GLOBAL WARMING :
FOREST-BASED OPTIONS FOR AUSTRALIA

An International Perspective

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1. TERMINOLOGY

abatement	reduction in degree or intensity
afforestation	establishment of forest on land previously used for some purpose other than growing trees
AIJ / JI	Activities Implemented Jointly / Joint Implementation
anthropic	of or relating to humans or the era of human life
biosphere	portion of the Earth and its atmosphere capable of supporting life
carbon flux	the rate of mass transfer of carbon between two *reservoirs*
climate change	the changes in the Earth's climate that are expected to be caused by the *enhanced greenhouse effect* (see text). This is also referred to as *global warming* (see text) but includes changes in precipitation, circulation patterns, and other climate variables besides temperature
Climate Convention	United Nations Framework Convention on Climate Change
CSIRO	Commonwealth Scientific and Industrial Research Organisation (AUS)
deforestation	removal of forest cover followed by conversion of land to another use, such as agricultural land or urban expansion
fossil fuel	any organic fuel derived from carbonaceous sedimentary deposits of organic material accumulated during the geological past, including coal, crude oil and natural gas
FCCC	Framework Convention on Climate Change
greenhouse effect	see text
greenhouse gas	atmospheric gas constituent which absorbs electromagnetic radiation in the longwave band, and hence contributes to radiative warming of the Earth's surface by the atmosphere (the *greenhouse effect*)
ICESD	Intergovernmental Committee on Ecologically Sustainable Development
IPCC	Intergovernmental Panel on Climate Change
mitigation	the act of making or becoming less severe or intense
NGRS	National Greenhouse Response Strategy (AUS)
OECD	Organisation for Economic Cooperation and Development
peat	organic material, consisting of plant remains in various states of decomposition, preserved under anaerobic conditions
reforestation	establishment of forest on land previously under some form of forest cover, which may have been harvested for merchantable timber, or cleared to allow establishment of more valuable species
reservoir	component of the biosphere or physical climate system where carbon, or more generally a *greenhouse gas*, is stored
sequestration	the process of increasing the carbon content of a reservoir from Latin, *sequestrare* : to give up for safekeeping
sink	any process, activity or mechanism which removes a *greenhouse gas*. A reservoir can be a sink for atmospheric carbon if, during a time interval, (1) more carbon is flowing into it than is flowing out, and (2) the changes in the remainder of the connected system are such that there is a net withdrawal of carbon from the atmosphere
source	opposite of *sink*

2. EXECUTIVE SUMMARY

This report provides a summary of forest-based initiatives for climate change mitigation in Australia, and has related these efforts to those that have been undertaken, or are currently underway in other countries, particularly the United States of America. These initiatives are working to reduce the atmospheric concentration of carbon dioxide (CO_2), which is increasing rapidly as the world continues to exploit the seemingly vast carbon reservoirs in our fossil fuel reserves and tropical forests at an unsustainable rate. As anthropic emissions of CO_2 increase, the enhanced greenhouse effect will create a global warming which will generate potentially devastating impacts for civilisation today.

- Forest-based options for reducing the atmospheric concentration of CO_2 provide an attractive way for emitters to 'offset' their contribution to global warming. These options are relatively cost-effective, and provide many other environmental and socio-economic benefits, particularly in developing countries. 'Joint implementation' is a means by which developed and developing countries can cooperate to maximise the benefits of forest-based offsets to all parties.

- Through their commitments to international agreements, such as the United Nations Framework Convention on Climate Change, and national directives, such as Australia's National Strategy for Ecologically Sustainable Development, countries and industries will be increasingly obliged to reduce their carbon consumption to a sustainable rate or increase their compensatory offsets.

- Pilot projects have demonstrated that, for organisations committed to undertaking climate change mitigation, forest-based options are relatively cost-effective. However, there is limited cost-benefit information available to organisations considering whether or not to undertake mitigation activity. Forest-based options provide many ancillary benefits in many different circumstances and many of the benefits are difficult to quantify in financial terms. This report makes no attempt to provide the specific cost-benefit analyses required for individual consideration.

- In the longer term, the sustainable growth and harvest of wood for substitution of fossil fuels and other energy-intensive products will offer a more efficient climate change mitigation strategy than one based on increased carbon sequestration in vegetation, soils and forest products, which will saturate with time. However, managing forests to conserve and expand carbon reservoirs offers an effective mitigation option during the transition period of many decades necessary to stabilise atmospheric concentrations of CO_2.

- There is significant potential for forest-based options around the world, including Australia. The forest industry alone cannot mitigate global warming resulting from increasing emissions of CO_2, but there is no doubt that it has a substantial role to play. Governmental recognition of the significant contribution that joint implementation and other forest-based options can provide to a portfolio of mitigation actions is vitally important to fulfilling this potential.

- Forest-based mitgation options have been the focus of several Australian agencies for close to 10 years, and the Australian government has created a framework for activity that closely follows the models in other developed countries. Through processes such as the development of a workbook to guide quantification of vegetation sinks for CO_2, technical obstacles to increased use of forest-based mitigation options are being overcome. With additional government support in the form of industry regulation or economic incentives, this infrastructure should be even more successful in engaging Australians to combat global warming with healthy, productive forests. Use of these tools by the government in Finland has generated a move towards greater use of renewable energy sources, while in Costa Rica, funds have been raised to protect their forest reserves and encourage ecotourism through the sale of "certified tradable offsets".

- It is useful to compare Australia's response to global warming with the response in the USA. Both countries operate under democratic governments, and are currently dependent upon their fossil fuel resources for domestic energy consumption and export revenue. In this sense, they face similar obstacles to increasing their mitigation efforts. As in Australia, the American response to global warming relies on voluntary initiatives to reduce CO_2 emissions, which to this point have been inadequate in achieving established targets. There is no regulatory system that requires CO_2 emitters to reduce or offset their emissions, but proactive leadership in the government has maintained the threat of regulatory action. In this environment, the electric utility industry and the U.S. Initiative on Joint Implementation are notable contributors to the increasing interest in forest-based mitigation activity. Both groups are working to develop defendable carbon offset portfolios in anticipation of a regulatory system which they believe to be inevitable.

- The public impetus to slow the rate of global warming would appear to be critical, but currently lacking. Academic studies in the USA indicate that global warming is not well understood by a significant proportion of the population. However, volunteers are cooperating on the American streets and in river basins in Brazil to undertake affirmative mitigative action. It is clear that the Clinton Administration believes it is important to convince the American public of the dangers in failing to check global warming. In a democratic country, the government must follow the will of the people, and climate change mitigation activity will be limited without their strong support.

- There are substantial programs incorporating forest-based mitigation operations in many countries. As developed and developing countries alike head towards the third Conference of the Climate Convention Parties in December 1997, political and industrial activity increases at a frenetic rate. The existing Framework Convention on Climate Change, which will direct national and international policy on mitigation activity, continues to be debated and criticised, particularly on the issues of flexibility and differentiation. Currently, there is no satisfactory compromises between the Parties on how to proceed towards the next millennium. The expectation of resolution weighs heavily on the forthcoming conference.

- Forest-based initiatives for climate change mitigation will provide substantial benefits for Australia and its forest industry. Australians and their forest industry must not lose their opportunity to secure these benefits on account of failing to lobby the government and industry players for a proactive response to global warming and our unsustainable use of energy.

3. INTRODUCTION

This report was commissioned by the Australian Forest & Wood Products Research & Development Corporation, and written in cooperation with the National Association of Forest Industries and the World Forest Institute in Portland, Oregon, USA. The Australian forest industry has expressed a keen interest in the international development of climate change mitigation policy and projects. The forestry sector is the only industry sector in Australia, and most parts of the world, that, through removals of carbon dioxide from the atmosphere, slows rather than accelerates global warming.[1] It is important that the Australia forestry sector keeps abreast of international efforts to slow the global warming process with forests, and their critical ability to sequester large amounts of carbon.

4. STUDY OBJECTIVES

The objectives of this study are to identify:
1. the magnitude of benefit forest activities can provide in terms of climate change mitigation
2. the scope of, and relationships between, forest activities in Australia to reduce CO_2 emissions
3. the scope of forest activities in the USA and other key countries to reduce CO_2 emissions
4. the implications of these findings for the Australian forest industry.

5. HISTORICAL PERSPECTIVE TO CLIMATE CHANGE MITIGATION

5.1 The Greenhouse Effect and Global Warming

The Earth's climate is determined by energy received from the sun and the response to this energy by the atmosphere, oceans and biosphere. One of the dominant processes is the *natural greenhouse effect*. The greenhouse effect is the warming of the Earth's surface and lower atmosphere caused by carbon dioxide (CO_2) and other greenhouse gases trapping energy in the lower atmosphere.

Most of the incoming radiant solar energy is in the form of visible light that passes straight through the atmosphere.[2] Some of this solar energy is reflected back into space by clouds, but most arrives at the Earth's surface and is absorbed.[3] The absorbed energy produces heat and warms the surface. The warmed surfaces radiate infra-red radiation into the atmosphere where it is absorbed by greenhouse gases which heat the atmosphere. This, in turn, further heats the Earth's surface. The Earth's surface and lower atmosphere warm until they reach a temperature where the infra-red radiation emitted back into space, plus the directly reflected solar radiation, balance the energy coming in from the sun.[4] Greenhouse gases added to the

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1 Environment Australia. (1997) *Australia's National Greenhouse Gas Inventory: Overview of the 1995 inventory*. [On-line]. Available: http://www.environment.gov.au/portfolio/esd/climate/ggi

2 Schimel, D., Alves, D., Enting, I., Heimann, M., Joos, F., Raynaud, D., et al. (1996). Radiative forcing of climate change. In J.T. Houghton, L.G. Meira Filho, B.A. Callander, N. Harris, A. Kattenberg & K. Maskell (Eds.), *Climate change 1995: The science of climate change.* (pp. 65-132). Cambridge, UK: Cambridge University Press.

3 Trenberth, K.E., Houghton, J.T., Meira Filho, L.G. (1996). The climate system: An overview. In J.T. Houghton, L.G. Meira Filho, B.A. Callander, N. Harris, A. Kattenberg & K. Maskell (Eds.), *Climate change 1995: The science of climate change.* (pp. 51-64). Cambridge, UK: Cambridge University Press.

4 Ministry for the Environment. (1996). *Climate change and CO_2 policy: A durable response:*

atmosphere, such as from human activities, absorb more of the infra-red radiation, which causes further warming of the Earth's surface and lower atmosphere. This is the *enhanced greenhouse effect*, but in common usage is termed simply the greenhouse effect.

The other greenhouse gases include water vapor, methane, nitrous oxide and near surface ozone. It is important to note that ozone in the lower atmosphere plays a different role from its critical presence in the upper atmosphere. Upper atmosphere ozone serves to shield Earth from dangerous levels of ultra-violet rays emanating from the sun. The hole in the ozone and global warming are separate problems confronting life on Earth, though related in terms of the composition and quantity of incoming solar radiation.

Although existing in much lower concentrations, the other greenhouse gases absorb infrared radiation much more efficiently than CO_2 does.[5] As a result, their combined effect may account for approximately half of the global warming expected to take place over the next several decades. However, it is the increase of atmospheric CO_2 concentrations that is the most important factor in the greenhouse effect. Based on 1992 values, the approximate contribution of CO_2 to global warming is 64%; the next highest contributor is methane (CH_4) at 19%.[6]

In the equilibrium state, carbon flows between the various reservoirs of the global carbon cycle are in balance, as demonstrated in Figure 1.[7] Over the last 160,000 years, being the extent of reliable CO_2 data, the carbon cycle has slowly moved in and out of balance a number of times, with atmospheric CO_2 concentrations ranging between 200 and 280 parts per million by volume (ppmv) during that time.[8] There is little doubt that the carbon cycle is now out of balance. In little more than 200 years, CO_2 concentrations have risen from approximately 280 ppmv in 1750 to nearly 360 ppmv in 1997, and are currently rising by about 1.5 ppmv or 0.4% per year on average.[9]

Discussion document of the working group on CO_2 policy. Wellington, NZ: Author.

5 Hair, D., & Sampson, R.N. (1992). Climate change - History, prospects, and possible impacts. In R.N. Sampson & D. Hair (Eds.), *Forests and Global Change, Vol. 1. Opportunities for increasing forest cover*. (pp. 1-10). Washington D.C.: American Forests.

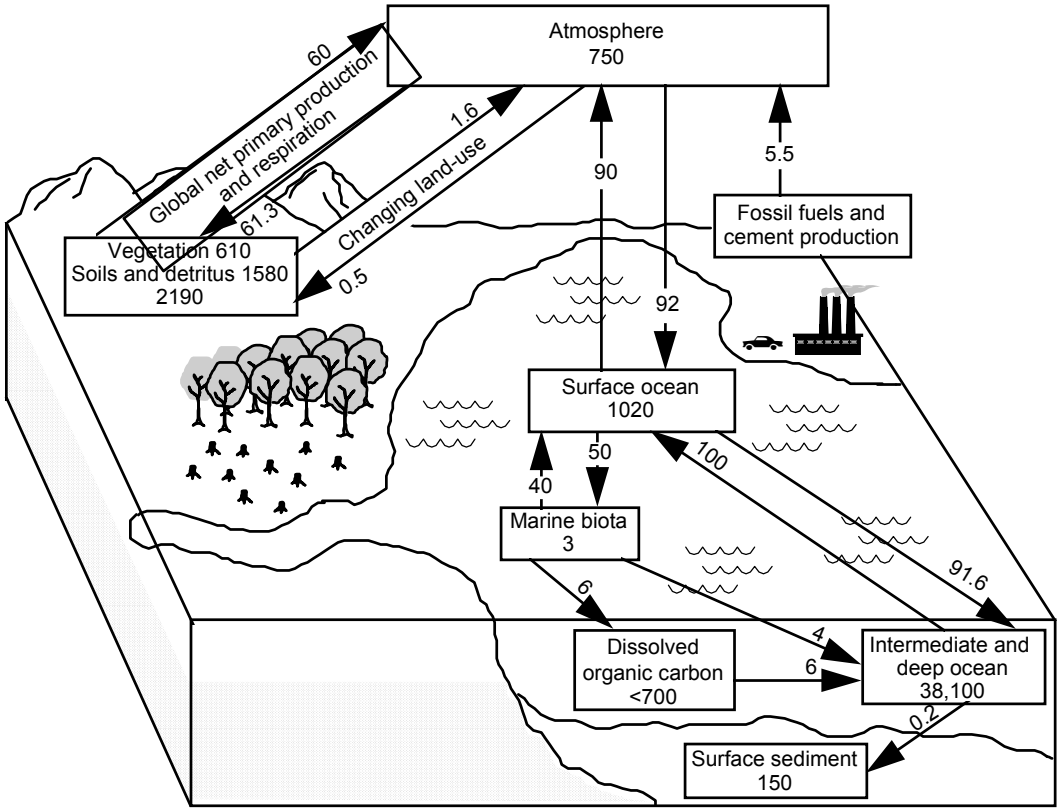
6 Intergovernmental Panel on Climate Change. (1996). *IPCC second assessment: Climate change 1995: A report of the Intergovernmental Panel on Climate Change.* WMO, UNEP.
Note: The IPCC provides calculations of 'radiative forcing', which gives a close approximation of the percent contribution to global warming. Schimel, D., (personal communication, October 24, 1997).

7 Trexler, M.C. (1991). *Minding the carbon store: Weighing U.S. forestry strategies to slow global warming.* Washington, D.C.: World Resources Institute.

8 World Resources Institute. (1990). *World Resources 1990-91*. New York: Oxford University Press.
Note: An ice core recovered from a drill hole in Vostok in Antarctica reveals changes in climate and CO_2 and methane concentrations that have taken place in the last 160,000 years - through the present warm period, the last 100,000-year Ice Age, the preceding warm period, and into an earlier Ice Age.

9 World Resources Institute. (1996). *World Resources 1996-97*. New York: Oxford University Press.

Figure 1. The global carbon cycle : reservoirs (billion tonnes C) and fluxes (billion tonnes C per year) for anthropic annual averages between 1980 and 1989[10]



Human activities are primarily responsible for the enhanced greenhouse effect. The average annual anthropic emissions between 1980 and 1989 were approximately 26.1 billion tonnes of CO_2, or 7.1 ± 1.1 billion tonnes of carbon.[11] Of this total, industrial processes, including fossil fuel combustion and cement production, accounted for about 5.5 billion tonnes of carbon. Net emissions from changes in land use, which includes deforestation and on-site burning, accounted for about 1.6 billion tonnes of carbon.

Natural sources of CO_2 emissions range from volcanic eruptions to the aerobic digestion of decayed vegetation by soil bacteria. Natural sinks for CO_2 include regions of expanding forests, peat bogs, seafloor sediments which accumulate carbonate-rich materials, and the ocean waters themselves. As a result of these competing processes, the net accumulation of CO_2 in the atmosphere has in recent years amounted to about half of the annual anthropic emissions.[12]

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[10] Eswaran et. al., 1993; Potter et., al. 1993; Siegenthaler & Sarmiento, 1993; cited in Schimel, et al., *op. cit*.
Note: The component cycles are simplified and subject to considerable uncertainty. In contrast to this static view, the carbon system is clearly dynamic and couple to the climate system.

