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**The Greenhouse Effect:
Ramifications for
New South Wales**

by

Stewart Smith

Briefing Paper No 11/95

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NSW PARLIAMENTARY LIBRARY RESEARCH SERVICE

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ISSN 1321-2559

ISBN 0 7310 5905 0

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April 1995

ACKNOWLEDGEMENTS

I would like to acknowledge the helpful contributions of Mr Leigh Glover of the Climate Change and Marine Branch of the Commonwealth Department of Environment, Sports and Territories.

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EXECUTIVE SUMMARY

This Briefing Note: explains the mechanisms of the greenhouse effect; places it in an international context; describes Australia's contribution to greenhouse gas emissions and outlines the impacts of greenhouse on New South Wales. Some of the main findings include:

- The greenhouse effect is a natural phenomenon that keeps the planet habitable. Greenhouse gases include water vapour, carbon dioxide, methane and nitrous oxide. The increasing concentration of carbon dioxide and other greenhouse gases in the atmosphere from human activity has resulted in the "enhanced greenhouse effect". (page 4)
- Climate models indicate that with the enhanced greenhouse effect global average warming of 0.6 - 1.7 degrees Celsius by 2030 and 1.0 - 3.9 degrees Celsius by 2070 may be expected. (page 8)
- In 1990 Australia emitted 572 million tonnes of carbon dioxide equivalent of greenhouse gases. Australia, with 0.3 percent of world population produces 1.2 to 1.6 percent of global carbon dioxide, and has one of the world's highest output of greenhouse gas per capita. (page 8)
- The greatest source of Australian greenhouse gas emissions (54%) is energy transformation, including electricity supply and transport. The second largest (25%) is land use change such as clearing of native vegetation for agriculture and forestry operations. (page 9)
- The Framework Convention on Climate Change, which Australia signed in 1992, commits Australia to reducing greenhouse gas emissions to 1990 levels by the year 2000. (page 11)
- Australia has responded to greenhouse problems with a National Greenhouse Strategy, featuring 'no regrets' policies. Many of these have yet to be implemented. (page 13)
- Greenhouse effects on NSW could include:
 - Increased storm surges leading to greater coastal erosion. (page 26)
 - Marked changes to climatic extremes may occur, with a greater number of days over 35 degrees Celsius. (page 26)
 - Flood frequency and potential damage may increase. (page 27)
 - Snow cover duration in the alps is likely to be reduced. (page 27)
 - Biodiversity conservation is severely threatened due to habitat loss or movement of habitat areas. (page 28)

PART I: GREENHOUSE, AN INTRODUCTION

This Briefing Note: explains the fundamentals of what is commonly referred to as the greenhouse effect; places it in an international perspective; and discusses ramifications of climate change for New South Wales. Whilst climate change is a global issue, and nations have coordinated a global response, this paper demonstrates that all levels of government, industry and individuals can help reduce greenhouse gas emissions, and seek to minimise, avoid or adapt to the potential impacts of climate change.

The greenhouse effect is a natural phenomena that has been operating for billions of years.¹ With no natural greenhouse effect, the planet would be about 33 degrees Celsius cooler than would otherwise be the case.²

The earth's climate is driven by the energy of the sun. Some of this energy is reflected back into space by clouds and particulates. However, most is absorbed by the earth. The earth reflects much of this energy as infrared radiation, which is absorbed and re-emitted by gases in the atmosphere.³ This complex pattern of energy transfer is known as the greenhouse effect, which helps keep the earth's climate constant. Water vapour contributes about two-thirds to this natural greenhouse warming effect, combined with carbon dioxide, methane and nitrous oxide as other significant natural greenhouse gases.

The concentration of natural greenhouse gases has been further enhanced in recent years as a result of burning fossil fuels, deforestation and the release of certain human made gases such as chlorofluorocarbons. Scientists refer to this as the 'enhanced greenhouse effect'. For instance, global atmospheric concentrations of carbon dioxide have increased by around a quarter since the Industrial Revolution as a result of human activities and continue to increase.⁴ Many scientists now believe that a future doubling of carbon dioxide is inevitable.

¹ Australia and New Zealand Environment Council, ND, *Towards a National Greenhouse Strategy for Australia. A summary report.*

² National Greenhouse Advisory Committee, 1992, *Grappling with Greenhouse. Understanding the science of climate change.*

³ Commonwealth of Australia 1992, *Ecologically Sustainable Development Working Group Chairs Greenhouse Report.* AGPS Canberra.

⁴ Intergovernmental Panel on Climate Change, 1994, *Radiative Forcing of Climate Change, Summary for Policy Makers.* WMO/UNEP.

The extent of this further enhancement of the greenhouse effect is still being debated. It is generally now accepted that the increasing concentration of greenhouse gases will lead to global warming, it is only the rate and precise nature of this warming that is still contested. This is due not only to limitations of data (for instance, weather records have only been kept since the 1880's) but also to the fact that prediction is largely dependent on computer models of the atmosphere, oceans and land surface. These models cannot possibly hope to take into account all elements of the climate system. There is some evidence to suggest that the global warming to date is the result of the enhanced greenhouse effect and this warming is consistent with model predictions. However, this linkage is not yet conclusive, these rises are still consistent with climatic variability.

Whilst some scientists and social commentators believe that the greenhouse problem is over-rated, the majority of scientists believe that greenhouse and climate change will occur, and only the time-frame and magnitude is in doubt. There is recent evidence suggesting that the recorded global warming of the atmosphere and the oceans can now be attributed to the enhanced greenhouse effect.

SUMMARY OF ARGUMENTS SUPPORTING THE ENHANCED GREENHOUSE EFFECT AND GLOBAL WARMING

The main reasons why the majority of scientists believe that greenhouse may be a problem are:⁵

- Atmospheric concentrations of greenhouse gases have increased significantly over the last three decades, and this may lead to global warming
- Using computer models that simulate current climate, it is calculated that for an equivalent doubling of greenhouse gas concentrations, the earth's climate should warm significantly
- Comparisons from other planetary atmospheres, particularly of Venus, support the results of simulations for earth
- There has been a global warming trend over the last 15 years. Six of the seven warmest years in this century occurred in 1981,

⁵ Tolba, M.K. & O.A. El-Kholy (eds) 1992, "Climate Change" in *The World Environment 1972-1992: Two Decades of Challenge*. Chapman and Hall, London.

