy labelling has also been highlighted as an important factor in achieving energy efficient improvements. Programs based around endorsement labels for products that meet a high level of energy efficiency have been successfully introduced overseas. Through these programs, suppliers and customers can promote energy efficient products to consumers or business users. Retailers and distributors of products also have a significant role to play in promoting energy efficient products and will be involved in nationally coordinated activities. Programs to promote highly energy efficient

industrial motors and commercial lighting are currently being developed. These will be introduced in conjunction with MEPS to prohibit supply of inefficient products.

Expected outcome

Recommended action

5.2.2.3 Regulatory Measures

<i>Estimated CO_{2-e} Reductions in 2010</i>	<i>800 tonnes</i>
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Mandatory energy efficiency standards implemented through appropriate levels of government enact specific requirements that all buildings constructed and products manufactured meet defined energy use criteria. These are an important regulatory option for commercial buildings and such standards have the potential to yield the largest reductions in this sector. The major advantage of regulation over a voluntary regime is that it provides for greater certainty of outcome and can ensure comprehensive coverage (avoiding any potential “free-riding” problems). Internationally, the regulatory measures proved to be 2-10 times more effective than the voluntary standards in reducing energy use and the resulting GHG emissions.

In October 1999, nationally consistent laws relating to appliance energy labelling requirements and minimum energy performance standards for *domestic refrigerator and electric hot water systems* come into effect.

The introduction of Minimum Energy Performance Standards for packaged air conditioners, lighting ballasts and motors is likely in the foreseeable future. These new regulatory measure is expected to have positive medium term effect on emissions from residential sector.

Recommended Measure and Estimated Outcome

<i>Expected outcome 000 tonnes of CO_{2-e}</i>
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made the following recommendations Assuming successful incorporation of the ‘Minimum Energy Performance Standards for in the Building Code of Australia the expected GHG emissions reductions by the year 2010 are estimated at ,000 tonnes of CO_{2-e}

Recommended Measure and Estimated Outcome

<i>Expected outcome 000 tonnes of CO_{2-e}</i>
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5.2.2.4 Demonstration Projects

<i>Estimated CO_{2-e} Reductions in 2010</i>	<i>1,000 tonnes</i>
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Worthwhile medium to long term benefits can be expected from demonstration projects involving advanced technologies. Although not always cost competitive, demonstration projects can show a leadership, increase market share educate a community and contribute to GHG reduction objectives.

It would be prudent if the demonstration projects were directed toward the most significant causes of GHG emission in the residential building sector together accounting for 84% of the total emissions namely:

- *Electrical Appliances(55%),*
- *Water Heating (29%) and*

Lighting has been identified as the most significant area of application for greenhouse gas emissions abatement initiatives with an reduction potential of up to 84%.

Potential demonstration projects which fulfil the above criteria

Residential Roof Mounted Photovoltaic Programme. This programme would be supported by the Commonwealth sponsored Photovoltaic Rebate Programme (PVRP). Details about this programme are contained in the Appendix 10.

- Domestic Solar Hot Water Programme in cooperation with utilities manufactures AGO.
- Residential Roof Mounted Photovoltaic Programme. This programme would be supported by the Commonwealth sponsored

□ **The embodied energy**

The embodied energy of a material is the energy consumed, directly or indirectly, to produce that material. The embodied energy represents a significant proportion of a building's total life cycle energy consumption and hence its contribution to greenhouse gas emissions. Embodied energy can be equal to as much as 20 years of operational energy for a typical new house. Most of this energy is effectively consumed at or before the time of construction, and most of this is accounted within the industrial and construction sectors of the economy. In addition, over a typical building life of up to 100 years, a further 20 years of operational energy can be embodied through. Thus a complete assessment of the greenhouse gas impact of buildings must ultimately include embodied and operating energy on a life cycle basis. Research in embodied energy is ongoing and suitable tools for assessing its contribution to a building's life cycle energy are not yet available.

Potential demonstration projects which fulfil the above criterion detail and some examples of the interaction between embodied and operational energy for a range of construction materials and approaches are included.