[11] Schimel, et al., *op. cit*.
Note : CO_2 emissions are often measured in terms of weight of carbon contained in the gas: to convert mass of CO_2 to mass of carbon, divide by 3.67 - Intergovernmental Panel on Climate Change, *op. cit*.

[12] World Resources Institute. (1996), *op. cit*.

Accelerated global warming would generate potentially devastating impacts for civilization today. If sea levels were to rise by 0.5 metres by 2100, which is the current "best estimate" by the Intergovernmental Panel on Climate Change, the number of people per year at risk of flooding would rise from 46 million to 92 million.[13] Land loss to invading seas would be about 6% in the Netherlands, 17.5% in Bangladesh, and 80% for the Majuro Atoll in the Marshall Islands. Temperature increases of 3-5^{o}C, which are at the upper part of the IPCC-projected range, could create 50-80 million additional annual cases of malaria, primarily in tropical, subtropical and less well-protected temperate zone populations.[14] The David Suzuki Foundation, an organisation with the objective of finding solutions to global environmental problems, interpreted the IPCC forecasts for Canada:

> It would spawn droughts, economic losses in forestry, agriculture and fisheries, species extinction and the potential of more severe hurricanes and storms. Canada would suffer insect infestations, forest fires, deaths from heat and smog, melting permafrost, coastal flooding and more frequent and severe storms.[15]

Human activity is at least partially responsible for the increased rate of climatic change, and the global community now has the challenge of slowing this change sufficiently for mankind and nature to adapt. All sectors of the community need to look for and adopt effective and expedient climate change mitigation measures.

5.2 Carbon Offsets and Mitigation Banking

Discussions regarding the role that forests can play in climate change mitigation have featured the terms "carbon offsets" or "carbon credits". These are terms that relate to a broader concept of "mitigation banking", which describes the trading of environmental resources of an agreed financial value that will mitigate environmental damage in its various forms. Mitigation banking is being used to address environmental problems such as sulphur dioxide pollution from manufacturing facilities, nitrous oxides from widespread use of nitrogen fertilisers, and loss of wetlands to development activity. Under the USA Federal Clean Water Act of 1972, development that results in the permanent destruction of wetlands must be mitigated by the creation of a new wetland or the restoration of a degraded one.[16] Rather than require developers to create and maintain wetlands on their own on a fair trade basis, mitigation banking allows them to pay for wetlands that have been created and maintained properly by others to compensate for their damage.

In environmental economics parlance, an offset is an action taken 'beyond the smokestack' in order to compensate for emissions considered excessive by regulations, thus avoiding a penalty for excess emissions.[17] Since the cost of reducing pollutants varies between polluters, those who can reduce emissions inexpensively have a business opportunity in undertaking emissions reductions beyond the required standard. They can then sell their additional reduction 'credits'

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13 Intergovernmental Panel on Climate Change, *op. cit*.

14 *ibid*.

15 Fulton, J. (1997, October 2). Global warming: Canada is breaking its promise to the world. *David Suzuki Foundation.* [On-line]. Available: http://www.vkool.com/suzuki/climate.html

16 Marsh, L.L., Douglas, R.P., & Salvesen, D.A. (1996). *Mitigation banking: Theory and practice*. Washington, D.C., Island Press.

17 Jones, D.J. & Stuart, M.D. (1994). The evolving politics of carbon offsets. *ITTO Tropical Forestry Update. 4*(5), 13-15.

to polluters with higher reduction costs. A carbon offset is an investment activity made for the purpose of decreasing the sum total of CO_2, the primary greenhouse gas, in the atmosphere so as to slow the rate of global climate change.

In the realm of mitigation banking opportunities, carbon dioxide is a unique pollutant, in several ways. Unlike sulphur dioxide and nitrous oxide, for example :

- CO_2 is not an immediate health or environmental threat to humans or sensitive ecosystems.
- CO_2 is not an impurity of the combustion process - it is the intended byproduct of using fossil fuels for energy production. Changes in the combustion process or fossil fuel source will not eliminate CO_2 emissions.
- CO_2 cannot be practically removed from flue gas before being emitted to the atmosphere. The stripping of flue gas is technically possible, but costly, and the stripped carbon still needs to be disposed of.

Of particular importance to offset purposes:

- CO_2 is a global gas. It mixes well in the atmosphere, and has a long atmospheric residence time.[18]

Forestry, especially in tropical countries, is recognised as a highly cost-effective means of sequestering atmospheric CO_2 in long-term "sinks".[19] As CO_2 emissions can be offset by sequestration activities anywhere in the world, tropical forestry has attracted a great deal of attention from greenhouse gas emitters in developed countries for this potentially valuable by-product service.

The carbon offset concept dates back to at least 1977 when Freeman Dyson of the U.S. Institute for Energy Analysis first quantified the area of new forest that would be required to absorb the quantity of fossil-fuel carbon being emitted through combustion each year. His startling conclusion was that about 700 million hectares of rapid-growth plantations, being 91% of the area of Australia, would need to be established in the tropics to offset the global emission of some five billion tonnes of carbon per year .[20] Despite this enormous task, Dyson was optimistic : "There seems to be no law of physics or of ecology that would prevent us from taking action to halt or reverse the growth of atmospheric CO_2 within a few years if this should become necessary." Regarding the options of planting rapid-growth trees or swamp-plants on a massive scale, he concluded "the possible scale and speed of these operations appear to be limited by the availability of fertiliser rather than by land or financial costs."

The first practical application of carbon offsets took place in 1988, when the American power producer AES Corporation decided to voluntarily offset the emissions of a coal-fired power plant in Connecticut by expanding a pre-existing CARE social forestry project in Guatemala. The forestry components of the effort include tree planting in woodlots, increased biomass yields through soil conservation techniques, and conservation of biomass through fire prevention. Farmers on the land holdings have been provided with training and support to undertake these program activities over the longer term. Approximately 45 million trees will

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[18] Trexler, M.C., Kosloff, L.H., & Gowen, M. (1994). Carbon offset potentials and design: Anticipating future public policy. In C.V. Mathai & J. Stensland (Eds.), *Proceedings of the Air & Waste Management Association: Global Climate Change - Science, Policy and Mitigation Strategies,* (pp. 1006-1017). Phoenix, Arizona.

[19] Jones, & Stuart, *op. cit*.

[20] Dyson, F.J. (1977). Can we control the carbon dioxide in the atmosphere? *Energy, 2,* 287-291.

be planted over a 10 year period. Although the trees will absorb CO_2, the trees themselves are intended to be used as firewood, building materials, and fodder. The long-term carbon benefit will be in the form of indirect effects of tree-planting on reducing forest conversion and firewood pressures in the area. It is estimated that this project will sequester 10.5 million tonnes of carbon.[21] Unfortunately, no empirical monitoring of the carbon benefit is feasible given the project's geographic dispersion and its reliance on many different types of measures to indirectly protect neighbouring forests.

5.3 United Nation's Framework Convention on Climate Change

In 1988, the World Meteorological Organization and the United Nations Environment Programme responded to growing concern about the greenhouse effect by establishing the *International Panel on Climate Change* (IPCC). The IPCC carries out coordinated assessments of the magnitude, timing and potential impacts of climatic changes. In response to an IPCC proposal, the United Nations General Assembly at its 1990 session set up the Intergovernmental Negotiating Committee for a *Framework Convention on Climate Change* (FCCC, or 'Climate Convention'). This committee was given a mandate to draft the framework treaty and any related legal instruments it considered necessary. Negotiators adopted the Climate Convention in May 1992 and one month later, at the *United Nations Conference on Environment and Development* in Rio de Janiero, the Climate Convention received 155 signatures from country 'parties'. Australia was one of the first signatories. Following the 50th ratification in 1994, the Intergovernmental Negotiating Committee was dissolved, and the 'Conference of the Parties' took over responsibility for the ongoing process of implementing the Climate Convention.

The ultimate objective of the Climate Convention is to :

> *achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.*[22]

As a framework treaty, the 1992 Climate Convention set out principles and general commitments, leaving more specific obligations to future legal instruments. The general commitments, which apply to both developed and developing countries, are to adopt national programs for mitigating climate change; to develop adaptation strategies; to promote the sustainable management and conservation of greenhouse gas "sinks", such as forests; to take climate change into account when setting relevant social, economic and environmental policies; to cooperate in technical, scientific, and educational matters; and to promote scientific research and the exchange of information.

The Climate Convention distinguishes between developed country parties, countries in transition to a market economy, and developing countries. It requires developed countries to take the strongest measures, while the countries in transition are allowed a certain flexibility. It also recognises that compliance by developing countries will depend on financial and

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[21] Trexler & Associates, Inc. (1996). *Other offset projects around the world.* [On-line]. Available: http://www.teleport.com/~taa/othrproj.htm

[22] *United Nations framework convention on climate change*. (1992). Geneva, Switzerland: UNEP / WMO Information Unit on Climate Change.

technical assistance from developed countries. The needs of those countries particularly vulnerable to climate change for geographical reasons are also given special consideration.

In requiring developed countries to take the lead, the Climate Convention urged these countries to take measures designed to limit emissions of CO_2 and other greenhouse gases, with the aim of returning to 1990 emission levels by the year 2000. National assessments presented in March 1995 at the first Conference of the Parties in Berlin demonstrated that the world was not yet meeting this goal. By 1994, emissions of CO_2 were already as much as 5% above the 1990 level in some developed nations, and up by as much as 40% in some developing countries.[23]

The evidence in Berlin suggested that the climate change issue was still being ignored by many energy decision makers, in both the public and private sector. At the same time, the urgency of climate threat was being heightened by new scientific studies, including the results of IPCC working groups for their Second Assessment Report, and powerful environmental lobbyists made their presence felt throughout the conference.[24] Climate Convention parties agreed to the "Berlin Mandate": signatory countries were charged with developing a binding protocol for the Climate Convention by the third Conference of the Parties in Kyoto, Japan, in December 1997. Governments also agreed to consider a range of specific measures to reduce emissions, and launched a voluntary joint implementation pilot program to allow countries to explore the benefits of working together to reduce CO_2 emissions.

5.4 Joint Implementation

The concept of "joint implementation" or "activities implemented jointly" (JI or AIJ) was introduced during negotiations leading up to the United Nations conference in Rio in 1992, and was formally adopted into the text of the Climate Convention. Both JI and AIJ are used to describe a wide range of possible arrangements between interests in two or more countries, leading to the development of cooperative development projects that reduce, avoid or sequester greenhouse gas emissions. The Climate Convention recognises that allowing emissions sources to contract with each other to implement required emissions reduction can substantially reduce the costs of achieving global targets. Facilities that could reduce emissions only at great cost can compensate another facility with less expensive mitigation possibilities to make reductions on their behalf.

The pros and cons of JI have been debated since 1992. The arguments of JI opponents include:

- JI lacks one global target. For example, Australia has a target : to return emissions to 1990 levels by 2000. But developing countries, Australia's likely partners in JI projects, have no quantifiable obligations under the Climate Convention as yet. Apparent emission reductions could easily dissipate through increases elsewhere, or at a later date. Furthermore, if or when developing countries are asked to adopt quantifiable obligations under the Climate Convention, they may respond that they are unable to adopt sufficiently stringent targets because all their affordable options have been used in JI projects.

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[23] Flavin, C. (1996). Facing up to the risks of climate change. In L. Starke (Ed.), *State of the World 1996*. (pp. 21-39). New York: W.W. Norton.

[24] *ibid*.

- Under general Climate Convention commitments, developing countries already have obligations to reduce their emissions and protect their "sinks", e.g., forests and grasslands. Developed countries are committed to paying the incremental costs of meeting those obligations, but the non-incremental costs and resulting emission reductions should belong to the developing country.
- If developed countries like Australia rely on JI to meet their commitment to reduce emissions to 1990 levels by year 2000, it will send a message to other parties, especially developing countries, that Australia does not take its commitments under the Climate Convention seriously. Goldberg (1993) argues that a minimum benchmark of "leadership" by developed countries is a return to 1990 levels by 2000 without JI projects.[25]

The arguments JI proponents include:

- JI projects have the potential to dramatically reduce national and global costs associated with Climate Convention implementation, providing attractive mitigation opportunities now.[26]
- Mitigation projects in developing countries with funding from developed countries have many additional benefits. Such JI projects combine foreign investment, technology transfer, increased employment opportunities and environmental protection.
- The Climate Convention targets will be difficult to achieve, and all climate change mitigation projects should be given an opportunity to contribute. The mitigation strategies of both Australia and the USA have called for voluntary emission reductions. The most cost-effective mitigation options must be considered if the targets are going to be met.

AIJ is the international pilot phase (1995-2000) for cooperative opportunities between countries to reduce, avoid or sequester greenhouse gas emissions, introduced by the Climate Convention to develop and test this mitigation mechanism. Australia, Canada, Costa Rica, Denmark, Finland, Germany, Iceland, Japan, the Netherlands, Norway, Sweden and the United States have all announced official AIJ pilot initiatives. Various forest-based JI initiatives are underway around the world, and some examples are described in the individual country discussions within this report.

5.5 IPCC Findings

The IPCC produced its Second Assessment Report in 1995, a compilation of findings from three working group reports. Major findings included :

- The balance of evidence suggests a discernible human influence on the global climate;
- Climate change will have significant and mostly adverse consequences on ecological and socioeconomic systems;
- Cost-effective responses are available, and can be implemented through appropriate policies in all sectors of the global community.[27]

The IPCC report recognised the scope for emission reductions in the forestry sector, through the utilization of technologies and policy measures.

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[25] Goldberg, D.M., Trexler, M.C., & Kosloff, L. (1993, April). Joint implementation: Pro and con. *Energy, Economics and Climate Change,* 7-12.

[26] *ibid.*

[27] Intergovernmental Panel on Climate Change, *op. cit*.

6. CLIMATE CHANGE MITIGATION THROUGH FORESTRY

6.1 The Means

For the purpose of this study, forests include native forests, plantation forests, farm forestry plantings, parks and reserves. Atmospheric CO_2 concentrations can be reduced by forest-based activities in the following ways :

- *conservation* of carbon reservoirs in forests to reduce CO_2 emissions resulting from deforestation and logging impacts
- *enhancement* of existing carbon sinks with improved forest management techniques (e.g. fertilisation, soil carbon management)
- *creation* of new carbon sinks by planting on unforested lands
- *storage* of carbon in wood products
- *substitution* of wood products for processes that burn fossil fuels:
    - *production of bioenergy* : net CO_2 emissions are effectively zero for a system where CO_2 released during biomass combustion is simultaneously sequestered by the next energy crop.[28]
    - *production of more energy-intensive materials* : In 1991, Buchanan, of the University of Canterbury, New Zealand, compared the impact of the main building materials on the greenhouse effect. He calculated that one tonne less carbon is emitted to the atmosphere when one tonne of steel is replaced by timber in building construction. "The results showed that timber is significantly the best material to use for construction with regard to reducing CO_2 emissions to the atmosphere."[29]

In the longer term, the sustainable growth and harvest of wood for substitution of fossil fuels and other energy-intensive products will offer a more efficient climate change mitigation strategy than one based on increased carbon sequestration in vegetation, soils and forest products, which would saturate with time. The development of fossil fuel substitution will depend critically upon the competitiveness of these substitutes in their respective marketplaces. However, managing forests to conserve and expand carbon reservoirs offers an effective mitigation option during the transition period of many decades necessary to stabilise atmospheric concentrations of CO_2.

Both Kirschbaum and Trexler[30] suggest that the land and technology resources available to pursue forest-based mitigation projects, in Australia and the USA, are greater than the demand for them is ever likely to be. It is unlikely that either country would ever want to pursue any given option to the full extent of its theoretical potential, as global warming mitigation is not the only policy goal on their agenda. In his literature review of 1993, Trexler concluded that most estimates of land availability take little account of the social, economic and political pressures and barriers on using land for forestry offset. As a result, estimates of land

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[28] Kinsman, J.D. & Trexler, M.C. (1993). Terrestrial carbon management and electric utilities. *Water, Air and Soil Pollution, 70,* 545-560.

[29] Buchanan (1991), cited in Honey, B.G. & Buchanan, A.H. (1992). *Environmental impacts of the New Zealand building industry*. (Research report 92/2). Christchurch, New Zealand: University of Canterbury, Department of Civil Engineering.

[30] Kirschbaum, M.U.F. (1996). The carbon sequestration potential of tree plantations in Australia. In K.G. Eldridge, M.P. Crowe, & K.M. Old (Eds.), *Environmental management: The role of Eucalypts and other fast growing species*. (pp. 77-89). Canberra: CSIRO Forestry and Forest Products.
Trexler, (1991). *op. cit*.

availability range widely.[31] Quantifying the carbon sequestration limit is difficult because of the uncertainties involved with all biotic options. Given that the limit is never likely to be tested, determining the actual quantity may not be important. *Governmental recognition of the fact that forestry options can make a significant contribution to a portfolio of mitigation options is however, vitally important*.