1983, 1987, 1988, 1989 and 1990

- The precautionary principle - that not having full scientific evidence about a potential threatening phenomena is no reason for not responding to it.

Whilst none of these arguments, taken individually, is convincing evidence of climate warming, it is thought that combined they cause reason for alarm.

SUMMARY OF EVIDENCE FOR NO GREENHOUSE PROBLEM

Doubters of greenhouse problems note the following reasons for rejecting global warming projections:⁶

- They do not accept the correlation between increasing greenhouse gases and global warming
- Mathematical models used to predict greenhouse rates are inconsistent and misleading
- Most of the global warming in the last 100 years has occurred in period pre 1940, indicating no greenhouse problem
- Panic responses to 1988 global warming predictions have carried over to the 1990's when problems have been revised and warming predictions downgraded
- Greenhouse is sloppy science influenced by the politics of environmentalism

PART II: THE SCIENTIFIC ARGUMENTS IN MORE DETAIL

Monitoring results and analysis of other information sources, such as from air trapped in ice cores, have shown the increases in greenhouse gases as a result of human activities. Since the Industrial Revolution carbon dioxide has increased by 27% (from about 280 to 356 parts per million), methane has more than doubled (from 0.7 to 1.7ppm), and nitrous oxide increased from 275 to 310

⁶ Brian J. O'Brien (1994) "The Greenhouse Effect: Fact or Fiction?" in *Significant Speeches*, Autumn 1994.

ppbv.⁷

The glacial ice studies show a strong correlation between the levels of carbon dioxide and methane in the atmosphere and the average global temperature. The ice ages were accompanied by low levels of these gases. Proponents of greenhouse therefore claim that increasing carbon dioxide levels will lead to global warming. Opponents to greenhouse doubt the above link, and suggest that the glacial record demonstrates that the concentration of greenhouse gases is a response to changing temperature rather than a cause of it.

Over the last 100 years the earth has warmed about half a degree C. The increase occurred mainly before 1940, at a time when humans were not pumping out huge amounts of greenhouse gases into the atmosphere. Between 1940 and 1975, when the world industrialisation and growth was expanding greatly, there was a decrease in temperature of about 0.2 degrees C. Since 1975 the temperature has increased by 0.3 degrees C. Global temperature rises are consistent with the predicted warming effects of the enhanced greenhouse effect, although could still be explained by natural climate variability. However, a recent announcement by the World Meteorological Organisation stated that the current higher temperatures in the atmosphere and oceans were most likely the result of the enhanced greenhouse effect.

Opponents to greenhouse suggest that the climate record as stated above is actually the reverse to what would be expected if there was such a thing as greenhouse.

Supporters claim that global temperature patterns are cyclical and the temperature drop in the 1960's would have been even more noticeable but for the warming effect of the greenhouse gases. They also identify the late 1980's and 1990's as the warmest years on record. Lower rates of warming are attributed to the influences of aerosol particles, a result of pollution and biomass burning, which have masked some greenhouse warming. Without these aerosols, warming from the enhanced greenhouse effect would have been greater.

THE EFFECTS OF AEROSOLS

Some observers claim that with the increased dust and particles in the atmosphere (referred to as aerosols), temperatures will actually decrease and

⁷ Intergovernmental Panel on Climate Change, 1994, *op. cit.* p.5.

from power stations, burning of forests, volcanoes and industrial plants. The aerosols help to cool the atmosphere by scattering sunlight reducing the amount that hits the earth. The climatic record shows that areas with the highest aerosol concentrations temperatures have cooled.

Whilst some scientists claim that this will negate any global warming, it is very much a northern hemisphere phenomena. It may then result in greater inter-hemisphere differences which may cause further disruptions. Greenhouse warming operates on a global scale whilst aerosol cooling tends to operate on a regional scale. The phenomena of aerosol cooling makes climatic modelling that much more difficult again.

The majority of scientists believe that greenhouse is a problem, yet cannot agree on the likely impact. Most therefore agree we should adopt a "no regrets" policy. This stance accepts that the time lag between emissions and full impact is too long for us to wait on complete evidence, and that we should plan with caution.

PART III: PREDICTIONS OF GLOBAL CLIMATE CHANGE

The authoritative science body which provides advice to the United Nations is the Intergovernmental Panel on Climate Change (IPCC). Its finding include that if concentrations of carbon dioxide were to instantaneously double from pre-industrial times, and the climate allowed to come to a new equilibrium, the resultant mean surface air temperature would increase in the range of 1.5 - 4.5 degrees Celsius.⁸ This is known as climate sensitivity. New models taking into account absorption of the heat by the oceans and sensitivity indicate an average global warming in the range 0.6-1.7 degrees Celsius by 2030 and 1.0-3.9 degrees Celsius by 2070.⁹ These 'scenarios' are still uncertain due to such things as the role of clouds and the range of greenhouse gas emission scenarios.

PART IV: AUSTRALIA'S GREENHOUSE GAS EMISSIONS

The National Greenhouse Inventory states that in 1990 Australian output of greenhouse gases was equivalent to 572 million tonnes (Mt) of carbon dioxide.¹⁰

⁸ Intergovernmental Panel on Climate Change, 1994, *op. cit.*, p.5

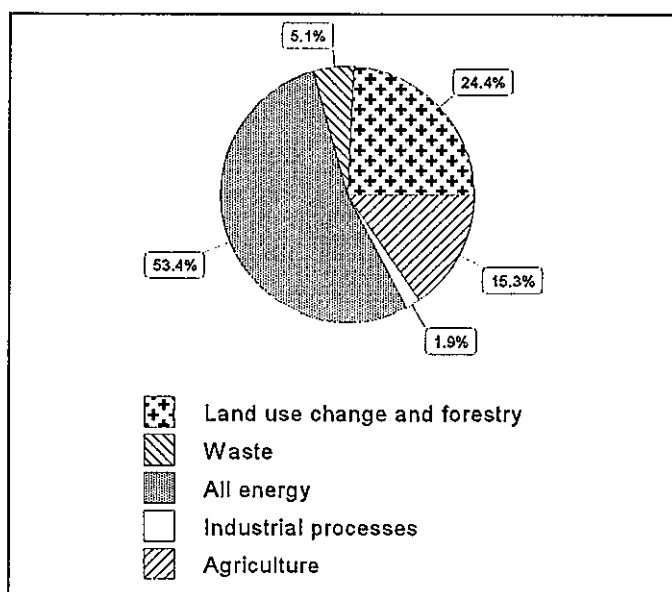
⁹ *Ibid*, p.73.