5.2.2 Increase use of Renewable and Less Greenhouse Intensive Energy Sources

In 1994 the City of Adelaide used 126,763 GJ (68.7%) of electricity and 57619 GJ (31.3%) of natural gas. This can be translated to 33,257 (91.4%) and 3,111 (8.6%) tonnes of CO_{2-e}. The table below shows contribution from electricity and natural gas and their respective greenhouse impact:

Table 5.2.2 Contribution from electricity and natural gas

<i>Energy Source</i>	<i>CO_{2-e} tonnes</i>	<i>CO_{2-e} %</i>	<i>Energy GJ</i>	<i>Energy %</i>
Electricity	33,257	91.4	126,763	77.6
Natural Gas	3,111	8.6	57,619	22.4
Total	36,368	100	184,382	100

Fig 5.2.2.1 Share of electricity and natural gas supplied to the City of Adelaide

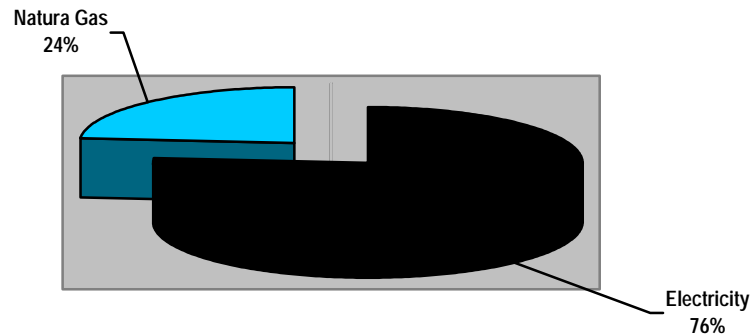
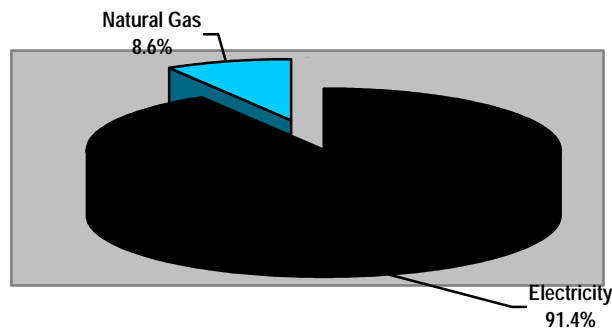


Fig 5.2.2.2 Greenhouse Gas Impact of Electricity and Natural Gas



The above pie charts demonstrate disproportionately high greenhouse impact of electricity in comparison with natural gas. The reason for this is comparatively high greenhouse intensity of the existing electricity sources. A strategy aimed at reducing carbon intensity of energy used within the City of Adelaide will focus on three main areas:

- Supply of renewable and less greenhouse intensive electricity into the City;
- Generation of less greenhouse intensive electricity within the City itself including natural gas and renewable energy using. (Decentralising electricity generation);
- Encouraging substitution of electrical energy with other direct energy sources eg natural gas. Direct use of gas could provide greenhouse reduction of up to 470% over electricity generated in coal fired power stations (eg Gas hot water versus electric hot water).

The general policy measures can be grouped into following main categories:

- **market based programmes** such Green Power;
- **voluntary energy standards such as** Electricity Labelling;
- **market based programmes** such Green Power;
- **voluntary energy standards such as** Electricity Labelling;
- **mandatory energy efficiency standards** such as 2% renewable energy;
- **development and demonstration programmes** PV Roofs.

5.3 GHG Emission Reduction Strategy from Transport Sector - *Rationale*

5.3.1 Strategy Rationale

In 1998 Australia's road transport sector greenhouse gas emissions totalled 64.8 million tonnes of CO_{2-e}. This sector accounted for 14.2 % of total national net emissions. This represents an increase of 1.8% above 1997 level 18.2% higher than in from the Kyoto Protocol baseline year of 1990. The fuel used by cars increased by 12% from 1990 to 1998 but emissions increased by 16.6 % in the same period. Emissions from trucks and light commercial vehicles increased by 22.4% from 1990 to 1998. Bureau of Transport Economics projects that, without reduction measures, emissions from the road transport sector will rise by 38 per cent between 1990 and 2010.

The City of Adelaide greenhouse gas emissions from transport are expected to grow at a slightly slower rate and reach 520,900 tonnes of CO_{2-e} under a business as usual (BAU) scenario by 2010. The achievement of the 10% community reduction goal in this sector would result in 398,986 tonnes of CO_{2-e} emissions by 2010. This equates to 23.4 % reduction on (BAU) basis.