6.2 The Magnitude

The World Resources Institute refers to the IPCC (1994) calculation that stabilization of atmospheric CO_2 concentrations at 1994 levels would require 1994 emissions to be cut by 60%, and that emissions be maintained at these reduced levels throughout the next century.[32]

Regarding the contribution that forests can make to emissions mitigation, Harmon (1995) and Kirschbaum (1996) both warned against stating the carbon sequestration potential for any large area of land. Ongoing research on the carbon dynamics of two significant forest regions, the Pacific Northwest, USA, and northwestern Russia, clearly demonstrates substantial differences in carbon fluxes between different regions of the world.[33] However, several estimates have been offered for global and national potential, and all suggest that forest-based measures can offer a significant contribution.

In 1989, Barson and Gifford concluded that if Australia were to plant 40,000 hectares of unforested land with Eucalyptus or Pinus species for 40 years, the cumulative amount of carbon removed from the atmosphere by 2030 would be about 180 million tonnes[34] - which is almost double Australia's net anthropic carbon emissions in 1995. While the authors acknowledged that the average growth rate used for this calculation (7.5 tonnes carbon per ha per year) was "generous", the planting rate is not unrealistic. The Australian forest industry has embarked on a program that aims to treble the size of Australia's 1995 plantation estate (about 1.1 million ha) by 2020, which will necessitate a planting rate that exceeds that of the 1989 study.

In 1992, Grierson et al. calculated the carbon storage in above-ground biomass of Victoria's forests. Based on the assumption that organic matter contains 50% carbon, their analysis showed an average rate of net fixation of around 6-7 tonnes carbon per ha per year.[35] *Eucalyptus regnans* forests were shown to fix around 9 tonnes carbon per ha per year during the first few years of growth, with this rate decreasing to 6 tonnes carbon per ha by age 10, while *Pinus radiata* plantations in Victoria were shown to accumulate around 7 tonnes carbon per ha per year.[36] This calculation provides support for the sequestration potential calculated by Barson and Gifford three years earlier.

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31 Trexler, M.C. (1993). Manipulating biotic carbon sources and sinks for climate change mitigation: Can science keep up with practice? *Water, Air, and Soil Pollution, 70,* 579-593.

32 World Resources Institute, (1996), *op. cit*.

33 Harmon, M.E. (1995, September 25). *Regional carbon dynamics.* Oregon State University. [On-line]. Available: http://www.fsl.orst.edu/lter/research/compplns/carbon/carbsum.htm

34 Barson, M.M. & Gifford, R.M. (1989). Carbon dioxide sinks : The potential role of tree planting in Australia. In D.J. Swaine (Ed.), *Greenhouse & Energy*. (pp.433-443). Melbourne: CSIRO.

35 Grierson, P.F., Adams, M.A. & Attiwill, P.M. (1992). Estimates of carbon storage in the above-ground biomass of Victoria's forests. *Australian Journal of Botany, 40,* 631-40.

36 *ibid*.

For the USA, Trexler concluded in 1991 that conventional tree planting and forest management alone are probably capable of increasing biotic carbon uptake by more than 800 million tonnes per year.[37]

In 1995, an IPCC working group concluded that a number of measures in the forestry sector could theoretically conserve and sequester 60-90 billion tonnes of carbon over the next 50 years.[38] Literature cited by the IPCC indicates that tropical forests have the potential to conserve and sequester 80% of this total, while temperate and boreal zones could sequester about 20%.[39] Approximately 1.6 billion tonnes of carbon are released each year by deforestation in tropical countries,[40] an activity that could be dramatically reduced in the short term by providing effective economic incentives to establish sustainable agroforestry.[41] In 1994, Dixon and Brown calculated that temperate forests worldwide, being young and actively growing, currently sequester about 0.7 billion tonnes of carbon annually. One-third of the stored carbon is in above-ground vegetation; the other two-thirds is in soils, and most of that in peat, especially at high latitudes.[42]

6.3 The Benefits

Forest-based mitigation options appear to be one of the most attractive approaches to sequestering atmospheric CO_2 and conserving carbon reservoirs. They are attractive because :

- *forests have the potential to sequester large amounts of CO_2*, as previously shown
- *the technology for establishing new forests exists*, in contrast with ideas such as affordable capture of CO_2 before it leaves industrial smokestacks[43], and fertilising the oceans with iron or nitrates to increase surface sequestration[44]
- *forest-based projects are feasible on a large range of size and time scales*
- *the costs of forest-based projects are modest and relatively cost-effective*. Sedjo (1994) reviewed various studies that suggest relatively low carbon sequestration costs through tree planting, including Winjum et al. (1992) who estimated that the costs of sequestering CO_2 on a massive world-wide scale would range from less than US$1 to about $8 per tonne of carbon sequestered.[45]

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37 Trexler, (1991), *op. cit.*

38 Intergovernmental Panel on Climate Change, *op. cit*.

39 Brown, S.A., Sayathe, J., Cannell, M., Kauppi, P., et al. (1996). Management of forests for mitigation of greenhouse gas emissions. In R.T. Watson, M.C. Zinyowera & R.H. Moss (Eds.), *Climate change 1995: Impacts, adaptations and mitigation of climate change: Scientific-technical analyses* (pp. 773-797). New York: Cambridge University Press.

40 Dixon, R.K., Brown, S.A., Houghton, R.A., Solomon, A.M., Trexler, M.C, & Wisniewski, J. (1994). Carbon pools and flux of global forest ecosystems. *Science, 263*, 185-190.

41 Dixon, R.K., Andrasko, K.J., Sussman, F.G., Lavinson, M.A., Trexler, M.C. & Vinson, T.S. (1993). Forest sector carbon offset projects : Near-term opportunities to mitigate greenhouse gas emissions. *Water, Air, and Soil Pollution, 70,* 561-577.

42 Dixon, Brown, et. al. (1994) *op. cit.*

43 Trexler, Kosloff, et al. (1994), *op. cit*.

44 Omerod, W., (personal communication, September 5, 1997).
Note : There is a controversial proposal that iron fertilisation in the Southern Ocean has the potential to increase the ocean carbon sink by 1.5 gigatonnes of carbon per year. Bill Omerod, Project Manager with the International Energy Agency Greenhouse Gas R & D Programme in Gloucestershire, United Kingdom, is writing a review of this subject which should be published by the end of 1997.

45 Sedjo, R.A. (1996). The economics of increased carbon storage through plantations and forest management. In M.J. Apps & D.T. Price (Eds.), *Forest ecosystems, forest management and the global carbon cycle.* (pp. 315-326). Berlin: Springer

Trexler et al. (1994) discussed the cost of "carbon offsets", which encompasses forest-based offset activities as well as other activities including improved energy production and conversion efficiencies, coalbed methane capture, and reducing the use of agricultural fertilisers. They stated:

> *generally speaking, ... carbon offsets should prove less costly than onsite emissions reductions for utilities and other CO_2 emitters, especially as the less expensive onsite opportunities are taken advantage of.* As compared to the possibility of a $50 to $100 per tonne carbon tax or externality adder, or the high costs of stripping and storing CO_2 at the point of emission, carbon offsets are currently extremely cost-effective.[46]

In 1994, Sathaye cited various sources of specific marginal cost estimates for Brazil, Russia, the USA, India, China, and Thailand to show that between 50 and 90% of the technical potential for expansion of carbon stocks may be tapped at a cost less than US$10 per tonne of carbon.[47]

- *forests provide other environmental and socio-economic benefits beside CO_2 sequestration*. The cost, if not justified on the basis of emission reductions alone, may be justified by the ancillary benefits that forestry provides:
    - economic development through increased rural employment and forest products, in contrast to non-land use mitigation options
    - biodiversity conservation and enhancement
    - watershed conservation
    - erosion and salinity prevention
    - recreational opportunities enhancement

When the ancillary benefits are taken into account, forest-based activities provide among the most cost-effective mitigation options for society. In the previously referenced text, Sayathe cited a work by Winjum and Lewis which confirmed that accounting for the monetary timber benefits alone can often more than offset the project costs.[48] As much remains uncertain in the debate over climate change policy options, there is good reason to maximise the ancillary benefits of whatever biotic policy initiatives are undertaken. Australia is one country wary of committing itself to mitigation options beyond its national and international obligations. In its National Greenhouse Response Strategy of 1992, Australia adopted the principle of "no regrets" measures in the phase one response.[49] The Climate Convention recognises the encompassing principle of common but differentiated responsibilities and respective capabilities, and defines "no regrets" measures as those whose benefits equal or exceed their cost to society, excluding the benefits of climate change mitigation.[50] Actions beyond these measures impose costs upon the present generation, and there is still great debate about how to share these costs equitably.

Pilot projects have demonstrated that, for organisations committed to undertaking climate change mitigation, forest-based options are relatively cost-effective. However, there is limited cost-benefit information available to organisations considering whether or not to undertake

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46 Trexler, Kosloff, et al. (1994), *op. cit*.

47 Sayathe, J. (1996). Costs of forest-sector mitigation options. In M.J. Apps & D.T. Price (Eds.), *Forest ecosystems, forest management and the global carbon cycle.* (pp. 327-334). Berlin: Springer.

48 *ibid*.

49 National Greenhouse Steering Committee. (1992). *National greenhouse response strategy.* [On-line]. Available: http://www.environment.gov.au/air/climate/greenhouse/greenh1.html

50 Intergovernmental Panel on Climate Change, *op. cit.*

mitigation activity. This is primarily due to the fact that different circumstances generate a different set of potential benefits, some of which are extremely difficult to quantify. Many studies indicate that carbon can be conserved or sequestered for less than US$10 per tonne in developed and developing countries. A regional utility in the USA has voluntarily chosen to sequester carbon by planting trees in the neighbourhoods of Salt Lake City, Utah, for a cost of about $18 per tonne. They welcomed the opportunity to undertake a highly visible means of demonstrating a service to the community.[51]

It is difficult to calculate the value of this good publicity, but the utility believes that the publicity plus the other benefits the plantings will provide is worth the cost. Other organisations are sequestering carbon with trees that also enhance wildlife habitat and watershed conservation, which are benefits that are also difficult to quantify in financial terms. Forest-based options provide many ancillary benefits in many different circumstances, and this report makes no attempt to provide the specific cost-benefit analyses required for individual consideration.

Urban trees also make significant contributions to reducing CO_2 emissions. Kinsman and Trexler (1993) stated an urban tree, depending on where it is and what it shades, can be up to 15 times as effective at "managing" atmospheric CO_2 as a rural tree.[52] Tree shading of building infrastructures reduce heating and cooling energy requirements, which in turn reduces CO_2 emissions from the burning of fossil fuels. They will also break up the urban "heat island", and improve air quality by immediately intercepting air pollution from high-density urban activity.

Forest-based mitigation measures in developing countries or countries with an economy in transition have advantages over similar measures in developed countries. These advantages include:

- *Increased benefits to community living around forests*
  Communities within these countries will tend to be more dependent on their forests for livelihood and survival, as their economy is based on natural resources capital as opposed to the human capital of developed nations. By increasing the forest estate, or enhancing its forest products (including sequestered carbon), the multiplied economic impact will provide greater benefits to the forest communities of developing countries.
- *Increased grant leveraging opportunities*
  Developing countries are in a position to offer "debt for nature" transactions, which may be attractive propositions for JI sponsors or the World Bank, who would otherwise be unrewarded for their prior investments in these countries. A transaction of this kind was undertaken in Costa Rica in the 1980s, and has subsequently attracted US$80 million for conservation of its forests.[53]
- *Decreased costs*
  Forest management costs will be less because of lower labor rates and land prices. Dixon (1993) cited Krankina and Dixon in stating that lower labour, land-rent, transportation and

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[51] Edmonds, W. & Trexler, M.C. (1995, August). Approaching the climate challenge: The experience of PacifiCorp. In *Second biomass conference of the Americas : Energy, environment, agriculture, and industry,* Proceedings, Portland, Oregon, USA.

[52] Kinsman, J.D. & Trexler, M.C. (1995, March/April). Into the wood. *Electric Perspectives*. 27-37.

[53] Moura-Costa, P., (personna1 communication, September 8, 1997).

supply costs reduce the near-term costs of CO_2 sequestration in forest systems to less than $5 per tonne in developing countries and countries with an economy in transition.[54]

- *Increased growth rates, particularly in tropical countries*
  The Institute of Forestry Research in Brazil has advertised Brazil's fast-growing Eucalyptus and Pinus plantations as "more efficient" means to "capture the excess of CO_2 [in the] atmosphere". This is demonstrated through statistics contrasting the mean annual increment of broadleaved plantations in Sweden, USA, Portugal and South Africa, given as 6-18 m3 per hectare per year, with that of Brazilian plantations, being 29-45 m3 per hectare per year. The CO_2 sequestration potential was determined as being 5-16 and 26-41 tonnes CO_2 per hectare per year respectively.[55]

6.4 The Perspective

The transitional nature of forest-based CO_2 sequestration and carbon conservation needs to be stressed. In direct proportion to biomass accumulation, CO_2 sequestration occurs rapidly during the early growth of the forest. Over time, forest trees cease to sequester large incremental amounts of carbon as forest stands approach maturity, at which time CO_2 releases through respiration and decomposition negate carbon sequestration.[56] Forests reserved from clearing or logging will conserve the existing carbon reservoir. Forest areas that are logged and replanted will release CO_2 from operational activity and the decay of vegetation matter left behind. They will also generate wood products that contain carbon, and new, young forests that rapidly sequester CO_2 in the form of carbon. In either scenario, *it is only when unforested land is converted to forest that there is a once-off carbon sequestration gain*. *Sequestration in subsequent rotations or generations is roughly balanced by emissions from natural processes or timber harvesting practices*.

Forest management plays a critical role in determining how and where carbon is sequestered and conserved. McLaren (1994) demonstrates that if long-term carbon sequestration in the living forest is the goal, and land suitable for re/afforestation is limited, it is advantageous to select species with a long rotation age, despite slower growth in terms of annual biomass production, providing these species can produce a standing volume commensurate with their long rotation ages.[57] However, when the goal is reducing CO_2 emissions by material substitution and bioenergy production, the best results are achieved in short rotation plantations, providing forest types with the highest mean annual increment.[58]

The controversial issue of harvesting old-growth forests has included debate over the global warming implications. On the basis that one large senescent tree could be replaced by many young trees that rapidly sequester carbon, it has been suggested that some old-growth forests be replaced by new plantations. In 1990, a scientific study in the Pacific Northwest of the USA calculated that converting one hectare of old-growth forest to younger forest reduces net

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54 Dixon, Andrasko, et al. (1993), *op. cit*.

55 Institute of Forestry Research. (1997). *The CO_2 "kidnapping" and reforestation cost with Eucalyptus spp. and Pinus spp. in Brazil.* [Brochure]. Piracicaba, Brazil: Author.

56 Dixon, Andrasko, et al. (1993), *op. cit*.

57 McLaren, J.P. (1996). Plantation forestry - its role as a carbon sink: Conclusions from calculations based on New Zealand's planted forest estate. In M.J. Apps & D.T. Price (Eds.), *Forest ecosystems, forest management and the global carbon cycle.* (pp. 257-270). Berlin: Springer.

58 Nabuurs, G. (1996). Significance of wood products in forest sector carbon balances. In M.J. Apps & D.T. Price (Eds.), *Forest ecosystems, forest management and the global carbon cycle.* (pp. 245-256), Berlin: Springer.

terrestrial carbon storage by 305 tonnes, even after the new trees have had a chance to grow for 60 years and even if 42% of the originally harvested timber is assumed to be used for long-term product.[59] It was concluded that the conversion of some 5 million hectares of old-growth forest to young plantations in the Pacific Northwest in the last century has added an estimated 1.5 to 1.8 billion tonnes of carbon to the atmosphere.

These results stem from only one study, for one specific ecosystem in the Pacific Northwest. Other ecosystems would generate different results. However, these results do highlight the importance of old-growth forest in its capacity to store CO_2, even in comparison with young plantations. Old-growth forest should not be harvested and replanted with fast-growing plantations if maximising carbon sequestration is the only objective. There may however be other valid reasons for harvesting old-growth forest.

When forests are harvested, a large proportion of the accumulated carbon remains on site, with surface carbon in non-merchantable stemwood, branches and leaves, and below-ground carbon in roots and soils. While soil carbon is vigorously retained, surface reservoirs of carbon usually decay rapidly, returning carbon to the atmosphere. Of the stemwood that is removed from the site, a proportion is classified as pulpwood, which is destined for end-uses of short duration, although some pulpwood will be used for longer-lasting products such as panelboards. The durability of paper disposed in landfills is not exactly known, though some evidence indicates that decay is quite slow. This decay will eventually yield both CO_2 and methane, the latter being a much more potent greenhouse gas than the former.[60] Not all of the stemwood classified as sawlog is destined for long-lasting uses. Sawmill waste can be as high as 50%, and further processing produces more particulate waste which will decay faster. Some solid-wood products, such as pallet, packaging or formwork pieces, quickly deteriorate under the strain of utility use. Even structural and furniture grades will eventually decompose or otherwise release the bound carbon to the atmosphere.