¹⁰ Commonwealth of Australia 1994a, *Summary, Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks and National Greenhouse Gas Inventory 1988 and 1990*. AGPS, Canberra.

In the absence of measures, this total would reach 654 Mt by the year 2000 (about 14% over the 1990 levels).¹¹

Figure 1 shows the sources of greenhouse gas emissions as a percentage of total emissions.

FIGURE 1 GREENHOUSE GAS SOURCES AS A PERCENTAGE OF TOTAL EMISSIONS.¹²



The greatest source of greenhouse gas emissions is the category all energy, which includes energy transformation such as electricity/power supply and transport. The second greatest, releasing nearly a quarter of emissions, is land use change and forestry, involving the clearing of native vegetation usually for agricultural purposes. There is considerable uncertainty on the amount of greenhouse gas released from land clearing due to lack of information on the amount of area cleared and the carbon content of soils and vegetation. Agricultural emissions, accounting for just over 15 percent of total emissions (of carbon dioxide equivalent), include methane generated from enteric fermentation in ruminants, animal wastes and rice cultivation. The production of greenhouse gases from waste is the result of anaerobic digestion of putrescible waste, resulting in the formation of methane. Industrial processes are emission

¹¹ *Ibid.*

¹² Commonwealth of Australia, 1994a, *op. cit.* p.10.

generated in the process of producing goods and do not include emissions related to energy use.¹³

Australia, with only 0.3 percent of the world's population, produces 1.2 to 1.6 percent of global carbon dioxide.¹⁴ Carbon dioxide is the most significant anthropogenic greenhouse gas for Australia and comprises almost 75 percent of total emissions. The next most significant is methane (23%) and then nitrous oxide (3%) and other sundry gases.¹⁵

Under the International Convention on Climate Change, Australia is required to report on greenhouse gas sinks, defined as any process, activity or mechanism which removes a greenhouse gas, or a precursor of a greenhouse gas from the atmosphere. In Australia, forests and pasture improvement are said to account for a sink of carbon dioxide of 25 Mt, considerably less than the 420 Mt emitted.¹⁶

PART V: THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

Scientists have been researching climate change for over two decades. This has resulted in the development of the United Nations Framework Convention on Climate Change, which was signed by Australia at the United Nations Conference on Environment and Development in Rio de Janeiro in 1992.

Milestones in the international debate on climate change can be summarised as:

- 1970 SMIC-Study of Man's Impact on Climate, Sweden
- 1974 International Study Conference on the Physical Basis of Climate and Climate Modelling, Stockholm, Sweden
- 1976 Launch of GARP-Global Atmospheric Research Program, by World Meteorological Organisation (WMO) and International Council of Scientific Unions (ICSU)

¹³ Ibid, p.10

¹⁴ Kinrade, P. 1992, "Looking for win-win solutions" in *Habitat*, Vol 20 No.1.

¹⁵ Commonwealth of Australia, 1994a, *op. cit.* p.11.

¹⁶ Commonwealth of Australia, 1994a, *op. cit.* p.11.

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- 1979 First World Climate Conference, Geneva
 - 1980 Launching of World Climate Program by WMO, United Nations Environment Program (UNEP) and ICSU
 - 1985 International Conference on the assessment of the role of carbon dioxide and of the other greenhouse gases, Austria
 - 1988 Conference on the changing atmosphere, Toronto
 - 1989 Ministerial Conference on Atmospheric Pollution and Climate Change, The Netherlands
 - 1989 Intergovernmental Panel on Climate Change (IPCC) formed
 - 1990 Nairobi declaration on Climate Change
 - 1990 Second World Climate Conference, Geneva
 - 1990 Intergovernmental negotiations on a climate convention
 - 1992 United Nations Framework Convention on Climate Change open for signature at UNCED, Rio de Janeiro. Australia signs the Convention at UNCED.¹⁷

Australia signed The Framework Convention on Climate Change at the United Nations Conference on Environment and Development at Rio in 1992.¹⁸ The Convention came into force in March 1994, so it is worthwhile to briefly discuss what is involved. The Convention is comprised of 26 Articles, of which the most important to this paper are discussed below. One of the most important agreements was that developed countries have agreed to the target of reducing their greenhouse gas emissions to 1990 levels by the year 2000.¹⁹

¹⁷ Tolba, M.K. & O.A. El-Kholy, 1992, *The World Environment 1972 - 1992: Two Decades of Challenge*, Chapman and Hall, London.

¹⁸ For more information on how international treaties work, see, Swain, M. 1995, "International Treaties" *NSW Parliamentary Library Briefing Note No.006/95*.

¹⁹ Pearce, F. 1994, "All gas and guesswork." *New Scientist* No. 1936, pp 14 - 15.

The objective of the Convention is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. In the preamble to the Convention, it is stated that human activities have substantially increased the atmospheric concentrations of greenhouse gases, that these gases enhance the natural greenhouse effect, and that this will result on average in an additional warming of the earth's surface and atmosphere and may adversely affect natural ecosystems and humankind.

- **Article 3(3)** states that Parties to the Convention should take precautionary measures to anticipate, prevent or minimise the causes of climate change and mitigate its adverse effects, noting that measures should be cost effective. To achieve this, policies and measures should take into account different socio-economic contexts, be comprehensive, cover all relevant sources, sinks and reservoirs of greenhouse gases and comprise all economic sectors. The article states that economic development is essential for adopting measures to address climate change
- **Article 4(1a)** states that Parties shall develop and periodically update and publish national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases
- **Article 4(1b)** requires Parties to formulate, implement, publish and update national programs containing measures to mitigate climate change by addressing anthropogenic sources
- **Article 4(1d)** requires Parties to promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases,... including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems
- **Article 4(1f)** requires Parties to take climate change considerations into account, to the extent feasible, in their relevant social, economic and environmental policies and actions, and employ appropriate methods, for example impact assessments, formulated and determined nationally, with a view to minimising adverse effects on the economy, public health and on the quality of the environment
- **Article 4(2a)** commits Parties to adopt national policies and take

corresponding measures on the mitigation of climate change, by limiting its anthropogenic emissions and enhancing greenhouse gas sinks. These policies and measures will demonstrate that developed countries are taking the lead

The rest of the Articles of the Convention refer to administrative matters such as the calling of the Conference of the Parties, financial instruments and dispute resolution. The first Climate Change Conference of the Parties was held in Berlin between March 28 and April 7, 1995, where Australia will present its greenhouse response strategy. The above Articles place in context Australia's responsibilities.

