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The Greenhouse Effect and Climate Change: An Update

by

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EXECUTIVE SUMMARY

The threat of global climate change has produced one of today's most intractable policy issues. This is because the emission of gases that contribute to climate change are currently intricately associated with our everyday lifestyle. Some of the most important conclusions to come out of recent work by the Intergovernmental Panel on Climate Change include: global average surface temperature has increased over the 20th century by about 0.6°C; globally, it is very likely that the 1990s was the warmest decade and 1998 the warmest year in the instrumental record since 1861; snow cover and ice extent have decreased; there has been a widespread retreat of mountain glaciers in non-polar regions during the 20th century; and global average sea level has risen and ocean heat content has increased. However, a few areas of the globe have not warmed in recent decades, mainly over some parts of the Southern Hemisphere oceans and parts of Antarctica (pages 1 – 2).

The IPCC concluded that atmospheric concentration of carbon dioxide has increased by 31% since 1750. The present carbon dioxide concentration has not been exceeded during the past 420,000 years and likely not during the past 20 million years. The current rate of increase is unprecedented during at least the past 20,000 years. About three-quarters of the anthropogenic (ie, human generated) emissions of carbon dioxide to the atmosphere during the last 20 years are due to fossil fuel burning (page 2).

The IPCC projected that globally averaged surfaced temperatures are projected to increase by 1.4 °C to 5.8 °C over the period 1990 to 2100. The projected rate of warming is much larger than the observed changes during the 20th century and is very likely to be without precedent during at least the last 10,000 years (page 3).

The vulnerability of human populations and natural systems to climate change differs substantially across regions and across populations within regions. For Australia and New Zealand, the IPCC noted that the net impact on some temperate crops of climate and carbon dioxide changes may initially be beneficial, but this balance is expected to become negative for some areas and crops with further climate change. Water is likely to be a key issue due to projected drying trends over much of the region and change to a more El Nino like state (page 4).

The international framework for reducing greenhouse gas emissions is based around the United Nations Framework Convention on Climate Change. The Kyoto Protocol is part of this Convention, and commits Australia to limiting greenhouse gas emissions to 108% of 1990 emissions in the period 2008-2012 (pages 13 – 17). However, the Kyoto Protocol is yet to be ratified. The Commonwealth and States have co-operatively developed a National Greenhouse Strategy in an attempt to meet the Kyoto Protocol emission target. The Strategy is divided into eight modules encompassing: profiling emissions; understanding climate change; partnerships; efficient energy use and supply; efficient transport; greenhouse sinks; greenhouse best practice for industrial processes; and adaptation to climate change (pages 18 - 20).

A key response of NSW to reducing greenhouse gas emissions was the establishment of the Sustainable Energy Development Authority in 1996 (pages 20-27).

1.0 INTRODUCTION

The threat of global climate change has produced one of today's most intractable policy issues. This is because the emission of gases that contribute to climate change are currently intricately associated with our everyday lifestyle. Modern economic and social frameworks have been built around the consumption of fossil fuels, and to change this basis may ultimately require a fundamental rethink in the way that society operates.

The greenhouse effect is a natural phenomenon. Approximately 70 percent of the sunlight falling on earth is absorbed and re-radiated as longer length, infra-red energy (ie, heat). Water vapour and atmospheric gases, including trace gases such as carbon dioxide, absorb some of the outgoing infra-red radiation, warming the air. This 'greenhouse effect' raises the temperature of earth to an average of around 15 ^{o}C. However, with the burning of fossil fuels since the industrial revolution, the atmospheric concentration of these greenhouse gases has increased. This alters the radiation balance so that more long wave radiation is being absorbed in the lower atmosphere, and some of this is being re-emitted back to the earth's surface. This is known as the 'enhanced greenhouse effect'.[1]

2.0 THE LATEST ASSESSMENT OF CLIMATE CHANGE FROM THE IPCC

The InterGovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organisation and the United Nations Environment Program. The role of the IPCC is to assess the scientific, technical and socio-economic information relevant for the understanding of the risk of human-induced climate change. It does not carry out new research nor does it monitor climate related data. It bases its assessment mainly on published and peer reviewed scientific technical literature.

The IPCC completed its First Assessment Report in 1990. Its Second Assessment Report, *Climate Change 1995*, provided key input to the negotiations which lead to the adoption of the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) in 1997.

The Third Assessment Report, *Climate Change 2001*, provides a comprehensive and up-to-date assessment of the policy-relevant scientific, technical, and socio-economic dimensions of climate change. It concentrates on new findings since 1995, pays greater attention to the regional (in addition to the global) scale, and non-English literature. The three Working Groups' contributions were published in July 2001.[2] This section of the Paper provides a summary of the Third Assessment Report.

2.1 The IPCC Third Assessment Report – Climate Change 2001

Some of the most important conclusions to come out of this work include the following:[3]

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1 NSW EPA, *New South Wales State of the Environment Report 2000*, at 86.

2 See the IPCC website URL: http://www.ipcc.ch/about

3 Intergovernmental Panel on Climate Change, *Climate Change 2001. Summary for*

- The global average surface temperature has increased over the 20th century by about 0.6°C.
- Globally, it is very likely[4] that the 1990s was the warmest decade and 1998 the warmest year in the instrumental record, since 1861.
- On average, between 1950 and 1993, night time daily minimum air temperatures over land increased by about 0.2° C per decade.
- Temperatures have risen during the past four decades in the lowest eight kilometres of the atmosphere
- Snow cover and ice extent have decreased – satellite data shows that there is very likely to have been a decrease of about 10% in the extent of snow cover since the late 1960s. Ground based observations show that there is very likely to have been a reduction of about two weeks in the annual duration of lake and river ice cover in the mid and high latitudes of the Northern Hemisphere over the 20th century;
- There has been a widespread retreat of mountain glaciers in non-polar regions during the 20th century;
- Global average sea level has risen and ocean heat content has increased;
- However, a few areas of the globe have not warmed in recent decades, mainly over some parts of the Southern Hemisphere oceans and parts of Antarctica;
- No significant trends for Antarctic sea-ice are apparent since 1978, the period of reliable satellite measurements;
- Changes globally in tropical and extra-tropical storm intensity and frequency are dominated by inter-decadal to multi-decadal variations, with no significant trends evident over the 20th century. Conflicting analyses make it difficult to draw definitive conclusions about changes in storm activity, especially in the extra-tropics.
- No systemic changes in the frequency of tornadoes, thunder days, or hail events are evident in the limited areas analysed.

The IPCC concluded that atmospheric concentration of carbon dioxide has increased by 31% since 1750. The present carbon dioxide concentration has not been exceeded during the past 420,000 years and likely not during the past 20 million years. The current rate of increase is unprecedented during at least the past 20,000 years. About three-quarters of the anthropogenic (ie, human generated) emissions of carbon dioxide to the atmosphere during the last 20 years are due to fossil fuel burning. The rest is predominantly due to land use change, especially deforestation. Currently, the ocean and land together are taking up about half of the anthropogenic carbon dioxide emissions.[5]

Policymakers. A report of Working Group 1 of the Intergovernmental Panel on Climate Change, 2001, at 2.

4 The IPCC defines the following terms: virtually certain (greater than 99% chance that a result is true); very likely (90-99% chance); likely (66-90% chance); medium likelihood (33-66% chance); unlikely (10-33% chance); very unlikely (1-10% chance); and exceptionally unlikely (less than 1% chance).

5 Intergovernmental Panel on Climate Change, *Climate Change 2001. Summary for Policymakers. A report of Working Group 1 of the Intergovernmental Panel on Climate*

The IPCC also concluded that there is new and stronger evidence that most of the warming observed over the last 50 years is likely to have been due to the increase in greenhouse gas emissions. Furthermore, it is very likely that the 20th century warming has contributed significantly to the observed sea level rise, through thermal expansion of sea water and widespread loss of sea ice.[6]

The IPCC projected that globally averaged surfaced temperatures are projected to increase by 1.4 °C to 5.8 °C over the period 1990 to 2100. The projected rate of warming is much larger than the observed changes during the 20th century and is very likely to be without precedent during at least the last 10,000 years. Global average water vapour concentration and precipitation are projected to increase during the 21st century. By the second half of the 21st century, it is likely that precipitation will have increased over northern mid to high latitudes and Antarctica in winter. At low latitudes there are both regional increases and decreases over land areas. Larger year to year variations in precipitation are very likely over most areas where an increase in mean precipitation is projected.[7]

In regards to El Nino[8], the IPCC noted that confidence in projections of changes in frequency and amplitude of El Nino are tempered by some shortcomings in complex models. Current projections show little change or a small increase in amplitude for El Nino events over the next 100 years. However, even with little or no change in El Nino amplitude, global warming is likely to lead to greater extremes of drying and heavy rainfall and increase the risk of droughts and floods that occur with El Nino events in many different regions.