Combining all these factors, it is apparent that a large proportion of carbon in a forest stand is returned to the atmosphere soon after harvest, even in sawlog-driven forest industries. In 1990, Harmon et al. reported that approximately 42% of the timber harvested in the Pacific Northwest of the USA enters long-term storage, being products with a life-span of more than five years.[61] With promise for the future, they compare this to much lower historical levels, notably a low of 20% in the 1950s. Figure 2 provides a guide to the flow of carbon following harvesting operations in old-growth Douglas-fir and hemlock forests.

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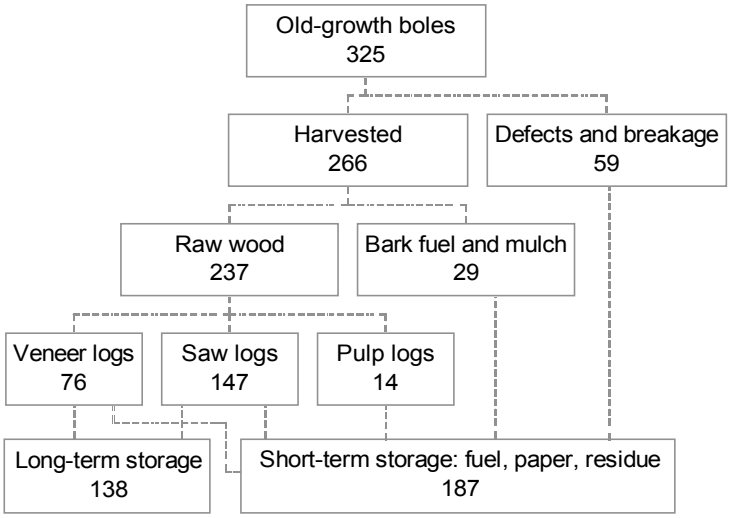
[59] Harmon, M.E., Willliam, K.F., & Franklin, J.F. (1990). Effects on carbon storage of conversion of old-growth forests to young forests. *Science*, *247*, 699-702.

[60] Pingoud, K., Savolainen, I., & Seppala, H. (1996). Greenhouse impact of the Finnish forest sector including forest products and waste management. *Ambio*, *25*(5), 318-326.

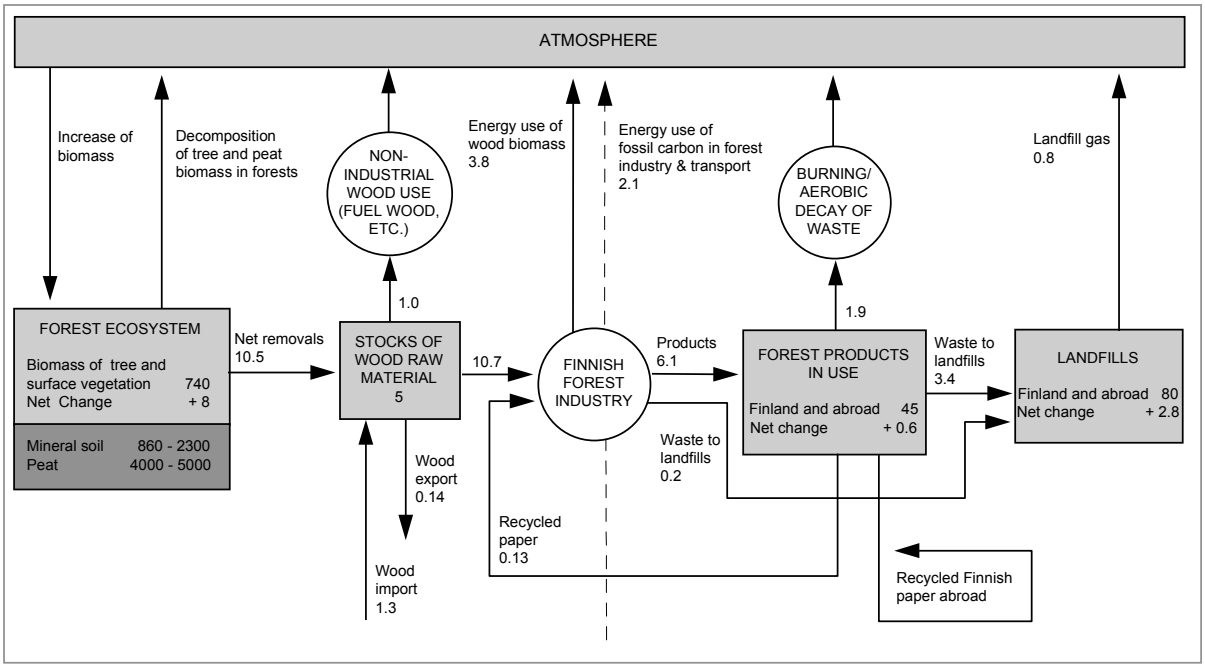
[61] Harmon, Willliam, et al. (1990), *op. cit*.

Figure 2. Flow of carbon (tonnes per hectare) into long- and short-term storage components following harvest of old-growth forest in the Pacific Northwest, USA.[62]



The forest sector in Finland is also active in quantifying the fluxes between reservoirs, including forest products and their waste management. Based on calculations by Seppala and Siekkinen, the carbon content of wood material fluxes in the Finnish forest industries from 1980 and 1990 are shown in Figure 3. This diagram provides a whole-of-sector perspective to carbon flows in and out of the significant reservoirs. It also indicates that forest products in use and in landfills are only a small fraction of the total carbon pool in the Finnish forest sector, paling in comparison with the reservoir capacity of the soils, particularly the peat soils.

Figure 3. Carbon reservoirs (million tonnes carbon) and fluxes (million tonnes carbon per year) of the Finnish forest sector in 1990.[63]



62 *ibid.*

63 Pingoud, et. al., *op. cit.*

There are other factors that reduce actual carbon gains below the potential carbon gains of forest-based climate change mitigation options. Dixon et al. (1993) noted that, particularly in tropical countries, it is difficult to guarantee the long-term success of forestry projects because of other socio-economic demands for the available resources.[64] Long-term success depends both on the extent to which these projects are integrated into the local cultural, economic, and physical environment, and on future socio-economic developments. These factors can be difficult to predict or fully account for forestry project design. There are also the 'Act of God'-type factors, including forest fire, insect attacks and wind damage that can reduce the conservation and sequestration potential of small to very large tracts of forest land.

The role that forestry can play in slowing climate change must be put into this global perspective. *It is clear that the forest industry alone cannot mitigate the enhanced greenhouse effect and the global warming resulting from increasing emissions of CO_2.* Freeman Dyson recognised the limits to forestry carbon offsets in 1977.

> The establishment of such a 'carbon bank' in the form of trees or peat is not to be regarded as a permanent solution of the CO_2 problem. It is a stop-gap measure to hold the atmospheric CO_2 level down for a few decades and buy time in which a permanent shift from reliance on fossil fuels to renewable photosynthetic (or nuclear) fuels can be completed.[65]

However, *there is no doubt that forests, and the forest industry as their custodian, have a role to play in slowing climate change*. Based on inventory statistics for 1995, the Australian forest sector is a net carbon sink[66], and there is potential for significant increases in its capacity as a carbon sink. Based on his 1995 study of the carbon sequestration potential of tree plantations in Australia, Kirschbaum concluded that "if wood grown in plantations could replace fossil fuel in energy generation, it could lower net Greenhouse gas emissions in a sustainable manner, and would be a preferred use of tree plantations in the climate change context."[67] To the extent that forests provide an efficient and renewable means for carbon storage, the forest sector should strive to fulfill their carbon benefits potential within other multiple-use constraints. Through substitution of wood products for energy sources or more energy-intensive products, forestry can then contribute to CO_2 emission reductions in other sectors. Increasing carbon storage in forest and wood products can give the international community time to develop responses to deal fundamentally with the release of fossil carbon to the atmosphere.

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64 Dixon, Andrasko, et al. (1993), *op. cit*.
65 Dyson, *op. cit*.
66 Environment Australia, *op. cit*.
67 Kirschbaum, *op. cit*.

7. REGIONAL REVIEW OF PROGRESS IN FOREST-BASED MITIGATION

7.1 AUSTRALIA

7.1.1 Historical Research

Extensive research on forest-based options for climate change mitigation has been undertaken in Australia.

- In 1989, then-Prime Minister Hawke's Statement on the Environment noted the need to increase carbon sinks as a response to the greenhouse effect.[68] In the same year, Barson and Gifford developed a model to explore the dynamics of carbon sequestration by new forest plantations in Australia. They estimated that an establishment rate of 40,000 ha per year for 40 years on non-forested land could sequester a maximum of 10 million tonnes of carbon per year,[69] which is approximately 10% of Australia's total CO_2 emissions for 1995.[70]
- From its comprehensive Forest & Timber Inquiry of 1990-92, the Resource Assessment Commission concluded that large scale expansion of plantations in Australia would absorb no more than about 10% of "current" CO_2 emissions in Australia.[71]
- The National Greenhouse Gas Inventory for 1995 reported that the Australian forestry sector, comprising commercial forestry, plantations and revegetation activities, provided a net sink of 21.1 million tonnes of CO_2, compared with the total net CO_2 emissions of 348.6 million tonnes.[72]
- In 1995, Kirschbaum (CSIRO) studied the land availability and economics of tree plantations for carbon sequestration in Australia. He demonstrated that there are large areas of land suitable and available for plantation establishment, and that with some government subsidies, carbon sequestration by plantations could be possible on significantly large areas. However, he stated that "it is not possible to give a broad-scale regional assessment of carbon sequestration without consideration of ... variable growth potentials and costs".[73]
- In July 1996, the Ministerial Council on Forestry, Fisheries & Aquaculture agreed to a national goal of trebling Australian forest plantation estate by the year 2020. In 1996, the size of the estate was a little over one million hectares. To achieve the goal, it will require the establishment of about 80,000 hectares of new plantations each year.[74] A consultant was commissioned in 1996 to report on the feasibility of this objective, and the policy changes required to attract the necessary investment. The "Plantation Vision 2020" has not focused on its potential to sequester CO_2. The underlying philosophy is the establishment of commercial plantations in response to market forces.[75] If carbon was to accrue a market value, carbon sequestration could potentially play a significant role in the development of this program.

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68 Hawke, R.J.L. (1989). *Our country our future: Statement on the environment*. Canberra: Australian Government Publishing Service.

69 Barson, & Gifford, *op. cit*.

70 Environment Australia, *op. cit*.

71 Resource Assessment Commission. (1992). *Forest and timber inquiry final report, Vol. 1*. Canberra: Australian Government Publishing Service.

72 Environment Australia, *op. cit*.

73 Kirschbaum, *op. cit*.

74 National Association of Forest Industries. (1997, October). *Plantations 2020: The target*. [On-line]. Available: http://www.nafi.com.au/issues/2020/target.html

75 Prosser, M., (personal communication, August 5, 1997).

7.1.2 Active Initiatives

Australian research efforts have contributed to the following climate change mitigation initiatives:

7.1.2.1 National Greenhouse Gas Inventory

The *National Greenhouse Gas Inventory* is part of the work of the Environment Protection Group of Environment Australia. The Inventory records estimates of greenhouse gas emissions and removals of CO_2 from anthropic sources and sinks.

Figure 4. Anthropic CO_2 Emissions and Removals in 1995[76]

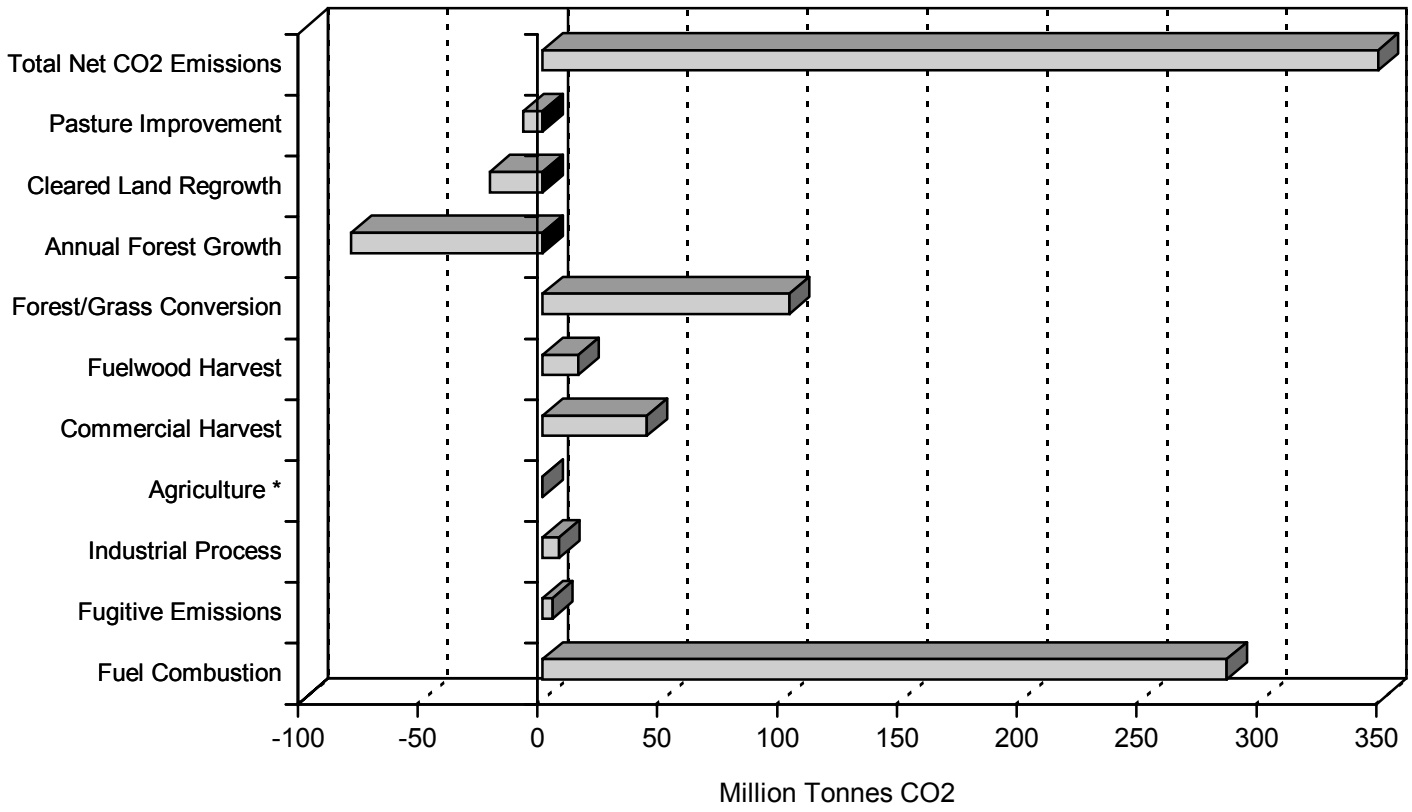
Type of Emissions	CO_2 Million Tonnes	
Australia - 1995		
1. All Energy (Combustion and Fugitive)		
Fuel Combustion	285.5	
Fugitive emissions from fuels	4.2	
Total energy emissions		289.7
2. Industrial Processes		7.0
3. Agriculture *		N/A
4. Land Use Change & Forestry		
Emissions from total biomass removed in commercial harvest	43.6	
Emissions from traditional fuelwood harvest	15.0	
Emissions from forest and grassland conversion	103.0	
Total gross emissions		161.6
Removals through annual growth increment in managed forest	- 79.7	
Removals through regrowth of cleared lands	- 22.0	
Removals through pasture improvement	- 8.0	
Total removals		-109.7
Total Gross Emissions for Australia	458.3	
Total Removals for Australia	- 109.7	
Total Net CO_2 Emissions for Australia		**348.6**
USA - 1994		
1. Emissions from fuel combustion, fugitive fuel and industrial processes		5,126
2. Net removals through land-use change and forestry		- 532
Total Net CO_2 Emissions for USA		**4,594**
The World - average annual for 1980-1989 **		
1. Emissions from fossil fuel combustion and cement production		20,200 ± 1,800
2. Net emissions from changes in tropical land-use		5,900 ± 3,700
Total Net CO_2 Emissions for the World		**26,100 ± 4,000**

* The NGGI assumes net CO_2 emissions from the Agriculture sector to be zero in accordance with international inventory guidelines. However, this sector was the largest emitter of CH_4 and N_2O in 1995; livestock generated three quarters of the agriculture sector emissions, and over 14% of total national CO_2-equivalent emissions.

* Emissions of carbon were multiplied by 3.67 to provide data CO_2 emissions, as advised by the IPCC Synthesis of Scientific / Technical Information Relevant to Interpreting Article 2 of the UN Framework Convention on Climate Change.

[76] Environment Australia, *op. cit*.

