

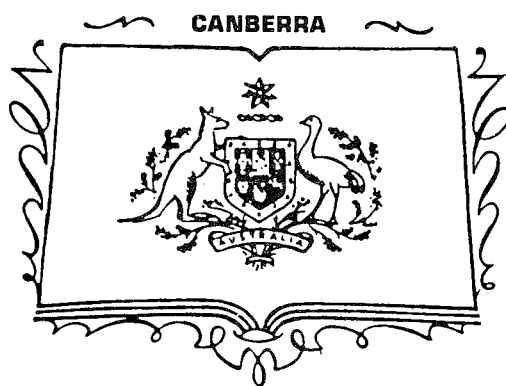
# The Greenhouse Challenge

The Victorian  
Government's  
Response

A draft strategy  
for public comment

*June 1989*

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# The Greenhouse Challenge

## The Victorian Government's Response

A Draft Strategy  
for Public Comment

Ministry for Planning and Environment

June 1989

 **Victoria** - Protecting Our Environment

## Foreword

The environmental message of the past few years is resounding - global pollution problems can no longer be ignored as too hard or too big to tackle.

As the Government's recent proposals for ozone protection made clear, Victoria has the capacity and the commitment to take action on global environmental issues and can set a powerful example for others to follow.

The Victorian Government is committed to tackling the greenhouse effect by contributing where it can to further understanding of the problem and by taking action to counter it. Progress has already been made through the State Conservation Strategy but more needs to be done.

The Government proposes a five-part strategy based on:

- research to reduce the uncertainties;
- actions to limit emissions of greenhouse gases and slow down the impacts;
- education to build community awareness and action;
- planning to cope with future climatic change;
- co-ordination at national level.

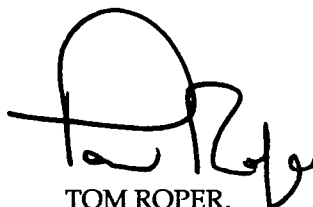
The highest priority must be to reduce the level of greenhouse gases released into the atmosphere and therefore to minimise and delay the impacts of the greenhouse effect.

This is not a problem that can be tackled by governments alone - even if they all agreed. It requires the support of entire communities, and shifts in individual attitudes. There will be major social and economic problems to address

and overcome. The greenhouse effect is a long-term global issue, but its early indicators are already with us and the consequences will be far worse if we do not make a start now.

Many of the actions proposed will take 15 years or more to have their full impact. Changing our behaviour, the type of cars we use and the type of power station is not something which can be done overnight. Immediate action is possible in some areas and forward planning will be redirected to make the long term changes. The challenge is to respond to the problem with effective long-term programs that have the community's full support.

There is already considerable public interest in the greenhouse effect. The release of this statement for public comment is the first step in engaging community action in response to the major environmental challenge facing our earth. The closing date for comments is 31 August 1989. I urge the community to examine this draft over the next three months, to forward their comments and participate in the development of actions and policies to help meet the challenge.



TOM ROPER,  
MINISTER FOR PLANNING AND  
ENVIRONMENT

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# Introduction

The greenhouse effect (the gradual warming of the earth) has captured community attention and concern in Australia and overseas, bringing into sharp focus the extent to which human use of the earth's resources is straining natural systems.

There is now considerable consensus within the international scientific community that the greenhouse effect is the major environmental threat facing the earth, although the extent and timing of global warming is still uncertain. The Victorian Government accepts that the greenhouse effect has the potential to create very serious problems for future generations, and that it is necessary to act now to reduce the potential impacts and deal with the wide range of potential problems associated with rapid climate change. The strategy proposed in this statement is a first step towards meeting these challenges.

The greenhouse issue involves all people in all parts of the world. The problems future generations are likely to experience because of it will not be confined to national boundaries; they will require an international response. There are already proposals to develop internationally binding agreements on reductions in greenhouse gases, similar to those for ozone protection.

While supporting international initiatives, it is also important to act at a local and national level. The developed countries of the world are in a position to provide leadership on the greenhouse issue. Not only do countries like Australia have the resources and capacity to tackle the problems it presents, but as high per capita producers of greenhouse gases they have a responsibility to help reduce emissions.

In 1987 the Government made a commitment to protect and preserve the environment through the State Conservation Strategy, which aims to set Victoria on the course of sustainable

development. The emergence of the greenhouse effect as a major environmental issue reinforces the importance of that commitment and highlights the implications of environmental degradation not only for Victorians but for the global community.

The Government's Greenhouse Strategy responds to both local interests and needs and global responsibilities. The objectives of the program are twofold: first, to enable Victorians to plan for and make the changes necessary to adapt to progressive global warming; and second, to help limit the accumulation of greenhouse gases and hence the global warming trend.

This statement proposes actions to achieve these objectives and also to fill the gaps in our present knowledge of the greenhouse effect. Government policies will be reassessed and modified as additional information becomes available.

Community response to the greenhouse effect is of critical importance to the strategy's success. Reductions in greenhouse gas emissions and successful adaptation to future changes will involve the community in changing existing practices affecting everyday life. Local government and various industry sectors will also have important roles to play in planning for and responding to greenhouse change.

Despite the popular media's attention to the greenhouse effect there is still a good deal of public confusion as to what it really means for us, partly because of its complexity, and partly because of the uncertainty as to the details of timing and extent of change and particular impacts. The Government's Greenhouse Strategy will help to reduce these uncertainties and provide a progressively more reliable and environmentally responsible basis for future planning.

# Summary of proposed actions

The Government proposes a five-part Greenhouse Strategy involving: research, emission reduction, education, planning and national coordination. It proposes specific actions in each of these areas.

## Research

### *Climate research*

Support fundamental research into the atmosphere and the potential impacts on regional climatic conditions due to the greenhouse effect. Closely coordinate Victorian research with other national and international efforts.

### *Monitoring programs*

Establish monitoring programs to track climatic trends and sea level changes. Study the impact on key elements of the environment, using satellite imagery to measure snowcover and vegetation changes.

## Emission reduction

### *CFCs and other non-CO<sub>2</sub> greenhouse gases*

Implement the Government's policy on ozone depleting substances (CFCs and halons) for a staged phase-out of these substances by the mid 1990s. Explore opportunities for reducing emissions of other greenhouse gases such as methane and nitrous oxides.

### *Objective for reduced CO<sub>2</sub> emissions*

Aim for the Toronto goal of a 20% reduction (based on 1988 levels) of CO<sub>2</sub> by the year 2005 as an interim objective for planning purposes. This will be subject to progressive review. Any international agreements for greater reductions in greenhouse gas emissions will be at least matched by the Government.

### *Energy conservation*

Implement energy demand management measures based on the report now being completed by the SECV and the Department of Industry, Technology and Resources (due for release after June 1989). This will contain proposals for a wide range of energy conservation programs in both the residential and commercial/industrial sectors. The Government will also promote action by individuals to conserve energy.

### *More efficient electricity generation and transmission*

Undertake a five-year SECV research and development program for improving the efficiency of brown coal usage through new technology and alterations to existing and planned power stations. \$7m has been committed to this program for the next two years.

Determine the timing of the last two units of Loy Yang B. Continue to prohibit nuclear energy because of its unsolved safety and environmental problems.

### *Transport fuel conservation*

Achieve increased transport fuel efficiency through a combination of more efficient vehicles, better planning to reduce dependence on motor vehicles and a 20% increase in usage of public transport through the implementation of METPLAN.

### *Renewable energy and fuel substitution*

Promote opportunities for using renewable energy sources including increasing use of hydro-electricity through careful development of small hydro-stations at existing dams. The Victorian Solar Energy Council's activities and objectives are being reviewed with a view to improving its capacity for development and promotion of renewable energy.

## *Revegetation*

Implement Tree Victoria, a major new revegetation program aimed at planting 100 million trees by 2010. The carbon fixed by this program will be equivalent to that released by a 600 MW brown coal fired power station.

## *Resource conservation, waste minimisation and recycling*

Expand programs for recycling, waste production and resource conservation to provide the general community with more environmentally sound choices.

## **Education**

### *Environmental education programs*

Develop of new environmental curricula for schools and continuing education programs for various professions, and expand community education in relation to the environment, in particular the greenhouse effect.

### *Promoting community action*

Develop community awareness of the greenhouse problems and the appropriate practical responses. Upgrade existing programs and initiate new programs with particular emphasis on energy conservation, recycling, revegetation and the protection of trees.

## **Planning**

### *Adaptation to future climate change*

Undertake long-term planning for, and adaptation to, potential changes in the environment for the following areas:

- Urban development
- Flora and fauna conservation
- Coastal areas
- Agriculture and forestry
- Water resources
- Tourism

## **National coordination**

### *Development of a national approach*

Develop a coordinated national approach to the greenhouse effect through the Australian Environment Council. This approach is already being pursued in relation to the control of ozone depleting substances. A coordinated approach to greenhouse issues will include consideration of research and monitoring programs, control measures, community education and future planning.

## **Implementation of the strategy**

### *Greenhouse unit*

Establish a Greenhouse Unit within the Ministry for Planning and Environment to: coordinate further development and implementation of the Strategy; promote community awareness; monitor developments in greenhouse research; report on progress on emission reductions; and develop further policy responses.

### *Greenhouse funding*

Provide coordinated funding of actions in response to the greenhouse problem, through agency budgets.



# Part One

## BACKGROUND

*'Humanity is conducting an unintended, uncontrolled, globally pervasive experiment whose ultimate consequences could be second only to a global nuclear war. ... It is imperative to act now.'* So begins the final statement of the **World Conference on the Changing Atmosphere: Implications for Global Security**, held in Toronto 27-30 June 1988.

LAYERS OF THE ATMOSPHERE			
Height (km)	Approximate Temperature Celsius	Temperature Layers	Ozone
600	1,227	Thermosphere	
80	-93	Mesopause Mesosphere	
50	-3	Stratopause Stratosphere	
10	-53	Tropopause	Ozone (decrease is bad)
0	17	Troposphere	Ozone (increase is bad)

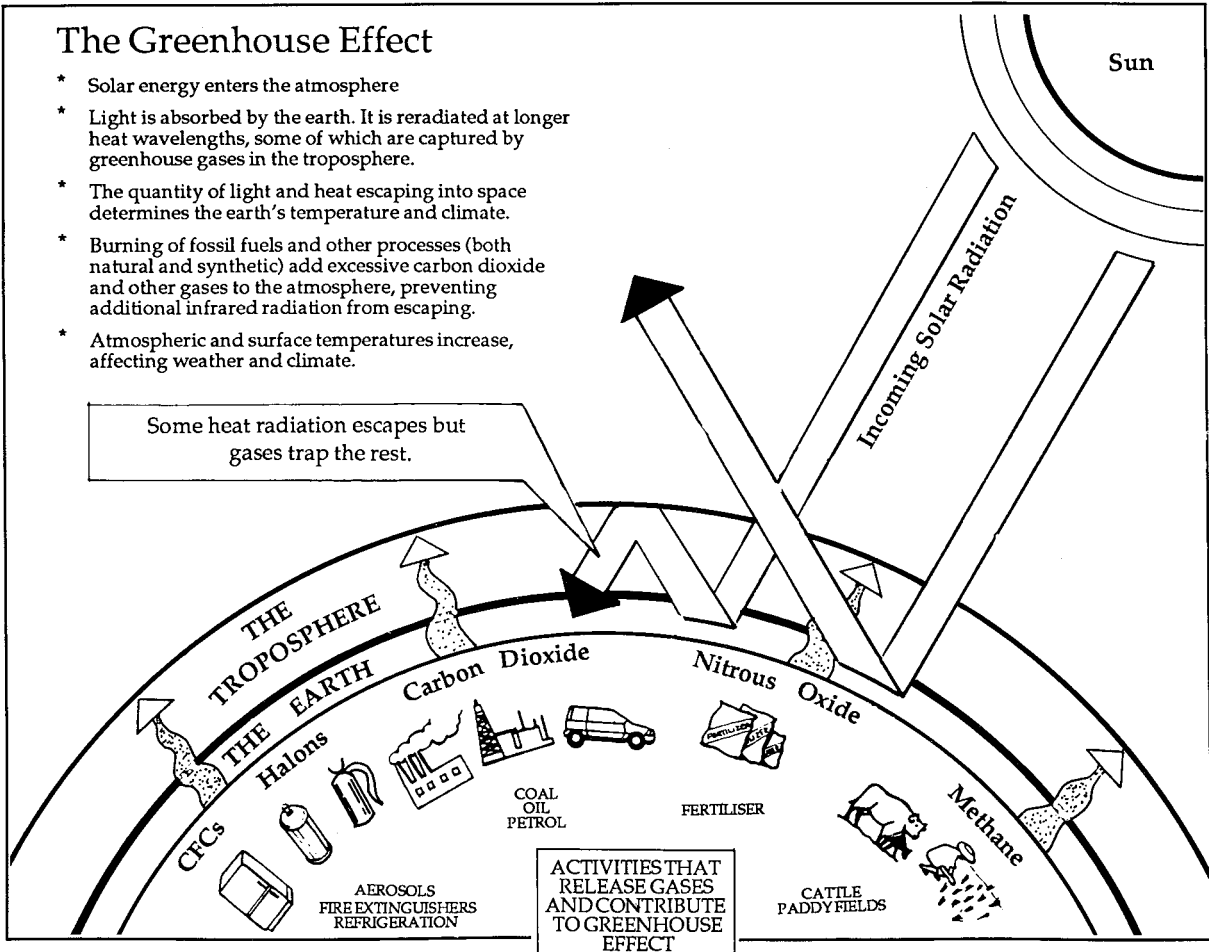
Greenhouse effect occurs here

## What is the Greenhouse Effect

### The Greenhouse Effect

- \* Solar energy enters the atmosphere
- \* Light is absorbed by the earth. It is reradiated at longer heat wavelengths, some of which are captured by greenhouse gases in the troposphere.
- \* The quantity of light and heat escaping into space determines the earth's temperature and climate.
- \* Burning of fossil fuels and other processes (both natural and synthetic) add excessive carbon dioxide and other gases to the atmosphere, preventing additional infrared radiation from escaping.
- \* Atmospheric and surface temperatures increase, affecting weather and climate.