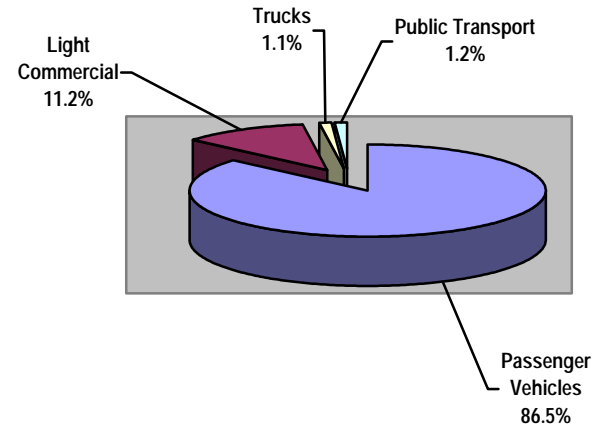
The attainment of the Community goal will require GHG emissions reductions from all transport sub sectors:

- Passenger Vehicles;
- Light Commercial Vehicles;
- Trucks; and
- Public Transport

Figure 5.3 shows the proportions of greenhouse gas emissions from different categories of vehicles. Passenger vehicles contribute the far largest share of transport emissions 86.5% followed by light commercial vehicles

11.2 %. Contributions from trucks and public transport is insignificant by comparison.

Fig 5.3 Greenhouse gas emission share by vehicle category



5.3.2 TRANSPORT SECTOR GHG REDUCTION POLICY MEASURES

<i>Estimated CO_{2-e} Reductions in 2010</i>	<i>17,500 tonnes</i>
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GHG mitigation in transport sector presents particular challenge because of the unique role that travel and goods movement play in enabling people to meet personal, social, economic and development needs. This sector may also offer a practical opportunity because of the commonality of vehicle design and fuel characteristics.

Transport has many stakeholders, including private and commercial transport users, manufacturers of vehicles, suppliers of fuels, builders of roads, planners, and transport service providers. Measures to reduce transport GHG emissions often challenge the interest of one or another of these stakeholders. Mitigation strategies in this sector run the risk of failure unless they take account of stakeholder concerns and offer better means of meeting the needs that transport addresses.

There are many approaches that may be taken to reduce the emission of CO₂, as well as nitrogen oxides, carbon monoxide and volatile organic compounds from local corporate vehicles. The main two options include:

- **Replacing petrol with other fuels; and**
- **Substituting large vehicles with smaller, more efficient ones**

Other approaches include

- A reduction in total vehicle kilometres travelled (particularly the use of vehicles for short trips;
- Use of bicycles by field staff in lieu of cars
- The implementation of staff car pooling schemes
- An increase in vehicle fuel efficiency through driver education or improved maintenance;
-

The general policy measures can be grouped into four main categories:

- **market based programmes** in which building manufacturers owners/tenants/managers are provided with technical support and /or incentives;
- **voluntary energy standards;**
- **mandatory energy efficiency standards** applied at the point of manufacture or at the time of construction.; and
- **development and demonstration programmes** for the development of more efficient practices, products

5.3.2 Conversion of Petrol and Diesel Driven Passenger Vehicles to alternative fuels and technologies

<i>Estimated CO₂e Reductions in 2010</i>	<i>50 tonnes</i>
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Alternative fuels and technologies can be classified under two categories (NRMA,1998a)

- Current Cleaner Fuel and technology options, such as Liquefied Petroleum Gas (LPG), Compressed Natural Gas (CNG), ethanol and methanol;
- Future Ultra Clean Fuel and Technology Options, such as electric vehicles, hybrid electric vehicles, and solar power

Two most established and mature technologies in Australian technologies include LPG (Liquid Petroleum Gas) and CNG (Compressed Natural Gas).

5.3.2.1 Current Cleaner Fuel and technology options

5.3.2.1.1 Liquefied Petroleum Gas (LPG)

 Liquefied Petroleum Gas (LPG) is the general name given to mixes of hydrocarbons, predominantly propane and butane, which enter a liquid state when compressed to about 8 times atmospheric pressure. The use of LPG instead of petrol offers some potential to reduce greenhouse gas emissions from passenger vehicles. LPG is environmentally friendlier, with up to 20% lower global warming potential, 15% lower carbon dioxide emissions. Other environmental benefits include 20% lower ozone (smog) forming potential, and 80% less harmful air toxic emissions compared to petrol.

The estimated ghg emissions reduction resulting from conversion of executive corporate vehicles from petrol to LPG are shown in Table 4.3.2.1.