Figure 5. Anthropic CO_2 Emissions and Removals by Australia in 1995 (Data from Figure 4)



The development of inventory methods and compilation of inventories is overseen by the National Greenhouse Gas Inventory Committee, which consists of representatives from the Commonwealth, State and Territory Governments. Australia monitors activity within categories specified by the IPCC, including the Land Use Change and Forestry category, which requires determination of factors such as areas cleared, standing biomass, forest growth rates, and carbon content of soils.

The National Greenhouse Gas Inventory does qualify its statistics, particularly those for the Land Use Change & Forestry sector:

> There is a high degree of uncertainty associated with emissions from land use change, mainly due to a lack of accurate statistics on rates of past and present land clearing, mass of vegetation cleared per hectare, whether vegetation cleared is intact (native) vegetation or regrowth, carbon content of soils and extent of soil carbon loss (both with an especially high level of uncertainty) and carbon content of species cleared. Methodological difficulties also contribute to uncertainty.[77]

However, there has been considerable improvement in these methodologies over the last five years. Inventories published between 1988 and 1994 did not include emissions due to land use change, except for the years 1988 and 1990. It was judged that until the existing method for measuring emissions from the Forest and Grassland Conversion subsector was improved

[77] *ibid*.

and better data became available, inclusion of emission estimates from land use change should be delayed. The 1995 Inventory announced that a revised methodology is now complete, and new estimates are provided for all subsectors of the Land Use Change & Forestry sector.[78]

7.1.2.2 National Greenhouse Research Program

In 1989-90, the Federal Government provided funding for a Core Research Program aimed at extending its fundamental understanding of climate change. This Program, undertaken by CSIRO, the Bureau of Meteorology Research Centre and the National Tidal Facility, explores issues along the whole climate change spectrum, though their biotic focus is more on adaptation to climate change rather than the potential for mitigation options. In 1989, the Government also established the National Greenhouse Advisory Committee (NGAC), as a source of expert advice on greenhouse issues, research priorities and international greenhouse activities. Other functions of NGAC include overseeing the Core Research Program, and awarding grants under the Dedicated Greenhouse Research Grant Scheme, a program designed to draw University expertise into greenhouse research. The Core Research Program and the Dedicated Greenhouse Research Grant Scheme together comprise the National Greenhouse Research Program.[79]

CSIRO has its own Climate Change Research Program, coordinated by the Division of Atmospheric Research, which receives funding from the National Greenhouse Research Program. Additional funding for the CSIRO program is obtained from contract work, sponsored research by State Governments, and receipts from competitive grants. Funding for the National Greenhouse Research Program by the Federal Government was reduced in the 1996/97 budget, which has substantially reduced funding for research grants.[80]

7.1.2.3 National Greenhouse Response Strategy

The primary mechanism for meeting Australia's commitments under the Climate Convention is the *National Greenhouse Response Strategy* (NGRS), which provides a framework for climate change mitigation activities in Australia. It was initiated by Federal, State and Territory Governments in 1990 in response to the IPCC's efforts to carry out global assessments of climate change. Developed in parallel with the international Climate Convention negotiations of 1991-92, the NGRS was endorsed by the Council of Australian Governments in December 1992. The Climate Convention commits Australia and other signatory countries to implement policies and actions to limit emissions of greenhouse gases. In particular, it contains an implied target for developed countries to stabilise their emissions of greenhouse gases at 1990 levels by the year 2000. This target equates to a 14% reduction by the year 2000 on "business as usual" emission levels[81].

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78 Environment Australia, *op. cit*.

79 National Greenhouse Advisory Panel. (1995, October 16). *The national greenhouse research program*. [On-line]. Available: http://www.erin.gov.au/portfolio/esd/climate/warming/warm4a.html

80 Mitchell, C.D., (personal communication, November 7, 1997).

81 Intergovernmental Committee on Ecologically Sustainable Development. (1995, December). *Progress in implementing the national greenhouse response strategy and issues to be considered in the 1996 major review*. [On-line]. Available: http://www.erin.gov.au/net/ngrs95_2.html

Current Climate Convention targets for emission reductions are not legally binding. However, nations such as the USA are expected to demand legally binding agreements at the forthcoming Kyoto Conference in December 1997. U.S. Ambassador to Australia, Mrs. Genta Hawkins Holmes, clearly indicated in June 1997 that the USA will exert considerable pressure on Australia to follow their lead.[82]

The 1992 Strategy addressed forestry in the "Natural Environment" section, linking forestry and land use management objectives with those of *the National Forest Policy Statement* and the *National Strategy for Ecologically Sustainable Development*, which were also endorsed by Australian Governments in 1992. The Strategy calls for a 'State of the Forests' report, to be produced at regular intervals, which would provide total forest areas, rate of native vegetation clearing, and greenhouse impacts. It cited several forest-based initiatives to slow climate change, including the 'One Billion Trees' and 'Save the Bush' programs, the National Association of Forest Industries' wood promotion campaigns, the National Landcare Program's efforts to improve soil quality, and the *Intergovernmental Agreement on the Environment* of May 1992.

The United Nations FCCC Intergovernmental Negotiating Committee produced a National Communication of Australia in October 1994, which described the national circumstances that influence Australia's response capacity for climate change, and outlined what strategies and measures the nation had taken to address the greenhouse effect. The committee stated that Australia's greenhouse gas emissions in 2000 would be 7% above 1990 levels if only existing response measures were continued.[83] The NGRS acknowledged the need for subsequent further development of Australia's greenhouse response. In March 1995, the Federal Government launched 'Greenhouse 21C', a package of additional measures which would bring Australia within an estimated 3% of the target.

Greenhouse 21C

Greenhouse 21C focuses on forest-based mitigation options in its Biosphere 21C module. This modular package promised extra support for National Forest Policy Statement objectives, particularly noting the development of a comprehensive, adequate and representative reserve system (CAR) and regional forest agreements (RFA) for all of Australia's timber-producing forests. The Government also committed a further AU$7.5 million to the One Billion Trees program, in recognition of its successful implementation. Another $3.4 million was promised to support a joint project between Federal and State Governments to develop a better database on land clearing through collection and analysis of satellite monitoring data.[84] These Biosphere 21C commitments were built around the Greenhouse 21C philosophy of voluntary partnerships between all community sectors.

The NGRS requires the Intergovernmental Committee on Ecologically Sustainable Development (ICESD) to report to the Council of Australian Governments at regular intervals on progress in implementing the Strategy. The ICESD noted in its 1995 progress report that biomass burning is a significant issue for Australia, as are the uncertainties in estimating net greenhouse gas emissions from land use change and forestry, due to lack of

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82 Sutherland, T. (1997, June 12). U.S. signals radical shift in relations. *The Australian*.

83 United Nations Intergovernmental Negotiating Committee for a Framework Convention on Climate Change. (1994). *Executive summary of the national communication of Australia.* [Report No. A/AC.237/NC/4]. Geneva, Switzerland: United Nations.

84 Department of Environment, Sport & Territories. (1995). *Greenhouse 21C.* [On-line]. Available: http://www.erin.gov.au/air/climate/greenhouse/grn_21c.html

information.[85] This report re-emphasized the need for satellite monitoring tools to increase the quality and quantity of data.

Future Directions for Australia's National Greenhouse Strategy

The ICESD undertook a major review of the Strategy in 1996, and released a Discussion Paper in March 1997, titled "Future Directions for Australia's National Greenhouse Strategy". This document stated their recognition that governments, business, stakeholder groups and the broader community needs to do more to reduce Australia's greenhouse gas emissions and to prepare for the potential impacts of climate change. The ICESD cited the National Landcare Advisory Committee in stating there is "evidence of excessive clearing of native vegetation", and identified a need for accelerated action on native vegetation retention.[86] It also identified six major objectives to be adopted by the "Vegetation and Forest Management" sector, which includes clearing through land use change, and accounted for nearly 25% of Australia's net greenhouse gas emissions in 1994. The forestry-specific objectives included:

- conserve and enhance net carbon sink and storage capacities of public and private forests;
- facilitate a dynamic and viable timber processing sector which provides a stimulus for productive forest and plantation establishment, and produces products that lead to long term storage of atmospheric carbon;
- realise opportunities for the production of renewable fuels and other products from woody biomass.[87]

Proposed Policy Tools : Carbon taxes and Emissions trading systems

In developing the objectives and proposed measures within the paper, a range of policy tools were considered. Economic instruments, such as the widely discussed carbon tax and a domestic emissions trading system are briefly discussed. The former is a tax levied on all fossil fuels in proportion to their carbon contents. Raising the prices of fuels and energy-intensive products would discourage all fossil fuel uses in proportion to their carbon contents and encourage development of less carbon-intensive alternatives. *Regarding the carbon tax, the ICESD stated "such a tax would have major implications for Australia and its introduction is not on the agenda of any Australian government*."[88] A system for trading greenhouse gas emission rights is considered more likely, with its impact perceived as "a more cost-effective overall response." This system would utilise permits for the sale or use of fossil fuels. By limiting the total number of permits, the regulatory authority could control carbon emissions. The Discussion Paper invited public comment on the potential for economic instruments, as it did for all components of the paper, in preparation for the development of the 1997 National Greenhouse Strategy. The ICESD intends to publish the new Strategy before the Climate Convention Conference in December 1997.

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85 Intergovernmental Committee on Ecologically Sustainable Development. (1995), *op. cit*.

86 Intergovernmental Committee on Ecologically Sustainable Development. (1997, March). *Future directions forAustralia's national greenhouse strategy: Discussion paper*. [On-line]. Available: http://www.environment.gov.au/portfolio/esd/climate/dp/ngsdp.html

87 *ibid*.

88 Intergovernmental Committee on Ecologically Sustainable Development. (1997), *.op. cit*.

Corporate Participation in the Greenhouse Challenge Program

Australian industry is already playing a significant role in greenhouse gas mitigation by participation in the 'Greenhouse Challenge', a program of cooperative agreements between industry and government. This program is encouraging a process of change within industry that enables industry to devise creative, cost-effective measures that will lead to mitigation of greenhouse gas emissions in Australia.

The Commonwealth Government has established a Greenhouse Challenge Office to promote and implement the Greenhouse Challenge Program. This office is a joint initiative of the Departments of Primary Industries and Energy; Industry, Science and Tourism; and, Environment, Sport and Territories. Its function is to act as a one stop shop to assist industry in the development of action plans to mitigate greenhouse gas emissions and to facilitate the development of a cooperative agreement which satisfies the requirements of each of the parties involved. As of May 1997, 42 companies and associations have signed cooperative agreements. The Greenhouse Challenge program states that without the action plans to limit their emissions, these companies would, due to operational growth, have increased greenhouse gas emissions from a total of 89 million tonnes CO_2-equivalent emissions in 1995 to 111 million tonnes in 2000 -- an increase of 25%. Through measures agreed to in the action plans, it is estimated that these companies are reducing their year 2000 emissions to 95 million tonnes, which is an increase of 7%.[89]

Alcoa of Australia is one of the 42 companies with a Greenhouse Challenge Cooperative Agreement. While a large proportion of its emission reductions will be due to efforts to reduce energy consumption and CO_2 produced per tonne of alumina, it has committed to supporting a number of non-industrial projects which will generate greenhouse benefits. These include a Landcare conservation project, the establishment of large-scale tree plantations, and continued efforts at improved waste reduction. Total emissions in 2000 are expected to rise by 10% over 1990 levels, while the projected growth in production output is 18%.[90]

Australian Paper is another Greenhouse Challenger. While the company generates net emissions from its 13 pulp and paper mills across Australia, it also owns a large forest plantation resource which offsets the mill emissions. Despite an expected 25% increase in production between 1990 and 2000, Australian Paper is working towards gross emissions 8.5% below 1990 levels. Three major actions were set down in the Cooperative Agreement : a move from coal to natural gas as the primary fuel source; an ambitious tree planting program that will increase the eucalypt plantation estate in eastern Victoria by 150% over the next 20 years; and an increase in net annual consumption of recycled waste paper by over 200,000 tonnes by 2000, which will in turn reduce the amount of paper going to landfill.[91]

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[89] Greenhouse Challenge. (1997, May 1). *Greenhouse challenge program - Emissions update*. [Brochure]. Canberra, Australia: Greenhouse Challenge Office.

[90] Greenhouse Challenge. (1997). *Alcoa of Australia Refineries cooperative agreement*. [Brochure]. Canberra, Australia: Greenhouse Challenge Office.

[91] Greenhouse Challenge. (1997). *Australian Paper cooperative agreement*. [Brochure]. Canberra, Australia: Greenhouse Challenge Office.

In 1997, the Greenhouse Challenge Office engaged a consultant to develop a workbook containing project methodologies for quantification of vegetation sinks for CO_2. The credibility of cooperative agreements negotiated by the Office depends on systematic, scientific monitoring of net emission reduction performance against agreed targets over time. While the National Greenhouse Gas Inventory Committee has a workbook that provides methodologies for calculation of sources and sinks in respect to forests, they are focused on national inventory compilation and provide insufficient guidance for project based inventories. The brief requires the consultant to address numerous needs, including:

- information on a range of species and vegetation types, their growth rates on a range of sites under different management practices, and the carbon sequestration rates that would apply in each case.
- techniques for monitoring carbon sequestration related to biomass
- methodologies for estimating and measuring carbon emissions associated with the activity for which the sink is claimed, eg. clearing, burning and cultivation before plantation establishment
- appropriate conventions for quantification of sink capacity claimed in respect of carbon stored in timber products of varying degrees of durability.

A coalition of consultant firms from Canberra, the USA and Canada were awarded the contract in June 1997. The workbook, a dynamic document which will incorporate actual project data as it accumulates, is to be ready for use by December 1997.[92]

7.1.2.4 Joint Implementation

Given that the cost of reducing greenhouse emissions in the domestic sector is limiting mitigation activities, Australia needs to explore the possibility of lower cost options overseas. Joint implementation is expected to allow the cooperative parties to meet future greenhouse commitments in a more efficient and cost-effective manner than if the parties acted alone. The Australian AIJ Initiative complements the domestic climate change programs under the NGRS and the Greenhouse Challenge. It is designed to provide Australian industry with a chance to demonstrate that greenhouse gas emissions can be limited through voluntary, cost effective and commercially viable actions at the international level. Successful implementation of AIJ projects will be an important consideration in the international review of the pilot phase which is to take place before the year 2000.

The Commonwealth Government has established an AIJ Australia Office in late 1996 to facilitate the establishment of AIJ projects involving Australian-based organizations. As of August 1997, AIJ projects are underway in Fiji, the Solomon Islands, and Indonesia. These projects are focused on greenhouse climate change mitigation through increased energy efficiency and alternative power supplies, including solar energy.[93] *At this early stage, the AIJ Australia Office has no project using forest-based options to sequester CO_2 offshore*.

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[92] AACM International, FORTECH, & Clean Commodities, Inc. (1997, October). *Greenhouse Challenge carbon sinks workbook : A discussion paper*. (Available from the Greenhouse Challenge Office, Canberra, Australia).

[93] Stevens, M., (personal communication, August, 1997).

7.1.2.5 Other Australian Initiatives

The Natural Heritage Trust was established by the Howard Government in May 1997. It draws together a number of complementary programs under the same capital funding base, which was allocated AU$290 million by the 1997/98 federal budget. The two programs now funded by the Trust that specifically relate to forestry and climate change mitigation are *Bushcare : The National Vegetation Initiative*, and the *Farm Forestry Program*. Bushcare is the largest single initiative of the Trust, providing funds for extensive revegetation activities, and protection of remnant native vegetation at risk. The Howard Government states that Bushcare represents a tenfold increase in direct on-ground funding for vegetation programs, building on existing programs such as Save the Bush, One Billion Trees, Wet Tropics Tree Planting and Corridors of Green.[94]

The Natural Heritage Trust recognises that, in addition to direct economic returns, farm forestry "has the potential to provide substantial environmental benefits, including absorbing greenhouse gases".[95] *The Farm Forestry Program is intending to extend commercial farm forestry into lower rainfall areas of Australia. Bushcare seeks to build to its revegetation rate to 250,000 hectares per annum*.[96] These efforts, in addition to those required by the Plantation 2020 Vision, will provide significant carbon benefits for Australia.