Whilst Australia as a nation has signed the Climate Change Convention, every individual, it could be argued, has a responsibility to help reduce the emissions of greenhouse gases. In NSW, with the largest population of all the states, we have the potential to make some of the greatest greenhouse gas savings. The next section should be read bearing in mind the commitments of the convention on climate change.

PART VI: A NATIONAL GREENHOUSE RESPONSE STRATEGY

The Australian Bureau of Agricultural and Resource Economics identifies the following policy options in response to greenhouse:²⁰

- direct regulatory controls
- no regrets policies
- taxing emissions or the outputs associated with the emissions
- subsidising reductions in greenhouse gas emissions
- introducing tradeable emission quotas

As will be discussed later in the paper, Australia has adopted the 'no regrets' policy response, ie, actions designed to yield net economic benefits through the adoption of better policies whilst also addressing the greenhouse effect.

Whilst Australia contributes only about 1.27 percent of the world's carbon

²⁰ Australian Bureau of Agricultural and Resource Economics 1994, *Reducing Greenhouse Gas emissions from Australian agriculture. A regional analysis*. ABARE Research Report No. 94.5

dioxide emissions, (the United States is the largest single greenhouse emitting country, with 23.27 percent), we have one of the largest per capita emission rates, emitting 16.02 tonnes of carbon dioxide per person.²¹

The Business Council of Australia notes the following factors explaining why it may be more costly for Australia to reduce greenhouse gas emissions compared to other countries:²²

- compared with other OECD countries Australia has the largest land area per head of population. The need to move large quantities of material (commodities for export, tourism) over long distances means that Australia will always be a transport intensive country, which accounts for high fossil fuel use
- Australia has a comparative advantage in possession of fossil fuel resources such as coal, gas and oil production. This has meant that no nuclear power stations have been built, unlike other OECD countries, and energy intensive industries such as metals processing and chemical manufacture are present
- history and geography have led to the widespread development of agriculture, which contributes to greenhouse gas emissions
- Australia supports high levels of immigration, making it difficult to more difficult to stabilise energy demands

In response to global climate change Australia developed a National Greenhouse Response Strategy, the basis of which is to adopt the interim planning target;

to stabilise greenhouse gas emissions (not controlled by the Montreal Protocol on Substances that deplete the ozone layer) based on 1988 levels by the year 2000, and to reduce these emissions by 20 percent by the year 2005...subject to Australia not implementing response measures that would have net adverse impacts nationally or on Australia's trade competitiveness, in the absence of similar action by major greenhouse producing

²¹ OECD/International Energy Agency 1992, *Climate change policy initiatives*. OECD, France.

²² Beck, T. 1994, "International Climate Change: Policy and Action" in *Business Council Bulletin*, May 1994.

countries.²³

The strategy notes that all governments have supported the interim target as part of the Intergovernmental Agreement on the Environment process.

The strategy identifies that Australia's response to the enhanced greenhouse effect should be a phased one, and that immediate priorities should be:

- actions in the first phase will concentrate on those of a 'no-regrets' nature, that is those that will have net benefits (or at least no net costs)
- first phase measures will also include a number of 'insurance' measures to reduce uncertainties about climate change impacts and the viability of response measures... involving research and review studies, education and adaptation measures
- in respect of both no-regrets and insurance measures, any economic and social costs will be low
- first phase measures will meet equity objectives by causing minimal disruption to the wider community, any single industry sector, or any particular geographical region
- the first phase measures will give particular attention to energy production, distribution and use...
- the timing and funding of the implementation program of the first phase measures will be determined by individual jurisdictions following an assessment of the budgetary priority they should command...

The Strategy then details twelve sectoral strategies, all of which have ramifications for State planning and environmental policy. Because of the crucial nature of State involvement with these sectoral issues, they will be discussed in the next section on New South Wales.

²³ Commonwealth of Australia, 1992a, *National Greenhouse Response Strategy*. AGPS Canberra.

PART VII: A NEW SOUTH WALES RESPONSE

In June 1990 the then Premier of NSW Mr Nick Greiner released a discussion paper on the Government's response to greenhouse.²⁴ Comprised of 41 definite actions or proposals for action, the discussion paper was superseded by the national approach and the adoption of the National Response Strategy. The following areas refer to the contents of the National Strategy.

ENERGY SUPPLY

Energy and transformation industries produce 160 Mt or 38% percent of total carbon dioxide emissions,²⁵ therefore it makes ecological sense to choose the energy source that is going to produce the least amount of greenhouse gas per unit of energy. Similarly, distribution networks also need to operate efficiently. The National Greenhouse Response Strategy calls for four actions in this sectoral area:

- promote markets for energy that are transparent and open to all suppliers of energy services
- promote a pricing regime that better reflects costs of supply (including economic, social and environmental costs)
- develop and apply more widely... cost competitive energy sources with lower greenhouse gas emissions, such as natural gas and renewable energy sources
- coordinate action on the energy supply side with action on the energy demand side to achieve the most effective outcome.

Electricity supply reform across eastern Australia has been in train for sometime, driven by microeconomic reform and the pursuit of integrated least cost planning- a system which can enable energy efficiency and renewable energy measures to be assessed on an equal basis to traditional forms of energy

²⁴ NSW Government, 1990, A Greenhouse Strategy of for New South Wales: Discussion Paper.