Some heat radiation escapes but gases trap the rest.



# 1. What is the greenhouse effect?

The atmosphere is the earth's most precious resource, it is a vital protective shield that makes life possible. As well as providing the air necessary for life, the atmosphere acts as an ultraviolet filter and a thermal blanket. The temperature of the earth is kept some 30°C warmer than it would otherwise be by the presence of small quantities of so called greenhouse gases in the atmosphere which are transparent to incoming sunlight but which absorb some of the outgoing heat radiation which the earth radiates to space.

The greenhouse effect refers to this process and it has become the focus of growing concern in recent years because of evidence that increasing concentrations of greenhouse gases in the atmosphere are trapping more heat and are causing a gradual global warming.

The main greenhouse gases are carbon dioxide, methane, nitrous oxide, chlorofluorocarbons (CFCs), halons and tropospheric ozone. As a result of human activities, especially the use of fossil fuels and agricultural activities, emissions of these gases are increasing and increased levels in the earth's atmosphere are clearly measurable.

The crucial issue is the long-term effect of these changes on our climatic systems and on sea levels. There is some uncertainty as to the timing and specific impacts on local weather patterns, but the global atmospheric warming is likely to cause profound climatic changes, leading to changes in our environment and way of life.

The greenhouse effect is commonly linked to the depletion of the ozone layer because certain gases act as both greenhouse gases and ozone-depleting substances. CFCs and halons are best known for their role in the upper atmosphere (stratosphere) where they break down to substances which result in the depletion of ozone. Depletion of the ozone layer leads to increased exposure of the earth to harmful ultraviolet rays from the sun. This problem is different from the warming of the

earth caused by the action of CFCs, halons and other greenhouse gases in the lower atmosphere (troposphere). In the troposphere, CFCs and halons are stable and do not affect levels of tropospheric ozone which itself acts as a greenhouse gas.

## Global trends in greenhouse gas emissions

In the past 150 years human activities have had an increasingly marked impact on the atmosphere. Before the industrial revolution levels of greenhouse gases in the atmosphere had remained fairly constant for thousands of years. As industrialisation and associated development pressures have spread worldwide emission rates have been increasing at an ever greater rate. The main reasons for these increases have been:

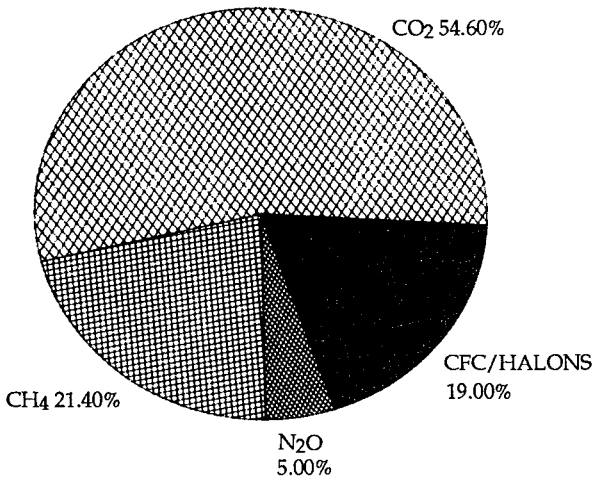
- the growth in energy demand in both developed and developing countries, which has been largely met by increased combustion of fossil fuels;
- the expansion of agricultural activities and losses of vegetation cover resulting from population pressures;
- the introduction of artificial gases (mainly in the last 30 years).

If current trends in human activities continue, it is expected that an effective doubling of present carbon dioxide (CO<sub>2</sub>) levels in the atmosphere (including all greenhouse gases converted into CO<sub>2</sub> equivalents) would occur by 2030.

Currently, CO<sub>2</sub> emissions are the major contributor to the greenhouse effect (up to 55%) with ozone-depleting substances being responsible for up to 20% and methane, nitrous oxide and tropospheric ozone contributing some 25%. However, levels of the non-CO<sub>2</sub> greenhouse gases are growing rapidly and will have an increasingly significant impact. Even small amounts of CFCs and halons contribute substantially to the overall greenhouse effect

because CFCs in general have a much greater greenhouse warming effect, molecule for molecule, than  $\text{CO}_2$ . Current estimates (based on existing practices) indicate that by 2030 CFCs will contribute approximately 20% of the greenhouse effect with carbon dioxide contributing 50% and other gases such as nitrous oxides, ozone and methane the remainder. These estimates will need to be modified if international controls on CFCs are successful.

### *Annual Contribution of Major Greenhouse Gases*



Source: CSIRO

Global trends for emissions of each of the main greenhouse gases are detailed below. Research and monitoring studies being undertaken here and overseas, will continue to advance our knowledge of these greenhouse gases, and to define more precisely the sources of various gases, their relative contributions to greenhouse warming and any changes over time.

#### *Carbon dioxide ( $\text{CO}_2$ )*

The concentration of  $\text{CO}_2$  in the atmosphere has increased from pre-industrial levels by about 25% in 200 years, and levels are expected to increase a further 30% in the next 50 years.

At present  $\text{CO}_2$  levels are increasing by 0.4% p.a. Most of the current increase is a result of the burning of fossil fuels with the other major contribution coming from the clearing and burning of forests.

Of the estimated yearly output of 19,000 million tonnes of carbon dioxide from fossil fuels, about half is taken up by the atmosphere. The rest is absorbed by vegetation or dissolved in the oceans.

#### *Methane ( $\text{CH}_4$ )*

Over the past 200 years, levels of methane in the atmosphere have increased by 120%. Currently levels are increasing by 1% p.a.

Methane is produced naturally by the breakdown of vegetation where the supply of oxygen is limited, such as in rotting or digestion. Growing world population and increased agricultural activities have significantly increased emission levels. Nearly half the present global emissions are associated with cattle populations and rotting vegetation in rice paddies. Wood burning contributes about one fifth and the remainder is released by coal mining, extraction of other fossil fuels and from naturally decaying peat in bogs and tundra.

#### *Chlorofluorocarbons (CFCs) and halons*

CFCs and halons do not occur naturally in the atmosphere. Since the 1930s CFCs have been industrially produced for use in refrigeration and air conditioning and more recently as propellants in aerosol spray cans and in foam products for packaging and insulation. Halons are used as fire extinguishants. CFC production has been increasing rapidly through the 1980s as a result of new applications by industry and the growing market for refrigeration in less developed countries. CFCs are of special concern because of the present rapid rate of increase (5-10% p.a.) and because once formed, they resist chemical breakdown in the lower atmosphere and may persist for more than a century.

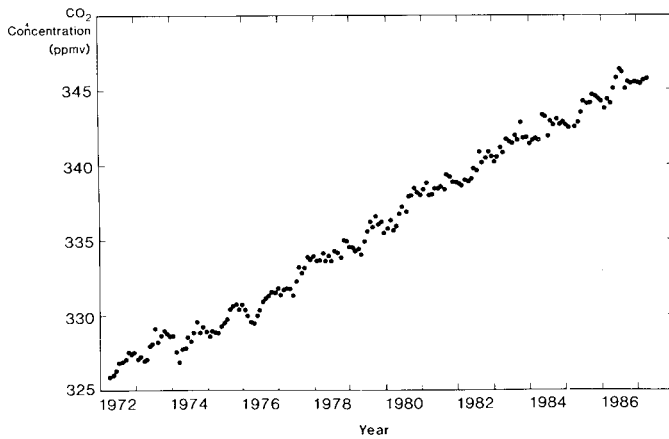
The Montreal Protocol of 1987 established an international agreement for achieving a 50% reduction in the emissions of ozone-depleting substances by 1998. Already this target is widely regarded as inadequate. The Victorian Government has responded to the problems of ozone depletion and the greenhouse effect by planning for the phase-out of emissions of ozone-depleting substances by the mid 1990s.

#### *Nitrous oxide ( $\text{N}_2\text{O}$ )*

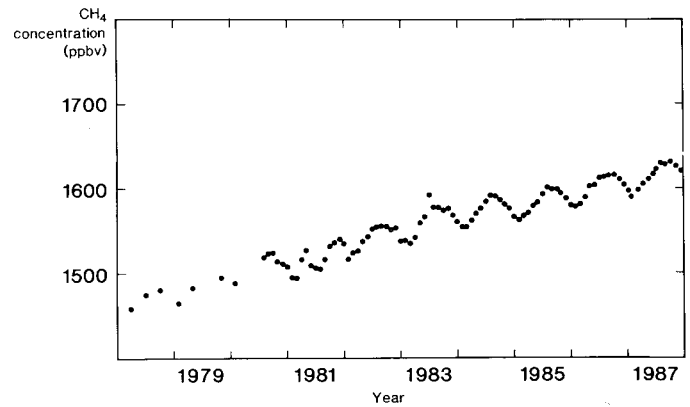
Nitrous oxide occurs naturally, but as with other greenhouse gases, concentrations have been boosted by human activities, in particular the use of nitrogen-based chemical fertilizers

# *The Build-up of Major Greenhouse Gases in the Atmosphere*

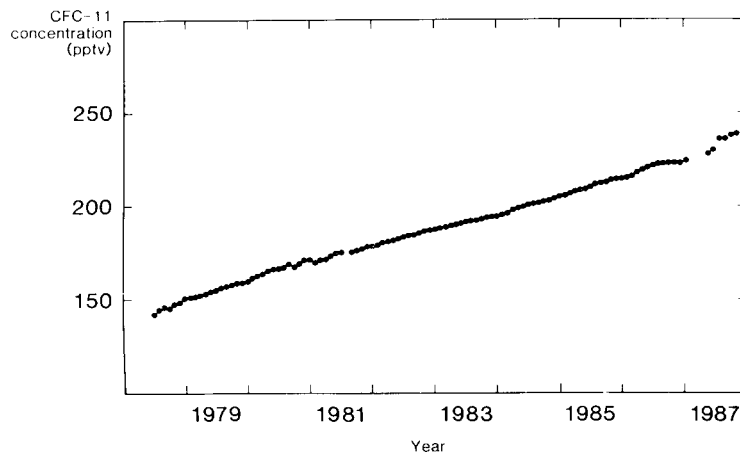
## Carbon Dioxide



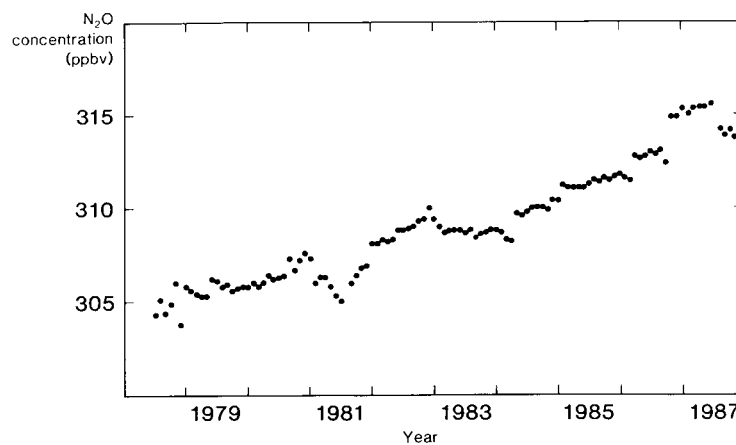
## Methane



## CFC-11



## Nitrous Oxide



1. Not all CFCs have the same greenhouse warming potential. CFC11 and CFC12 are the two most significant CFCs with respect to the greenhouse effect.

and the combustion of fossil fuels.

Concentrations of this greenhouse gas are increasing by about 0.3% p.a. About one third of the atmospheric nitrous oxide is thought to be of human origin.

### *Tropospheric ozone (O<sub>3</sub>)*

The ozone layer refers to the naturally occurring concentration of ozone in the middle and lower stratosphere, which protects the earth by filtering out potentially harmful ultraviolet radiation from the sun. By contrast, ozone occurs in the troposphere as a result of human activities and has the effect of a greenhouse gas. Urban and industrial pollution is the main cause of tropospheric ozone. It is estimated that motor car exhausts are responsible for 75% of the ozone-forming pollutants, with most of the remainder coming from coal-burning plants.

Increases in tropospheric ozone have been observed in recent years, mainly in the northern hemisphere, and it appears likely that there will be greater increases in the future, reflecting levels of fossil fuel combustion. Tropospheric ozone increases would only be partially offset by the decline in ozone levels occurring in the stratosphere.

## Global climate changes

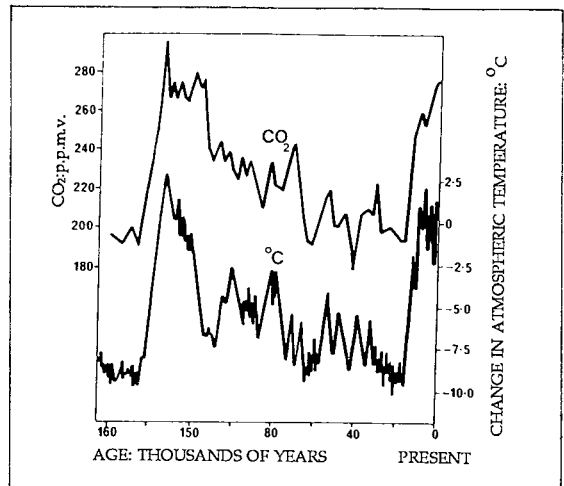
With greenhouse gases in the atmosphere steadily on the rise, scientists have been looking for clear signs that the projected global warming is happening. Recent temperature rises and extreme weather conditions have further fuelled scientific debate and community concern that greenhouse-induced climate change is already a reality. What therefore, is the evidence so far for global warming?