A recent development in the state of Victoria has provided motorists with an opportunity to fund a new carbon sequestering tree planting project. The Victorian Government launched the '*Greenfleet*' project in 1997, a tree-planting initiative to mitigate the carbon emissions from road vehicles. The project invites Victorian drivers to pay an extra AU$25 for Greenfleet subscription when they renew their car registration each year. The Foster Foundation, a Victorian environmental group, will use subscription funds to plant at least seven trees for every driver who subscribes, which will capture the average amount of carbon emissions produced by the average vehicle each year.[97] Some of the plantings may be in the form of commercial plantations. If and when the plantings are harvested, profits will be used for replanting the area. Subscribers receive a recognition sticker for their car, a newsletter, and the satisfaction of contributing to climate change mitigation. Greenfleet has secured the patronage of a famous motor racing legend, and is already receiving support from a wide range of donors.[98]

The National Association of Forest Industries (NAFI) of Australia has actively promoted the role the forest and wood products industry can play in reducing CO_2 emissions to the atmosphere. Internet Fact Sheets provided by NAFI state "planting trees can contribute to slowing the greenhouse effect. Most of the trees planted in Australia today are planted by the forest industry."[99] *The Queensland Department of Natural Resources and DPI Forestry have joined NAFI in actively promoting forests as allies in climate change mitigation*. Their fact

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94 Natural Heritage Trust. (1997,.July 4). *Natural Heritage Trust - overview.* [On-line]. Available: http://www.nht.gov.au/overview/

95 *ibid.*

96 Intergovernmental Committee on Ecologically Sustainable Development. (1997), *op. cit*.

97 Paul, W.E., (personal communication, October 10, 1997).

98 National Association of Forest Industries. (1997, September/October). Greenfleet project launched. *NAFI News*. 2.

99 National Association of Forest Industries. (1996, June 7). *Forests today: The greenhouse effect*. [On-line]. Available: http://www.nafi.com.au/

sheets quote Turner (1989) who stated "the timber frame of a house of 180 square meters stores about 7.5 tonnes of carbon. The same house made from steel actually adds about 2.9 tonnes of carbon to the atmosphere when the coal is burned for energy to produce the steel."[100]

7.1.3 Proposed Mitigation Measures

As previously stated, the ICESD Discussion Paper, a precursor to the 1997 National Greenhouse Strategy for Australia, briefly discussed the use of *economic instruments*, such as a carbon tax or a trading system for CO_2 production permits, to reduce total CO_2 emissions. Carbon taxes have been discussed by Australian governments before. The previous Labour government discussed a carbon tax as a cross-policy tool that would reduce CO_2 emissions and provide tax relief in other sectors.[101] The suggestion was dismissed, due mainly to considerable opposition from Australia's powerful energy and minerals lobby groups. In early 1997, it was promoted again by the Australia Institute, a public policy consultancy, which used an econometric simulation model to demonstrate its potential benefit to gross domestic product and employment, on top of the projected emission reductions. Allaying concerns that a sectorial tax would distort the economy, the Institute reflected that, given the extent to which all sectors are directly and indirectly dependent on fossil fuels, the carbon tax can be thought of as, more or less, a broadly based consumption tax.[102]

Before a carbon tax could be introduced, many conceptual and operational issues need to be resolved. Whether the Australian carbon tax would apply to gross or net emissions is still to be determined. The resolution of this issue, if it is pursued, will have a critical impact on future offset activities. The Discussion Paper for a forthcoming 1997 National Greenhouse Strategy stated that the introduction of a carbon tax is "not on the agenda of any Australian government".[103] Given that this Strategy will replace a predecessor created in 1992, it is unlikely that a carbon tax will be introduced before 2000.

Kirschbaum (1995) of CSIRO suggested an economic instrument for consideration in his discussion of carbon sequestration potential for tree plantations in Australia.[104] A scheme could operate in which the government determines a bench-mark figure for supporting carbon sequestration in preference to spending the same amount of money on other measures to reduce emissions, such as improving energy efficiency, subsidizing renewable resources of energy generation or switching to low-carbon fossil fuels. Once a figure has been agreed on, it would then be up to individual land-holders to decide whether such a subsidy on their parcel of land would make the establishment of tree plantations a commercially viable option. Subsidies could be paid at plantation establishment or they could be paid progressively as carbon accumulates over time.

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[100] DPI Forestry & Department of Natural Resources. (1997, August 13). Forests, timber and the greenhouse effect: Facts and furphies. In *Between the Leaves.* [On-line]. Available: http://www.dpi.qld.gov.au.fiqweb/educat/btl/greenhse.htm

[101] Kerr, D., (personal communication, October 27, 1997).

[102] MacLeay, J. (1997, May 12). Carbon tax good for economy. *The Australian*.

[103] Intergovernmental Committee on Ecologically Sustainable Development. (1997), *op. cit.*

[104] Kirschbaum, *op. cit*.

Australian Conferences on Climate Change Mitigation

Australia has recently hosted several important conferences on climate change and greenhouse gas emissions mitigation, indicative of a country keen to address these issues:

- An "International Symposium on Greenhouse Gas Reduction" was held in Sydney in February 1996, covering issues relating to international progress in greenhouse gas mitigation and its relevance to Australia. It was organised by the Australian consortium of the International Energy Agency (IEA) Greenhouse Gas R&D Programme, and as such, the emphasis was on activities and responsibilities in the Energy sector. However, "afforestation" and "enhancement of sinks" were mentioned as options considered, notably by the representative from the U.S. Department of Energy.[105]
- In August 1997, Canberra hosted the conference titled "Countdown to Kyoto : The Consequences of Mandatory CO_2 Emission Reductions". The conference was organised by APEC, and presentations addressed the political and economic implications of the possible outcomes from the third Conference of the Parties in Kyoto in December 1997.
- The "Fifth International Carbon Dioxide Conference" was held in Cairns in September 1997. The theme for this gathering was recent advancements in knowledge of the global carbon cycle, and the capability to predict future CO_2 levels in the atmosphere.

7.1.4 Obstacles To Mitigation Through Forestry

The 1997 Discussion Paper prepared by the ICESD identified several obstacles for Australian forestry to overcome if more of the forests' potential for sequestering carbon is to be realised. It noted that impediments to investment in plantation forestry are limiting the expansion of existing revegetation and reforestation programs. This obstacle is now being addressed by Australian governments through the Plantation 2020 Vision program. The Discussion Paper also noted that *opportunities for the production of renewable fuels and other products from woody biomass are not being grasped by investors*. The paper called for further research on various aspects of forest soil carbon, including carbon budget dynamics, management strategies, and the impact of different harvesting regimes.[106]

While economic instruments for climate change mitigation may encourage forest-based mitigation activity, they are being strongly opposed by lobby groups within the energy and minerals industry. These groups have insisted that the Federal Government resist international calls for legally binding and unilateral emission reduction targets on account of Australia's unusual circumstances.

Australia is the world's largest coal exporter, and is heavily dependent on the export of products such as petroleum products, basic metals, chemicals, cereals and livestock.[107] Furthermore, the rate of economic growth, population growth, and geographic size, all contribute to a relatively high rate of emissions growth compared with other countries in the

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[105] International Energy Agency. (1996, March). International symposium on greenhouse gas reduction. *Greenhouse Issues* [On-line serial], *23.* Available: http://www.ieagreen.org.uk/march23.htm

[106] Intergovernmental Committee on Ecologically Sustainable Development. (1997), *op. cit.*

[107] *ibid*.

Organisation for Economic Cooperation and Development (OECD). The FCCC reported in 1995 that :

> [Australia] shows a relatively high level of energy-related CO_2 emissions per capita of 16 tonnes, compared to 12 tonnes for members of the OECD and 8 tonnes for OECD-Europe, as well as a level of energy-related CO_2 emissions per unit of gross domestic product which is 60 per cent higher than the OECD average.[108]

Australia has no nuclear power generation, which contrasts markedly with other OECD countries where, according to the FCCC National Communication of Australia in 1994, average consumption of nuclear energy is about 24% of energy use.[109]

The energy and minerals industry in Australia clearly has substantial reason to oppose policies that tax, in one form or another, activities that generate CO_2, and the Australian government is clearly dependent on the welfare of its energy and minerals industry. *Inviting this industry to participate in voluntary initiatives to reduce CO_2 emissions is proving to be an insufficient means of achieving Australia's commitments under the Climate Convention*. At a climate change mitigation conference in Canada in May 1997, the representative from Enron, an international energy producer, was reported to say if the government wants something to happen, it must provide regulation. "If governments were to implement flexible schemes for compliance, then countries, companies and citizens would discover cost-effective means to meet targets. Now governments need to have the courage to put these schemes into place."[110]

Calls for legislative development of markets within the Australasian Executive of the Australian and New Zealand Solar Energy Society supports the push for regulation.

> In a so-called free market, it is paramount that the non-market driven but socially and environmentally important constraints are set by legislation so that all industries are competing on a level playing field. But for that to happen, the government has to really value social and environmental problems.[111]

Government funding for climate change research programs has fluctuated over the past two years. The federal budget of May 1997 substantially cut funding of energy efficiency and renewable energy programs, effectively ending the work of the Energy Research & Development Corporation.[112] Government funding of the corporation, at AU$6 million in 1996, attracted additional private investment that now will not be as as forthcoming.[113] Then, in August 1997, the government announced it would spend between AU$50 - 100 million in an effort to further reduce Australian industry's greenhouse gas emissions.[114]

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[108] United Nations Framework Convention on Climate Change. (1995, December 14*). Australia: Report on the in-depth review of the national communication of Australia.* [Report No. FCCC/IDR.1/AUS] Geneva, Switzerland: United Nations.

[109] United Nations Intergovernmental Negotiating Committee for a Framework Convention on Climate Change, (1994), *op. cit.*

[110] Palmisano, J. as cited by Ross, N. (1997, July 9). Global climate change and joint implementation: Industry enters the fray. *JIOnline*. [On-line mailing list]. Available E-mail: JIOnline@eei.org.

[111] Kieboom, J. (1997, May 21). State of emergency in Australia. *JIOnline*. [On-line mailing list]. Available E-mail: JIOnline@eei.org.

[112] Lunn, S. (1997, August 16). $100m budget for green credentials. *The Australian.*

[113] Kieboom, *op. cit*.

[114] Lunn, S. (1997, August 16). *op. cit.*

These inconsistencies have stimulated debate about Australia's commitment to actively addressing the threats of global warming. The debate continued at the South Pacific Forum, held in the Cook Islands in September 1997, where the Australian media reported the Prime Minister dismissed claims that rising sea levels triggered by global warming could destroy small Pacific island states, and challenged the science used to make such "apocalyptic" predictions.[115] Five South Pacific island states called for the forum to push for a worldwide reduction of 1990 emission levels by 20% before 2005. This target is more challenging than the European Union proposal for a 15% reduction by 2010, one which the USA has had to reject as an unrealistic tax on its economy. Australia rejected the South Pacific proposal on similar grounds, stating that the proposed emission reduction commitments "depends heavily on energy-intensive industries, and that binding greenhouse-gas limits would hit [Australia] unfairly."[116] At the forum's conclusion, the Prime Minister won agreement from the forum that it should argue for different targets for different nations at the third Conference of the Parties in December 1997.

The Australian government's reluctance to accept uniform, legally-binding emission reduction targets stems from the concern that if such a target regime applies only to developed countries, the new mineral processing investment and jobs the Government wants will be diverted to the newly industrialised countries in Asia.[117] Other groups view Australia's position as the world's largest coal exporter as an opportunity to become a world leader in industrial reform of energy production. The Assistant Treasurer on the Australasian Executive of the Australian and New Zealand Solar Energy Society has highlighted the fact that the biggest solar energy companies in the world are owned by oil companies.[118] Adaptation is possible, and desirable in terms of climate change mitigation objectives. The March 1997 Discussion Paper on the National Greenhouse Response Strategy does recognise that international demands for climate change mitigation present some "special opportunities", highlighting the fact that *Australia has some of the best renewable energy technologies in the world, including competitive advantages in photovoltaics and biomass energy*.[119] These developments provide Australia with a platform to gain from greater worldwide uptake of these technologies.

It would appear that the opportunity for Australian forestry to utilise and capitalise on its significant potential to reduce atmospheric CO_2 concentrations would be enhanced by strong governmental support for industry wide mitigation responses. It is in the better interests of the Australian forest industry that the Federal Government commits to aggressive climate change mitigation policy at international treaty negotiations. The opportunity to take this step will present itself in Kyoto in December 1997.

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115 Short, J. & Lunn, S. (1997, September 19). Howard disputes greenhouse threat. *The Australian*.
116 New meaning to the term down under. (1997, September 27). *The Economist.*
117 Lunn, S. (1997, August 16), *op. cit*.
118 Kieboom, *op. cit*.
119 Intergovernmental Committee on Ecologically Sustainable Development. (1997), *op. cit.*

7.2 UNITED STATES OF AMERICA

7.2.1 Background on U.S. Climate Change Policy

The USA is taking a proactive role in international negotiations aimed at slowing climate change by reducing greenhouse gas emissions. At a Special Session of the United Nations General Assembly in June 1997, President Clinton outlined a comprehensive framework for international agreement on climate change mitigation.[120] The proposed framework contains three key objectives:

- *Binding emissions targets for developing countries*, where these targets are "meaningful, realistic and achievable";
- *Flexibility in achieving targets*. Given that reducing emissions sufficiently to address climate change requires a sustained effort over several decades, the USA propose support systems that provide nations with the flexibility necessary to achieve the maximum possible protection at the lowest cost.
- *Participation of developing countries*. While greenhouse gas emissions from developing countries are much lower than those from the developed world, they are rising rapidly. China is already the second largest emitter of these gases, and India is currently the sixth largest.

The USA justifies this proactive stance by stating :

- "The science is clear : human activities are impacting the Earth's climate, with potentially devastating effects".
- International actions to date have not been successful at addressing the global warming problem.[121]

On Earth Day (April 22) 1997, U.S. Secretary of State Madeleine Albright announced a cohesion of Foreign Affairs and Environment Affairs under her direction. She presented the first annual "Report on the Environment and Foreign Policy", and particularly noted the challenge to forge an international diplomatic response to global climate change at the third Conference of the Parties in December 1997 - "we will be pressing for clear, common and enforceable targets for greenhouse gas emissions."[122] Whether this political restructuring works well for the U.S. Government is another matter, but it is clear that the Clinton administration has now placed global environmental issues at the top of its agenda.

To further prepare his administration, Congress and the American people for this conference, President Clinton convened a White House Conference on Climate Change in October 1997 to discuss the science of climate change, the role of technologies in reducing greenhouse gas emissions, climate change policy and the USA economy. The American President is "completely persuaded" by the argument that anthropic greenhouse gas emissions will cause a dangerous global warming if not checked.[123] Clinton said "the USA must commit to steps to

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[120] President Clinton's address to U.N. General Assembly special session. (1997, June 26). *JINews.* [On-line news]. Available: http://www.ji.org/jinews/062697.shtml#Clinton

[121] *ibid.*

[122] Albright, M.K. (1997, April 22). *Environmental diplomacy: The environment and U.S. foreign policy*. [Press Remarks]. (Available from Office of the Spokesman, U.S. Department of State, Washington D.C.).

[123] Hebert, H.J. (1997, October 7). Clinton: Warming a real threat. *The Oregonian*.

control global releases of heat-trapping gases. But ... the answer lies in promoting new energy-efficient technologies, not imposing steep energy price increases to encourage efficiency."[124]

Two weeks after the White House Conference, the Clinton administration announced its policy position on global climate change, a plan that will be taken to international negotiators for revision of the Climate Convention. The proposal focuses on tax credits and research subsidies to encourage energy conservation, emphasizing incentives and rewards for those who move quickly to adopt promising new technologies.[125] There was little mention of funding for forest-based mitigation programs. A Senator from Oregon has since lobbied the President to have forestry options included in the tax incentive package.[126] The plan also calls for developing nations to be "engaged" in meeting the challenges of climate change.[127] Clinton has called the American people to accept and respond to the reality of global warming. In a speech to the American University in September 1997, Clinton said "we need the young people of America, particularly the university students who are in a position to study this issue, to make this a gripping national issue".[128]

The public impetus to slow the rate of global warming would appear to be critical, but currently lacking. President Clinton's remarks suggest that, at this stage, global warming is not a gripping national issue. A program on National Public Radio immediately after the White House conference on global climate change invited environmental sociologists to offer their thoughts on public attitude towards this issue. They highlighted three reasons why global warming is not a 'big' issue at this stage:

- the concept of global warming is still too vague and amorphous, if compared with graphic images of dying seal pups, or deforestation in tropical countries;
- the phenomenon does not pose an immediate health issue;
- the "tomorrow never comes" philosophy applies; as for smokers, who are prepared to live with smoking-related illnesses if they are at least 20 to 30 years away, a large proportion of the public are prepared to put the issue of global warming on the backburner.

An anthropological research team from the Massachusetts Institute of Technology recently investigated the cultural models that "laypeople" apply to the specific problem of global warming. Their results indicate that global warming is generally not well understood by laypeople in society, and is often confused with other environmental concerns.