The IPCC noted that global mean sea level is projected to rise by 0.09 to 0.88 metres between 1990 and 2100, primarily due to thermal expansion of the seas and the loss of mass from glaciers and ice caps. Global mean surface temperatures and rising sea levels are projected to continue for hundreds of years after stabilisation of greenhouse gas concentrations – even at present levels. This is due to the long time-scales on which the deep ocean adjusts to climate change. Ice sheets will continue to react to climate warming and contribute to sea level rise for thousands of years after climate has stabilised.[9]

Change, 2001, at 7.

6 Intergovernmental Panel on Climate Change, *Climate Change 2001. Summary for Policymakers. A report of Working Group 1 of the Intergovernmental Panel on Climate Change*, 2001, at 10.

7 Intergovernmental Panel on Climate Change, *Climate Change 2001. Summary for Policymakers. A report of Working Group 1 of the Intergovernmental Panel on Climate Change*, 2001, at 13.

8 The variability of Australia's climate is largely due to the El Nino – Southern Oscillation (ENSO) phenomenon. The ENSO cycle is a natural oscillation in the state of the ocean-atmosphere circulation throughout the Asia-Pacific region. ENSO consists of an oscillation between two extreme states: El Nino, characterised by low rainfall in the eastern States; and La Nina, characterised by high rainfall across Australia. See: NSW EPA, *New South Wales State of the Environment Report 2000*, at 12.

9 Intergovernmental Panel on Climate Change, *Climate Change 2001. Summary for Policymakers. A report of Working Group 1 of the Intergovernmental Panel on Climate*

2.2 The Impacts and Vulnerability of Climate Change as Identified by the IPCC

The vulnerability of human populations and natural systems to climate change differs substantially across regions and across populations within regions. The natural and social systems of different regions have varied characteristics, resources and institutions, and are subject to varied pressures that give rise to differences in sensitivity and adaptive capacity. From these differences the IPCC has identified different key concerns for each of the major regions of the world. However, even within these regions, impacts, adaptive capacity and vulnerability will vary. For Australia and New Zealand, the IPCC had the following analysis:

- Adaptive capacity of human systems is generally high, but there are groups in Australia and New Zealand, such as indigenous peoples in some regions, with low capacity to adapt and consequently high vulnerability;
- The net impact on some temperate crops of climate and carbon dioxide changes may initially be beneficial, but this balance is expected to become negative for some areas and crops with further climate change (medium confidence);[10]
- Water is likely to be a key issue (high confidence) due to projected drying trends over much of the region and change to a more El Nino like state;
- Increases in the intensity of heavy rains and tropical cyclones (medium confidence) and region specific changes in the frequency of tropical cyclones, would alter the risks to life, property, and ecosystems from flooding, storm surges, and wind damage;
- Some species with restricted climatic niches and which are unable to migrate due to fragmentation of the landscape, soil differences, or topography could become endangered or extinct (high confidence). Australian ecosystems that are particularly vulnerable to climate change include coral reefs, arid and semi-arid habitats in southwest and inland Australia, and Australian alpine systems. Freshwater wetlands in coastal zones in both Australia and New Zealand are vulnerable, and some New Zealand ecosystems are vulnerable to accelerated invasion by weeds.[11]

2.3 The Mitigation of Climate Change

Working Group III of the IPCC looked at the mitigation of climate change. The Group noted that climate change is a problem with unique characteristics. It is global, long-term (up to several centuries), and involves complex interactions between climatic, environmental, economic, political, institutional, social and technological processes. Developing a response to climate change is characterised by decision making under

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Change, 2001, at 17.

10 The following words have been used to indicate judgemental estimates of confidence: medium confidence (33-67%), high (67-95%), very high (95% or greater).

11 Intergovernmental Panel on Climate Change, *Climate Change 2001: Impacts, Adaptation, and Vulnerability. Summary for Policymakers. A report of Working Group 2 of the Intergovernmental Panel on Climate Change*, 2001, at 15.

uncertainty and risk, including the possibility of irreversible changes.[12]

The IPCC noted that the type, magnitude, timing and costs of mitigation depend on different national circumstances, socio-economic and technological development paths and the desired level of greenhouse gas stabilisation in the atmosphere. Development paths leading to low emissions depend on a wide range of policy choices and require major policy changes in areas other than climate change.

It was noted that lower emission scenarios require different patterns of energy resource development. The IPCC noted that there are abundant fossil fuel resources the use of which will not limit carbon emissions during the 21st century. The choice of energy mix and associated investment will determine whether, and if so, at what level and cost, greenhouse concentrations can be stablised.

In regards to options to limit or reduce greenhouse gas emissions and enhance carbon sinks[13], some of the key findings were:

- Hundreds of technologies and practices for end-use energy efficiency in buildings, transport and manufacturing industries account for more than half the potential of greenhouse reductions;
- At least up to 2020, energy supply and conversion will remain dominated by relatively cheap and abundant fossil fuels. Natural gas, where transmission is feasible, will play an important role in emission reduction;
- Low-carbon energy supply systems can make an important contribution: biomass from forestry and agricultural by-products, municipal and industrial waste to energy, dedicated biomass plantations, landfill methane, wind energy and hydropower, and the use and lifetime extension of nuclear power plants. Environmental, safety, reliability and proliferation concerns may constrain the use of some of these technologies.
- Methane and nitrous oxide emissions can be reduced in agricultural production;
- Emissions of fluorinated gases can be minimised.

The IPCC noted that forests, agricultural lands, and other terrestrial ecosystems offer significant carbon mitigation potential. Although not necessarily permanent, conservation and sequestration of carbon may allow time for further options to be developed and implemented. Biological mitigation can occur by three methods: conservation of existing carbon pools (eg forests); sequestration by increasing the size of carbon pools; and substitution of sustainably produced biological products, eg, wood for energy intensive construction products.

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12 Intergovernmental Panel on Climate Change, *Climate Change 2001: Mitigation. Summary for Policymakers. A report of Working Group 3 of the Intergovernmental Panel on Climate Change*, 2001, at 3.

13 A carbon sink is a 'reservoir' that absorbs or takes up released carbon from another part of the carbon cycle. Sequestration of carbon is the process that removes carbon dioxide from the atmosphere and retains it (for some time) in a carbon sink – for example, trees.

The IPCC recognised that conservation and sequestration result in higher carbon stocks, which can lead to higher future carbon emissions if these ecosystems are severely disturbed by either natural or direct/indirect human induced disturbances.

The IPCC accepted that there is no single path to a low emission future, and countries and regions will have to choose their own path. Most model results indicate that known technological options could achieve a broad range of atmospheric CO_2 stabilisation levels - such as 550 ppmv, or 450 ppmv or below over the next 100 years or more - but implementation would require associated socio-economic and institutional changes. To achieve stabilisation at these levels, a significant reduction in world carbon emissions per unit of GDP from 1990 will be necessary. Technological improvement and technology transfer will play a significant role in the stabilisation process. For the crucial energy sector, almost all greenhouse gas mitigation and concentration stabilisation scenarios are characterised by the introduction of efficient technology for both energy use and supply, and of low or no-carbon energy.[14]

National responses to climate change can be more effective if deployed as a portfolio of policy instruments to limit or reduce greenhouse gas emissions. The portfolio of instruments may include: emissions/carbon/energy taxes; tradeable or non-tradeable permits; provision and/or removal of subsidies; deposit/refund systems; technology or performance standards; energy mix requirements; product bans; voluntary agreements; government spending and investment; and support for research and development. Each government may apply different evaluation criteria, leading to different portfolios of instruments. The literature in general gives no preference for any particular policy instrument. Market based instruments may be cost-effective in many cases, and energy efficiency standards and performance regulations are widely used.