Records show that since 1860 there has been a rise of 0.5°C in average global temperatures. In particular, the four warmest years of the past century have all been in the 1980s and in the first five months of 1988 worldwide average temperatures were the highest on record. While a proven causal link between increased levels of greenhouse gases and increased average global temperatures has not been scientifically established, studies of Antarctic ice cores have identified a correlation between CO<sub>2</sub> levels and temperatures. Going back over 150,000 years, lower temperatures have occurred in parallel with lower CO<sub>2</sub> levels and higher temperatures with higher CO<sub>2</sub> levels. In the past few years a scientific consensus has emerged on the potential for greenhouse-induced climatic

change, with debate continuing as to the timing and extent of the changes.

What climate changes are likely to result from the greenhouse effect? Climate models are being developed by scientists around the world to provide indications of the magnitude and climatic impacts of the greenhouse effect. The task is a complex one and at this stage has only produced general global conclusions. The challenge is to produce reliable information on regional climatic changes including details of factors such as rainfall. The CSIRO is developing a climatic model for Australia. The Victorian Government is contributing to this research program which will provide more reliable and detailed information on the impacts of climate change within Victoria.

## *Carbon Dioxide and Temperature*



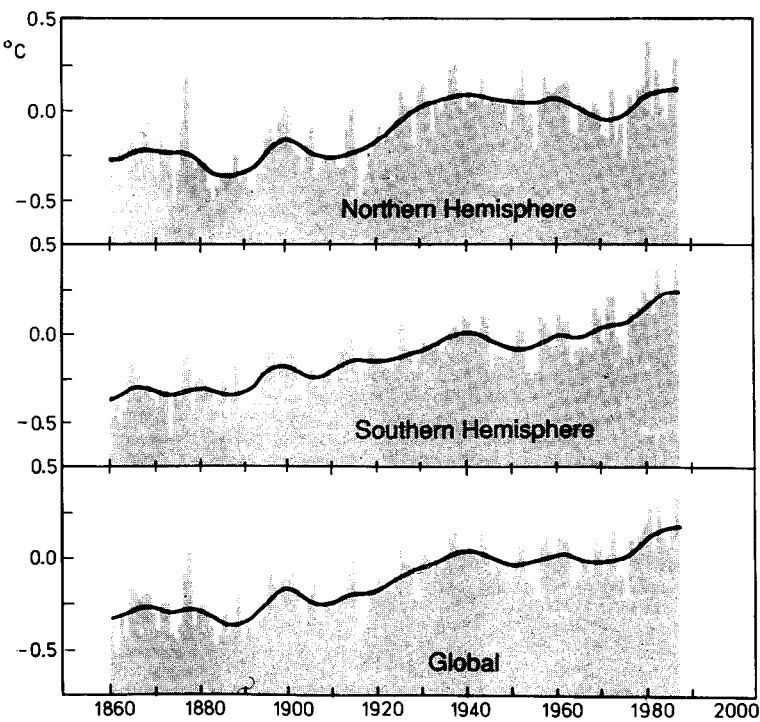
Recent evidence from air bubbles trapped in Antarctic ice has shown that there is a **clear link** between the **carbon dioxide concentration in the atmosphere** and the **global temperature**. A difference between the past and today is that we are now rapidly increasing the carbon dioxide concentration, to levels higher than any time in the last 160,000 years.

Source: The Vostock record of temperature and concentrations of carbon dioxide in the atmosphere over the past 160000 years (from New Scientist).

Despite these uncertainties, there is general agreement among scientists on the range of global temperature increase that we can expect at current emission rates for greenhouse gases.

Models have consistently shown that warming will be experienced across the globe in both summer and winter if CO<sub>2</sub> is doubled, and that temperature changes at high latitudes (close to

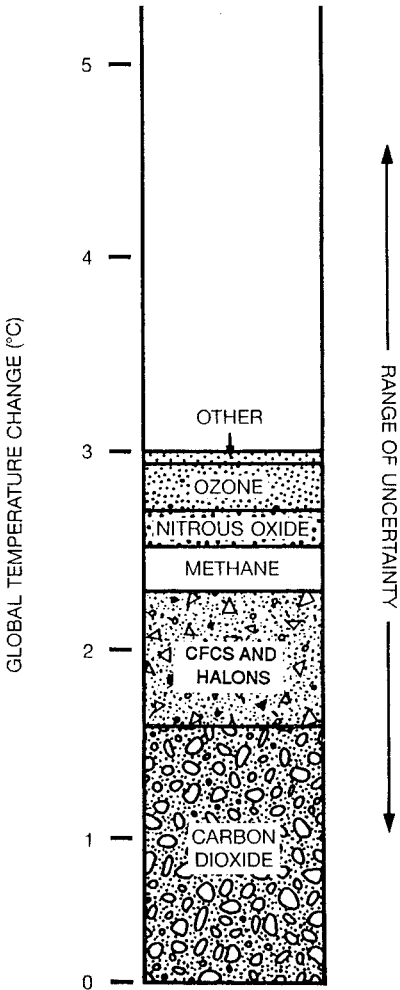
# Temperature changes 1860-1988



Source : New Scientist

## Contributions of Greenhouse Gases to Future Global Warming

Global temperatures may rise an average of 3 °C by the year 2030. The major contributors to this warming are expected to be carbon dioxide and CFCs, with the other greenhouse gases having lesser effects, as indicated (based on current rates of emission).



the poles) will be greater than those at lower latitudes (closer to the equator). The incidence of extreme events such as cyclones, floods, droughts and heat waves is also likely to change. Changes in rainfall patterns are also likely, with increased winter rain and snowfalls in the higher latitudes, intensified rain in the currently rainy lower latitudes and a possible decrease in rainfall and soil moisture in middle latitudes.

Based on current trends in greenhouse gas emissions it is estimated that in the next century the planet will warm by as much as  $5^{\circ}\text{C}$ , making it warmer than at any time in the last two million years. This global warming would cause a rise in sea levels as oceans warmed up and their waters expanded, and in the longer term as the ice caps melted. There is already evidence of rises in global sea levels over the past 100 years and projected future rises are likely to have major impacts on coastal environments around the world and the many people living in these areas. In global terms it seems likely that the rate and magnitude of climate changes which will be experienced by the next two generations will exceed any in previous human experience.

## Projected climate changes for Victoria

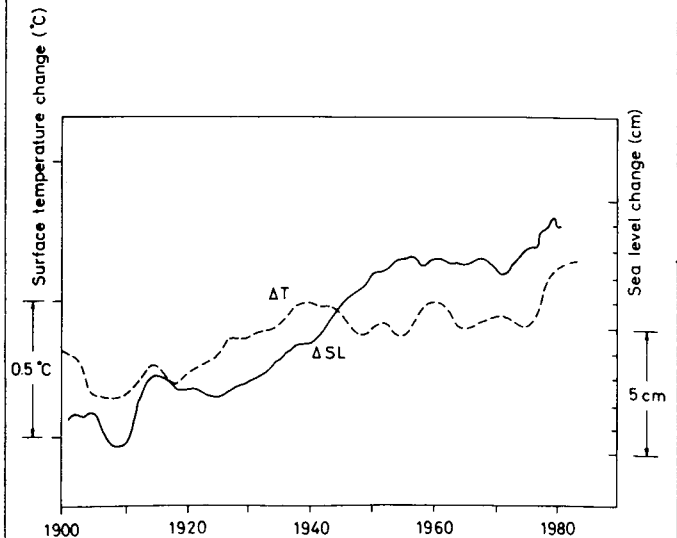
The following outline of Victoria's projected climate for 2030 is based on current global models. While this provides us with a starting point for examination of the implications of the greenhouse effect, more specific and reliable data will be required before detailed forward planning can occur. This information will become available progressively through the work of the CSIRO and other research being undertaken here and overseas.

By 2030 Victoria could be on average  $2-4^{\circ}\text{C}$  warmer in winter and in summer - Victorians will experience more hotter days and fewer colder days. Consequently, if nothing else changed, there would be higher evaporation

rates, drier soil and less runoff. Rainfall might be expected to increase in the summer half-year, especially in northern and eastern Victoria, with more easterly winds at that time of year. There is more uncertainty about winter rainfall, but a best guess might suggest less frontal rain with more from east-coast or cut-off lows. At all times of the year it is expected that rainfall will occur in generally heavier rain storms, leading to more flash flooding. More warm rain and higher temperatures would mean reduced snowfalls and shorter snow seasons. It is estimated that for every  $1^{\circ}\text{C}$  increase in temperature, the snow line can be expected to rise by approximately 100 metres vertically.

Victoria in general is expected to experience sea level rises in the range of 10-30 cm by 2030 and 20-70 cm by 2080, although these global average rises would be modified by local effects such as subsidence. Coastal areas may also experience changed wave patterns and more intense and more frequent storms.

### *Changes in Sea Level and Sea Surface Temperature 1900-1985*



Source: 'The Greenhouse Effect, Climatic Change and Ecosystems' ed. B. Bolin and others, 1986.



## 2. How Victoria contributes to the greenhouse effect

### Emissions into the atmosphere

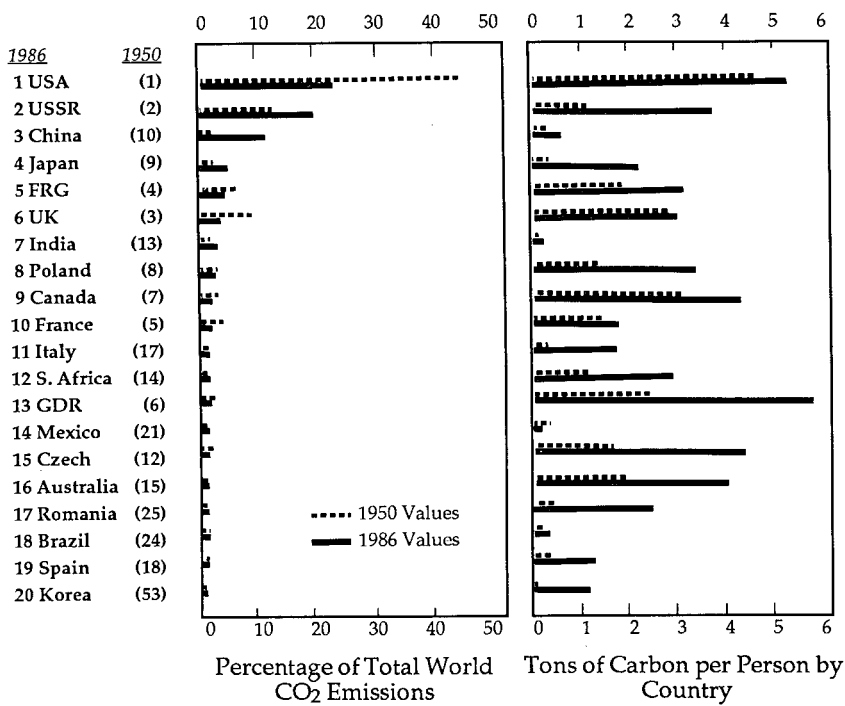
#### Carbon dioxide

The combustion of fossil fuels (coal, petroleum and natural gas) to provide energy is the main way in which human societies contribute to overall increases in CO<sub>2</sub> levels in the atmosphere.

Australia is a major contributor to this problem on a per capita basis, with the fifth highest use of carbon (4 tonnes per person) in the world, making it sixteenth among nations ranked for total annual emissions of CO<sub>2</sub>. Victoria contributes 0.4% of global CO<sub>2</sub> emissions, accounting for some 28% of total fossil fuel usage in Australia.

The reasons for these high levels of consumption in Victoria are: first, high levels of overall energy use, including widespread use of cars; and second, dependence on brown coal for electricity generation. Brown coal based generation produces relatively high levels of CO<sub>2</sub> emissions, because the high water content of the coal means that large quantities are required for the production of each unit of energy. Victorians have been fortunate in having access to plentiful and relatively cheap energy supplies and therefore there have been few constraints on energy demand growth and few pressures to introduce renewable energy sources or to improve fuel efficiencies.

CO<sub>2</sub> Emissions from Major Nations 1950-1986



The relative importance of the major emitting countries has changed since 1950—the source of emissions has become more widely distributed. However, on a per country or per capita basis, emissions are still dominated by the major industrialized nations.

Source: Carbon Dioxide Information Analysis Centre, U.S. Department of Energy.

Victoria's fossil fuel consumption is currently forecast to increase. Current growth assumptions to the year 2005, based on forecast population increases and levels of economic activity, are that electricity consumption will increase by 3.6% p.a., petroleum products by 1.6% p.a. and natural gas by 2.0% p.a. from 1990-1994 and 2.6% p.a. from 1994-2005. New forecasts for electricity demand are currently being prepared and are expected to be revised downwards.

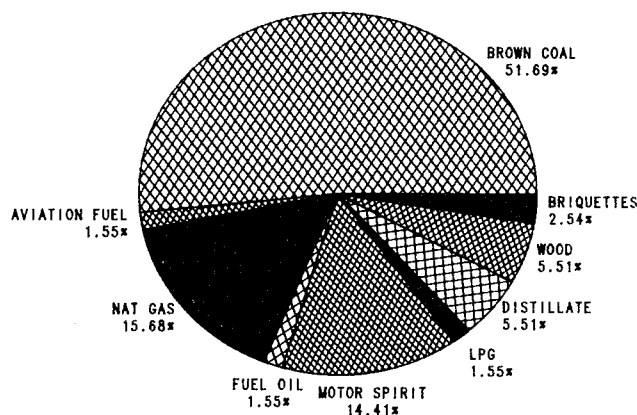
Victoria's electricity supply system produces 16% of the state's total energy requirements but it is a significant sector in terms of its contribution to CO<sub>2</sub> emissions - 50% of the state's total. Brown coal generates 85% of the electricity used in Victoria with some 40,000,000 tonnes being consumed each year. Natural gas, hydro-electricity and small amounts of liquid fuels also contribute to the electricity supply system. Current plans to meet future demand for electricity are based primarily on brown coal fired power stations. However, there is scope for an increased contribution from gas and in the long term the introduction of black coal, as well as for energy conservation measures and improvements in the efficiency of power generation.