Table 5.3.2.1 Potential greenhouse gas emission reductions (kg CO_{2-e}) due to converting executive corporate vehicles to LPG

Vehicle Model	Fuel Source				Reduction
	Petrol		LPG		
	Use	GHG emissions	Use	GHG emissions	
	L	Tonnes of CO _{2-e}	L	Tonnes of CO _{2-e}	Tonnes of CO _{2-e}
25x dedicated Ford Falcon LPG dedicated	2,300,000	6,000	3,000,000	4,800	1,200

(i) Based on travel distance of 20,000 km

(ii) Most of emission would occur outside of the city boundary

(iii) Based on a US Dept of Energy Study of LPG lifecycle emissions. Global Warming Potential (GWP) considers all greenhouse gases emitted through the production and use of a fuel and considers their global warming potency as well as their life in the atmosphere. Results are expressed as CO₂ equivalents. This study indicates that LPG offers 20% reduction in GWP versus petrol.

Based on Greenfleet estimate that 17 trees planted will absorb 4.33 tonnes of CO₂ during their lifetime.

An LPG fuelled engine increases the capital cost but the residual value of the vehicle is not affected by the conversion. Until recently the capital cost increase for factory fitted dual fuel vehicle was approximately \$ 2,200. This additional cost was considered as a major disincentive against choosing the LPG option. In a case of recently introduced **dedicated** LPG vehicles, the increase in capital cost has been reduced to approximately \$800. Consequently, the financial benefits available from opting for LPG vehicles are more evident. Table 4.3.2.2 demonstrates the reduction in fuel costs, which is possible through changing fuel source.

Table 5.3.2.2 Potential fuel cost savings (kg CO_{2-e}) due to converting larger executive corporate vehicles from petrol to LPG

Vehicle Model	Fuel Source				Annual Fuel Cost Savings	Payback
	Petrol		LPG			
	Fuel Cost per vehicle	Fuel Cost for 1000 vehicles	Fuel Cost per vehicle	Fuel Cost for 1000 vehicles		
	\$	\$	\$	\$	\$	Months (Km)
Dedicated 6 cylinder vehicle LPG	2,208	2,208,000	1,230	1,230,000	978,000	10 (16,319)

Information provided in this table should be used as an approximate guide to the cost recovery of the LPG options. LPG option cost recovery will vary with accordance to fuel consumption, fuel cost variances and change in cost of LPG options.

Figures for Dual Fuel system assume vehicle is running solely on LPG.



^ Fuel consumption figures based on AS2877 tests for Falcon Forté 6-cyl auto sedan. Actual fuel consumption will depend on many factors, including your driving habits, the prevailing conditions and your vehicle's equipment, condition and use.

Results are based on the following prices: **96c/L for petrol and 41c/L for LPG.**

Approximately \$3000 per vehicle (\$75,000 per 25 vehicles) could be saved during the recently introduced 3 year changeover period.

Other perceived and anecdotal technical disincentives historically causing resistance to change have also been overcome. Some of them are summarised in Table 5.3.2.3

Table 5.3.2.3

Alleged Problems	
Warranty	Factory fitted LPG options is currently offered by in Australia by Holden and Falcon where the supplied equipment is covered by the same warranty as the of the vehicle.
Operating vehicle on LPG results in lower level of power to that obtained using petrol.	This may have been true for older vehicles with an engine designed for petrol carburettors, but modern with electronic fuel injection engine management systems have addressed this deficiency. Modern LPG equipment has been designed to be compatible with the vehicle's engine management system so there is hardly any difference in performance
LPG vehicles have compromised boot space . 	In a dedicated LPG vehicle the gas storage unit replaces the petrol tank. As a result the spare wheel is mounted in the boot. This allows the Dedicated LPG sedans to have more space than a Dual Fuel Sedan. Also the convenience of split fold rear seat is retained. 
Higher Maintenance Costs.	As the LPG is release into the engine the pressure drops and the fuel vaporises again so that enters the engine as gas. This prevents it washing the lubricating oil from the inside of the cylinders, so that an engine that runs on LPG can expect a longer service life and reduced long term maintenance costs.

Progressive replacement of petrol driven executive vehicles with equivalent dedicated LPG vehicles would have the following benefits:

- Reduce corporate GHG emissions
- Demonstrate Council commitment and leadership to reduction of greenhouse gas and other emissions;
- Result in worthwhile financial savings;
- A changeover of executive vehicles (every 2-3 years) would boost number of LPG vehicles wider community.

Actions/Recommendations/Outcomes

Encourage and facilitate progressive replacement of larger executive corporate vehicles with LPG dedicated vehicles by both public and private sector fleet vehicles.