²⁵ Commonwealth of Australia 1994a, *op. cit.* p.10.

supply.²⁶ From July 1995 a national electricity market in the eastern and southern states is due to become operational, with customers of a certain size able to source their electricity needs from a multiplicity of generators within five states, forty retail suppliers or any number of retail brokers. In this environment, new generation or supply management will be initiated when market forces make it commercially attractive.²⁷ To achieve this eastern market, a transmission line needs to connect northern NSW and southern Queensland, which is predicted to have an electrical shortage soon. Estimated to cost \$400 million, some observers have noted that for this amount of money, investment in renewable energy and energy efficiency measures in homes and industry would be cheaper and achieve the same result, with reduced greenhouse gas emissions.²⁸

Pacific Power notes that the world will need to make the transition to a sustainable future, and that only the time frame for this to happen is in dispute. Measures to control greenhouse gas emissions such as carbon tax, tradeable emission rights or mandatory efficiency requirements are likely to be introduced in the future. Pacific Power says that it is imperative that Australia take a lead in the transition to ensure Australia maintains its international competitiveness.²⁹

Pacific Power has identified the following greenhouse response options:

- promote energy efficiency and conservation in end of use energy and developing technologies that help achieve this
- improving the thermal efficiency of existing plant
- reducing the carbon dioxide intensity of existing plant through fuel substitutions

²⁶ For more information on electricity market reform, see Mullen, V. (1994) "Electricity Transmission Authority Bill 1994" *NSW Parliamentary Library Research Service, Bills Digest No. 036/94*.

²⁷ Pacific Power, 1994, *Draft Strategic Plan June 1994*.

²⁸ Lowe, I., 1995, "Finding the energy for a new tax" in *New Scientist*, 4 February 1995, No. 1963.

²⁹ Pacific Power, 1994, *op. cit.* p.14

- developing new technologies and fuel sources that reduce greenhouse gas emissions eg, advanced fossil fuel technology, alternate fossil fuels, renewable energy technologies and supporting climatic research.

Pacific Power notes that there is sufficient capacity to meet electrical demand for some time, and therefore a 'window of opportunity' exists to develop alternatives without the need to commit to existing technologies. Yet here is the dilemma; earlier it was noted that Pacific Power considered that new electrical generation capacity would only be built when market forces make it commercially attractive. As shown below, electricity generation from fossil fuels is considerably cheaper than from renewable resources.

TABLE 1 COSTS OF ELECTRICITY PRODUCTION³⁰

MATURE TECHNOLOGY	COST OF PRODUCTION CENTS/KWH	GREENHOUSE GASES TONNES OF CO2/MWH
Pulverised fuel coal	3.2	0.87
Gas Turbine	4.3	0.63
Hydro	6.0	0
Nuclear	7.5	0
Wind	5.8	0
EMERGING TECHNOLOGIES	COST OF PRODUCTION CENTS/KWH	GREENHOUSE GASES TONNES OF CO2/MWH
Integrated Gasification Combined Cycle ³¹	4.1	0.72
Solar Photovoltaic	8-20	0

³⁰ Pacific Power, 1994, *op. cit.*

³¹ This is a combination of proven and currently available component technologies to give higher thermal efficiency and lower carbon dioxide, nitrous oxides and sulphur emissions and lower water consumption compared to a normal coal fired plant.

Cheap black coal has provided the fuel for 90% of the State's electricity generation for the last forty years, with Pacific Power currently consuming 21 million tonnes of coal per annum at a cost of \$710 million.³² If this sort of commitment was given to the development of renewable resources, then electricity generation would from these sources would be much cheaper. For a full account of the NSW coal industry, see the NSW Parliamentary Library Briefing Note "Coal Production in NSW".³³

Cogeneration of power is also being promoted, with the NSW Parliament being one of the first buildings to incorporate this facility. In Parliament House, existing emergency generating equipment is used to meet twenty five percent of the peak power demand. The heat generated, which was once wasted, is now used to heat the building's hot water system.³⁴

There are two methods to utilise solar power, solar thermal systems which rely on recovering heat from the sun to drive steam turbines, and photovoltaic cells that turn sunlight directly into electricity. A solar thermal power station of 345MW with gas back up is in operation in California, whilst in Australia a 25kW solar thermal power station was in operation in White Cliffs in western NSW, and a 2MW solar thermal plant at Tennant Creek in the Northern Territory is currently under construction.³⁵ The technology to be used in the NT was developed at Australian National University, and uses parabolic mirrors to reflect sunshine onto a receiver, generating superheated steam to drive a turbine. The developers claim that in desert locations, power can be generated for as little as 4 cents per Kwh.³⁶ The developers of photovoltaic cells from the University of New South Wales predict that within ten years the cost of solar electricity using these cells would be about 5 - 8 cents per Kwh.³⁷

Governments are in a strong position to assist the development of renewable energy sources. The Federal government's announcement in the 1993 Budget of

³² Pacific Power, 1994, *op. cit.* p.50.

³³ Wilkinson, J. (1995) "Coal Production in New South Wales" *NSW Parliamentary Library Briefing Note No. 010/95.*

³⁴ Willis, M. & Rozzoli, K.R., 1994, Media Release. "Hot air from Parliament will cut energy needs whilst reducing greenhouse emissions". 28 November 1994.

³⁵ Pacific Power, 1994, *op. cit.* p.56.

³⁶ Anderson, I, 1994, "Sunny days for solar power" in *New Scientist*, Vol. 143, No. 1932.

³⁷ *Ibid*, p.25.

an energy card, a cheap loan scheme to promote sales of solar hot water systems is an example. Under the scheme, consumers could use the special credit card to purchase energy efficient products without paying a deposit and at lower interest rates. However, in 1995 the card has still not been released and it was reported in *The Sydney Morning Herald* that industry sources have accused the Federal Department of Primary Industries and Energy of "bungling the whole scheme".³⁸ The Queensland government has set aside \$35 million over three years to provide a one-off grant of \$500 to householders installing a new solar hot water system, and up to \$7,500 for those in remote areas buying stand alone solar or wind power energy systems.³⁹ The South Australian government has devised a draft strategy to achieve 20 percent of non-transport energy from renewable resource within ten years, requiring a massive investment in new equipment.⁴⁰

Other alternative renewable sources of energy include the generation of electricity from waste products, where anaerobic digestion of waste produces methane which is used in an engine or turbine. Rice husks in the Riverina district of NSW are potentially able to fuel up to 23MW of electricity, and Pacific Power and the NSW Waste Recycling and Processing Authority have called for expressions of interest to own and operate a 5MW landfill gas development at the Lucas Heights tip.⁴¹

The Australian Conservation Foundation believes that the microeconomic reform of the electricity industry should include genuine price reform, so that electricity prices gradually include the full environmental, health and social costs of using fossil fuels. The Foundation also notes that suppliers of electricity should move into the provision of energy services, so that the cheapest and most environmentally friendly way of providing energy may include an energy bill comprising electricity, gas, insulation, solar technology, efficient lighting and 'green' refrigerator components.⁴² Presently, even energy efficient display homes are not truly efficient. For instance, in Lane Cove, Sydney, an energy and water efficient unit in a medium density housing

³⁸ Beale, B. "Energy Card delay clouds solar water heating drive: Libs." in *The Sydney Morning Herald*, 16 February 1995, p.4.