The transport sector in Victoria uses more energy than any other sector (42% of the total) but produces proportionately less CO<sub>2</sub>. Almost all transport fuels are derived from crude oil (98%), with very small amounts of electricity (in the rail-based public transport system) and of LPG. Improvements in vehicle fuel efficiency, changes in land use patterns and improved access to public transport all have the potential to minimise consumption of transport fuels.

Of the major energy resources used in Victoria, natural gas has the lowest rate of CO<sub>2</sub> emissions. On average, oil releases about 40% more CO<sub>2</sub> per unit of energy than natural gas, while black coal releases 75% more CO<sub>2</sub> than natural gas. Low quality brown coal such as that used in Victoria, releases double the CO<sub>2</sub> of natural gas. There is significant heat loss when using any of these fuels to produce electricity and their respective emission levels increase by three to five times.

Natural gas from Bass Strait supplies just over a quarter of the total energy used in Victoria. More than half of the gas is used by Victorian industries primarily for process heating, while one third is used in Victorian homes mainly for space heating and water heating. Competitively priced local natural gas is a less plentiful resource than brown coal and has therefore been restricted to premium uses with

## Victorian CO<sub>2</sub> Emissions from Fuel Use 1986-87



Source: State Electricity Commission of Victoria.

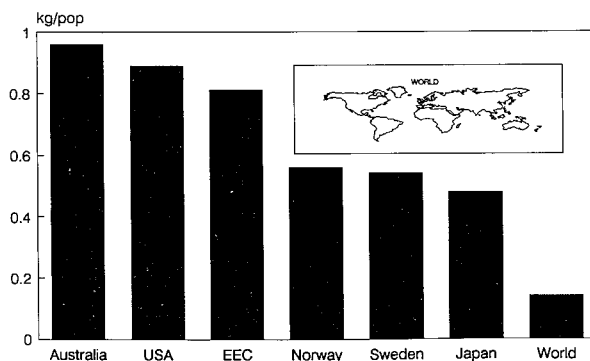
only relatively small amounts being used for electricity generation. Additional gas will be available in the longer term from fields off Western Australia.

## Other greenhouse gases

While Australia's contribution to total greenhouse gas levels is low compared to that of other developed nations, it has very high per capita rates of emissions for gases such as CFCs and halons.

On a per capita basis, Australia is one of the world's largest consumers of CFCs and halons. Victoria probably consumes one third of Australia's total. The major uses of CFCs and halon gas in Australia are as refrigerant gases in refrigeration and air conditioning, as aerosol propellants, in plastic foam manufacture, as fire extinguishants and as solvents in a variety of industrial cleaning applications. In 1986 these industries consumed approximately 14,900

## Per Capita CFC Consumption



tonnes of CFCs and halons, which was less than 1.5% of the total world production but represented 0.96 kg for each Australian. By comparison, 0.89 kg was consumed by each American (1985) and 0.14 kg was the world per capita consumption (1985).

Reliable, detailed data on emission levels and sources of other gases such as methane and nitrous oxide in Australia and Victoria are not currently available. However, it is clear that in Victoria leaks from natural gas wells and distribution systems and from coal mines and releases from cattle and sheep contribute to methane levels, while motor vehicle emissions and agricultural fertiliser use contribute to nitrous oxide levels.

## Deforestation

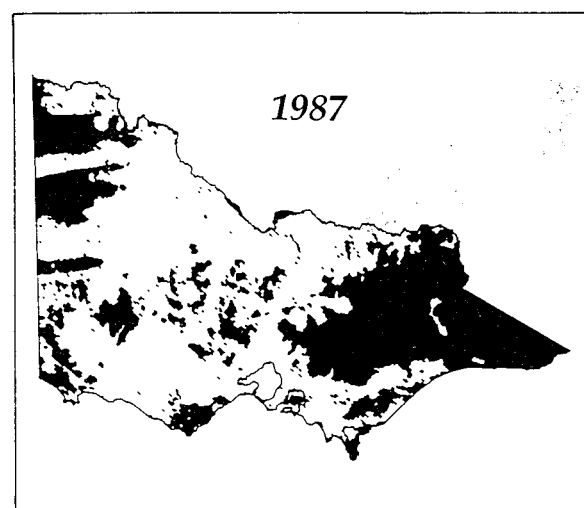
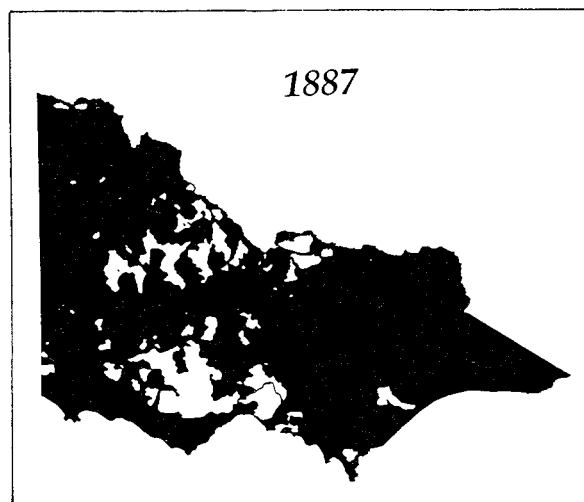
Deforestation contributes to the greenhouse effect through the CO<sub>2</sub> which is released when vegetation cover is cleared and burnt, and also the lost opportunity for absorbing CO<sub>2</sub> through photosynthesis and thereby reducing levels in the atmosphere.

Since 1900 forests in South America, Africa, South East Asia and the Indian subcontinent have been reduced by 50% and a further 15% is likely to be lost by the year 2000. The current rate of worldwide deforestation is estimated to be 10 times the rate of reafforestation. This progressive loss of vegetation cover has contributed to the atmospheric changes associated with the greenhouse effect.

Over the past 150 years of European settlement Victoria's forest cover has been dramatically reduced. Before European settlement forests and woodlands covered almost 90% of Victoria but now cover only 35% of the state. This clearing has been associated with a range of serious problems, including salinity, soil erosion, stream degradation and loss of wildlife habitat, in addition to its contribution to CO<sub>2</sub> emissions.

The benefits of revegetation have been recognised for some years but the current rate of revegetation is only about 2000 ha per year and Victoria is still experiencing net annual losses. In the period 1972-1987, 246,000 ha of predominantly native forest was cleared, an annual clearing rate of 16,000 ha. While the vast majority of Victoria's remaining forest cover is situated on public land (90%), the greatest losses are occurring on freehold land (209,000 ha in the period 1972-1987).

## *Changes in Victoria's Forest cover*



Source: Department of Conservation, Forests and Lands

## Community practices

The greenhouse effect is the product of industrialised society, the increasing world population and consequent requirements for energy and consumption of natural resources. Community expectations and practices determine, to a large extent, the level of consumption of these resources. In developed countries high consumption has become part of a way of life. The United States, for example, with only 5 or 6% of the world's population consumes upwards of 40% of the world's resources.

While these high patterns of consumption are also true for Victoria, there are signs of change. There is a growing awareness within the community that environmental problems are

now occurring on a global scale and are related fundamentally to the consumption of natural resources, particularly energy resources and forest products. Victorian consumers and industries have responded positively to the publicity about the use of CFCs in aerosol spray cans and their impacts on the ozone layer and contribution to the greenhouse effect. With regard to paper recycling, following government and industry initiatives, Victoria is now leading the nation with a 50% recycling rate, which compares well with the most active recycling nations in the world. These initiatives need to be expanded so that individuals are aware of the range of activities that relate to the greenhouse effect and know how these can be modified.

Issues such as reducing air and water pollution, minimising waste and litter, recycling, conserving energy and using land wisely are key areas where the community can play an important role in reducing emissions of greenhouse gases and protecting the environment. The decisions taken by individual consumers and households about what products they use, how much energy they consume and how they dispose of their rubbish are of critical importance.

Energy conservation in the home is one simple but very effective way in which the individual can take action in response to the greenhouse effect. For example, a 100 W light bulb burning

for ten hours or a 1 kW radiator burning for one hour will each contribute 1.2 kg of CO<sub>2</sub> to the atmosphere. Consumers need to have this sort of information, and to know what the alternatives are, for example, in choice of packaging materials, use of public transport, and use of solar hot water services so that they can make environmentally responsible decisions. As shown with CFCs, Victorian consumers are responsive to environmental concerns where they are provided with clear information and choices.

Many of the products used by the community have long-term harmful effects on the environment because of their ingredients, their manufacturing process or their packaging. Packaging in particular not only creates waste disposal problems but contributes to CO<sub>2</sub> emissions because of the energy consumed in its production and, in the case of paper products, because it uses up valuable forest products.

Community practices, such as our dependence on private motor vehicles, are even more significant contributors to greenhouse gas emissions and modifications will require a significant and sustained effort. Creating significant changes in community practices will require the cooperation of government (national, state and local), industry and the community, but it is the response of individual consumers which will be most critical to success.

### 3. Potential impacts of the greenhouse effect in Victoria

It is expected that climatic changes caused by the greenhouse effect will become apparent progressively over the next 20 to 50 years, though the actual rate of change is still uncertain. These changes will affect all parts of the state and a wide range of activities. However, the extent of disturbance to the environment and disruption to activities will vary considerably depending on the particular climatic effects and topography and on the capacity for adaptation. In some instances changes in climate will open up new opportunities.

Environmental systems and sectors of activity likely to be most affected by climate change are outlined below. This preliminary view of the potential impacts of the greenhouse effect on Victoria is intended to provide a focus for planning and to indicate priority areas for action. It is based on the broad projections of future change outlined in Chapter 1 and will need to be modified as more specific information for various regions becomes available and as studies are undertaken of the complex chain of effects flowing from climatic changes.

#### Ecosystems

Shifting climatic patterns are likely to have adverse effects as the state's flora and fauna. The extent of these impacts will depend on whether organisms can adapt to the changes, the actual rate of change and the possibilities for movement by species to more suitable areas. However, remnant habitats are often isolated and offer little opportunity for movement of species to enhance survival. Given current assumptions about the changes likely to occur over the next 50 years and the already fragmented nature of much of the state's

terrestrial and inland aquatic habitat, some rarer flora and fauna are likely to be threatened, and some endangered species may lose the battle for survival.

The present system of parks and reserves which is designed to include representative samples of all Victoria's natural ecosystems is one of the main ways of conserving flora and fauna. This system, however, is based on the expectation of a relatively unchanging climate. The greenhouse effect would affect the capacity of established parks and reserves to support existing ecosystems.

Environmental weeds already pose a serious threat which is likely to be exacerbated by the stresses on indigenous ecosystems resulting from climatic changes.

#### Coasts

As a result of the greenhouse effect Victoria's coasts are likely to be affected by changed weather patterns, increased sea levels and increases in sea surface temperature. Over the next 50 years it is likely that some areas of the coast will experience significant erosion and some land will also be lost through inundation.

The major threat to the coastline would arise from the higher incidence of extreme events combined with higher average sea levels. There are likely to be more major storms and they are likely to have more damaging effects on beaches and foreshores. Foreshore response across Victoria would be very varied. Overall it is expected that shoreline retreat will exceed any gains.

Estimates of future sea level rises vary. The Victorian Government is working with an estimate that gives a range of increase of

between 10-30 cm for 2030 and between 20-70 cm for 2080. There are other higher and lower estimates and this is obviously an area which will require close monitoring and review.

The projected sea level rises for 2030 will result in loss of some low-lying coastal land and wetlands areas and the creation of new wetlands. These rises would occur largely as a result of the warming and expansion of seas. Melting of the polar icecaps is a much longer term concern. While there would be some small contribution in the short term from melting of ice on the fringes of the polar region the time span for major melting is hundreds of years.

These potential coastal impacts have significant implications for some activities and particular areas. Highly vulnerable areas need to be identified as a matter of priority. Future development in these areas would need to be constrained to minimise the losses and costs in the long term. Erosion of the coastline would also affect the integrity of the present system of public coastal reserves, reducing public access and affecting flora and fauna. The long lead time for these changes does, however, provide an opportunity for protective measures, planning and adaptation, which will minimise impacts.

The projected rise in sea surface temperatures would also have a significant effect on flora and fauna in coastal areas, particularly in estuaries.

## Agriculture, forestry and fisheries

Agricultural land use and management practices will need to be adapted in response to the expected shifts in local climatic zones and of climates across the globe. Global climate shifts have the potential to alter significantly the balance of advantage and disadvantage in primary production. However, such changes have been a persistent feature of world agriculture and Australian farmers have a highly developed capacity for adaptation. Farmers adjust every season to the vagaries of the weather and market. In the last six years in Australia, for example, there has been a 24 % increase in sheep numbers, 21 % decline in the area planted to wheat and 292 % increase in the area sown to grain legumes.

A critical factor for Victorian agriculture will be the global effects on supply and demand of agricultural commodities in export markets.

While specific predictions of changes in Victorian primary production are not possible without more detailed research, the broad implications of the greenhouse effect are as follows.

Both positive and negative effects on existing agricultural systems are expected at this stage. Pasture and livestock production systems are likely to be able to cope with the rate of climatic change. For annual crops and pastures, increases in CO<sub>2</sub> concentration, temperature and summer rainfall could improve productivity, especially in winter. However, shifts in the balance of pests, weeds and diseases will need to be countered and management adapted. Increased temperatures expressed as higher night-time minima would substantially reduce the reliability of tree-fruit crops which have a strict chilling requirement for fruiting. This could severely affect the viability of current temperate fruit production.