> We found that people currently understand global warming by reference to prior experience with natural temperature fluctuations and to three cultural models: pollution, ozone depletion, and photosynthesis and respiration. .. One of the practical consequences of these models is that they misdirect concern. Based on our informants' reports, we

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124 *ibid.*

125 Cushman, J.H. (1997, October 23). Clinton unveils global warming plan. *The Oregonian*.

126 Bernton, H. (1997, December 2). Wyden seeks forestry tax incentives. *The Oregonian*.

127 American Forest & Paper Association. (1997, November 7). Global climate meeting in Japan. *Heads Up! A Weekly Fax from the AF&PA Forest Resources Group.*

128 Rankin, R.A. (1997, September 10). Clinton puts global warming, race at top of his agenda. *The Oregonian*.

would suppose that there are millions of Americans forgoing aerosol cans out of their concern for the greenhouse effect, an ineffective measure. As we will show, conclusions drawn from the use of inappropriate models also lead to support for ineffective policies.[129]

Based on these findings, governments and the scientific community should resolve to communicate with the public about global warming in the context of existing cultural models and concepts, starting now to prevent the creep of ignorance from the public into the governing policies. The American President appears to be convinced that the public could be a very powerful force against global warming if they make it a "gripping national issue". Through his public addresses and the White House conference on climate change, Clinton has been proactive in engaging this force within the constraints of his own administration.

The American position on climate change is by no means a unified national commitment to aggressive mitigation. Media reports have been quick to announce conflict in internal climate change negotiations. The Oregonian reported that "President Clinton's advisers are urging him to delay for decades the time when the USA and other industrial nations must achieve deep reductions in the pollution blamed for global warming."[130] The Natural Resources Defense Council and Sierra Club have indicated that the Clinton administration has already delayed aggressive mitigation, strongly criticising what they perceive to be contradictions between previous policy positions on climate change. In July 1996, in Geneva, U.S. Under-Secretary of State for Global Affairs Mr Wirth announced that the USA would seek a Climate Convention agreement with legally-binding limits on greenhouse gas emissions. In December 1996, American negotiators backed away from this stance, calling for a "delay" in legally-binding limits until 2010.[131] The U.S. Government described these stages as outlining a "broad framework for negotiation of next steps" in July 1996, and "further elaborating its ideas by describing the key elements that should be discussed for inclusion in a protocol" in December 1996.[132]

These key elements include an "emissions budget", which would allow parties to bank for future use emissions not used during a given period, borrow a limited amount of emissions from a subsequent period, and trade emissions.[133] The American plan of October 1997 proposes a target of reducing average annual emissions to 1990 levels by some point between 2008 and 2012. European environment ministers have criticised this target for not showing sufficient commitment to averting the threats of global warming.[134] At the climate negotiators meeting in Germany in March 1997, EU countries offered a proposal to cut emissions 15% by 2010.[135] In October 1997, the German Foreign Minister warned the USA

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129 Kempton, W., Boster, S. & Hartley, J.A. (1996) *Environmental values in American culture*. Woburn, Massachusetts: DEKR Corporation.

130 Cushman, J.H. (1997, October 10). Clinton aides urge delay in reducing pollution. *The Oregonian*.

131 Natural Resources Defense Council. (1997, August 20). *International climate negotiations update.* [On-line]. Available: http://www.nrdc.org/nrdc/nrdc/status/gwsr.html
Sierra Club. (1996, December 6). *Sierra Club blasts administration global warming plan.* [Online]. Available: http://www.sierraclub.org/news/global-warming/0018.html

132 U.S. Environmental Protection Agency. (1997, January 17). *U.S. climate change proposal fact sheet.* [Online]. Available: http://www.epa.gov/globalwarming/sub3/events.sub/uccp_fq.htm

133 U.S. Environmental Protection Agency. (1996, December). *U.S. Government position on climate change policy and international negotiations*. [On-line]. Available: http://www.epa.gov/globalwarming/sub3/events.sub/govpos.htm

134 Handyside, G. (1997, October 16). EU scorns lack of commitment to cut climate change. *Reuters.* [On-line news]. Available: http://www.mbnet.mb.ca/linkages/climate/news.html

135 Natural Resources Defense Council, *op. cit*.

and Japan, host of the Climate Convention conference in December, that the EU might reject climate change mitigation agreements that are not deemed strict enough.[136]

According to U.S. Senator Wendell Ford , the Senate passed a unanimous resolution in August 1997 saying they "would not ratify a treaty unless it mandates *"*new specific scheduled commitments to limit or reduce greenhouse gas emissions for developing country parties within the same compliance period*"* ... nor will we ratify a treaty that *"*would result in substantial harm to the economy of the United States*."*[137] At the other end of the spectrum, the Chair of the Oregon Energy Facility Siting Council wrote to President Clinton in September 1997 urging him to support the target proposed by the European Union:

> We believe that such a target is achievable and realistic for the United States as well as the European Union. We believe that the United States can achieve that target along with the other developed countries without doing damage to our economies when all developed countries are bound by the same target. Furthermore, we believe that such a reduction is a necessary response to the threat of climate change.[138]

The American business community believes it has much to lose if strict emission reduction measures are imposed. The USA is the world's largest producer and consumer of energy, and the largest producer of greenhouse gases. Annual emissions reached an all-time high of 1,387 million tonnes of carbon in 1994, which is approximately 67% higher than emissions from China, the world's second largest emitter. Like Australia, the USA relies heavily on fossil fuels to power its industrial, residential, and transportation sectors. In 1994, 41% of total emissions from the USA were from petroleum products, while the coal share accounted for 36%.[139]

7.2.2 Active Initiatives

The USA approach to meeting its commitments under the Climate Convention has three 'pillars':

1. Contribute to the necessary foundation in science
2. Domestic mitigation through partnerships between the public and private sectors
3. Global mitigation through international Joint Implementation agreements

7.2.2.1 USA Global Change Research Program

The USA maintains an extensive research effort on climate change, coordinated through the inter-agency USA Global Change Research Program. It was created as a Presidential Initiative in 1989, formalised by legislation in 1990, and has remained a key U.S. science initiative since.[140] The program provides a foundation for increasing the skill of predictions

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136 Kinkel: EU might reject climate agreement. (1997, October 22). *STT - Reuters.* [On-line news]. Available: http://www.mtv3.fi/

137 Ford, W.H. (1997, August). Global climate treaty is high stakes game for U.S. workers. *CEED News,* [On-line newsletter], *5*(7). Available: http://www.conx.com/ceed/comms/newsltr/v5n7.html

138 Edvalson, T. (1997, September 9). *Resolution of the Oregon Energy Facility Siting Council regarding international greenhouse gas emission reduction targets.* (Available from the Oregon Office of Energy, Salem, OR).

139 Marland, G., & Boden, T.A. (1997). Global, regional and national CO_2 emissions. In *Trends: A compendium of data on global change.* Oak Ridge, TN: Carbon Dioxide Information Analysis Center, Oak Ridge national Laboratory.

140 U.S. Global Change Research Program. (1997, September 9). *Introduction to the U.S. global change research program.* [On-line]. Available: http://www.usgcrp.gov/usgcrp/GCRPINFO.html

of climate fluctuations over time and long-term climate change. It also sponsors research on the vulnerabilities to changes in important environmental factors, including ultraviolet radiation at the Earth's surface, and land cover.

7.2.2.2 Climate Change Action Plan

In October 1993, President Clinton announced the Climate Change Action Plan (CCAP) as the basis for the USA response to challenges set forth by the Climate Convention. The Plan outlined a comprehensive set of measures to reduce net emissions, covering greenhouse gas emissions in all sectors of the economy.[141] It is the American equivalent of Australia's 'National Greenhouse Response Strategy'. Several of its voluntary programs, including reforestation efforts within the *Climate Challenge* program, have achieved a relatively high profile. However, the U.S. Congress has never fully funded the initiatives laid out in the CCAP. Like Australia and many other industrialised nations, the USA will fail to meet the Climate Convention target of reducing CO_2 emissions to 1990 levels by 2000.[142] As previously stated, the USA is now focusing on a target of reducing average annual emissions to 1990 levels between the years 2008 and 2012.

Recognizing forests as "a potentially important terrestrial sink for CO_2", the Action Plan set out several 'Forestry Strategies' that would have provided about 9% of the CO_2 emission reductions needed to reach initial greenhouse gas reduction targets. These strategies included:

- *Reduce depletion of Non-industrial Private Forests*

The USA recognised that "non-industrial private landowners generally do not manage their holdings intensively. As a result, about 16% of these forests are in poor health, and many are harvested for short-term economic gain without adequate regard for the future condition of the forest."[143] The government committed itself to providing technical and economic assistance to non-industrial private forest landowners to help them enhance the health of private forests.

- *Accelerate Tree Planting in Non-industrial Private Forests*

This program aims to increase tree planting on poorly stocked and non-stocked non-industrial private forest land by 95,000 hectares within five years. The government is committed to providing technical assistance and up to 75% federal cost-sharing by the Forest Service in cooperation with respective State Foresters.

The CCAP draws on two other forestry-related programs for carbon sink enhancement and protection:

- Increased efforts to enhance *recycling of forest products,* thus reducing the demands on rapidly growing forests and other biotic carbon sinks.
- The *Cool Communities* program, which encourages the planting of shade trees to improve home energy efficiency, and also enlarge biotic carbon sinks.

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[141] *Climate action report: Submission of the United States of America under the United Nations framework convention on climate change.* (1994). Washington, D.C.: U.S. Government Printing.

[142] U.S. Environmental Protection Agency. (1996). *op.cit.*

[143] *Climate action report: Submission of the United States of America under the United Nations framework convention on climate change*. (1994). *op. cit.*

The Climate Action Report (1994) noted that the USA has already taken significant steps to protect carbon sequestered in forests. "Lower harvests in old-growth forests help prevent CO_2 emissions, even if accompanied by increased harvests elsewhere, because old-growth forests have higher carbon densities than second-growth forests".[144] The USA also recognises the need for a shift toward ecosystem management, as opposed to timber management, which favors timber harvest methods that inflict less stand damage, therefore preventing carbon seepage.

Voluntary Reporting of Greenhouse Gases

The U.S. Energy Information Administration, in accordance with the Energy Policy Act of 1992, established the Voluntary Reporting of Greenhouse Gases Program to promote voluntary, innovative and low-cost approaches to reducing greenhouse gas emissions. It provides an opportunity for any organization or individual to establish a public record of emissions, emission reductions, or sequestration achievements in a national, publicly available database. This record provides recognition of environmental stewardship, and supports the exchange of information on the most effective ways to reduce greenhouse gas emissions. In mid-1996, more than 100 companies, accounting for about 23% of American CO_2 emissions, had reported some 645 individual projects to reduce emissions of greenhouse gases. Variations in estimation methods, and the fact that more than one participant may report on the same activity, make emissions and reduction total results somewhat unreliable.

Climate Challenge

The Climate Challenge program is a joint, voluntary effort of the U.S. Department of Energy (DOE) and the electric utility industry to reduce, avoid or sequester greenhouse gases. Utilities, in partnership with DOE, identify and implement cost-effective activities which are specified in individual agreements. Each utility reports its results annually, in accordance with the voluntary reporting of greenhouse gas emissions guidelines of the Energy Policy Act of 1992.

The actions that utilities commit to in their agreements cover a broad spectrum, and include various forestry activities. The Climate Challenge Program has developed a "Climate Challenge Options Workbook", an evolving manual that will identify a range of opportunities for greenhouse gas reduction, avoidance or sequestration. It will also describe many of the barriers which may deter progress, and suggestions for overcoming these barriers. It provides guidance in a context similar to that proposed for the workbook being commissioned by the Australian Greenhouse Challenge program.

The American workbook contains an option named "Forestry Carbon Management Projects". The option acknowledges the ability of forests and forest products to store carbon, that preliminary information indicates some forestry measures have a relatively low cost per tonne of carbon sequestered, and that net CO_2 emissions are effectively zero for a system where CO_2 released during biomass combustion is simultaneously sequestered by the next energy crop. The option also discusses barriers, solutions to the barriers, and brief case studies for consideration. One case study is the agreement between PacifiCorp, a regional utility in the Pacific Northwest, and DOE. PacifiCorp has developed four ongoing efforts to test cost-effective ways to offset emissions through forestry. There is no regulatory agency that requires American utilities to compensate for their CO2 emissions with carbon offsets at

[144] *ibid.*

this stage, but PacifiCorp has determined that sequestered carbon has a value that is worth collecting now. Their pilot projects are:

- *Reforestation* of non-industrial private forest lands in southern Oregon in cooperation with the Oregon Department of Forestry. During the two years of the project (1993-94), 255 hectares were planted, which should sequester an estimated 66,150 tonnes of carbon over a minimum 65 year rotation period.[145] In return for PacifiCorp paying the costs of site preparation and planting, landowners signed contracts giving PacifiCorp all the carbon benefits associated with the reforestation. The undiscounted cost per tonne of carbon sequestered ranges from approximately US$2 on site class 2 lands to $2.50 on site class 3 lands.[146]

- *Reforestation* of privately-owned lands in eastern Washington that were devastated by fire in 1991. The fire damaged some 20,000 hectares of forested lands, and depleted most seed stock required for natural regeneration. Many do not qualify for federal forestry cost-share programs, and are not required to restore the forest under state law. Many landowners in the area cannot bear the cost of reforestation on their own, and without carbon offset funds, these lands would probably remain unforested.[147] Tenaska Inc., an independent power producer, and PacifiCorp are providing funding for the reforestation of approximately 2,200 hectares, which is being implemented by the Upper Columbia Resource Conservation & Development Council. They are funding 75% of the planting costs, with the remaining 25% of reforestation costs borne by the individual landowners. This arrangement is designed to ensure landowner commitment to the reforestation effort. In the contracts, landowners agree to carry out a site-specific management plan and to maintain the forest stand(s) as part of a sustainable forestry effort spanning at least 80 years, at which time a seed tree or shelterwood harvest will start natural regeneration. Commercial thinning is permitted, under certain conditions. As for the reforestation in southern Oregon, landowners have assigned all carbon benefits associated with planted trees to Tenaska Inc. and PacifiCorp. Based on the management plan and existing stand yield projections, approximately 17 tonnes of carbon per hectare will be sequestered in tree biomass, plus 5 tonnes per hectare in the soils and forest floor, for a total of more than 250,000 tonnes of carbon through the existing project. The undiscounted cost of sequestering the carbon is estimated at $2 per tonne. At a 4% discount rate, the cost is $5.25 per tonne.[148]

- *Shade tree planting* of over 1,000 trees in several residential areas in Salt Lake City. PacifiCorp worked with TreeUtah, a non-profit organisation, to obtain carbon benefits from the sequestration as trees grow, and the shade created by the trees which decreases the amount of electricity needed for cooling. Based on a 4% discount rate, the cost of sequestered carbon was calculated as $18 per tonne for homes with air-conditioners, and $47 per tonne for homes with evaporative cooling. These costs are considerably higher than those of rural tree planting initiatives. However, PacifiCorp welcomed the opportunity to plant trees in the city, a highly visible means of demonstrating a service to the community. PacifiCorp also cited in its reasons the opportunity to advance their knowledge of the effects of planting shade trees on energy consumption.[149]

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[145] Trexler & Associates, Inc. (1995, August 22). *Southern Oregon reforestation.* [On-line]. Available: http://www.teleport.com/~taa/odf.htm

[146] *ibid.*

[147] Edmonds & Trexler, *op. cit.*

[148] *ibid.*

[149] Edmonds & Trexler, *op. cit.*

- *Investment in the Oregon Forest Resource Trust*, an organisation established by the Oregon legislature to fund planting on unforested and understocked lands. PacifiCorp has agreed to invest US$75,000 in the Trust in exchange for 37,500 tonnes of carbon offsets.[150] This cost is based on the cost of sequestering carbon in PacifiCorp's other pilot projects in the Pacific Northwest. By combining PacifiCorp's investment with state funds, the Trust can reforest 2,000 hectares in the near term, with a long term goal to plant over 100,000 hectares in 15 years.[151]

An important program under the Climate Challenge banner is the 'Utility Forest Carbon Management Program' (UFCMP). This initiative was developed in 1994 by the Edison Electric Institute, with support from 55 electric utilities, to advance the state of knowledge regarding forest-based mitigation options, promote environmental stewardship by the utility industry, and implement low-cost forestry projects to manage greenhouse gases.[152] The UFCMP developed criteria and a process to review proposed projects. Thirty-two proposals were received in March 1995 and reviewed by the UFCMP committees, an outside consultant and, to a limited extent, by the UFCMP Advisory Council, which is comprised of representatives from nine non-electric utility organizations, including American Forests, U.S. Department of Energy, and the USDA Forest Service. Proposed projects were located in the USA, Central America, South America and Asia.

The technical criteria address estimation of full life cycle carbon sequestration benefits, emissions calculations, monitoring, contingency plans, and non-emission impacts, as well as project developer qualifications and experience. The cost-effectiveness of the project in terms of cost per tonne of sequestered CO_2 was a key project criterion. Projects were ranked, and a pool of five projects emerged as the final product for which sponsorship was sought. Subsequently, 40 UFCMP members joined together to form 'UtiliTree Carbon Company' and provide cooperative funding. The five projects in the final pool represent a diverse mix of rural tree planting, forest preservation, forest management and research efforts at both domestic (eastern and western USA) and international sites. As of 1995, the UtiliTree Carbon Company has committed slightly over $2.4 million to fund the pool of projects. It is anticipated that CO_2 will be 'managed' at a cost of under $1 per ton, including administrative expenses. Over two million tonnes of CO_2 benefit will result from the five projects over their lifetimes. Participants will share on a pro rata basis reporting of CO_2 benefits to the voluntary reporting of greenhouse gases program.