Estimated CO_{2-e} reductions in 2010

1,200 tonnes

5.3.2.1.1 Compressed Natural Gas CNG

□ Passenger Petrol Vehicles

Compressed natural gas (CNG) has been used overseas for automotive purposes but, despite having considerable reserves of natural gas, Australia has been slow to develop engines capable of running on CNG and the infrastructure to support them. Factory fitted fuel systems for CNG are not generally offered by passenger vehicle manufacturers in Australia. Several companies do so overseas, including Honda, Ford and Volvo. At the end of 1998, Australia had 1766 natural gas vehicles-half of them forklifts and only 437 passenger vehicles. The use of CNG instead of petrol offers good potential to reduce greenhouse gas emissions from passenger vehicles by approximately 30%. Higher ghg emissions reductions (up to 47%) can be achieved with engines specifically designed to operate on CNG. Potential greenhouse gas emission reductions (kg CO_{2-e}) due to converting larger corporate vehicles from petrol to CNG.

Table 4.3.2.1.1. Potential greenhouse gas emission reductions (kg CO₂e) due to converting corporate executive vehicles from petrol to CNG.

Vehicle Model	Fuel Source				Reduction
	Petrol		CNG		
	Consumption	GHG emissions	Consumption	GHG emissions	Tonnes of CO ₂ e
	L	Tonnes of CO ₂ e	L	Tonnes of CO ₂ e	
25 x Holden VT Commodore	2,300,000	5,200	1,082,000	3,640	1,560

It is envisaged that the petrol to CNG technology will continue its progress in line with improvement in of the infrastructure (refuelling stations)..

Recommended Measures and Estimated Outcome

Monitor progress petrol to CNG technology and improvements in infrastructure.

□ **Conversions from Diesel to CNG**

Diesel engines are generally amenable to conversions to natural gas, in either dual or spark ignition mode. It is worth noting that several manufacturers are committing to engines specifically designed for natural gas. These include: Daimler Chrysler, MAN, Mack-Renault, Scania, Detroit Diesel, Caterpillar and Cummins.

There are several fleets of heavy vehicles in Australia which currently operate on CNG:

- Sydney Buses currently operates 104 Scania CNG buses, is taking delivery of further 150 and has an option for an additional 150 CNG buses from Daimler Chrysler;
- South Australian public transport currently operates 110 MAN CNG buses and is having an additional 53 built by MAN;
- Cities of Unley in SA and Waverley in NSW have been trailing the use of CNG in Municipal Solid Waste collection trucks.

Compared to their diesel counterpart, natural gas engines emit much less pollutants from their exhaust. Some of the natural gas engines already meet the strictest emissions standards being proposed in the US and Europe.

The Table 5.3.2.1.2 shows CNG engine emissions reductions in comparison with a diesel engine.

Table 5.3.2.1.2 - CNG engine emissions reductions in comparison with a diesel engine.

Emissions type	Emissions Reduction
NO _x Nitrogen Oxides	65% less
CO carbon monoxide	45% less
NMHC non Methane Hydrocarbons.	60% less
PM Particulate Matter.	75% less
SO ₂ Sulphur Dioxide	95% less
Carbon Dioxide	10% less

Particulate Matter of <10µm (PM10) can be inhaled deeply into the lungs and has been linked to pneumonia, loss of lung function, asthma and other respiratory problems

At present the Corporation uses 200,000 L of Diesel which generate 456 tonnes of CO₂e. Most of diesel is used is being used by 100 diesel engine powered vehicles. There are 26 vehicles weighting 3.5 tonnes and over.

Table 5.3.2.1.3 Potential greenhouse gas emission reductions (kg CO_{2-e}) due to converting of diesel fuelled vehicles to CNG

Vehicle Model	Fuel Source				Reduction
	Diesel		CNG		
	Consumption	GHG emissions	Consumption	GHG emissions	
	L	Tonnes of CO _{2-e}	L	Tonnes of CO _{2-e}	Tonnes of CO _{2-e}
All diesel vehicles	200,000	450	270,500	315	45

(i)Based on 10% CO_{2-e} reduction

Recently, a economic viability of conversions CNG of larger vehicles weighing 3.5 tonnes gross vehicle mass (GVM) or more has been substantially enhanced by the Commonwealth Government Alternative Fuel Conversion Programme.