Specific land management issues would be: erosion risks posed by intense rainfall and higher winds in some areas; development and refinement of sustainable systems which optimise productivity; and maintenance of soil fertility where the hydro-geological equilibrium and soil salting alters in response to changes in rainfall and evaporation.

Unlike most primary production, forestry is an activity with long (20-40 year) lead times and therefore is less capable of flexibility in response to climate changes. Climate changes and increased levels of atmospheric CO<sub>2</sub> would have a mixed effect on Victoria's native forests, plantations and the future economics of forestry.

Climate changes, in particular temperature rises, are likely to cause changes in the distribution of particular forest species and may diminish species diversity in national parks and forest reserves. The response of Australian native species to increases in CO<sub>2</sub> is uncertain, but the productivity of *Pinus radiata* plantations is likely to increase significantly. Productivity of these plantations is only likely to be limited by the availability of nutrients and soil moisture. Fire risks are likely to be greatly increased as a result of higher rates of plant growth (particularly in the forest understorey),

the higher temperatures and possible decrease in soil moisture in summer. Plans for future plantations and forestry industries need to build in these potential factors and the possible effects of greenhouse-related developments on overseas production and markets.

Increased sea surface temperatures and changes in coastal systems would affect marine ecosystems and have implications for the fishing industry. Altered ocean circulation patterns and increased temperatures are likely to affect the productivity of the oceans and the distribution and abundance of marine species, including those which are economically important. Coastal and estuarine habitats would be modified with some being lost, some created and some expanded. Loss of coastal wetlands in particular would have significant implications for the fishing industry as these are important fish nursery areas.

## **Water and catchment management**

The greenhouse effect is likely to affect rainfall levels and patterns and therefore result in changes in the volume of water and seasonal pattern of flow in Victoria's waterways. While these changes may have impacts on future water supply security and water quality, the nature, direction and magnitude of changes is still uncertain and, depending on these factors, there may be beneficial as well as adverse effects. Changes in streamflows would also affect riverine and wetland environments and are likely to require a review of management activities for catchments, rivers and floodplains.

Any increase in frequency and severity of extreme events (i.e. drought and floods) and in the variability of weather patterns is likely to cause significant problems. The increased risk of floods has implications for the capacity of existing drainage systems and flood protection works, for the safety of existing spillways and for the design of future structures and systems.

An increase in climatic variability together with likely decreased streamflows in certain areas may cause problems for water supply systems. Higher temperatures will lead to earlier and less snowmelt, causing increased winter river flows and decreased summer flows in streams fed by the Victorian alps. Water supply systems may

therefore need to make greater use of alternative sources of supply such as groundwater, recycled and desalinated water, and water conservation measures. Also, increased variability may mean that future water storage structures have to be designed with larger capacities to maintain the same reliability of supply.

There are also likely to be significant impacts on aquatic ecosystems and waterway stability. The severity and frequency of flooding of rivers and floodplains is likely to increase with adverse effects on some localities.

Changes in water consumption are also likely as a result of climatic change. Increased temperatures are expected to create increased demand from urban consumers. This may be offset to some extent by more summer storms. Rural demand, primarily for irrigation water, is less predictable. The use of irrigation water will be affected by changes in temperature, rainfall and atmospheric CO<sub>2</sub> levels, in addition to changes in land use. Overall, it is likely that demand will increase. Higher summer rainfall may help to meet irrigation demands in some localities.

## **Urban infrastructure and systems**

The greenhouse effect on physical infrastructure and systems will be apparent in all urban settlements. This will be intensified in coastal settlements affected by both climate changes and coastal erosion and inundation. The effects on the Melbourne metropolitan area are of particular concern because of the numbers of people involved and the continuing pressures there for metropolitan growth. Further expansion into vulnerable coastal areas would exacerbate future problems.

Urban drainage and sewerage systems are likely to experience significant impacts as a result of the greenhouse effect. Changes in rainfall frequency, intensity and duration will place considerable pressures on the present drainage system and increase the potential for stormwater flooding from drains and urban waterways. A rise in sea levels will also be critical to the drainage of bayside areas and areas adjacent to the tidal sections of the Maribyrnong and Yarra rivers.

The sewer reticulation and transfer system would be affected by higher groundwater tables and an increase in the frequency of stormwater surcharging and potential overflows would mean that more pumping would be necessary. Treatment systems, however, may be improved by the more humid climate, increased temperature, wind and atmospheric CO<sub>2</sub>.

Other urban systems and infrastructure are likely to be affected by the greenhouse effect. Urban parks, gardens, riverine and coastal environments are likely to require changed management practices and flora and fauna may be affected as a result of climate changes. Electricity supply systems would have to cope with a shift in seasonal loads as a result of any increased demand for air conditioning. Flooding of low-lying areas would cause localised problems with road access and other physical infrastructure. An increase in the frequency and intensity of rainfall would increase the probability of flooding of minor roads in local areas, but this is unlikely to have a significant effect on the operation of the overall road network.

## Tourism and recreation

The tourism industry is largely based on a market for specific natural resources such as beaches, rivers and mountains and the availability of desirable weather patterns - summer sun and winter snows. Tourism activity in Victoria is likely to be significantly affected by changes in these factors occurring in Victoria, in Australia (for example increased cyclone risks in Queensland and northern New South Wales) and internationally.

Within Victoria, the impacts of climate change would particularly affect tourist activities based on snowfields, beaches, the coastline and other water resources, and some flora and fauna. However, while some resources would be adversely affected, opportunities would also emerge both in the form of expanded activities and new environments. In particular, a rise in temperatures and shift in rainfall patterns is likely to extend the peak tourist season in Victoria.

Some projections have been made of the impact of temperature changes on Australian snowfields. It is estimated that for every 1°C increase in temperature, the snow line could be expected to rise by approximately 100 metres vertically. While possible increases in precipitation could have the effect of lessening the impact of these temperature increases in the short term, by 2030 lower altitude snowfields will almost certainly not receive viable snowfalls. The increased variability of future weather patterns would also adversely affect the operation of snowfields resorts.

Climate changes have implications for resort developments in the alpine region of Victoria given the present emphasis on winter activities. However, there is potential for the industry to adapt to these changes, in the short term by utilising snowmaking technology, and in the longer term, by continuing the shift to increased summer use.

## Social impacts

For all Victorians the climate changes projected for the middle of the next century are likely to cause gradually some level of change in everyday life. Some areas of the state and some sectors of the population will experience disruption and adjustment. However, Victorians will not experience anything like the scale of major impacts expected to affect countries such as Bangladesh and certain Pacific islands.

In line with expected global changes, the main impacts Victorians are likely to experience are:

- loss of some coastal areas through coastal erosion and flooding, although the distribution of settlement in Victoria means that this would not affect large numbers of people;
- constraints on land use imposed by risks of future flooding or erosion;
- increase in bushfire risk;
- coping with more extreme climatic events such as storms, floods and droughts;



- changes in agricultural land use and industry restructuring which may result in changes in rural communities;
- changes in some recreational areas and opportunities such as beaches, wetlands and bushland, and reduction in snowfields;
- an increased demand for air conditioning, but a reduced need for heating;
- health problems as a result both of the increased temperatures and increased incidence of tropical infectious diseases;
- changes in lifestyles such as reduced energy use, more recycling and greater use of public transport.

As a community we would also be faced with the pressing responsibility of helping the parts of the world most severely affected, particularly by coastal flooding. There is likely to be considerable pressure for countries such as Australia to absorb refugees displaced by flooding in the Asian-Pacific region.

## Economic impacts

The climate changes associated with predictions of the greenhouse effect would also affect the state economy. There is considerable uncertainty, however, as to the precise nature of such climatic change and its impacts on commercial and industrial activity.

Climatic change is most likely to have implications for the Victorian economy through its impacts on the agricultural, forestry and energy sectors. Relatively high rainfall and temperate climate are major reasons why the state has developed such a diverse primary commodity base, including forestry, meat and dairy products, wool and field crops. The real gross value of agricultural and forest production in Victoria fluctuates between \$4 and \$6 billion annually. Any change in the economics of these primary industries is likely to have more widespread ramifications, due to multiplier effects upon regional economies, and the contribution of the primary sector to the employment-generating food processing and paper and pulp industries.

Any shift away from the use of our cheap and abundant brown coal resource and any general increase in the cost of fossil fuel usage due to international agreements on limitation, would lead to higher energy costs. However, there is likely to be an expansion of opportunities for the exploitation of solar and other renewable energy sources, and associated manufacturing industries.

In spite of the uncertainties, the net impact upon Victoria of current greenhouse predictions is likely to be a negative one.

First, a general increase in extreme climatic events, such as storms, droughts, floods and forest fires, will all bring about net losses in primary production.

Second, structural adjustment will impose significant economic costs on both the individuals concerned and society generally.

Third, greater variability of rainfall will result in greater strains on the state's water management systems, planning processes and drainage and sewerage infrastructure, thus imposing economic costs on the community.

Finally, temperature and rainfall variations are likely to compound present environmental problems, such as erosion and salinity, exacerbating the economic impacts of those problems.

# Part Two

## THE GREENHOUSE STRATEGY

### Responding to the challenge

The greenhouse effect is a complex issue requiring a commitment from government and the community alike to long-term sustained action.

The impacts associated with the greenhouse effect may not be obvious to us for some 20 to 50 years but this does not allow room for inaction. This breathing space provides us with an invaluable opportunity to plan our response and minimise the effects of change. Intervention by government to protect the atmosphere is especially necessary because there is no market structure which could otherwise regulate use of this valuable natural resource. Actions taken now by individuals, communities and government will help to modify and eventually limit future impacts and assist our society in adapting to change. Further, in responding to the greenhouse challenge, Victoria can provide leadership to other communities and give an impetus to the global response that will be required.

If highly populated, developing countries are to be persuaded to limit their potentially very high emissions of greenhouse gases by modifying their population and development policies, highly developed countries, such as Australia, with their high per capita emissions, must demonstrate their commitment to reducing emissions. In March of this year, Australia together with 23 other nations, signed the Hague Declaration. This establishes in principle support for new principles of international law to combat a further warming of the atmosphere and foreshadows the development of standards to enhance or guarantee the protection of the atmosphere.

The Government's Greenhouse Strategy outlined in the following pages, is the first step in the process of investigation and action on the greenhouse effect. As knowledge and experience grow and the picture of future climatic change is clarified, this Strategy will need to be reviewed and modified and where necessary further responses will be developed.

The Strategy has five main areas in which actions and policy commitments are proposed:

- *a research program designed to provide better information about the greenhouse effect and its impacts on Victoria;*
- *actions aimed at limiting further greenhouse gas emissions to the atmosphere to meet specified objectives and, in concert with national and international actions, at delaying the impacts of climate change;*
- *an information and education program aimed at building community awareness of environmental and greenhouse issues and stimulating community action;*
- *long-term planning to cope with future climatic change;*
- *development of a coordinated national approach to the greenhouse effect.*

## 4. Reducing uncertainties

Detailed predictions of regional and sub-regional climate changes are not available at present and this places a severe limitation on our capacity to respond to the greenhouse effect. In a complex area such as climate modelling there will always be an element of uncertainty, but an ongoing research effort will enable us to improve progressively the reliability and detail of these predictions.

In 1988 the Victorian Government recognised the high priority of greenhouse research by committing itself to a five-year cooperative research program with the CSIRO. Victoria is the only state currently contributing to this program. Some \$100,000 has already been made available for greenhouse research as part of this program, and the Government now proposes to expand its commitment to greenhouse research. The Victorian Government welcomes the recent Commonwealth commitments to funding greenhouse-related research, and will seek to complement that research.

Much research work on the greenhouse effect will need to be long-term. It is therefore essential to make a start now so that information is available as soon as possible to refine the response to the greenhouse effect. Monitoring programs are also required to inform and test research efforts and to provide progressive information to the community on what is actually going on in the environment. Effective monitoring will require a long-term commitment if it is to produce significant results, and it will also involve joint State/Commonwealth action.

### Climate research

Basic climate research will be supported by the Victorian Government to provide improved regional and sub-regional predictions for the purposes of forward planning. Victorian research programs will be closely co-ordinated with other research efforts, nationally and internationally.