³⁹ Lowe, I. (1995) "Where renewables is not an ugly word" in *New Scientist*, 18 March 1995, No. 1969.

⁴⁰ *Ibid*, p.47.

⁴¹ Pacific Power, 1994, *op. cit.* p. 57.

⁴² Diesendorf, M., 1994, "Power Politics" in *Habitat*, Vol. 22, No.1.

complex is on display, sponsored by Pacific Power and Sydney Water. In this display home, whilst a heat pump is used to heat water requiring about a quarter of the energy of a normal electrical hot water system, a combined solar and gas backup water heater is the most environmentally sound energy source.

HOUSEHOLD ENERGY USE

The National Greenhouse Response Strategy includes the objectives of improving the energy efficiency of residential buildings and domestic appliances, and to influence householders to become more economical in their use of energy. The Strategy suggests the following actions;

- introduce appropriate energy efficiency standards and codes for new housing and appliances
- improve consumer (and especially women's) knowledge on energy efficiency
- require energy utilities to pay greater attention to demand side management and pricing to influence the behaviour of householders
- consider cost-effective incentives to encourage householders to adopt practices and appliances that would reduce greenhouse gas emissions.

Gilchrist, in a wide ranging study on the Australian energy supply industry, noted that in 1992 Australian households spent \$3770 million on electricity to make their appliances work, another \$1150 million buying new whitegoods and \$150 million buying new water heaters.⁴³ Savings in energy from the residential sector are potentially greater than other sectors, with studies showing potential reductions of greenhouse gases of 24 to 67 percent.

Minimum energy performance standards (MEPS) are one way to enforce energy standards, where manufacturers are not allowed to sell products that do not comply with the standard. As an example, the United States government ordered a 10 percent improvement in refrigeration efficiency in 1987, and a further 25 percent in 1989. In 1989, only 7 of the 2114 models on the US market met that standard, by September 1993 they all did. As a result of this

⁴³ Gilchrist, G. 1994, *The Big Switch Clean Energy for the Twenty-First Century*. Allen and Unwin.

MEPS, between 1990 and 2015, U.S. citizens will have to pay \$31 billion more for their fridges, but save \$76 billion running them, and US energy companies will have to build 25 fewer power stations.⁴⁴

In Australia, the Greenhouse Response Strategy states that governments will develop and implement nationwide energy performance standards for major domestic appliances, after considering the costs and benefits involved.⁴⁵ The Australian New Zealand Minerals and Energy Council, comprising representatives from all the States, Commonwealth and New Zealand, is the lead agency responsible for implementing this part of the Strategy. A consultants report to State and Federal governments in 1993 indicated that a conservative MEPS on fridges, freezers, clothes driers and electric water heaters, implemented by mid 1996, would save \$575 million off what would have been spent between 1993 and 2007 on buying and running these appliances.⁴⁶ The Australian Electrical and Electronic Manufacturers Association, the peak body representing industry that manufactures those goods that would be subject to a MEPS, supported the introduction of an Australian MEPS, with certain reservations on water heaters and clothes dryers. However, governments, especially federally, have taken no further action in this area.⁴⁷ This is unfortunate, as minimum energy performance standards are the perfect example of a no-regrets policy option response to greenhouse, and were a key feature of the National Greenhouse Response Strategy. Instead, labelling of appliance energy efficiency is standard, and MEPS are still only talked about.

INDUSTRIAL AND COMMERCIAL ENERGY USE

The Greenhouse Strategy includes the introduction of energy efficiency standards in new commercial buildings, and standards, codes and labelling programs to achieve improvements in the energy efficiency of new industrial and commercial equipment.

Australian Energy Solutions, a partnership between Sydney Electricity Enterprises and the company INTESCO Pacific, has recently launched a new energy efficiency program aimed at the top 1000 companies with energy costs in excess of \$500,000. The program hopes to cut 39,000 tonnes of greenhouse gas

⁴⁴ Mackenzie, D. (1993) "Britains fridges: too hot to handle" in *New Scientist*, 4 September 1993.

⁴⁵ Commonwealth of Australia, 1992a, *op. cit.* p.21.

⁴⁶ Gilchrist, 1994, *op. cit.* p. 236.

⁴⁷ *Ibid*, p.236.

emissions by 1999, with every megawatt of electricity saved, one tonne of carbon dioxide is prevented from polluting the atmosphere.⁴⁸

The Queensland government has recently announced initiatives, aimed at cutting the state government's power bill by \$40 million, by imposing energy efficiency measures in all public sector buildings and operations, setting minimum design requirements in all new public housing and placing guidelines for government purchasing.⁴⁹

TRANSPORT AND URBAN AND TRANSPORT PLANNING

Energy use for transport contributes around 15 percent of total carbon dioxide emissions.⁵⁰ Pacific Power has noted that Australia's natural advantage in gas and petroleum has impeded development of energy efficient products, for instance new Australian cars are the least efficient in the OECD in terms of litres of fuel consumed per 100 kilometres.⁵¹ Actions to reduce carbon dioxide emissions from transport sources include rail reform, improving public transport efficiency and use, road transport reform, promotion of technical innovation, control of vehicle emissions, use of alternate fuels, travel demand strategies and urban planning design.⁵² (This is the subject of a forth coming paper from the Parliamentary Library Research Service).

Local government has a leading role to play in energy efficient environmental planning. A report prepared for the Local Government and Shires Association notes that greenhouse gases could be cut by an average of six percent if the principle of 'structured mixed use' is adopted. This principle involves:

- people living near their workplace, shopping centre and services
- a mix of housing types in each area

⁴⁸ Anon, 1995, "Big energy users target of new plan." in *Australian Environment Review* Vol. 10, No. 2.

⁴⁹ Emerson, S. "Goss woos green groups with five year efficient energy plan" in *The Australian*, 27 February 1995, p.3.

⁵⁰ Commonwealth of Australia 1994b, *Climate Change. Australia's national report under the United Nations Framework Convention on Climate Change*. AGPS Canberra.