This program commenced in January 2000. Commercial on-road vehicles and buses weighing 3.5 tonnes gross vehicle mass (GVM) or more are potentially eligible for grants under this program. The program focuses on the conversion, purchase or fuel systems upgrade of vehicles operating on compressed natural gas (CNG) or liquefied petroleum gas (LPG); Subject to environmental conditions, the program will provide either:

- up to a 50 per cent grant to purchasers for the difference in the purchase price between new original equipment manufacture (OEM) vehicles and their conventionally fuelled equivalents;
- up to a 50 per cent grant towards the cost of converting vehicles to CNG or LPG; and
- up to a 50 per cent grant towards the cost of upgrading the fuel systems of vehicles already operating on CNG

or LPG where a reduction of greenhouse gas emissions can be demonstrated.

\$15 million has been allocated to the program up to June 2001 and \$20 million in the subsequent three financial years.

Consequently an average payback period for conversions from Diesel to CNG has been reduced to less than two years. With current price differential between diesel and CNG substantial ongoing savings could be realised by taking advantage of this Federal Government initiative. The Corporation of Adelaide in unique position of having CNG refuelling station in close proximity of it's London Rd Depot. An example confirming financial attractiveness of Diesel to CNG Conversion is included in Appendix 9.

It is envisaged that number larger vehicles using CNG will continuously increase

□ **Ethanol, Methanol Bio-diesel**

Other alternative fuel such as Ethanol, Methanol Biodiesel also offer potential ghg emissions reduction. They are not considered a viable options due to lack of appropriate infrastructure.

Recommended Measures and Estimated Outcome

Monitor other alternative fuel options

5.3.4 Vehicle substitution

The substitution of a large engine capacity by one with smaller engine capacity, with associated savings in fuel consumption, will have obvious benefits in reducing greenhouse gas emissions. This measure should be directed towards smaller vehicles where factory fitted LPG/CNG is unlikely be Substituting the vehicles in the corporate fleet for, more fuel efficient vehicles is one of effective means of reducing the greenhouse gas emissions arising from corporate fleet operation. In order to maximise the benefits, in

economic terms and on a lifecycle basis, vehicles should only be substituted when the vehicles are next due to be replaced. Table 4.3.4 rates the most popular models in each passenger vehicle class using information derived from ABARE Research Report 97.2. Vehicles have been ranked initially on the basis of greenhouse gas emissions which operating costs differentiate between vehicles with equivalent emissions

Greenhouse ranking of most popular models by greenhouse gas emission and running cost. It is expected that fuel efficiency of vehicles will continue to increase. Similar reductions are available by carefully choosing the heavy vehicles used in corporate operations.

Table 5.3.4 Greenhouse Ranking of Vehicles

Make/Model/ Capacity	Fuel Use	Running c/km	Cost	GHG emissions Tonnes/year	Overall Ranking
Toyota Starlet Life, 1.3L	7.2	31.19		3.25	1
Mitsubishi Mirage 1.5 L	7.6	32.76		3.43	2
Mitsubishi Lancer Gli, 1.5L	7.6	40.52		3.43	3
Ford Festiva, 1.5L	8.0	31.74		3.61	4
Toyota Corolla 1.8L 8.5	42.30	42.30		3.84	5
Holden Vectra GL, 2.2L	9.5	44.0		4.29	6
Toyota Camry Csi,2.2L	10.0	45.92		4.51	7
Mitsubishi TH Magna Exec, 3.0L	10.5	49.41		4.74	8
Mitsubishi Verada Xi, 3.5L	11.0	68		4.96	9
Toyota Camry Csi V6, 3.0L	11.5	49.8		5.19	10
Ford AU Falcon, 4.0L	11.5	51		5.19	11
Holden VT Commodore Exec, 3.8L	11.5	51		5.19	11
Holden Calais VT 3.8L	11.5	69		5.19	13
Ford AU Fairmont Gia, 4.0L	12.5	68		5.64	14

(i) Running costs based on previous model, where necessary

(ii) Annual greenhouse emissions based on 20,000 km travelled

Recommended Measures and Estimated Outcome

Include in the purchasing of vehicles the fuel/greenhouse efficiency criterion. Estimated CO_{2-e} reductions in 2010 5 tonnes

It should be kept in mind that the local action plan includes measure that will be current for at least 10 years. Many new vehicle models and fuel technologies will inevitably become available during that time, so it is important that the measures are revised frequently to ensure that the ultimate target is reached. In particular, the efficiency of CNG engines in Australia is certain to improve markedly in the coming years (based on overseas experience) so this option should be reviewed during entire life of the LAP.