#### *Proposed actions:*

- *Continue to contribute to the CSIRO's climate modelling project and to complementary research work being undertaken by the Environment Protection Authority, with the aim of establishing by 1993 more reliable predictions of the effects on: Victorian rainfall and snowfall; average and seasonal variations in temperature; evaporation; coastal weather patterns; wind patterns and urban smog.*
- *Use the newly established Victorian Strategic Research Fund to facilitate basic research in relation to the greenhouse effect.*

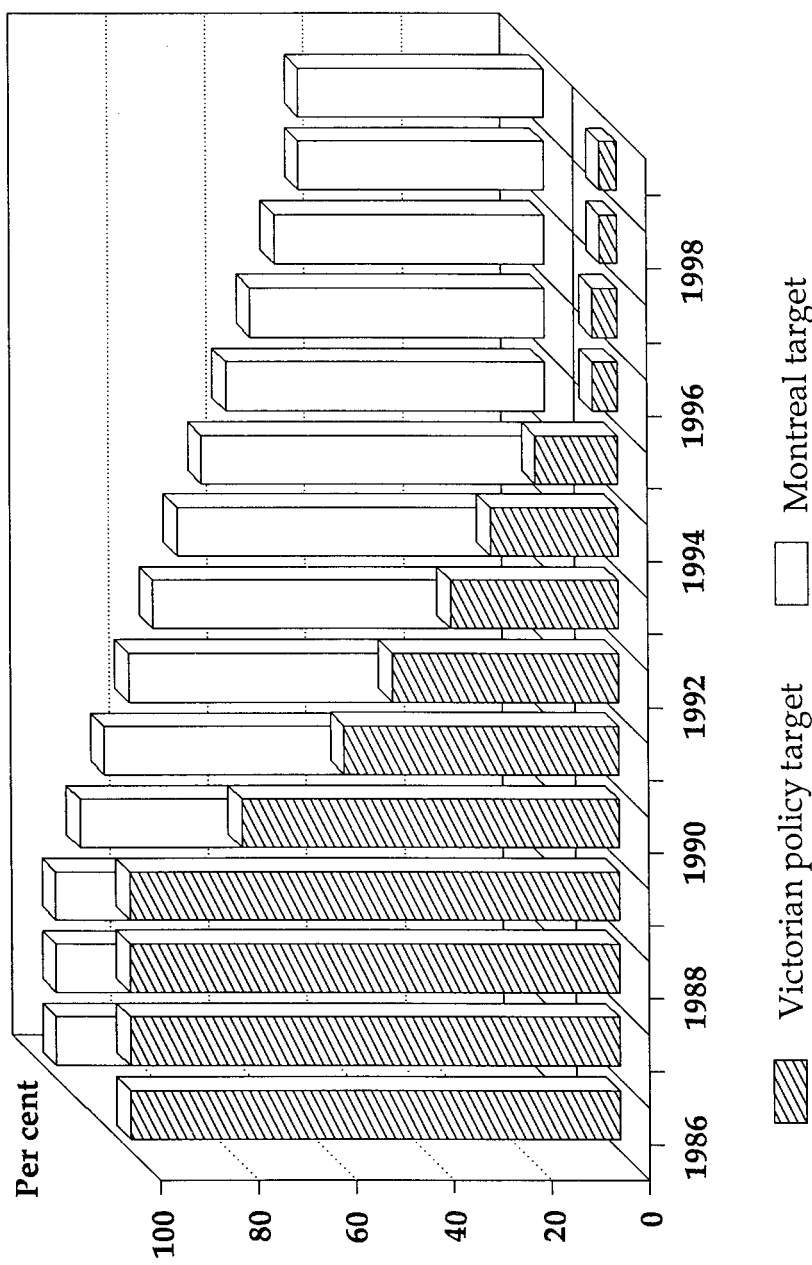
### Monitoring programs

Monitoring programs will be established by the Victorian Government to track trends in climate and sea level changes and to provide information as to the progressive effects of such changes on key elements of the environment.

#### *Proposed actions:*

- *Establish a program to monitor sea level rises and effects along the Victorian coastline, bays and estuaries.*
- *Monitor the extent of snowfields in the Bogong High Plains - Mt Hotham area, using satellite imagery, as part of the Government's Geographic Information System.*
- *Undertake regular surveys of tree cover in Victoria to monitor trends and assist revegetation programs.*
- *Review streamflow monitoring networks (and upgrade where necessary) and undertake routine analysis procedures to facilitate the detection of long-term trends in hydrological characteristics.*
- *Use data from the Government's continuing program of Flora and Fauna Surveys to assess the progressive impact of greenhouse-related changes.*

*Reduction of Ozone Depleting Substances*



(expressed as Ozone Depletion Potential)

## 5. Limiting the greenhouse effect

Actions taken now to reduce greenhouse gas emissions can assist significantly in delaying the onset of climate change thus providing us with more time for planning and adaptation. International conferences on climate change have attached a high priority to such actions and identified the particular responsibility of industrially developed countries, such as Australia, to lead the way in reducing their high per capita greenhouse gas emissions.

The Victorian Government has already moved to cut back the use of chemicals such as chlorofluorocarbons which even in small quantities make a significant contribution to the greenhouse effect. A draft Victorian policy launched earlier this year is aimed at phasing out emissions of these chemicals by the mid 1990s.

The more difficult problem is to slow the build up of other greenhouse gases, particularly carbon dioxide. If we are to minimise our contribution to future global warming, we need to shift away from the present carbon-based economy and reduce our dependence on fossil fuels, to improve the efficiency with which we use those fuels and to emphasise those sources of energy which produce little or no CO<sub>2</sub>.

A dramatic and unilateral curtailment of fossil fuel combustion in Victoria is not a practical option because it would be likely to lead to increased energy prices in this state and could affect individual domestic consumers, the economic efficiency of a range of manufacturing industries and the Victorian economy as a whole.

The Government also rejects nuclear power as an alternative energy supply option because of safety and environmental problems. Increasing the number of nuclear power stations world wide would also be more expensive than alternative measures. Investment in nuclear power would have less impact on the problem than similar spending on energy efficiency and conservation programs. U.S. research based on

optimistic assumptions of future nuclear generating costs suggests that improving electrical efficiency is nearly seven times more cost-effective than nuclear power in terms of carbon dioxide emissions displaced.

There are three thrusts to the Government's strategy.

- to achieve a significant reduction in greenhouse gas emissions by the year 2005;
- to aim for the Toronto goal of 20% reduction in 1988 levels of CO<sub>2</sub> emissions by 2005 as an interim target for planning purposes, subject to review in 1991; and
- to at least match any international agreements for action on the greenhouse effect.

The Victorian Government will also be working for the adoption of a coherent national approach to the greenhouse effect, similar to that being developed for ozone protection, through the Australian Environment Council.

Policy commitments and specific actions are proposed in the areas listed below:

- *Reduction in emissions of CFCs and other non-CO<sub>2</sub> greenhouse gases.*
- *Objective for reduced CO<sub>2</sub> emissions*
- *Energy conservation to reduce the need for fossil fuel burning*
- *More efficient generation and transmission of electricity to reduce the substantial contribution from present brown coal stations*
- *Transport fuel conservation*
- *Shift towards renewable energy sources and fossil fuels that produce less CO<sub>2</sub>*
- *Revegetation to increase the amount of CO<sub>2</sub> naturally re-absorbed.*
- *Resource conservation, waste minimisation and recycling to cut waste and conserve energy.*

The Victorian Government has already put in place a number of programs in these areas in recent years as part of its Conservation Strategy. Extending and upgrading these programs will represent a major commitment to reduce the extent of climatic change whilst more immediately producing environmental and social benefits. Additional action in response to the greenhouse effect is proposed where this will also contribute to environmental objectives and is economically feasible.

## CFCs and other non-CO<sub>2</sub> greenhouse gases

The first priority is the reduction in emissions of CFCs and halons which despite their relatively small quantities contribute a substantial portion of the greenhouse effect, as well as depleting the ozone layer. Addressing this problem is also urgent because the gases already released will persist in the atmosphere for some time. The Victorian Government has introduced legislation to control the use of CFCs and halons and released a draft Ozone Protection Strategy. These initiatives will be implemented as part of a national strategy now being developed through the Australian Environment Council.

Further research and analysis needs to be undertaken regarding the role and levels of emissions of other greenhouse gases, such as methane and nitrous oxide, in Victoria to identify appropriate actions. The proposed inventory of greenhouse gas emissions will assist in this process together with specific investigations proposed below.

### *Proposed actions:*

- *Implement the Government's proposed policy 'Ozone Protection: Towards a Safer Future' for a staged phase-out of these substances by the mid 1990s. Essential medical and fire protection uses will be exempted.*
- *Introduce regulations under the Environment Protection (Ozone Layer) Bill to control the sale, manufacture, use, disposal and emission of substances which deplete stratospheric ozone. Such substances also contribute to the greenhouse effect.*
- *Promote the tapping of methane emissions from solid waste landfills for energy production.*
- *Investigate the emissions of greenhouse gases from agricultural activities and examine the potential for their reduction.*

- *Review EPA emission controls on gases with high greenhouse potential (eg. methyl chloroform) and amend the existing State Environment Protection Policy - Air Environment to reflect increased knowledge of threats to the global atmospheric environment.*
- *Investigate the potential for reducing natural gas leaks (releasing methane and CO<sub>2</sub> to the atmosphere) from gas fields and through the gas processing and distribution systems.*

## Objective for reduced CO<sub>2</sub> emissions

Reducing CO<sub>2</sub> emissions poses very significant challenges and problems for both developed and developing countries because energy is an essential commodity and a vital component of all economies. The achievement of international controls on CO<sub>2</sub> emissions will be a complex business and is likely to take some years.

At the 1988 Toronto Conference on the Changing Atmosphere a global goal was proposed of a 20% reduction (based on 1988 levels) in CO<sub>2</sub> emissions by 2005. About one half of this reduction was proposed to come from increased energy efficiency and other conservation measures and the other half was to be sought by modifications in energy supply. This is a dramatic goal which would represent a major step forward if agreed to at an international level. This proposal is now being considered by governments around the world.

The first stage of this process has commenced. Proposals for a global law of the atmosphere are being developed and will be presented to the United Nations Conference on Sustainable Development in 1992. Together with research findings coming out of the current United Nations Environment Program, they will provide the basis for protocols setting limits on emissions.

An international agreement on reductions is essential, but it is not necessary to wait on such an agreement. Victoria has both the responsibility (as a high per capita producer of greenhouse gases) and the capacity to take a lead in achieving reductions.

Victoria is committed to making substantial reductions in CO<sub>2</sub> emissions as part of its strategy to limit the extent of greenhouse warming. It also recognises the importance of the Toronto goal for a 20% cut in CO<sub>2</sub> by the year 2005. The Government will therefore aim

for this 20% reduction goal as an interim objective for planning purposes and take initial steps towards achieving this.

At this stage, the difficulties of achieving this goal in the timeframe set should not be underestimated. This does not mean that we should not start to act now. If community concern continues to grow and technological advances are made in coming years and beyond the turn of the century, there is no reason why the goal is not ultimately feasible. Further analyses of the implications for Victoria of a 20% reduction in CO<sub>2</sub> and the policy options for achieving this will also be undertaken. This position will be reviewed in 1991 in light of commitments made at a national and international level.

The Toronto target will require quite rapid changes in community behaviour, as well as technical advances and major shifts in the state's energy sector. Results will not be apparent overnight because of the time lag as improved technologies are phased in and conservation measures take effect. In particular, changes in power generation are likely to be long term.

### **Proposed actions:**

- *Aim for the Toronto objective of a 20% reduction on 1988 levels of CO<sub>2</sub> emissions by 2005 as an interim objective, for planning purposes.*
- *Undertake a detailed evaluation of the options for Victorian reductions in CO<sub>2</sub> production and their social, economic and environmental implications and identify the extent to which the costs of reducing emissions are offset by the potential economic and environmental costs of predicted climatic change.*
- *Establish and maintain an inventory of greenhouse gas emissions in Victoria and report annually on progress in achieving reductions.*
- *Review the CO<sub>2</sub> reduction objective in 1991 in the light of:*
  - commitments by other governments, internationally and in Australia, to such an objective (or to an alternative objective);*
  - findings from the proposed inventory of Victorian greenhouse gas emissions;*
  - initial results on progress towards achieving reductions;*
  - research findings regarding the projections of climatic change and the most appropriate level and type of response required.*

## **Energy conservation**

Energy conservation measures are already being promoted by the government. Further action on energy conservation has significant potential to reduce the expected rate of growth in energy demand and to contribute to future reductions in CO<sub>2</sub> emissions. Community and business attitudes are crucial to the successful adoption of many energy conservation measures and it is anticipated that the growing awareness of greenhouse issues will provide a new impetus for community action.

Stronger government support will be given to ensure the adoption of a number of cost effective and technically proven conservation measures. Local government also has a role to play where it is involved in municipal electricity supply authorities.

Following the recent Natural Resources and Environment Committee (NREC) Parliamentary Inquiry into future electricity needs a detailed Report on Electricity Demand Management is being prepared jointly by the SECV and DITR.

### **Proposed actions:**

- *Expand energy conservation programs in the context of the Report on Electricity Demand Management. Sectors identified as offering opportunities for action are:*
  - industrial and commercial cogeneration;*
  - residential appliance standards;*
  - domestic storage hot water and space heating;*
  - energy-efficient new dwellings;*
  - lighting in existing commercial buildings;*
  - heating, ventilation and air conditioning in existing buildings;*
  - new commercial buildings;*
  - energy efficiency improvements in industry.*
- *Investigate further opportunities for energy conservation in relation to natural gas use.*
- *Investigate levels of energy use and indirect consumption (through energy-intensive products) in the agricultural sector and identify opportunities for energy conservation.*
- *Introduce into the Victoria Building Regulations compulsory insulation standards for new residential buildings and investigate the introduction of energy standards for these and other buildings.*

- *Review the Residential Development Provisions to include guidelines for passive solar design principles in subdivision and house siting.*
- *Promote energy-efficient land subdivision and residential buildings through the programs of the Ministry of Housing.*
- *Promote energy conservation measures to individual consumers and households.*

## More efficient electricity generation and transmission

Improved energy efficiency in the electricity supply system is important as a long-term strategy because of the high rate of CO<sub>2</sub> emissions from existing brown coal fired plant and Victoria's dependence on such plant for base load power.

The Government has accepted the recommendations of the NREC Inquiry that Loy Yang B3 and B4 be the next base load power station constructed in Victoria, subject to demonstrated cost competitiveness with other supply options. Further consideration will be given to the development of around 500 MW of gas fired power generation for peak and intermediate load. This would assist in reducing CO<sub>2</sub> emissions, as generating electricity from gas can result in as little as 30% of the CO<sub>2</sub> emissions from brown coal for each unit of energy produced.

A detailed report on the implications for the SECV of the greenhouse effect is currently being finalised. This will explore specific technical aspects affecting future electricity planning and will also identify feasible scenarios for achievement of reductions in CO<sub>2</sub> emissions and their economic and other implications.