The effectiveness of climate change mitigation can be enhanced when climate policies are integrated with the non-climate objectives of national and sectorial policy development. Climate change decision making is essentially a sequential process under general uncertainty. The relevant question is not "what is the best course for the next 100 years" but rather "what is the best course for the near term given the expected long-term climate change and

The IPCC confirmed findings from the Second Assessment Report that earlier actions, including a portfolio of emissions mitigation, technology development and reduction of scientific uncertainty, increase the flexibility in moving towards stabilisation of atmospheric concentrations of greenhouse gases. Economic modelling suggests that a gradual near term transition from the world's present energy system towards a less carbon-emitting economy minimises costs associated with premature retirement of existing capital stock. It also provides time for technology development, and avoids premature lock-in to early versions of rapidly developing low-emission technology. However, it was also recognised that more

14 Intergovernmental Panel on Climate Change, *Climate Change 2001: Mitigation. Summary for Policymakers. A report of Working Group 3 of the Intergovernmental Panel on Climate Change*, 2001, at 8.

rapid near term action would decrease environmental and human risks associated with rapid climatic changes. It would also: stimulate more rapid deployment of existing low-emission technologies; provide strong near term incentives to future technological changes that may help to avoid lock-in to carbon-intensive technologies; and allow for later tightening of targets should that be deemed desirable in light of evolving scientific understanding.[15]

3.0 CLIMATE CHANGE FOR AUSTRALIA

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a key leader in the field of climate change analysis for Australia. CSIRO has modelled climate change projections for Australia for 2030 and 2070, based on global warming projections by the IPCC, as detailed above. CSIRO noted that conditions of any individual year will continue to be strongly affected by natural climatic variability and cannot be predicted.[16]

By 2030, modelling indicates that annual average temperatures will be 0.4 to 2.0 ^{o}C higher over most of Australia, with slightly less warming in some coastal areas and Tasmania, and the potential for greater warming in the north-west. By 2070, annual average temperatures are expected to be 1.0 to 6.0 ^{o}C higher over most of Australia, with similar spatial variation as 2030. The range of warming is greatest in spring and least in winter. The climate models indicate that future increases in daily maximum and minimum temperatures will be similar to the changes in average temperature.

The impact of climate change on rainfall projections varies across the country. For instance, projected annual average ranges tend to decrease in the south-west of the country (-20% to +5%), whilst for much of eastern Australia projected ranges are –10% to +10% by 2030, and –35% to +35% by 2070. Where average rainfall increases, there would be more extremely wet years, and where average rainfall decreases there would be more dry spells. Most models simulate an increase in extreme daily rainfall leading to more frequent heavy rainfall events. This can occur even where average rainfall decreases. Increases in extreme daily rainfall are likely to be associated with increased flooding.

The CSIRO models also indicate that higher temperatures are likely to cause an increase in evaporation. Modelling suggests that increases in evaporation occur in all seasons and, annually averaged, range from 0 to 8% per degree of global warming over most of Australia. The difference between potential evaporation and rainfall gives a net atmospheric moisture balance. In general, Australia has an annual net moisture balance deficit, and our environment is generally moisture limited. When the projected increases in potential evaporation are considered in combination with simulated rainfall change, the overall pattern shows decreases in moisture balance on a national basis.

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15 Intergovernmental Panel on Climate Change, *Climate Change 2001: Mitigation. Summary for Policymakers. A report of Working Group 3 of the Intergovernmental Panel on Climate Change*, 2001, at 13.

16 This section of the paper is adapted from: CSIRO, *Climate Change. Projections for Australia*, CSIRO, 2001.

In regards to tropical cyclones, the CSIRO noted that projections are difficult since they are not well resolved by global or regional climate models. Similarly, as the El Nino Southern Oscillation has a strong influence on climatic variability in parts of Australia, climate models do not give a consistent indication of future changes. However, it was concluded that global warming is likely to enhance the drying associated with El Nino events.

In terms of impacts of climate change on Australia, CSIRO has identified the following:[17]

3.1 Agriculture

Increases in carbon dioxide concentrations and temperature and projected changes in rainfall could have a significant impact on Australia's agriculture. However, CSIRO has noted that predicting the likely impacts of these changes is complicated because increased carbon dioxide boosts plant growth and changes water use efficiency, while projected changes in climate can offset or enhance these benefits. Because projected changes in rainfall and temperature vary across Australia, it is important to assess regional impacts. The opportunities to adapt to climate change via new crops, industries and management practices also will vary from region to region.

Wheat – future wheat yields will depend on both the positive effect of increased carbon dioxide levels and the generally negative impacts of projected climate change. As wheat is planted in autumn and winter and grows through to spring, any projected reductions in winter and spring rainfall over southern Australia will increase moisture stress. The positive response of wheat to higher carbon dioxide levels may come at the price of lower grain protein levels. Low protein wheat is not suitable for pasta or bread making, so farmers may need to add fertiliser or alternate with nitrogen-fixing plants.

Fruits – many fruits are sensitive to frost late in the growing season, so a projected decrease in frost frequency and severity will reduce frost damage. Conversely, temperate fruits need winter chilling to ensure normal bud development and fruit set, and warmer winters will reduce the accumulated chilling, leading to lower yields and reduced fruit quality. Stone fruit and apples in southern Australia are particularly vulnerable. Adaptation through increased use of chemical treatments is possible, as is selection of varieties that have a lower chilling requirement.

High-rainfall pastures – temperate pastures in high-rainfall regions are largely found in NSW and Victoria. They are based on exotic grass and grass-legume pastures and require fertilisation, and provide excellent animal feed and support high levels of animal production. The positive impact of elevated carbon dioxide levels and negative impact of warming are likely to cancel each other out in this zone. However, likely decreases in winter and spring rainfall would greatly reduce plant production, significantly constraining animal production. In addition, rising temperatures are likely to lower milk yield from cows.

Rangelands – rangelands (arid and semi-arid land where rainfall is too low or too variable

[17] This section of the paper is adapted from: CSIRO, *Climate Change. Impacts for Australia*, CSIRO, 2001.

to support cropping) covers nearly three-quarters of Australia. Cattle and sheep grazing are the main land uses. Rangelands are ecologically important because of their high species diversity and unique ecosystems. If rainfall decreases in southern Australia by more than 10% in winter and spring – the main growing seasons for herbage in this area – then forage and animal production will be reduced, despite the benefits of increased carbon dioxide. For northern Australia, summer rainfall may increase or change very little, so higher carbon dioxide levels should have a positive impact on plant production.

3.2 Forestry

Future forest productivity will depend in part on the balance between the benefits of increased carbon dioxide and the patterns of change in rainfall and temperature. For instance, a doubling of carbon dioxide with a warming of 3.0 ^{o}C and no rainfall change, possible by 2070, would encourage tree growth across much of southern Australia, particularly in the wheat belt and semi-arid regions. However, a reduction in rainfall in winter and spring in southern Australia, and increased fire frequency, would offset some of these benefits. The benefits will also be affected by changes in pests and in the longer term by limited nutrient supply.

3.3 Natural systems

Many natural systems will have difficulty adapting to climate change. In native forests and woodlands, warmer and drier conditions could threaten many eucalypt species. Eucalypts in alpine areas are particularly vulnerable, as less snow and a shorter snow season appears likely. Wetlands are already under threat from human activity, and climate change and sea level rise would add to the vulnerability. Riverine environments would be severely affected by reductions in rainfall. All natural systems are vulnerable to invasion by exotic species. Disturbance by more frequent extreme events like fires and floods is likely to increase that vulnerability by increasing the stress on established vegetation. Coral reefs around the world are becoming stressed by a number of factors, including: bleaching due to warmer oceans; rising sea levels; and damage from tropical cyclones. Projected global warming will contribute additional stress.

Pests and weeds – projected warming will increase the ability of pests to survive winters, and accelerate the development of most of the species that are active in summer. A warmer climate would enable tropical species, such as the Queensland fruit fly and the cattle tick, to spread southwards and threaten exclusion zones. Plant pathogens are likely to become more severe in areas with dry summers if the frequency of summer rainfall events increases.

Water resources – increased water stress is likely due to higher temperature and evaporation. Decreased streamflow is expected in southern Australia due to reductions in rainfall. Estimated changes in stream flow in the east-central Murray Darling Basin range from 0 to –20% in 2030, and +5 to –45% in 2070. This would result in water shortages and sharpen competition between water users.