⁵¹ Pacific Power, *op. cit.* p.14

⁵² Commonwealth of Australia 1994b, *op. cit.* p.54.

- the aggregation of businesses into centre, nodes and districts according to their job densities
- the reduction of car parking and dependence on private transport
- greater residential densities to maximise services
- preservation of historical buildings but considering their relationship to the land use around them.⁵³

The above report for the Local Government and Shires Association found that the traditional grid subdivision system for new housing land is more energy efficient than a tree form pattern. Advantages include; habitable room windows and private areas can face north, land is efficiently divided, pattern is easily understood and navigated, pattern favours pedestrians and cyclists, and can be better served by public transport, vehicular traffic is distributed more evenly, pattern is more appropriate for a mixture of housing styles and the grid system lends itself to progressive redevelopment.⁵⁴

AGRICULTURE

Agriculture contributes an estimated 15.2 percent of all greenhouse gas emissions, largely through the emission of methane from livestock.⁵⁵ In response, the National Greenhouse Response strategy aims to give special attention to measures with the greatest potential to reduce greenhouse gas emissions, such as reduction of methane from ruminants, yet provides no real direction on how to achieve this.⁵⁶ Options available to reduce agricultural greenhouse gas emissions include improved stock management and efficiency, improved animals waste management and disposal, and increased efficiency in the use of mineral nitrogen fertilisers and legume pastures.⁵⁷ As agriculture is

⁵³ Local Government Association of NSW & Shires Association of NSW, 1993, *Local Government and Energy Efficiency. A report and guidelines for local government in the application of energy efficiency principles in development and building controls*. Local Government and Shires Association of NSW.

⁵⁴ *Ibid*, p.13.

⁵⁵ Commonwealth of Australia 1994a, *op. cit.* p.8.

⁵⁶ Commonwealth of Australia, 1992a, *op. cit.* p.30.

⁵⁷ Commonwealth of Australia 1992b, *Ecologically Sustainable Development Working Groups Chairs Greenhouse Report*. AGPS Canberra.

such a broad scale industry, involving many producers, these practices will require strong government leadership to achieve an outcome.

NATURAL ENVIRONMENT

The problem of global warming due to the emission of greenhouse gases may be mitigated by the sink capacity of the natural environment and the development of plantation forests. Vegetation absorbs carbon dioxide and emits oxygen, yet when native vegetation is cleared, as are 500-600,000 hectares in Australia each year, stored carbon is released from the soil and from vegetation which is rotting or burning.⁵⁸ The result is that more carbon dioxide is released and there are less trees to absorb it. Approximately 25 percent of Australia's greenhouse gas emissions are released from land use change and forestry. State governments have constitutional responsibility for determining land use, and therefore have a big responsibility to determine what will have minimal impact on greenhouse gas emissions.

An argument often used by supporters of the logging industry is that logging of old growth forests is good because the new growth trees, growing fast, absorb more carbon dioxide than an old growth forest.⁵⁹ The Resource Assessment Commission analysed this and found that in all modelled cases carbon storage in an old growth forest exceeded that in a regrowth forest.⁶⁰

Other elements of the National Greenhouse Response Strategy include adaptation. This involves identifying areas most at risk and planning for change, climate change research, community information and involvement and evaluation and review of the Strategy itself. As State governments have much greater direct contact with the community, through schools for instance, they should lead the way in community information programs.

PART VIII: REGIONAL IMPACT OF THE ENHANCED GREENHOUSE EFFECT ON NEW SOUTH WALES

The NSW Environment Protection Authority has contracted the CSIRO to produce reports on the impact of global or regional warming on NSW. Below are summaries of some of the main points from this work. The scenarios as

⁵⁸ Kinrade, P. 1995, "Australia's greenhouse obligations and options" in *Habitat* Vol. 23, No. 1.

⁵⁹ Forest Industries, 1992, *Forest Facts: The Greenhouse Effect*.

⁶⁰ Commonwealth of Australia 1992b, *op. cit.* p.99

presented below do not take into account such factors as the El-Nino-Southern Oscillation effect, ocean currents, tropical cyclone behaviour or sulfate aerosol. The CSIRO has used general circulation models of a limited area incorporating twice the level of carbon dioxide in the atmosphere. The high and low climate change effects refer to the scenarios of global climate change as discussed earlier in the paper.

STORM SURGE

Greenhouse induced climate change was determined to have the potential to exacerbate the storms which form off the NSW coast, exacerbating storm surges. It is often the case that these storm surges and associated wave activity cause widespread damage to coastal structures, properties and contribute to flooding. Coastal erosion may therefore increase. Coastal inundation and erosion will also degrade recreational opportunities and habitats of native flora and fauna. The coastal impact models developed by CSIRO, whilst site and event specific, found that with sea surface temperatures increase of 3 degrees Celsius, peak surges were found to increase by between 10 and 20 percent.⁶¹

EXTREME TEMPERATURES AND ACCUMULATION OF WINTER CHILL

One of the most important aspects of climate change is that whilst only small changes in climatic averages may occur, more marked changes to climatic extremes may be evident. A low climate change scenario indicates little change from present climatic conditions by 2030. In contrast, the high change scenario produces changes where the frequency of summer days over 35 degrees Celsius increases by at least 50 percent at Armidale, Bathurst, Bega, Canberra, Dubbo, Forbes, Grafton, Griffith, Gundagai, Narrabri, Narrandera, Sydney and Tumbarumba by 2030.⁶²

Climate change also has implications for horticulture. For instance, most deciduous fruit trees need sufficient accumulated chilling to ensure normal flowering and fruit-set. Inadequate chilling results in reduced yield and quality. The amount of chilling is expressed as chill units, where one chill unit is equivalent to one hours exposure at 7 degrees Celsius. The minimum chilling requirement for high chill stone fruit is approximately 800 chill units and about

⁶¹ McInnes, K.L., Hennessy, K.J., Whetton, P.H. and T. Beer, 1994, "Climatic Impacts" in Mitchell, C.D., Hennessy, K.J. and A.B. Pittock (ed) *Regional Impact of the Enhanced Greenhouse Effect on New South Wales*. CSIRO.

⁶² *Ibid*, p.26.