The SECV is currently reviewing its demand projections and this may also contribute to a different timetable being developed for construction of the last two units of Loy Yang B, which could then coincide with the retirement of older plant producing greater volumes of CO<sub>2</sub>. Reductions in CO<sub>2</sub> emissions from brown coal fired power stations are likely to be feasible from 2000 as major older stations, such as Hazelwood and Yallourn W, are phased out and technical advances are achieved. Already the Loy Yang A units produce about 15% less CO<sub>2</sub> per unit output than older stations and further refinements are being planned for the last two Loy Yang B units (3 and 4).

Detailed forward planning for the state's energy supply system will also take into account the following considerations:

the need for improvements in the efficiency of brown coal fired power stations;

the potential for additional savings through energy conservation and cogeneration;

changes in forecasts for growth in demand;

the need for flexibility on the timing and fuels used in future power stations;

introduction of revegetation programs designed specifically to offset increased CO<sub>2</sub> emissions; and

agreed government objectives for CO<sub>2</sub> emissions.

### Proposed actions:

- *Determine the timing of the last two units of Loy Yang B on the basis of trends in future demand, the social and environmental needs of the Latrobe Valley, schedules for retirement of older plant, and the possible inclusion of gas-based plant for peak and intermediate load.*
- *Undertake a five year SECV research and development program aimed at improving the efficiency of brown coal utilisation in large scale power generation. In particular, investigate emerging technologies including: improved drying of brown coal prior to combustion; integrated gasification combined cycle; and coal-fired gas turbine.*
- *Improve the energy efficiency of new power stations by various means, including: development of improved burner characteristics; modifications of boiler design and optimisation; improved milling systems.*
- *Investigate the potential for retrofitting existing power stations to improve their energy efficiency and reduce CO<sub>2</sub> emissions. In particular, develop retrofitting proposals for Jeeralang power station for combined gas turbine and steam cycle (utilizing waste heat).*
- *Consider the potential for the introduction of gas-powered generation for peak and intermediate load.*
- *Investigate the potential for reducing energy losses in the electricity transmission system.*

## Transport fuel conservation

Improvements in transport fuel conservation will focus on developing opportunities for increased use of the public transport system and reduced dependence on private motor vehicles, and improvements in the fuel efficiency of the public and private transport fleet.



New cars in Australia currently consume an average 9.6 litres of fuel per 100 kilometres. While there was considerable community awareness of transport fuel conservation and movement towards greater fuel efficiency in the 1970s and early 80s, in recent years some of this ground has been lost and new vehicle fuel consumption has increased slightly. The Victorian Government will seek a new national standard for vehicle fuel efficiency to reduce vehicle CO<sub>2</sub> emissions.

Current policy for metropolitan Melbourne directs future growth into extensive corridors reducing accessibility and effectiveness of the existing transport system. This outward growth will be modified by further action on urban consolidation. Coordinated land use and transport planning for both new and established areas will be aimed at reducing and providing alternatives to car usage.

#### **Proposed actions:**

- *Encourage more fuel-efficient road transport by:*
  - proposing a new national standard for vehicle fuel efficiency aimed at achieving significant reductions in vehicle CO<sub>2</sub> emissions by 2000;*
  - promoting driver awareness of the benefits of fuel efficiency and of means of achieving improved fuel efficiency through correct engine turning, fuel-efficient driving and other measures;*
- *Implement the Metplan program to upgrade and extend the public transport system with the aim of increasing patronage by 20% over the next 15 years. The 1988-1992 Action Plan includes: extension to, and service improvements in, the electrified rail and tram systems; provision of a cross-town bus network (Metlink); and greater public transport priority on road systems.*
- *Ensure that the future development of metropolitan Melbourne is planned to:*
  - provide access to public transport services in metropolitan growth corridors and fringe areas;*
  - co-ordinate the development of residential, recreational and employment opportunities so that they are readily accessible;*
  - design roads and other facilities to encourage alternatives to car travel, such as walking and bicycle use in existing and new urban areas.*

- *Increase urban consolidation in new and established areas of metropolitan Melbourne by:*
  - making small scale medium density developments as of right in residential C and equivalent zones, subject to conditions (eg. overlooking, privacy);*
  - identifying sites suitable for medium density housing on surplus government land;*
  - ensuring that major redevelopment sites include significant residential components;*
  - promoting smaller lot sizes for housing in new development areas.*
- *Continue improvements in the fuel efficiency of the public transport fleet through fuel saving devices on trams, trains and country locomotives and conversion of ten new MAN buses to run on compressed natural gas as well as diesel.*
- *Investigate conversion of motor vehicles to alternative fuels with lower CO<sub>2</sub> emission rates.*

## **Renewable energy and fuel substitution**

Switching to less CO<sub>2</sub> intensive fuels can have an impact in the medium term but adjustments must also be made to reduce energy demand and develop renewable energy sources if sufficient change is to be achieved.

Natural gas use is not an ideal solution, in that significant quantities of CO<sub>2</sub> and some methane will still be produced, but it has advantages in that a degree of improvement can be made and shifts in use can be readily achieved. This approach will however depend on gas availability in the medium term and energy pricing structures. The wider use of energy forms that produce no CO<sub>2</sub> at all has a potentially greater impact but with a longer time frame.

The Government's Solar Energy Strategy identifies areas where solar and other renewable energy sources are currently competitive and applications where it may become so in the future. The Government will upgrade its research and promotional activities in relation to renewable energy.

At present, wood is the major source of renewable energy. Within the electricity generation system, hydro-electricity contributes 8% with a negligible amount coming from other renewable sources - most of which are not connected to the SECV grid.

### **Proposed actions:**

- Increase the amount of hydro generation by careful development of small (less than 20 MW) hydro stations at existing dams.
- Promote solar energy in specialist applications where it is already viable and in areas, such as the north of the state and areas away from the natural gas grid, where it has particular suitability.
- Maintain close review of developments in wind technology and photovoltaic (solar) electricity to find opportunities to go beyond the pilot stage. The Government will provide a financial incentive for the development and operation of a 10 MW wind farm to provide electricity to the grid.
- Stimulate exploration for and evaluation of natural gas reserves in Bass Strait and elsewhere around Victoria.
- Evaluate the merits of early Victorian participation in a possible national gas distribution network, with gas sourced primarily from the major reserves off north-west Australia.
- Review government energy marketing strategies, in particular the promotion of renewable energy and the potential for greater incentives.
- Review the environmental and social costs of various energy sources.

### **Revegetation**

Tree planting is a positive way of damping down the greenhouse effect while the more significant adjustments of the energy sector are being implemented. It has been estimated that new forests covering 7 million square kilometres (about the area of Australia) could absorb all the CO<sub>2</sub> accumulating over a 20 to 30 year period from the burning of fossil fuels on earth. In Victoria, CO<sub>2</sub> absorbed by revegetation would provide an offset for additional CO<sub>2</sub> released from energy supply and use and would assist the state to achieve CO<sub>2</sub> emission objectives.

A substantial increase in the rate of revegetation (mainly tree planting) will play an important role in providing a major new reservoir for carbon. Revegetation will be concentrated on those critical areas of the state where benefits for other problems such as salinity, soil erosion, stream degradation and habitat loss can be concurrently realised. These areas occur throughout the state, including the Melbourne metropolitan area. Land managers will be encouraged to retain existing natural vegetation.

### **Proposed actions:**

- Undertake Tree Victoria, a major new revegetation program, aimed at planting 100 million trees by the year 2010. The Government will provide \$2.5m p.a. and will seek matching funds from the Commonwealth. This program will be community-based, and will build on existing successful revegetation schemes. It will provide a new grant scheme to assist community groups and local councils involved in revegetation.
- Commence a community-based tree planting program for metropolitan Melbourne. Tree planting plans and targets will be developed in conjunction with local councils, with initial priority being given to the following areas:  
     future metropolitan growth corridors (Plenty, Berwick/Pakenham and Werribee);  
     major arterial roads;  
     foreshores and waterways.
- Review the effectiveness of existing vegetation retention mechanisms and consider the need for additional, innovative approaches.
- Continue plantation share farming to encourage the establishment of hardwood and softwood plantations on private land.
- Examine the impact on CO<sub>2</sub> levels of current forest management practices, such as fuel reduction and slash burning, and management options, such as alternatives to clear felling.
- Support government-backed community programs which encourage revegetation and the protection of existing vegetation, including Land Care, the Land for Wildlife program and the Land Protection Incentive Scheme.

### **Resource conservation, waste minimisation and recycling**

Improving the efficiency with which commodities are produced in society only addresses half the problem. A major distinction between industrialised and non-industrialised nations is the high per capita consumption of resources of all types.

Only by reducing the levels of consumption as well as increasing the efficiency of production can we bring some equity to the use of resources. This need not mean a reduction in the quality of life, but rather a more careful approach to how the necessities are provided. This is already being promoted through the Government's three year Clean Technology Incentive Scheme providing interest-free loans

to encourage the introduction of no-waste and low-waste technology.

Recycling and resource conservation programs have a big role to play in reducing total consumption by eliminating waste and by ensuring valuable resources such as aluminium, glass, paper and plastics are reused to extract the maximum value. Some 62% of Victoria's population already has access to door-to-door recycling services for glass, aluminium and some plastics. The Government has allocated \$220,000 to develop pilot multi-material recycling schemes in Brunswick and Nunawading, in conjunction with the local councils. This initiative will particularly tackle the issue of collecting and recycling plastics which are a growing proportion of the waste stream.

***Proposed actions:***

- *Expand community awareness and involvement programs demonstrating recycling techniques and benefits.*
- *Achieve 60% recycling targets for glass and aluminium beverage containers by 1991 and set appropriate targets for plastic and paper beverage containers by the end of 1989.*
- *Set targets for the recycling of materials used in government activities and begin programs for their achievement by the end of 1989.*
- *Expand existing municipal recycling initiatives, such as house to house recycling collections.*
- *Promote waste audits and the development of waste minimisation plans and guidelines.*

## 6. Environmental education and community action

Environmental education is fundamental in combating the greenhouse effect.

Environmental education programs for schools and the community are essential to any serious approach to this issue.

The greenhouse effect is not a simple pollution problem that can be fixed by a few government actions and some tighter standards. It will take a united approach by all sectors of the community here and around the world to make an impact on this problem. The industrialised nations, in particular, must face up to the hard questions about the way resources are used - and often wasted.

Living in tune with the environment need not mean lowering living standards, but rather a change in lifestyles. New ways need to be found to provide for our needs and make more efficient use of those resources we do enjoy. Above all, a new environmental consciousness is required so that individuals understand that their own actions are important as a part of the entire picture. The adage of 'think globally and act locally', is particularly applicable to the greenhouse effect.

Environmental education seeks to develop a community that has an understanding of environmental issues and is able to decide upon, and carry out, appropriate actions designed to address those environmental issues. The important role of environmental education and community involvement programs that lead to an informed and active citizenry was recognised in the State Conservation Strategy.

In recent years community education and involvement have been important parts of action on salinity and land degradation. There have also been community education initiatives in the areas of both litter and recycling. The Litter Act was revised in 1987 and penalties increased. Training programs were organised for enforcement officers throughout the state and backed by mass media promotions and

campaigns. Similar efforts have commenced to educate the community on the need for recycling. Again, the mass media has been employed along with campaigns supported and promoted by local government authorities. Government agencies, including the Departments of Agriculture and Rural Affairs and Conservation, Forests and Lands and the Ministry for Planning and Environment play an important part in educating the community about the greenhouse effect. Further support is provided by organisations such as the Centre for Education and Research in Environmental Strategies and the Commission for the Future and by local government. The net effect is a significant contribution to revegetation, waste minimisation and resource conservation, important remedies to the greenhouse effect.

It is important to enlist the energy, vitality and optimism of youth as part of our response to the greenhouse effect. There are many well established and highly successful environmental education initiatives for schools in Victoria. Several of these have been in existence for many years, others have been established more recently and there are more new programs underway.

Revegetation, a key action area and important response to the greenhouse effect, has been supported for many years by three well established programs in the Ministry of Education.

- *The Victorian Schools Nursery has promoted the propagation and planting of trees and runs horticultural and general environmental awareness programs. Their Arbor Week program is now well established.*
- *The Gould League of Victoria has an excellent record in production of high quality environmental education materials and professional development programs for teachers that encourage environmental care and protection.*

- *The School Forests Scheme has promoted greater knowledge of the need for proper management of trees and other natural resources. It has also enabled schools to participate in habitat conservation.*

The scope and diversity of environmental education support services continues to grow within the Ministry of Education. There are now many innovative and critical environmental education programs that contribute to students understanding of the greenhouse effect. Importantly, these services make a positive contribution in empowering students to take effective environmental action.

Education services supported by the Ministry of Education now exist at the Solar Energy Council, the Department of Conservation, Forests and Lands (including Salinity Education, the Royal Botanic Gardens, Forestry Education and the Land Protection Service), Royal Melbourne Zoo, Healesville Sanctuary, Environment Protection Authority (Recycling and Anti-Litter Program), CSIRO and the Commission for the Future (Greenhouse Information Service).

Organisations such as the Australian Conservation Foundation, the Rural Water Commission and the Victorian Institute of Marine Sciences also have education services, supported by the Ministry of Education, and they produce materials for school and community use relevant to the greenhouse effect and its consequences. Several new environmental education centres are also proposed and these will contribute to an increased appreciation of the environment and the need for its conservation.

The Ministry of Education is providing a significant lead through its curriculum programs - in particular Ministerial Paper Number Six (Curriculum Development and Planning and Victoria) and the Curriculum Frameworks Project. These are soon to be supported by a broad-ranging Environmental Education Policy Statement for all sectors of the Ministry.

Environmental education is encouraged at school level as both an interdisciplinary approach across subject areas as well as through specific environmental subjects. The Victorian Curriculum and Assessment Board has established a two-year, four-unit senior secondary Environmental Studies course for the new Victorian Certificate of Education. This will provide an important link between primary and secondary level environmental education programs and further tertiary level study.