3.4 Urban and coastal communities

Severe weather affects urban communities in many ways. Torrential rainfall over cities can produce severe runoff and flooding. Gales and strong winds directly damage buildings and also generate waves and storm surges that can contribute to coastal flooding. As more than

80% of Australia's population resides within 50km of the coast, the community's exposure to extreme events such as tropical cyclones, storm surges and flooding of rivers, is growing rapidly. Rising sea-level, stronger tropical cyclones and increased intensity of oceanic storm surges are likely with climate change. Changes in the timing and amounts of peak seasonal energy loads are likely. Warmer conditions mean less energy demand for winter heating and more energy demand for summer cooling.

Human health impacts – climate variability and change harm human health both directly and indirectly. Direct effects include injury and death from heat waves, cyclones and floods. Indirect effects include infectious diseases such as: dengue fever; food poisoning from fish contaminated from toxic algal blooms; water borne diseases such as giardia; and skin cancer and eye-cataracts due to ozone depletion.

4.0 AUSTRALIAN EMISSIONS OF GREENHOUSE GASES[18]

The 1999 National Greenhouse Gas Inventory, released in April 2001, provides the latest report on Australia's greenhouse gas emissions and removals by sinks according to the international requirements of the Framework Convention on Climate Change. The Inventory reports on human-induced greenhouse gas emissions from six sectors specified by the Intergovernmental Panel on Climate Change. These are:

1. Energy, which is comprised of three subsectors: - stationary energy (eg, emissions from electricity generation); fugitive emissions (eg, coal seams and oil and natural gas production); and transport emissions.
2. Industrial processes: such as emissions from cement clinker manufacture and aluminium smelting.
3. Solvent and other product use: includes emissions from the use of solvents and other products containing non-methane volatile organic compounds (NMVOCs). Emissions from this sector are not included in Australia's reported emissions total as NMVOCs cannot be converted into carbon dioxide equivalents.
4. Agriculture: such as methane emissions from livestock, nitrous oxide from fertilising soil and the burning of savannas.
5. Land use change and forestry: comprised of emissions and sinks from:
    - land clearing (officially called Forest and Grassland Conversion), which includes the burning and decay of cleared vegetation and emissions from soil disturbance (reported separately pending better estimates as methods and data improve).
    - Changes in forest and other woody biomass stocks (ie, forestry): this includes managed forests, plantations and vegetation establishment.
    - CO_2 emissions and removal from soils: including the sink from pasture improvement and minimum tillage practices.
    - Other, including emissions from prescribed burning and wildfires.

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18 Information from this section is taken from: Australian Greenhouse Office. *National Greenhouse Gas Inventory 1999. Overview: 1999 National Greenhouse Gas Inventory*. Fact Sheet 1, 2001.

6. Waste: such as emissions from municipal landfill and wastewater treatment facilities.

The Australian National Greenhouse Gas Inventory covers the major greenhouse gases, which are:

- carbon dioxide
- methane
- nitrous oxide
- carbon monoxide
- oxides of nitrogen
- non-methane volatile organic compounds (NMVOCs)
- perfluorocarbons
- sulfur hexafluoride

These gases are expressed in terms of their carbon dioxide equivalents (CO_2-e), where global warming potentials are available, which provides the basis for comparing the warming effect of the different greenhouse gases.

Australia's net greenhouse gas emissions for 1999, not including emissions from land clearing, were 458.2 million tonnes of carbon dioxide equivalents (Mt CO_2-e). Net greenhouse emissions in 1990 were 390.3 Mt, representing a 17.4% increase during the period 1990 – 1999. However, these calculations do not equate to the Kyoto Protocol accounting requirements.

The energy sector accounted for 79.6% (364.6 Mt) of total net national emissions in 1999. Energy emissions increased by 1.0% (3.7 Mt) from 1998 and 21.7% on the 299.5 Mt emitted in 1990. Stationary energy emissions, primarily those produced through electricity generation, were the main contributors to emissions from this sector - 56.7% (259.8 Mt) of national emissions. Emissions from electricity generation increased by 33.1% (42.7 Mt) between 1990 and 1999 with an increase of 1.9% (3.2 Mt) between 1998 and 1999. The demand for electricity nationally increased by 3.2% from 1998 to 1999. This was offset by a 1.1% decline in the emissions intensity as the share of the lowest emitting forms of electricity generation, hydro and natural gas, increased.

Transport was the next largest contributor to emissions from the Energy sector with 16.1% (73.9 Mt) of national emissions in 1999, compared with 15.7% (61.5 Mt) in 1990. Road transport is the largest contributor to transport emissions and makes up 14.5% (66.6 Mt) of total national emissions. Road transport emissions increased by 2.8% (1.8 Mt) during 1999. Cars contribute 9.1% (41.9 Mt) of national emissions and domestic aviation around 0.9%. Fugitive emissions from fuels contributed 6.7% (30.8 Mt) of national emissions in 1999 compared with 7.6% (29.5 Mt) in 1990. Over the period, increases in emissions from coal, oil and natural gas production have been offset by a decline in leakage from natural gas distribution and by the capture of coalmine waste gas. Methane leakage from coal mining accounted for the majority of fugitive emissions.

Agriculture

Agriculture contributed 20.5 % (93.8 Mt) of national emissions in 1999. Emissions were 1.9% (1.7 Mt) higher than in 1998 and 2.9% (2.7 Mt) greater than in 1990. Methane and nitrous oxide are the two gases that are included in emissions estimates from the Agriculture sector. The Agriculture sector accounts for 61.6% of total methane emissions and 79.7% of total nitrous oxide. Livestock produced 62.6 Mt or 13.7% of national emissions in 1999. Emissions from livestock were similar to 1998 and 5.5% (3.6 Mt) less than emissions in 1990. Although sheep numbers decreased by 31% from 1990 to 1999, beef and dairy cattle numbers increased and the area under crops also increased.

Agricultural soils contributed 3.7% (16.9 Mt) of total net national emissions, and burning of savannas contributed 2.9% (13.3 Mt).

Industrial Processes

Emissions from Industrial Processes were 2.1% (9.7 Mt) of national emissions in 1999. Emissions were 1.8% (0.2 Mt) less than in 1998 and 19.8% (2.4 Mt) less than in 1990. Emissions declined during the early 1990s due to a large reduction in emissions of perfluorocarbons (PFCs) from aluminium smelting as a result of technological changes. Production of aluminium has been increasing during this period and between 1997 and 1998 emissions increased as production exceeded reductions due to improved processes. However, from 1998 to 1999, despite increased production, emissions of PFCs declined due to a proportionately larger fall in emission factors. Production of cement clinker and lime increased from 1998 to 1999 with a consequent increase in emissions.

Waste

The Waste sector contributed 3.5% (16.0 Mt) of total national emissions in 1999. Emissions were 3.2% (0.5 Mt) greater than in 1998 and 7.6% (1.1 Mt) greater than in 1990. Most emissions are from solid waste disposal. Since 1993, methane recovery has grown significantly and in 1999 about 11.8% of methane generated from municipal solid waste disposal was recovered. Methane released from the decomposition of organic matter in sewage during disposal of domestic, commercial and industrial wastewater amounted to 0.3% (1.4 Mt CO_2-e) of total national emissions.

Forestry and Other land management

Forestry, including commercial forestry, is both a source of and sink for CO_2. In 1999, removals through growth of forests were 75.8 Mt. Harvesting of forests gave rise to 52.8 Mt of emissions, resulting in a net forestry sink that was equivalent to 5.0% (23.1 Mt) of total national emissions. Emissions from harvesting have increased by 6.0 Mt since 1990 while the removals by growth have increased by 4.5 Mt, leading to an overall decline in the net sink of 1.5 Mt (6.2%) from 1990 to 1999.

Minimum tillage practices and pasture improvement contributed a sink of approximately 4.2

Mt or 0.9% of total net national CO_2-e emissions. As a result of a lack of data, estimates of this sink have remained unchanged since 1990.

Land clearing

Land clearing is accounted for separately from other sectors due to the high level of uncertainty associated with the estimates and major improvements to methodology and sources of data.
Developments over the next couple of years are expected to lead to a more robust approach to estimating emissions in this sector that will be applied to estimates for all years. Emissions from land clearing are the result of burning cleared vegetation, decay of unburnt vegetation, and emissions from soil disturbed in the process of clearing. This is offset to some extent by carbon sequestration due to regrowth of vegetation on previously cleared land.