5.4.2 Mandatory Measures

National Initiatives

A number of significant emission reduction measures to improve the fuel efficiency of new vehicles in Australia are being introduced at a national level. The Adelaide City Council supports these national initiatives and will participate in their implementation. The initiatives will be introduced through the National Environmental Strategy for the Motor Vehicle Industry. This Strategy will contribute to emission reductions by

- The Federal Government is currently negotiating with industry to set National Average Fuel Consumption (NAFC) targets for new passenger vehicles for 2005 and 2010;
- introducing mandatory model specific fuel efficiency labeling through the Australian Design Rules;
- extending the NAFC framework to include light commercial and 4WD vehicles;
- progressively tightening noxious emissions standards with a view to harmonisation with international standards by 2006; and
- developing partnerships with consumer groups to engage their support in promoting fuel efficiency objectives to motorists.

Of these measures, increasing the national fuel efficiency target for passenger vehicles and introducing targets for 4WD and light commercial vehicles

are likely to have the greatest impact on transport emission reductions. In addition to these initiatives, the Australian Transport Council will pursue other national measures including:

- promoting best practice in transport and land use planning through developing policy guidelines; and
- ensuring that transport policy instruments are consistent with fiscal, economic and environmental policy, including greenhouse objectives.

The Commonwealth's New Tax System (ANTS) is also likely to have an impact on transport sector on greenhouse gas emissions in the City of Adelaide. Investigation of this potential impact will be undertaken as part of the first review of the Strategy.

Fuel Consumption Targets

Options for challenging but realistic fuel consumption targets for the Commonwealth government vehicle fleet are to be developed. These will come into effect from 2003. The target is intended to bring about a reduction in the greenhouse gas and noxious emissions from the Commonwealth fleet, showing the Government's commitment to environmental and greenhouse concerns

South Australian State Government through Transport SA is undertaking a number of programmes which are primarily aimed at behavioural change in the community to reduce vehicle use and hence emissions. These are important but tend to be long term by nature.

Transport SA has a successful ongoing program of conversion of public transport buses to compressed natural gas. More than 100 buses in its fleet have already been converted to CNG. It is envisaged that this programme will substantially benefit from the recently commenced Federal Government Alternative Fuels Conversion Programme.

5.4.1 Demonstration Projects using Future Ultra Clean Technologies

The future ultra clean technologies include:

□ **Electric**



The electrical vehicle technology is advancing rapidly as the vehicle manufacturers seek to comply with the US Clean Air Act. General Motors, Honda and Ford have all recently released electric vehicles with performance that is equivalent to petrol models, although the range of such vehicles is limited to 200-300 km before requiring recharging. Even with this range, electric vehicles are a viable alternative for movement of staff and materials between Council properties. The need to have the vehicle stationary for up to 8 hours during recharging is still one of the greatest impediments to broad market acceptance of electric vehicles. The use of electricity also causes greenhouse gas emissions at the point of power production, although a clear advantage of electric vehicles is that the emissions are not in urban areas or at the street level. There is potential for emissions to be reduced by using photovoltaic cells placed on the roofs of garages and other buildings. Green power could also be used for this purpose.

□ **Hybrid electric vehicles,**



A hybrid electric vehicle combines some of the advantages of an internal combustion engine with those of an electric motor, thus improving efficiency. Under urban conditions, with frequent stops and starts, a hybrid vehicle uses mainly electric power. The battery is recharged when the petrol engine starts automatically during stretches of uninterrupted driving. The use of a hybrid electric /petrol power eliminates the

need to keep the vehicle stationary when recharging batteries. Overall petrol consumption and emissions are approximately halved due to the vehicle utilising electric power for most urban driving. The benefits of such hybrid system have been recognised by several major car manufacturers, including Toyota, Ford, General Motors, Daimler Chrysler and others. First electric hybrid vehicles are available on the market overseas. Toyota Prius is expected to sell in Australia for approximately \$45,000. It is envisaged that competitively priced hybrid vehicles will be increasingly available later this decade. This will present an opportunity for corporation to include such vehicles in the corporate fleet.

❑ **Solar Power**



Solar-powered cars are electric cars that use solar energy through photovoltaic (PV) cells. PV cells convert solar energy into electricity, which is used directly to power an electric motor or is stored in batteries. PV cells only produce electricity when the sun is shining so without sun, the solar-powered car must depend on the electricity stored in its batteries. The major impediment to the development of solar powered vehicles remains the efficiency of the photovoltaic cells used to generate electricity. It is possible to build a one seat vehicle out of lightweight materials which is capable of speeds equal to those of petrol fuelled vehicles - but only at prohibitive cost. There are several ways in which solar power may be utilised other than directly powering a vehicle. The photovoltaic cells can generate power for sale into the grid and then recharging vehicles batteries overnight using off peak rates.