1200 for pome fruit such as apples and pears. With modelled climate change, chill areas contracted south and rose in elevation, with the regions of Forbes and Griffith at higher risk of poor stone fruit yield.⁶³ CSIRO notes that these horticultural studies should be indicative of possible reductions in chilling associated with global warming rather than firm predictions.

RAINFALL AND WATER RESOURCES

Climatic modelling of NSW precipitation shows that with global warming, January rainfall shows the greatest increase in the south and north-east of the State, and during July rainfall decreases.⁶⁴ CSIRO studies have shown that changes in rainfall are amplified in runoff changes. Potentially significant increases in flood frequency and potential damage are emerging as major issues due to global warming. If true, such a change would potentially have a major impact on the urban environment, built infrastructure and hydrological planning.⁶⁵

SNOW COVER IN THE AUSTRALIAN ALPS

Winter snow cover in the Snowy Mountains is important for specialised alpine ecosystems, water storage for the Snowy Mountains hydroelectric scheme and supports a major downhill and cross country ski industry.⁶⁶ The CSIRO notes that snow cover is highly climate dependent, and varies from year to year with interannual changes in air temperature and precipitation. Global and regional warming due to the enhanced greenhouse effect is expected to reduce both the depth and duration of snowcover.⁶⁷ Possible changes to temperature and precipitation with the CSIRO climate change scenario for 2030 results in the Perisher-Smiggins area to have simulated snow cover from 86 to fewer than 30 days. This demonstrates that climate change has a significant potential effect on snowcover and the viability of the ski industry, whilst noting that the CSIRO

⁶³ *Ibid*, p. 28.

⁶⁴ Hennessy, P.H., Whetton, J.L. and K.J. Walsh 1994, "Regional modelling" in Mitchell, C.D. *et al* (ed) *Regional Impact of the Enhanced Greenhouse Effect on New South Wales*. CSIRO.

⁶⁵ *Ibid*, p. 34.

⁶⁶ Fowler, A.M., Wang, Y.P., Pittock, A.B. and C.D. Mitchell (eds) 1992, *Regional Impact of the Enhanced Greenhouse Effect on New South Wales. Annual Report 1991-92*.

⁶⁷ *Ibid*, p.30.

accepts that the sensitivity of snowcover duration to climate change contains substantial uncertainty.⁶⁸

EL NINO - SOUTHERN OSCILLATION

Droughts and floods are major, periodic events in Australia, and the reasons for this have only recently been discovered. The El Nino - Southern Oscillation (ENSO) is an ocean-atmosphere interaction, centred in the Pacific, and is linked to many droughts and floods around the world.⁶⁹ During an El Nino event there is a band of warm water across the equatorial central and eastern Pacific, associated with an unusually low surface atmospheric pressure in the eastern Pacific and unusually high pressures in the Indonesian region.⁷⁰ ENSO exerts a significant influence on the NSW climate, with drought common in ENSO years and floods in anti-ENSO years. Therefore, a change in the ENSO regime due to global warming has major ramifications for the NSW climate.

Workshops held by CSIRO have found that the knowledge of ENSO is far from complete, and have developed the following tentative conclusions. ENSO is likely to continue to occur, and that possibly the frequency of episodes will change. Of greater note, models of ENSO suggest that the intensity of floods and drought may increase.⁷¹

BIODIVERSITY CONSERVATION

The Australian Nature Conservation Agency has released a report detailing the potential impacts of global warming of one degree Celsius on 57 endangered species. Three scenarios were considered, one resulting in 84 percent of the endangered species losing parts of their habitat, and two other scenarios, with slightly greater regional temperature increases, where more than 95 percent of species lost parts of their habitat, and seven or eight species lost their home

⁶⁸ *Ibid*, p.32.

⁶⁹ Allan,R.J. and I.N. Smith (1994) "The El Nino - Southern Oscillation" in Mitchell,C.D. *et al* (ed) *Regional Impact of the Enhanced Greenhouse Effect on New South Wales*. CSIRO.

⁷⁰ Fowler,A.M., Wang,Y.P., Pittock,A.B. and C.D. Mitchell (eds) 1992, *op.cit.* p.45.

⁷¹ Allan,R.J. and I.N. Smith (1994) *op. cit.* p.38.

range and faced likely extinction.⁷² Other difficulties noted in the report include the change in habitat location of potentially hundreds of kilometres and that climate change will happen so fast that species will find it difficult to disperse and adapt to new conditions. Corridors for species to move and relocate according to climate change are therefore an essential conservation planning tool, without which species will face extinction.⁷³

PART IX: CONCLUSION

Global climate change is firmly on the international agenda. Pacific island nations are particularly concerned of the effects of global warming and rising sea levels, threatening to submerge entire communities. Many of these island states are disappointed at the lack of response of developed nations to stabilise greenhouse gas emissions and have joined together to form the Alliance of Small Island States to lobby for greater greenhouse gas reductions.⁷⁴

Australia, whilst having signed the Framework Convention on Climate Change, and developed a National Greenhouse Response Strategy, has done relatively little to reduce greenhouse gas emissions. It is unlikely that Australia will be able to stabilise greenhouse emissions at 1990 levels by the year 2000, as required by the Convention, with a projected increase of 78 million tonnes of carbon dioxide equivalent.

The Federal Government hopes to reduce this projected increase to just three percent over 1990 emissions (17 million tonnes), with the introduction of a new \$63 million package to reduce greenhouse gas emissions. The package is based on voluntary agreements with industry, legislation to tie infrastructure funding with energy-efficiency gains, and a \$7.5 million boost to the One Billion Trees revegetation program.⁷⁵

Australia is highly vulnerable to the impacts of climate change, socially, economically and environmentally. Agriculture, forestry, water resources, cities, coastal areas, human health, and native flora and fauna could be effected.

⁷² Woodford, J. "Global warming a threat to wildlife" *The Sydney Morning Herald*, 23.2.1995, p.4.

⁷³ *Ibid*, p.4.

⁷⁴ Kinrade, P. (1995) *op. cit.* p.29.

⁷⁵ Goreham, G. 1995, "Australia: Industry says yes, Greens say no to emissions policy" *The Age*, 30 March 1995.

State governments have special responsibilities in reducing greenhouse gas emissions, due to their control over such factors as transport planning and operation, urban design, land use change and management, energy demand and management, and responsibility for education. New South Wales, with a large proportion of the Australian population, can make significant reductions in greenhouse gas emissions, if appropriate action is taken.