In 1999, gross emissions from land clearing were estimated at 89.7 Mt, partly offset by regrowth of 18.0 Mt, resulting in net emissions of 71.7 Mt, compared with 72.3 Mt in 1998 and 103.5 Mt estimated for 1990. The estimates indicate that land clearing emissions have fallen by 30.7% (31.8 Mt) since 1990. However, past clearing rates and trends in emissions since 1990 are subject to large uncertainties. The annual estimates and trends should be treated with caution.

5.0 THE INTERNATIONAL ARENA

The lead 'international law' in the field of climate change is the United Nations Framework Convention on Climate Change. Negotiations to develop the convention began in December 1990 by the UN General Assembly. The Convention was adopted on 9 May 1992, and opened for signature a month later at the UN Conference on Environment and Development in Rio de Janeiro, Brazil. It entered into force on 21 March 1994, after receiving the requisite 50 ratifications. The Convention now has 186 Parties and is approaching universal membership.[19] Australia signed the Convention in June 1992 and was the ninth country to ratify the Convention in December 1992.[20]

Since the adoption of the Convention, Parties have continued to negotiate in order to agree on decisions and conclusions that are designed to advance its implementation. They have done so in forums referred to as Conference of the Parties (COP).
Parties launched a new round of negotiations at COP 1 (Berlin, March/April 1995) to strengthen the commitments of Annex I Parties (ie, developed countries). These negotiations resulted in the adoption of the Kyoto Protocol at COP 3 (Kyoto, December 1997). Article 2 of the Protocol states that Annex 1 Parties, in order to promote sustainable development,

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19 See website provided by the United Nations Framework Convention on Climate Change: http://www.unfccc.de/issues/briefhistory.html

20 Commonwealth of Australia, *Climate Change. Australia's Second Report under the United Nations Framework Convention on Climate Change*. November 1997.

shall implement and/or further elaborate policies and measures in accordance with national circumstances, such as:[21]

1. Enhancement of energy efficiency in relevant sectors of the national economy;
2. Protection and enhancement of sinks and reservoirs of greenhouse gases;
3. Promotion of sustainable forms of agriculture in light of climate change considerations;
4. Research on, and promotion, development and increased use of, new and renewable forms of energy, of carbon dioxide sequestration technologies and of advanced and innovative environmentally sound technologies;
5. Progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the Convention and application of market instruments;
6. Encouragement of appropriate reforms in relevant sectors aimed at promoting policies and measures which limit or reduce emissions of greenhouse gases not controlled by the Montreal Protocol[22];
7. Measures to limit and/or reduce emissions of greenhouse gases not controlled by the Montreal Protocol in the transport sector;
8. Limitation and/or reduction of methane emissions through recovery and use in waste management, as well as in the production, transport and distribution of energy.

The Kyoto Protocol established mandatory targets for greenhouse gas emission reductions for developed countries, relative to a 1990 base year.[23] It was calculated that compliance with these targets would result in an overall global reduction in greenhouse gas emissions of slightly more than five percent from 1990 levels during the first commitment period (2008-2012).[24] It is at these talks that Australia successfully argued that targets should be allocated on the basis of equality of effort, which led to differentiated targets. Hence the target for Australia was 108 percent. With no greenhouse gas abatement measures, based on all sectors except land use change, Australia's greenhouse emissions were predicted to grow by around 28 percent from 1990 to 2010.[25] Other developed countries that had

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21 Kyoto Protocol to the United Nations Framework Convention on Climate Change, Article 2.

22 The Montreal Protocol on Substances that Deplete the Ozone Layer was agreed upon in 1987, and revised in 1990. It falls under the umbrella of the 1985 Vienna Convention for the Protection of the Ozone Layer. See Birnie PW and Boyle A E, *International Law and the Environment*. Oxford University Press, 1994.

23 Hill, R "The international climate change agreement: An evolution" in *UNSW Law Journal*, Vol 7 No 2 July 2001. Senator Hon Robert Hill, Minister for the Environment and Heritage.

24 Freeland,S "The Kyoto Protocol: An Agreement without a future?" in *UNSW Law Journal*, Vol 7 No 2 July 2001, at 2.

25 Commonwealth of Australia, *The National Greenhouse Strategy. Strategic Framework for Advancing Australia's Greenhouse Response*, 1998, at 1.

targets either 100 percent or above the 1990 base included: Iceland (110%); New Zealand (100%); Norway (101%); Russian Federation (100%); and the Ukraine (100%). The remainder countries had a reduction target ranging from 92 percent to 95 percent, with the majority committed to a 92 percent target.[26]

The Protocol also incorporated market based flexible mechanisms such as emissions trading and the Clean Development Mechanism. The Mechanism enables Annex 1 (ie, developed) countries to institute greenhouse emission reduction projects in non-developed countries. The reduced emissions can then contribute to the developed country's compliance with emission targets as set out in the Protocol.

The Kyoto Protocol, however, left many of its operational details unresolved and referred these to the COP and subsidiary bodies for further negotiation. The Protocol was signed by 84 Parties, and has received some 39 ratifications. Many Annex I Parties, however, stated that they needed to have a clearer picture of the operational details of the Protocol before they could ratify it.[27]

Australia is active in the negotiations involving the Conference of the Parties, and works closely with a range of countries including the members of the Umbrella Group (the United States, Japan, Canada, New Zealand, Russia, Norway, Iceland and the Ukraine). The members of the Umbrella Group share similar views on international emissions trading and some other key issues, such as flexible market mechanisms to achieve emission reductions at the lowest cost.[28]

At COP 4 (Buenos Aires, November 1998), Parties adopted the so-called "Buenos Aires Plan of Action", setting out a program of work both to advance the implementation of the Convention and to flesh out the operational details of the Kyoto Protocol. This program of work was conducted in the subsidiary bodies and at COP 5 (Bonn, October/November 1999), with a deadline of COP 6 (The Hague, November 2000). However, Parties were unable to reach agreement on a package of decisions on all issues under the Buenos Aires Plan of Action at that session. Nevertheless, they decided to meet again in a resumed session of COP 6 to try once more to resolve their differences.

At COP 6 part II (Bonn, July 2001), Parties finally succeeded in adopting the Bonn Agreements on the Implementation of the Buenos Aires Plan of Action, registering political agreement on key issues under the Buenos Aires Plan of Action. Parties also completed their work on a set of detailed decisions based on the Bonn Agreements, which were forwarded to COP 7 for formal adoption. Work remains outstanding on a small number of decisions, however, and these were referred to COP 7 for further negotiation.

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26 Kyoto Protocol to the United Nations Framework Convention on Climate Change, Annex B.

27 See website provided by the United Nations Framework Convention on Climate Change: http://www.unfccc.de/issues/briefhistory.html

28 The Australian Greenhouse Office, *Outcomes from Buenos Aires and the Implications for Australia*, URL: http://www.greenhouse.gov.au/pubs/factsheets/fs_buenos.html.

COP 7 met in Marrakesh in November 2001. At COP 7, Parties were expected to formally adopt the detailed decisions completed at COP 6 part II, and also to finalise those decisions where work remains outstanding. These included decisions on Kyoto Protocol issues that will be recommended for adoption to the COP serving as the meeting of the Parties to the Kyoto Protocol (COP/MOP) at its first session after the Protocol enters into force. Agreement on these issues should pave the way for Annex I Parties to ratify the Kyoto Protocol and thus bring it into force. Many have expressed a wish for the Protocol to enter into force in 2002, coinciding with the tenth anniversary of the Convention's adoption and the "Rio+10" World Summit for Sustainable Development (Johannesburg, September 2002).[29]

Australia's position on the ratification of the Protocol is that it should occur as soon as possible after COP-6, noting that otherwise the targets of industrialised countries would become progressively less likely to be met. However, the Australian Greenhouse Office notes that Australia, like many other countries, will only consider ratifying the Protocol after several key issues have been resolved, including:

- the rules and modalities for the Kyoto flexibility mechanisms - emissions trading, the clean development mechanism and joint implementation;
- important definitional and operational issues concerning the treatment of sinks;
- design of a system for compliance with the Protocol obligations; and
- developing country participation.[30]

The Federal Government considers developing country participation in the Framework Convention on Climate Change to be vital. For instance, Senator Nick Minchin, then Minister for Industry, Science and Resources, has stated:

> A notable omission from the framework set out by the Kyoto Protocol was a regime of emissions reduction commitments for developing countries. In 1998, China and India ranked as the 2nd and 6th largest of the world's greenhouse gas emitters, while South Korea, South Africa and Mexico also ranked 8th, 11th and 12th respectively. As a point of comparison, Australia ranked 13th with 1.4 percent of global greenhouse gas emissions.