❑ **Hydrogen vehicles**



Hydrogen vehicles which utilise hydrogen, generated by renewable energy, as a electricity source are effectively zero GHG emissions, with only steam and possibly, very small amounts of nitrogen oxide emitted from the exhaust pipe. Hydrogen can be used as a fuel source in different ways. It is possible to use the gas directly in a dedicated internal combustion engine or it can be used in on board fuel cell used to drive an electric motor. The use of fuel cells has been progressing rapidly to the stage where vehicles are expected to be available by 2004. Hydrogen has a substantially higher energy efficiency than either petrol or diesel, whether it is used directly or indirectly.

Recommended Measures and Estimated Outcome

<i>Monitor availability of ultra clean technology</i>	
<i>Trial a vehicle as high profile demonstration project</i>	
<i>Estimated CO_{2,e} reductions in 2010</i>	<i>5 tonnes</i>

Appendix 1

Commonwealth Government Founding Programmes

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GLOSSARY

Agreed perspective

A perspective will be selected to use when evaluating cost-effectiveness of energy efficiency measures. The agreed perspective could be that of an owner-occupier or that of society, and could include an allowance for the cost of infrastructure provision, externalities such as climate change or resource depletion and so on.

Co₂-e

Carbon dioxide-equivalent is used to quantify greenhouse gas emissions and includes all CO₂ released during the production, processing and transport of an energy resource, plus an allowance for methane and nitrous oxide released.

Currency

The unit of measure chosen for whole-building energy efficiency requirements. Candidates include measured energy (MJ), source energy (MJ), operating energy cost (\$) or greenhouse gas emissions (tonnes CO₂-e).

Deemed-to-satisfy

Agreed pre-packaged solutions to the performance requirements in the BCA.

Energy efficiency

Ratio of energy output of a conversion process or of a system to its energy input; also known as first law efficiency.

Enhanced greenhouse effect

Changes in the earth's climate as a result of increasing levels of greenhouse gases in the atmosphere due to human activity.

Envelope

The external elements of the building, that is walls, windows, roofs and so on.

Greenhouse gases

Gases that affect the temperature of the earth's surface. They include water vapour (H₂O), tropospheric ozone (O₃), chlorofluorocarbons (CFCs), carbon dioxide (CO₂), methane (CH₄) and nitrous oxides (NO_x). The last three gases are of particular concern because they take a long time to remove from the atmosphere.

Greenhouse intensity

An indication of the quantity of greenhouse gas emissions resulting from a particular activity or energy source.

Kyoto Protocol

An international agreement, reached in 1997 in Kyoto, Japan, which extends the commitments of the United Nations Framework Convention on Climate Change. In particular, it sets targets for future emissions by each developed country.

Life cycle analysis

Also known as cradle-to-grave assessment. Life cycle analysis provides a systematic approach to measuring resource consumption and environmental impacts associated with products, processes and services.

Megajoule (MJ)

One million joules. Units for measuring energy consumption at the building level. For example, annual energy consumption is often expressed in MJ/a.m², megajoules per annum per square metre of floor area.

Megatonne (Mt)

One million tonnes. Greenhouse gas emissions are often measured in megatonnes.

Petajoule (PJ)

One petajoule equals 10¹⁵ joules. This unit is used for measuring energy consumption at the national level.

Renewables

Energy forms that never run out or can be replaced, unlike fossil fuels. They include solar energy, wind, tidal, geothermal and ocean thermal power, fuels derived from plants such as wood (if harvested sustainably) and ethanol made from sugar cane.

Stringency level

Required level of performance of an element, system or the whole building in the BCA.

United Nations Framework

Convention on Climate Change

The United Nations Framework Convention on Climate Change arose from increasing international concern about the implications of climate change and recognition that no country can solve the global environmental problem alone. Australia signed the convention in June 1992 and ratified it in December 1992.

U-value

Used to measure the rate of heat transfer through a building element, the length and breadth of which is assumed to be much larger than its thickness (for example, a wall). Expressed in W/m².K. U-values are usually calculated from air at one surface to air at the other surface. Lower values indicate higher resistance to heat flow.