Further support to teachers in environmental education is provided by professional associations such as the Geography Teachers Association of Victoria, the Science Teachers Association of Victoria, the Victorian Association for Environmental Education and the Victorian Association of Social Studies Teachers.

These environmental education support services form a well-established network providing resources, services and programs which relate to the greenhouse issue.

Programs for schools and tertiary institutions will continue to receive support, and where appropriate, will be expanded to ensure that all students are given the opportunity to learn about the greenhouse effect. The Victorian community clearly has concerns about global environmental issues but many people undoubtedly regard these problems as too overwhelming and are unaware of the scope for local action in tackling global issues.

The programs outlined below reflect three objectives:

- *to provide the community with clear and concise information on the greenhouse effect;*
- *to show people how they can, both individually and collectively, take positive actions to limit emissions and cope with the consequences of climatic change; and*
- *to make community participation an integral part of government programs for the environment.*

Programs for community education and action will be long term because changes in community attitudes and practices occur over time. The slowly developing nature of the greenhouse problem does, however, give us the opportunity to put such programs in place now and gradually achieve goals over the next decade.

## Environment education programs

The Government will expand the program of environmental education outlined in the State Conservation Strategy to provide a specific focus on responses to the greenhouse effect. Programs within the formal education system and in the wider community will aim to raise public understanding of the issue and to develop positive community attitudes, behaviour and actions.

Environmental education will be a long term commitment of Government and will be closely coordinated with planning for an adaptation to

future climate change. The greenhouse effect will provide a useful focus for this program because it draws together a wide range of environment issues.

### **Proposed actions:**

- Establish a State Environmental Education Council, a commitment in the State Conservation Strategy, which will oversee the development of an Environmental Education Strategy for Victoria and continue initiatives in this important area. The strategy will set out the processes for school and community based educational experiences relating to the environment (including the greenhouse effect).
- Support the expansion of environmental studies in school curricula and promote the development of curriculum units and educational resources for schools on the greenhouse effect and associated topics such as recycling, revegetation and renewable energy.
- Support professional development activities to equip teachers with the skills and understanding to adopt environmental education approaches in their classrooms.
- Develop, in conjunction with tertiary institutions and relevant professional organisations, course components and continuing education programs designed to increase environmental awareness - in particular understanding of the implications of the greenhouse effect - among those working in areas such as planning, engineering, agricultural science, forestry, building and architecture.

## **Promoting community action**

### **Proposed actions:**

- Promote community action and support for activities to reduce the greenhouse effect. A major aspect will be environmental education and information campaigns in the mass media.
- Provide the community with up - to - date information on the greenhouse effect and on the role of community and individual action. Specific information services will include:

*the Environment Protection Authority's recently launched Global Pollution News, with updates on greenhouse research;*

*annual reports on greenhouse gas emissions in Victoria, with details of progress in achieving reductions;*

*articles in government-backed journals such as 'Common Ground' and 'Saltwatch News';*

*community information and action bulletins in relation to issues such as recycling, energy conservation etc.*

- Promote community awareness of environmentally sound practices, products and services through:
  - a consumer's guide to currently practical ways of protecting the environment with emphasis on energy conservation, recycling, revegetation and protection of existing vegetation, to be produced in 1989;*
  - the new 'Green Spot Specials' program providing information through the mass media;*
  - the development of local conservation strategies;*
  - the existing government information services, such as the Energy Information Centre.*
- Promote community involvement in government programs for revegetation, nature conservation, energy conservation, recycling, and pollution control. In particular, establish procedures and targets for community participation.
- Develop environmental education programs to focus on particular sectors in the community, including trade unions, people of non-English-speaking backgrounds, land managers, youth groups, etc.
- Encourage community groups to undertake projects aimed at raising public awareness and alleviating the greenhouse effect and support such community initiatives through government grants programs.
- Continue support for programs aimed at raising environmental awareness in rural communities, with particular reference to revegetation and the longer term implications of greenhouse for agriculture.
- Support the Sustainable Futures Program of the Commission for the Future.

## 7. Planning for future climate change

The greenhouse effect introduces a range of new factors and a greater degree of uncertainty into the strategic planning of all government agencies. Planning to prepare ourselves for a changed environment is essential and it is important to consider what steps need to be taken to enable us to adapt progressively to these changes. The extent of the effects that our society will experience will depend very much on how well we respond now.

Those areas of activity which will be substantially affected by future climate change are outlined below together with the planning and management responses that will be required in the short term. There are three broad levels of response. First, current plans and management practices will be reviewed in light of the potential impacts of the greenhouse effect, and long term strategies for meeting changes will be developed. As further information on the greenhouse effect becomes available, it will be incorporated in the strategic plans of all appropriate government agencies. Second, long term measures designed to encourage adaptation within the public and private sectors, will be developed. Third, land use planning measures will be introduced to preserve options for future action, and to assist individuals and environments to adapt to the effects of long-term changes.

### Urban development

The future growth of Victoria's population, its distribution and future patterns of housing, employment and recreation are complex issues with a critical bearing on the consumption of energy and other resources and therefore on levels of greenhouse gas emissions. Actions to limit these emissions will therefore directly and indirectly influence future urban development. There is an important role for state and local

government to play in determining the development of urban areas not only to achieve economic goals but to ensure long-term environmental protection. An immediate priority will be in relation to existing planning work on Melbourne's metropolitan corridors. Urban development issues which are of critical importance to achieving environmental goals are: residential densities, transport policies, and the environmental implications of alternative urban structures, eg. corridor growth, decentralization and regionalisation.

#### *Proposed actions:*

- *Review the Government's Melbourne Metropolitan Policy identifying those sectors which have a role to play in reducing greenhouse gas emissions and those activities which would be critically affected by climatic change, and modify policies where necessary.*
- *Assess urban development options for the medium to long-term development of the Melbourne metropolitan area and major Victorian provincial centres, on the basis of their relative greenhouse contribution and capacity to provide for future changes in lifestyle related to the greenhouse effect.*
- *Assess the implications of changes in coastal conditions on existing and future urban development and introduce planning provisions to prohibit development in areas identified as at risk. This is further detailed in the coastal areas section below.*

### Flora and fauna conservation

Once the necessary regional climatic data is available, priorities will be investigating the implications of potential climate change for the range of Victorian flora and fauna, identifying specific areas or species at high risk, and

reviewing the adequacy of existing conservation measures (i.e. parks and reserves) to respond to these changes.

**Proposed actions:**

- *Evaluate the possible impacts of greenhouse climate changes on Victorian vertebrate fauna and identify species at risk or requiring changed locations. The capacity and adequacy of the existing reserve system will also be examined.*
- *Evaluate the possible impacts of greenhouse climate changes on the distribution of wet sclerophyll forest in Victoria. This project would be the first of a series studying impacts on Victorian flora.*

## Coastal areas

The Government will evaluate and monitor the likely impacts and timing of greenhouse effect-induced changes on Victoria's coastline, and review planning arrangements along the coastline, with high priority being given to coastal settlements, port facilities and other areas of high social, environmental and economic value. Strategies for dealing with rising sea levels will be developed in consultation with local councils. These will range from stabilisation, with appropriate long-term protection and controlled retreat, with protection for a certain duration only, to letting nature take its course.

Options for minimising damage and disruption will be identified, and government commitment to protective works on public or private property will be determined after consideration of issues such as the extent of erosion, economic and social costs, and joint public and private funding. The protection and maintenance of a public coastal reserve will be given high priority. The community, however, should not expect that protection will be provided as-of-right to private property at government cost. Measures will be introduced to ensure that inappropriate coastal development does not occur in future.

**Proposed actions:**

- *Classify Victoria's foreshores, embayments and coastal lakes with respect to vulnerability to erosion or inundation and assess the consequences of likely damage.*

- *Investigate coastal areas considered to be of high vulnerability and high consequence to facilitate the preparation of management plans.*
- *Prohibit development in areas identified as at risk, that is, those which will be inundated by an extreme tide or a combination of rainfall and tides, which has a probability of occurrence of 1% in any year (average return period of 100 years). Median values for a sea level rise of 30 cm for 2040 will be added to the 1% annual tide to determine the appropriate building design levels. This figure will be reviewed as new information becomes available.*
- *Review the impacts on habitat values and fisheries in coastal wetlands considered to be of high vulnerability.*
- *Maintain a coastal reserve of public land through a review of zonings, protection and maintenance of coastal crown land, cooperation with land owners, and by land acquisition.*
- *Review recreational boat harbours and other facilities with regard to the possible need to modify breakwaters, ramps, etc. Public amenity structures on the foreshore, such as toilets, carparks and boat ramps, may need to be considered as expendable or be capable of relocation.*
- *Initiate a review of the legal implications of changes in sea level and shoreline. This will examine issues of sovereignty, where associated with the low water mark and internal waters; title and compensation, in relation to foreshores and waterways subject to change; and public liability for flood loss or damage and for maintenance of sea walls and other works.*

## Agriculture and forestry

Predicted changes in Victoria's climate arising from the greenhouse effect may improve the overall productivity of forests and the agricultural sector. Adaptation of these activities will occur progressively as the details of climatic change become more certain. However, in the short term there is a need for further study of the potential impacts of such changes and for modification of forestry management practices in response to the issue, release and storage of greenhouse gases.



**Proposed actions:**

- Undertake a preliminary assessment of possible greenhouse impacts on growth rates of plantations and indigenous ash forests, utilising the forest growth model established by the Department of Conservation, Forests and Lands to assist in ensuring harvesting on a sustainable yield basis.
- Refine the land capability mapping system so as to indicate, for the range of land types, the effect of climatic change on the degree of hazard likely to arise from particular forms of land use.
- Research the response of particular forest species to changes in temperature, rainfall, atmospheric CO<sub>2</sub> concentrations and UV-B radiation and the possible implications for the forestry industry.
- Examine the increased risk of forest fires and the need for alternative fire protection measures.

**Water resources**

The Government will ensure that planning and management systems for water supply, drainage and sewerage systems and for waterway and floodplain management activities are capable of flexibility to adjust to changes in rainfall and streamflow characteristics. These will be reviewed and modified as the nature of the changes becomes more certain. In developing long-term strategies for Victoria's water resources the Government will take account of the potential climate change due to the greenhouse effect. In the longer term the climate changes may necessitate earlier implementation of additional supply options and demand management measures.

**Proposed actions:**

- Review current management plans and strategies identifying issues which would be critically affected by climatic change and modify where necessary to preserve options for future adjustment.
- Ensure that future plans and strategies are sufficiently flexible to allow adaptation to cope with the increased uncertainty of major climatic factors and allow adaptation to a changing environment.

- Review the effect of changed streamflow on existing systems, structures and management activities. Also, review the implications for design guidelines and procedures.
- Identify localities most at risk from an increase in the frequency and severity of floods.
- Conduct a preliminary evaluation of the potential impacts of the greenhouse-induced sea-level rise on coastal groundwater supplies.
- Undertake research into the likely impact of projected climatic change on land use (in both dryland and irrigated areas), vegetation response, water demands and the hydrologic characteristics of catchments.
- Undertake research into the role of recharge 'events' in influencing groundwater pressures and levels and, as more definitive regional climatic scenarios become available, evaluate the likely implications of greenhouse changes for groundwater levels and land salinisation.

**Tourism**

There is considerable potential for the tourism industry to derive benefits from climatic changes associated with the greenhouse effect. These benefits will be maximised by ensuring that future major developments are capable of adaptation. Over a 20 to 30 year period, snowfields developments will be affected and these risks and the potential for adjustment will need to be part of the evaluation of future development proposals.

**Proposed actions:**

- Encourage developments which offer a variety of activities and are capable of adapting to climatic changes.
- Capitalise on tourism opportunities (e.g. cultural tourism) which would be relatively unaffected by climate change.

## 8. Implementation

This draft statement provides background material on the greenhouse effect and a starting point for actions. It is the beginning of what will be a continuing long-term program of action in response to the greenhouse effect. Knowledge of greenhouse problems and the appropriate actions will continue to improve and the Government's Greenhouse Strategy must be responsive to this to ensure that effective and responsible action is taken.

Following public consultation, the strategy will be confirmed and implementation will commence in the latter part of 1989. It is recognised that full implementation of all actions will take some years. As outlined in previous chapters there will be several opportunities during the course of implementation for monitoring reports on progress and for review of objectives and the effectiveness of measures.

The community will continue to be informed of developments in relation to the greenhouse effect through:

formal annual reporting of emission levels and progress towards achieving reductions;

information services, such as *Global Pollution News*, providing updates of research on greenhouse-related issues; and

community education programs aimed at raising awareness and encouraging the community to take action.

A wide range of government agencies, business and community organisations and the public at large have a role to play in the proposed

actions. For effective implementation of greenhouse-related activities there needs to be coordination of the efforts of all these parties and a clearly identified contact point responsible for integration of all programs. Consistent and coordinated funding for these activities is also essential.

### ***Proposed actions:***

- *Establish a Greenhouse Unit within the Ministry for Planning and Environment to be responsible for the co-ordination of the Greenhouse Strategy. Specific functions of the unit will be:*

*coordinating the further development of the Greenhouse Strategy;*

*coordinating the implementation of the strategy and the development of the greenhouse budget;*

*liaising with commonwealth and state government agencies on the development of a national approach to greenhouse issues;*

*promoting greenhouse information and community action;*

*monitoring the results of regional climatic research and developing further policy responses as necessary.*

- *Through agency budgets provide coordinated funding of actions, and ensure that priorities are clearly identified and that funding is available for areas requiring action.*
- *Develop, through the Australian Environment Council, a coordinated national approach to the greenhouse effect, dealing with research and monitoring, emission controls, community education and future planning.*