The election of George W Bush to the Presidency of the United States has also placed pressure on the success of the Kyoto Protocol. For instance, in a letter to senior Senators he opposed the Kyoto Protocol 'because it exempts 80 percent of the world, including major population centers such as China and India, from compliance, and would cause serious harm to the US economy'. President Bush continued: 'As you also know, I support a

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29 See website provided by the United Nations Framework Convention on Climate Change: http://www.unfccc.de/issues/briefhistory.html

30 The Australian Greenhouse Office, *Outcomes from the Bonn Conference of Parties (COP5) and implications for Australia*. URL: http://www.greenhouse.gov.au/pubs/factsheets/fs_cop5.html

comprehensive and balanced national energy policy that takes into account the importance of improving air quality… I do not believe, however, that the government should impose on power plants mandatory emissions reductions for carbon dioxide, which is not a "pollutant" under the Clean Air Act.' [31]

On 1 April 2001 Prime Minister Howard wrote to President Bush and supported the United States' position. He stated:

> I have long shared your view, and Australia has consistently argued, that a workable international framework to address climate change needs to be economically manageable and include developing countries, whose emissions will exceed those of OECD countries within this decade.
>
> In my view an effective global framework to address climate change needs to include commitments from all major emitters; unrestricted market-based mechanisms, including emissions trading; an approach to carbon sinks that captures both economic and environmental opportunities; a facilitative, rather than punitive, compliance system; and assistance for the most vulnerable countries to adapt to climate change.
>
> This will require that we engage developing countries, and seek firm commitments from them on future annual emissions. We will also need to encourage the European Union to re-think its opposition to market mechanisms and sinks, key issues for a cost-effective response to climate change.[32]

The Australian Government's position has been subject to considerable criticism by conservation groups, which have called on the Government to ratify the protocol. The Australian Conservation Foundation stated: "What is clear is that the rest of the world is not waiting around for the US and is getting on with the changes to their economies that are necessary to cut greenhouse pollution. Unless Australia ratifies we will not be able to benefit from international markets emerging in environmental technologies and greenhouse pollution reduction. Australia must get on with the job and join other nations committing to ratify the protocol."[33]

6.0 COMMONWEALTH GOVERNMENT POLICIES TO REDUCE GREENHOUSE GAS EMISSIONS

In 1992 the Commonwealth, State and Territory governments and the Australian Local Government Association jointly endorsed the National Greenhouse Response Strategy. The

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31 President George W Bush, *Text of a Letter from the President to Senators Hagel, Helms, Craig, and Roberts*, Media Release 13 March 2001. http://www.whitehouse.gov/news/releases/2001/03/20010314.html

32 Letter from Prime Minister John Howard to United States President George W. Bush, see http://www.lavoisier.com.au/papers/articles/Howardletter.html

33 Australian Conservation Foundation, Media Release, *Australia loses out as world moves closer to Kyoto*, 7 November 2001.

Strategy outlined specific strategies for limiting greenhouse gas emissions in such areas as energy supply, energy use, transport and agriculture. The Greenhouse Challenge Program, a cooperative voluntary initiative between industry and Government to mitigate greenhouse emissions through energy efficiency and other measures was also introduced.[34]

The 1992 Response Strategy was reviewed in late 1996, which led to the release of what is known as the 'Prime Minister's package' which was introduced on 20 November 1997. The Government committed $180 million over five years to the package, which had the following specific measures:[35]

- Renewable energy – the Government committed $65 million to increase the percentage of renewable energy produced from 6% to the OECD average of about 6.4%. The Government set a mandatory target for electricity retailers to source an additional two percent of their electricity from renewable sources by 2010;[36]
- Energy Market Reform – including developing and implementing efficiency standards for fossil fuel electricity generation;
- Automotive Industry – implementation of an Automotive Industry Environmental Strategy, including mandatory fuel efficiency labelling and a 15% fuel efficiency improvement target by 2010;
- Codes and Standards – working with the States to develop energy efficiency codes and standards for housing and commercial buildings, appliances and equipment;
- Tree Planting and Revegetation – to achieve the Plantation 2020 vision of trebling the plantation estate by 2020;
- Greenhouse Challenge Program – to increase the number of participants to more than 1000 companies by 2005;
- Commonwealth Greenhouse Office – the Office was established within the Department of the Environment, and is the lead agency on greenhouse matters;
- Other Measures – including funding towards an ethanol pilot plant and the development of a national carbon accounting system.

The 'Prime Minister's Package' developed into The National Greenhouse Strategy, which was released by the Commonwealth in 1998. The Strategy focuses on three fronts: improving awareness and understanding of greenhouse issues; limiting the growth of greenhouse gas emissions and enhancing greenhouse sink capacity; and developing adaptation responses.[37] The Strategy has been developed by the Commonwealth and all

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34 UNFCCC, Australia. *Report on the in-depth review of the second national communication of Australia*, 18 October 1999.

35 Statement by the Prime Minister of Australia the Hon John Howard MP, *Safeguarding the Future: Australia's Response to Climate Change*. 20 November 1997.

36 This measure will be implemented through the *Renewable Energy (Electricity) Act 2000 and the Renewable Energy (Electricity) (Charge) Act 2000*.

37 Commonwealth of Australia, *The National Greenhouse Strategy. Strategic Framework for Advancing Australia's Greenhouse Response*, 1998, at iii.

State and Territory governments. A high level group of senior officials from the Commonwealth and States and Territories is responsible for the on-going monitoring, review and further development of the Strategy, and this group will report to the Council of Australian Governments (COAG). An advisory committee has also been established. Detailed implementation plans for the Strategy have been developed on a State basis, and reports on progress in implementing the Strategy are to be prepared biennially.

The Strategy has been divided into eight modules, as follows:

Module 1: Profiling Australia's Greenhouse Gas Emissions – key measures include reducing uncertainties in the land use change and forestry sector, and the development of the National Carbon Accounting System for land based sources and sinks;

Module 2: Understanding and Communicating Climate Change and its Impacts

Module 3: Partnerships for Greenhouse Action: governments, industry and the community – key measures include reducing greenhouse emissions from government operations; developing local government action plans; extension and expansion of the Greenhouse Challenge program; household greenhouse action.

Module 4: Efficient and Sustainable Energy Use and Supply – as the largest single source of Australia's greenhouse gas emissions is the production and consumption of energy, a major focus of the Strategy is the pursuit of efficient and sustainable energy use and supply. Key measures include: accelerating and monitoring energy market reform; efficiency standards for power generation; strategic development of renewable energy; energy efficiency standards for residential and commercial buildings, and energy performance codes for domestic appliances and commercial and industrial equipment.

Module 5: Efficient Transport and Sustainable Urban Planning – key measures include traffic management and the development of an environmental strategy for the motor vehicle industry, including the introduction of a 15% fuel efficiency improvement target by 2010.

Module 6: Greenhouse Sinks and Sustainable Land Management – key measures include: trebling the nation's plantation estate by 2020; developing national principles for sustainable management of native vegetation and retention, including the development and implementation of guidelines and policies at a regional level.

Module 7: Greenhouse Best Practice: Industrial Processes and Waste Management – key measures include: the development of environmental strategies for synthetic gases; and minimising methane emissions from landfill and wastewater.

Module 8: Adaptation to Climate Change – reviewing current planning processes and strategies.

A review of Australia's greenhouse policies under the United Nations Framework Convention on Climate Change noted the following:

> … a substantial package of measures was introduced in November 1997 for addressing all sectors and sinks and the 1997 National Greenhouse Strategy was approved by Parliament in December 1998, which together constitute a step beyond the voluntary policy approach of 'no-regrets' by introducing regulatory measures, fiscal stimuli and market-oriented action.
>
> Including all emission sources and sinks (except land clearing), and without any measures in place, Australia's net emissions growth was projected to increase by 43 percent over the 1990 level by 2010. …[in regards to the National Greenhouse Strategy programs to reduce emissions] The review team felt that there is still large uncertainty as to the future carbon dioxide emission reductions associated with energy supply reform, as specific details of how this will be accomplished were unclear, although national experts believe that it will have a net beneficial impact through efficiency gains and fuel switching. Similarly, the team believes that measures outlined for greenhouse gas reduction in the transport sector may have to be strengthened to achieve expected emission reductions.
>
> The team commends the substantial array of research in greenhouse gases that is being conducted by Australia…coupled with the fact that climate change research seems closely tied to the development of national policy. However, those involved acknowledge that there is a gap between scientific opinion and views held by the general public on greenhouse gases and global warming, and that a concerted effort will be required to change consumer behaviour….
>
> Australia's work on the commercial application of solar thermal power and photovoltaics is especially noteworthy and has been replicated successfully. As part of Australia's strategic plan to transfer technology and best practices to developing countries, its work in the Asia-Pacific and South Pacific region to cut emissions, promote environmentally sound technology and industry, and raise public awareness is also commendable.[38]

7.0 THE NEW SOUTH WALES CONTRIBUTION TO THE NATIONAL STRATEGY

A key response to the issue of climate change from the NSW Government was the establishment of the Sustainable Energy Development Authority in 1996. SEDA's mission is to reduce the level of greenhouse gas emissions, and accomplishes this by promoting investment in the commercialisation and use of sustainable energy technologies.[39]
In order to facilitate the reduction in greenhouse gas emissions SEDA has three major programs. These are: business energy efficiency; residential energy efficiency; and sustainable energy supply. These programs are further discussed below.[40]

SEDA notes that business spends over $6 billion each year on energy consumption in NSW,

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38 United Nations Framework Convention on Climate Change, *Australia. Report on the in-depth review of the second national communication of Australia*, 1999, at 26

39 See the Sustainable Energy Development Authority website: www.seda.nsw.gov.au.

40 See Sustainable Energy Development Authority, *Annual Report 1999-2000*.

resulting in 65 million tonnes of greenhouse gases being released into the atmosphere. The SEDA business efficiency program aims to improve the energy efficiency of the business sector. The program has a number of components:

- Energy smart business program – to improve energy efficiency in the NSW business sector. The business program has 170 business partners who have signed a five year agreement to implement energy saving projects which deliver at least a 20 percent internal rate of return. By the end of June 2000 the program had reduced more than 180,000 tonnes of greenhouse gas emissions, and had achieved accumulated energy savings of $7.8 million.
- Energy smart government program – aiming to improve the energy efficiency of government buildings, and assisting agencies meet the Premier's energy reduction targets of 15% by 2001 and 25% by 2005;
- Driving the use of Treasury's $20 million Energy Performance Contracting Fund – used to finance upgrades whereby guaranteed future energy savings are used to pay for the capital cost of installing energy efficient technologies;
- Developing the Building Greenhouse Rating Scheme – launched in September 1999, in which software was developed to rate the greenhouse performance of commercial buildings;
- National energy star office equipment program – which incorporated the function that enables office equipment to power down into sleep mode into relevant energy efficiency programs;
- Energy star home electronics program – to ensure that all home electronics equipment is energy star compliant – principally by having a standby low power level;
- Energy smart allies program – developing and promoting a network of product and service providers.

SEDA notes that NSW households are responsible for a third of the State's energy use, emitting more than 15 million tonnes of greenhouse gases each year, and costing consumers more than $1.6 billion each year. Each NSW household emits more than eight tonnes of greenhouse gases per year, which is twice as much as the average family car.

The SEDA residential energy efficiency program has the following components:

- Energy smart homes program – to ensure that a further 15 percent of new homes built in NSW meet the minimum energy performance standards. To the end of June 2000, 55 NSW councils were signed up to the program, accounting for 69 percent of all new residential development applications in the State. The program will ultimately result in the reduction of 100,000 tonnes of carbon dioxide being emitted each year;
- Energy smart hot water program – specifically encouraging the installation of a heat pump or solar water heater, through the use of rebates and interest free loans. Over 572 households took advantage of a $500 cash rebate in the year ending June 2000, resulting in greenhouse gas reductions of up to 1,430 tonnes per year;
- 'Reach for the stars' program – promoting energy efficiency labelling of gas and electric appliances;

- Energy smart showerheads program. The installation of AAA rated showerheads saves 0.9 tonnes of carbon dioxide emissions per year. In the year ending June 2000, 8907 AAA showerhead sales were achieved, with annual expected savings of over 8000 tonnes of carbon dioxide emissions;
- Energy smart information centre – providing a free information and advisory service on the adoption of energy efficiency techniques in the home;
- Community housing energy project – to reduce energy and water bills for tenants of public and community housing.

The sustainable energy supply program is designed to assist the gradual shift in the makeup of NSW's electricity supply, from energy generated in the burning of fossil fuels to renewable and sustainable forms of energy generation. Particular programs include:

- A renewables investment program – which provides financial assistance on a diverse range of renewable energy projects;
- Hydro resource development program – creating additional hydro-electric capacity. SEDA has calculated the hydro resources in the State to be approximately 90 megwawatts, representing an annual reduction of 350,000 tonnes of carbon dioxide;
- Bioenergy program – promoting the use of organic matter, often a waste product, as a renewable energy fuel. A recent highlight was the commissioning of the Green Waste Gasifier at Whyte's Gully, outside of Wollongong. When fully operational the facility will process up to 110,000 tonnes of municipal waste every year with a generation capacity of 12 megawatts, sufficient to power over 10,000 homes;
- Wind energy program – including the identification and optimisation of wind power sites in NSW;
- Solar power program – promoting the installation of building integrated photovoltaic systems;
- Cogeneration development program – cogeneration is a highly efficient energy system that produces both electricity and useful heat from a single fuel source. However, with the continued low price of electricity and relatively high price of gas, cogeneration projects have been relatively few;
- Coal seam methane program – including the monitoring of technology to capture and utilise fugitive emissions of methane from coal mines;
- Green power accreditation program – accrediting and auditing 'green power' producers, and increasing the number of 'green power' consumers to drive demand for renewable energy. Over 29,635 NSW households use green power, and SEDA approved 40 new green power generators in the year to June 2000.

7.1 Carbon Rights and Carbon Trading

New South Wales has taken a lead role in the development of carbon trading. In 1998 the *Carbon Rights Legislation Amendment Act* was passed. This created a carbon sequestration right so that a person could hold the right (to the sequestered carbon) separately from either the right to the trees or the ownership of the land upon which the trees are located. The legislation provided that the carbon sequestration right could itself be registered on title. This arrangement has made it attractive for companies to 'buy' carbon credits and thereby

pay for the planting of trees.[41]

In March 1999 the NSW Government released an Information Memorandum promoting $30 million investment a year in new 'greenhouse forests'. As a result, the Tokyo Electric Power Company signed a letter of intent with State Forests to establish 1,000 hectares of new forest in the year 2000 with plans for an on-going program of between 10,000 and 40,000 hectares over the next ten years. Formal contracts for these plantings were signed in Tokyo in February 2000.[42] In this case, State Forests has been contracted to:

- Secure the land, primarily using land leased from private landowners;
- Obtain all relevant permits and consents for forest establishment and management;
- Establish, manage and protect the planted forest;
- Obtain markets for the timber products;
- Manage the carbon accounts.

Both the trees and carbon sequestration rights are owned by the Tokyo Electric Power Company and will be registered on the title of the land on which those trees are grown.[43]

The State Government has been keen to develop Sydney as an international centre of greenhouse gas trading. It initially looked like these ambitions would be achieved with the signing in August 1999 of a Memorandum of Understanding between the Sydney Futures Exchange and State Forests of New South Wales to develop the world's first exchange traded market for carbon sequestration credits. Dr Bob Smith, CEO of State Forests stated:

> State Forests is firmly committed to developing new business opportunities in environmental products and services related to forests. We see our future role increasingly as a service provider facilitating investment in forests to produce a range of environmental products, including carbon credits and green energy, as well as traditional forest products. Trading in carbon credits is a new market for the 21st century. I believe we will increasingly see the environmental benefits of forests becoming their primary commercial asset. Similar environmental markets could be established for the role of forests in salinity control and land repair.

However, 12 months later, the Sydney Futures Exchange announced that it had dropped its proposal to establish a trading centre for carbon credits. The decision was made in the context of the Exchange demutualising and moving to a public company. A spokesman noted that the commercial viability of carbon trading was not likely to be in a time frame proportional to other business initiatives. As well, political uncertainties existed over the implementation of the Kyoto protocol limiting the emission of greenhouse gases.[44]

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41 For further information on ownership issues with carbon sequestration rights see: Wylynko,B "On the Road to Greenhouse Gas Emissions Trading" in *AMPLA Yearbook 2000*, at 359.

42 See: "Carbon Trading Milestones" at State Forests Website: URL www.forest.nsw.gov.au.

43 "Planted Forests for Tokyo Electric Power Company" at State Forests Website: URL www.forest.nsw.gov.au.

44 "SFE drops plan to trade 'fresh air' carbon credits" in *Reuters News Service*, 16 August 2000.

Nevertheless, the State Government is still keen to push ahead with carbon credit trading, with the Premier stating that he considered part of the solution to global warming was to link the rehabilitation of the environment to the world's financial markets through initiatives such as carbon trading.[45]

7.2 Public Transport

The Environment Protection Authority's State of the Environment Report notes that the NSW Government's 25 year air-quality management plan, *Action for Air*, is seeking to reduce emissions from motor vehicles. Greenhouse gas emissions from the transport sector are the fastest growing emissions from any sector, rising 15 percent from 1990-96. An element of the *Action for Air* program involves increasing public transport through the construction of new bus transitways, extensions to the rail network and road improvements.[46] However, the State Government has announced changes to these ambitious plans. For instance, construction of the Chatswood to Parramatta rail link has been scaled back to the first stage from Chatswood to Epping. Similarly, the proposed seven new bus only transitways for Western Sydney have been altered. The Minister for Transport Hon Carl Scully MP was reported as saying: "We are trying to provide a network that grows with the population, not retrofit our transport after the communities move in. We are deliberately focusing our development on where people live now and where they will be living in the future."[47] The first bus only transitway, from Liverpool to Parramatta, is due to open in January 2003.

However, in a blow to reducing greenhouse gas emissions from transport, recent reports indicate that patronage of public transport services has slumped in the second half of 2001. Cheaper fuel, low interest rates and higher public transport ticket prices are encouraging people into their cars. For instance, one million fewer people used CityRail trains in September this year compared to 2000 (discounting Olympic trips), and falls of between two and seven percent have also been recorded on the bus network for the second half of 2001.[48]

7.3 Electricity Supply

In NSW licence conditions under the *Electricity Supply Act 1995* require electricity retailers to develop strategies to reduce greenhouse gases. Licence holders must develop one, three and five year plans for energy efficiency and demand management, as well as strategies for purchasing electricity from renewable sources. The Government has set a policy target of reducing greenhouse gas emissions arising from the supply of electricity to NSW customers by five percent per capita by 2000-2001 (based on 1989-90 levels).[49]

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45 "Carbon trading pushed by Carr" in *The Newcastle Herald*, 3 April 2001.

46 NSW EPA, *New South Wales State of the Environment Report 2000*, at 90.

47 "Scully's bus plan routed from fast track to slow lane." in *The Sydney Morning Herald*, 5 December 2001.

48 "Public transport losing fight with cars." In *The Sydney Morning Herald*, 30 November 2001.

49 NSW EPA, *New South Wales State of the Environment Report 2000*, at 90.

However, electricity retailers have not achieved these targets, and last years results show a 0.3 percent increase on the 1989-90 benchmark.[50] In spite of this, and in recognition of the fact that the electricity market is now a national market, in June this year the Premier took to the Council of Australian Governments meeting a proposal for compulsory national greenhouse targets to apply to the electricity retailer sector. The Premier stated:

> The proposal would work as follows. We would set a per capita greenhouse emission reduction target of 5 per cent for electricity retailers on 1989-90 levels. This would be done through compulsory benchmarks and it would be phased in by 2005-2006, to allow electricity retailers time to adjust. Penalties would be imposed on electricity retailers who fail to meet annual targets. Retailers would avoid payment of penalties by supporting the development of low-cost greenhouse abatement projects such as plantation-based carbon credits, faster up-take of natural gas fired power generation and renewable energy. A market to trade emission reduction certificates would be created in Sydney. This market would provide the platform for trading other environmental service products like carbon sequestration credits, salinity credits, and eventually biodiversity credits…it is important that this be advanced on a uniform national basis.[51]

Whilst COAG did not endorse the Premier's proposal, it did agree to establish a new Ministerial Council on Energy to examine: future energy use scenarios for Australia; potential for harmonising regulatory arrangements; opportunities for increasing interconnection and system security in electricity and gas; and ways of enhancing cooperative energy efficiency activities.[52]

It is also evident that the micro-economic reform of the national electricity market has led to perverse incentives for electricity suppliers to reduce their greenhouse gas emissions. Problems to emerge include:[53]

- The perverse effect of increasing competition in electricity markets, which has resulted because the highest emission intensity fuel sources (brown and black coal) are also the cheapest;
- There are considerable barriers to entry of less emissions-intensive fuels and forms of generation, particularly renewables such as wind and solar;
- The way that current market conditions are encouraging inappropriate new capital investment, such as the development of new coal fired power stations at the same time as plans for less emissions intensive alternatives, such as gas fired power stations, are being shelved.

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50 "Power emissions cloud Carr's green push" in *The Australian Financial Review*, 13 July 2001.

51 *NSW Parliamentary Debates*, Legislative Assembly Hansard 7 June 2001, p 14,683.

52 Council of Australian Governments, *Communique*, 8 June 2001. See the Department of Prime Minister and Cabinet website, URL: http://www.dpmc.gov.au/docs\coag080601.cfm

53 Senate Environment, Communications, Information Technology and the Arts References Committee, *The Heat is On: Australia's Greenhouse Future*, November 2000, at 151.

Another controversy to emerge from the implementation of the *Renewable Energy (Electricity) Act 2000* was the inclusion of wood waste in the definition of an eligible renewable energy source. Conservation groups have been highly critical of this, and claim that burning forests for power will produce at least five times more greenhouse gas emissions than burning coal to provide the same power output.[54] However, a CSIRO critique of the modelling used to make these claims rejects the arguments of the conservation groups. The CSIRO work indicated that a power station burning coal released about eight times more carbon dioxide into the atmosphere than a forest managed for sawn timber where wastes and residues are used for power generation.[55]

The Senate Environment, Communications, Information Technology and the Arts References Committee noted a range of solutions and policies that have been identified to rectify the above imbalance to coal fired power stations. However, the Committee noted there was a diversity of opinion on the best option, which included:

- The removal of market distortions such as fixed price contracts, biased transmission pricing, and grid access problems for small scale solar and other renewables;
- An expansion of existing voluntary programs such as the Greenhouse Challenge Program;
- The use of the taxation system, and grants for research and development, as a further spur to the development of renewable energy technologies;
- The introduction of a mechanism to price carbon, either through a carbon tax or a market-based system of tradeable emission permits.[56]

The majority report of the Senate Environment Committee recommended that the States and Territories agree to set mandatory targets to progressively increase the total proportion of electricity generated from efficient power plants and low greenhouse intensity fuels. However, the minority Government report disagreed with this recommendation and others on the basis that the recommendation(s) were "not supported by evidence, ill-conceived,[57]

8.0 CONCLUSION

The concept of global change is a difficult one to convey. The change of climate over decades and centuries is not immediately obvious on a day to day basis. Hence conveying

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54 "Power station a threat to forests" *The Newcastle Herald*, 11 June 2001.

55 Polglase,P. and Stein,W. "Relative CO_2 emissions from power stations fired by wood or coal –Comments on the model by Peter Barnes." July 2001.

56 Senate Environment, Communications, Information Technology and the Arts References Committee, *The Heat is On: Australia's Greenhouse Future*, November 2000, at 151.

57 Senate Environment, Communications, Information Technology and the Arts References Committee, *The Heat is On: Australia's Greenhouse Future*, November 2000, at 164 and 439.

the urgency of reducing the emissions of greenhouse gases is difficult. Nevertheless, it is apparent from the work of the Intergovernmental Panel on Climate Change (IPCC) that this is what society must do.

The cultural change away from the use of fossil fuels has commenced. Indeed, as an indication of this, the petroleum company BP has recently called on the Federal Government to ratify the Kyoto Protocol. BP's South Asia and Australasia President Greg Bourne was reported as saying that the world was going to have to change its energy use patterns and governments must quickly ratify the protocol.[58]

It is evident that a considerable amount of change is going to have to occur across the globe to prevent major alterations to our climate. As such change will ultimately have to occur across different societies and cultures, it seems inevitable that it will occur both slowly and incrementally. However, this should not prevent people, communities and governments from acting within their capabilities now.

58 "Oil giant tells Australia to back Kyoto" in *Sydney Morning Herald*, 8 November 2001.