The USA Environmental Protection Agency (EPA) has also launched a campaign focused on voluntary partnerships between various sectors of the community. Their wide array of partnership programs are collectively referred to as *Partners for the Environment*. While there are no specifically forest-based partnership programs for climate change mitigation in 1997, the EPA *Partners* program does work in cooperation with the U.S. Initiative on Joint Implementation to reduce global greenhouse gas emissions.[153] The EPA works closely with

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150 *ibid.*

151 Climate Challenge. (1997, August 17). *Climate challenge participation accord.* [On-line]. Available: http://www. eren.doe.gov/climatechallange/orig/cc_accord-PACIFCOR.htm

152 *UtiliTree carbon company / Utility forest carbon mangement program.* (1997, July 11). [On-line]. Available: http://www.ji.org/iuep/utree2.htm

153 U.S. Environmental Protection Agency. (1997, August 17). *EPA's partners for the environment*. [On-line]. Available: http://www.epa.gov/partners/

other agencies, including Federal and State Department of Energy offices, to promote mitigation activity in all sectors.

7.2.2.3 Joint Implementation

Like the Australian AIJ program, the US Initiative on Joint Implementation (USIJI) is a voluntary pilot program that contributes to the international knowledge base through projects demonstrating a range of approaches to reducing or sequestering greenhouse gases in different geographic regions.

Under this banner, there are some exciting activities underway to sequester CO_2 emissions. In July 1997, the USIJI approved funding for a project that will consolidate and legally protect national parks and biological reserves in Costa Rica. Although these lands already had reserve status, the Government was unable to ensure their permanent protection. A Costa Rican commission report found that only 5.4% of the country's total protected areas were guaranteed through government ownership and conservation management.[154] The project intends to purchase more than 500,000 hectares of threatened park lands from private owners and NGOs, and transfer titles to the Costa Rican Ministry of Environment and Energy for permanent protection. Tropical deforestation will be avoided and carbon sequestration by natural growth will increase in the secondary forests and reforested pasture lands. The project will generate funds to purchase these lands from the sale of "Certifiable Tradable Offsets" (CTOs). Each CTO will represent a third party certification of 1,000 tonnes of carbon sequestered by the project in the previous year. The Costa Rican government will guarantee the CTOs for 20 years. The World Bank will provide funding to support the monitoring and insurance of the CTOs. *It is hoped that CTOs will eventually provide funding for the construction of a $20 million Earth Center, to provide for ecotourism education and entertainment within the park system*. The Government of Norway has since purchased 200,000 tonnes at a price of at US$10 per tonne.[155] The USA-based Center of Financial Products Limited has also purchased the first 1,000 tonnes of CTOs, and placed their certificates on the Chicago Stock Exchange. Costa Rica will promote approximately 15 million tonnes of CTOs for their special conservation trust fund.[156]

Another example of diverse benefits through USIJI intervention is the introduction of "reduced impact logging" (RIL) practices to East Kalimantan, Indonesia. Moura-Costa (1997) cites Poore in stating that the majority of logging operations in tropical countries are considered unsustainable and damaging.[157] American Forests are working in cooperation with

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[154] U.S. Initiative on Joint Implementation (1997, July 28). Press release for newly accepted USIJI round 4 project. *JIOnline*. [On-line mailing list]. Available E-mail: JIOnline@eei.org

[155] Moura-Costa, P., (personal communication, September 18, 1997).

[156] McKenzie, T., (personal communication, May 19, 1997).

[157] Moura-Costa, P. (1997). Tropical forestry practices for carbon sequestration : A review and case study from Southeast Asia. *Ambio, 25,* 279-283.

a USIJI project developer, the Association of Indonesian Forest Concession Holders, the Center for International Forest Research and the two Indonesian concessionaires to implement RIL on 600 hectares of lowland rainforest.

It is not the first time that reduced impact logging has been encouraged through international cooperation for climate change mitigation. In 1993, an American utility company began a carbon-offset initiative in partnership with a Malaysian forest products corporation to use reduced impact logging techniques on about 1,400 hectares of Malaysian rainforest. Before these techniques were introduced, logging in this environment often netted as few as two trees per hectare, with as many as 54 tonnes of CO_2 emitted per hectare.[158] The utility company estimates that through reduced logging damage and enhanced regrowth, CO_2 emissions are reduced by 8 tonnes per hectare after one year, 77 tonnes after five, 105 tonnes after 10, and 142 tonnes after forty years.[159]

The U.S. Government also has bilateral climate change mitigation projects underway, providing funds, expertise and equipment to developing countries so that they may establish greenhouse gas inventory and mitigation programs.[160]

7.2.2.4 Other USA Initiatives

The state of Oregon is claiming the world's first CO_2 offset competition. In 1995, in a move towards deregulation, Oregon's legislature adopted a measure in which up to 500 megawatts of new gas-fired power plant capacity would be exempted from the "need for power" standard. The provision on this rule was that the exemption would be awarded to the facility with the least environmental impact based on monetised net air emissions per megawatt-hour, including CO_2. Three companies competed for the exemption, and the proceeding provided an initial process model by which regulatory authorities can evaluate carbon offsets as a mechanism for complying with climate change mitigation requirements. Two of the three competing energy producers, including the winning applicant, submitted offset portfolios that included commitments to carbon sequestration through forest management in Oregon and Washington states. One part of the winning bid was a commitment to provide US$1.5 million to reforest more than 2000 hectares of land in western Oregon, backed by a guarantee to procure another $1.5 million in matching funds.[161] *This ground-breaking competition had several positive outcomes*. It used competition to stimulate efficient commitments to CO_2 mitigation. It established specific financial commitments with funds for "performance insurance". It also developed an initial record for CO_2 offset standards.[162]

The state of Oregon is also recognised as the first state in the USA to control CO_2 emissions, through legislative changes made in June 1997. A bill was passed that requires developers to reduce the overall amount of CO_2 emitted from new power plants. Developers can achieve this net reduction in various ways, including tree planting, but the reduction must be at least 17% below the emission rate of the most efficient plant then operating. This bill had the

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158 Kinsman, & Trexler. (1995), *op. cit*.

159 *ibid.*

160 *Climate action report: Submission of the United States of America under the United Nations framework convention on climate change*. (1994). *op. cit.*

161 Trexler & Associates, Inc. (1996, May). Special issue : The Oregon 500MW exemption proceeding. *Mitigation Monitor,* [On-line newsletter]. Available; http://www.teleport.com/~taa/monitor5.htm

162 Trexler & Associates, Inc. (1996). *Carbon offsets as environmental mitigation: A First regulatory case study.* Unpublished report.

support of various utilities, environmental groups, and industry groups, and received unanimous passage through both houses of Oregon legislature.[163]

Established in 1875, American Forests is the oldest conservation organization in the USA today. It is active in rural, urban and international conservation programs, including forest management projects in Indonesia and Mexico which are endorsed by the USIJI. American Forests has recognised the role it can play in slowing climate change, stating "planting trees, or preventing the destruction of existing trees, will reduce the 'net emissions' of an individual or organisation. American Forests can provide an important component of an emissions reduction program through carbon offset forestry projects."[164] The organisation has now developed a portfolio of projects that can be tailored to the priorities of prospective partners. Through their 'Global Releaf 2000' program, American Forests has facilitated the planting of over five million trees in 32 states across the USA since 1990, with a mission goal of 20 million trees by the year 2000. Their 'Global Releaf International' program develops partnerships with non-profit, non-governmental environmental organisations based in other countries, providing 'partners' with opportunities to compare techniques in forestry, fundraising and office management. American Forests now has more than 20 partners in over 18 countries.

Utility companies have embraced the concept of tree planting initiatives for CO_2 emission reductions, recognizing the public relation benefits and the potential for credit under future regulation schemes. Portland General Electric, an Oregon utility, initiated a 'Seed the Future' program in November 1996 in partnership with the 'Friends of Trees' organisation. By mid 1997, some 3,000 volunteers had planted 1,850 trees in neighborhoods and 15,000 seedlings in natural areas, and won an Oregon Urban and Community Forestry Award.[165] The goal is to engage volunteers to plant more than 144,000 trees by the year 2001. There is no indication that 'carbon credits' will be sought for this tree planting initiative, but the utility will receive public praise for this initiative, which may carry benefits into a future regulatory framework.

'*Seed the Future*' is one of many urban tree planting initiatives in the USA. Kinsman and Trexler (1995) discuss other significant tree planting programs initiated by utility companies in the states of New York, Wisconsin, Florida, Southern California, Arizona and Oklahoma. The objectives of these programs include CO_2 sequestration, reduction of energy consumption by cooling cityscapes with shade trees, bioenergy production, and reforestation of areas damaged by disease, fire or hurricane. The Oklahoma Gas & Electric Company has a creative program for extending the life of power-line poles. Rotted or damaged wooden poles are injected with a liquid that dries to become a hard, environmentally safe material, while extending pole life by at least 10 years. It is a way to maintain the carbon already sequestered in the pole, and reduces the demand for costly new poles.[166]

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163 Sadler, S., (personal communication, October 6, 1997).

164 *American Forests* . (1997, October 31). [On-line]. Available: http://www.amfor.org/

165 Portland General Electric. (1997, October). *Seed the future program.* [On-line]. Available; http://www.pge-online.com/

166 Kinsman & Trexler. (1995), *op. cit*.

Like efforts by Australia's National Association of Forest Industries, agencies such as the Western Wood Products Association are promoting wood as a "carbon-friendly" product.[167] "The production of concrete emits more carbon dioxide, carbon monoxide, and hydrocarbons than the production of lumber. ... Wood does what the others cannot do. While growing, trees absorb CO_2 and release oxygen. CO_2 is locked out of the atmosphere in the wood fiber, where it remains even after the tree is manufactured into building products."[168]

7.2.3 Proposed Mitigation Measures

7.2.3.1 Carbon Tax and Tradable Permit Systems

As of October 1997, there are no carbon taxes employed in the USA. There is no tradable permit program for carbon units either. However, there has been considerable discussion on these proposed options in the USA. The 'State Carbon Tax Model' was developed by the Center for Global Change in 1991-92 in response to a request from the Maryland Legislature, and has since been tested by state officials and environmentalists in other states.

In 1997, the World Resources Institute released a comprehensive report on the economic impacts that a carbon tax or tradable permits system would have on the USA. It examined the assumptions and conclusions of the numerous models used to predict the economic impacts of "CO_2 abatement". The report identified considerable variation in predicted impacts stemming from differences in underlying assumptions.[169] However, two areas of general agreement were identified. The first is that *economic impacts will be much more favorable if revenue-raising policy instruments are used to control CO_2 emissions and the revenues are used to reduce other burdensome tax rates*. The Institute advances this conclusion by stating that, under reasonable assumptions and preferable policy approaches,

> a carbon tax is a cost-effective way of reducing the risks of climate change and would do no damage to the economy. More likely, taking the environmental effects into account, it would bring long-term benefits.[170]

The second area of agreement among economic models is that *joint implementation will reduce the overall costs of achieving emission reduction targets*. "The U.S. Government should continue to consult and negotiate with other nations to gain international acceptance for joint implementation".[171] This decisive conclusion stands brightly above the ongoing debate about the pros and cons for joint implementation, providing considerable support for those advocating continued AIJ activity.

The World Bank is also investigating the impacts of climate change mitigation on economic markets. In coalition with the Government of Norway, the World Bank initiated a three-year program in 1996 to explore greenhouse gas markets. The pilot phase launched will fund projects designed to maximise learning about the possible mechanisms for carbon deals, and how different mechanisms can contribute to the interests of the host countries and investors. Other objectives of the program include the exploration of solutions to analytical and methodological issues, and increasing private sector participation in carbon deals. The Bank

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[167] Western Wood Products Association. (1995, October). *Western wood works: Environmental background information.* [Brochure]. Portland, OR: Author.

[168] Western Wood Products Association. (1993). *Choices in building materials.* [Brochure]. Portland, OR: Author.

[169] Repetto, R. & Austin, D. (1997). *The costs of climate protection : A guide for the perplexed.* Washington, DC: World Resources Institute.

[170] *ibid.*

[171] Repetto & Austin, *op. cit.*

recently agreed to a new project in Burkina Faso, which will be the first AIJ project in Africa.[172] It is expected that more pilot projects will be initiated in Asia and Eastern Europe during 1997.

7.2.4 Obstacles To Mitigation Through Forestry

As in Australia, obstacles are slowing the adoption of forest-based mitigation projects in the USA, and some fear that the forestry option could be permanently discarded by national policymakers.

One substantial obstacle is the lack of progress towards implementing economic instrument(s) that would stimulate emitters into using many if not all available options. The U.S. Government fears that instruments such as a carbon tax would cripple the economy, on account of its dependence on fossil fuels. This fear is deeply rooted in the American business community, and vocalised by lobby groups such as the National Mining Association, the Climate Council and the Global Climate Coalition.[173] In 1995, the Executive Vice President of the American Petroleum Institute stated,

> European environmental ministers -- not finance or energy ministers -- are promoting a 20% reduction in greenhouse gas emissions from 1990 levels by 2005, 2010 or 2020. A reduction that would apply only to developed countries. USA competitiveness and trade would be crippled with little or no impact on long-term climate projections. Economic studies of such a scenario conclude that our GDP could be reduced almost 4% and almost 600,000 jobs would be lost annually.[174]

The primary message from the energy lobby groups is that, despite the weighty IPCC determinations of 1995, there is still scientific uncertainty regarding the rate of climate change and its consequences, and that economic development should not be sacrificed on the basis of environmentally-biased estimates. Furthermore, they profess global climate change can be addressed with business solutions which focus on concentrations rather than emissions, and support investment now in new technology and conditions which will be favorable to emission cuts later.

The DOE Climate Challenge Options Workbook identifies various other barriers to forestry carbon management projects. They include :

- uncertainty at State level regarding how forest carbon management projects will be treated by regulators
- surface mining regulations result in economic and other disincentives to tree planting on mine lands
- limited information regarding forest carbon management project costs
- competition for land use in many areas, and current agricultural subsidies encourage traditional crops rather than woody biomass for bioenergy[175]

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[172] World Bank. (1997, Winter/Spring). Building global markets to reduce climate change. *Environment matters at the World Bank,* 23.

[173] Holmes, C. (1996, July/August). What does Geneva mean for coal? *CEED News, 4*(7). [On-line newsletter]. Available: http://www.conx.com/ceed/comms/newsltr/v4n7.html,

[174] O'Keefe, W.F. (1995, November 8). The science and politics of climate change. [On-line]. Available: http://www.api.org/news/coalwrd.htm

[175] Climate Challenge. (1994, October). *Climate challenge options workbook.* [On-line]. Available: http://www.eren.doe.gov/climatechange/cc_options1.htm.

A new project was launched in 1997 by a team of American experts that specialise in various aspects of climate change science. The *'Land Use and Biotic Mitigation Policy Project'* is an effort to secure the role of forestry and other biotic mitigation measures in national and international climate change mitigation policy. The team has recognised that the obstructions to this task are questions, numerous and onerous, that currently lack technically and politically credible solutions.[176] As the demands on climate change policy approach urgent cries for affirmative action, policymakers may be inclined to remove options that are not as straightforward as emissions avoidance, or those that provide avenues for attack by opponents. The project team has identified various reasons why forestry and other biotic offsets may be excluded from evolving mitigation policies, including:

- widespread but largely ill-founded fears that forestry offsets might turn entire countries into carbon sequestration reserves;
- concerns that forestry offsets might impede progress on achieving direct emissions reductions and technology transfers in the energy sectors; and
- perceptions that biotic offsets involve more complex analytical issues that need to be solved than do other offset options.

There are technical questions, relating to the issue of analytical complexity and specific to forest-based options, that are still to be addressed.

- How can sequestration be equated with emissions avoidance?
- How should accounting systems deal with the impermanence of forestry offsets?
- Are leakages of CO_2 benefits more likely in the forestry sector than other sectors?

During the non-crediting phase of CO_2 offsets, it has not been critically important to find solutions to these issues and questions. As national and international climate change negotiations move closer towards more stringent commitments, solutions are necessary if forestry and biotic offsets are to be secured in forthcoming policies.

The project team has launched a three-phase program, to run over two years, with the desired result being a significant advance in both technical and political understanding of how forestry and related climate change mitigation measures can credibly and effectively contribute towards societal policy objectives in this area.

[176] Trexler, M.C., (personal communication, April 1, 1997).

7.3 OTHER NATIONAL INITIATIVES

7.3.1 Canada

There are many similarities between the national circumstances of Canada and Australia regarding climate change and CO_2 emissions. Canada is the second largest country in the world, and has one of the lowest population densities in the industrialised world : about 30 persons for every 1,000 hectares.[177] As a result, transportation needs can be much greater than in other countries. A large portion of Canada's natural resource endowment is geographically removed from the population and manufacturing centres that stretch along the border with the USA. When compared with other industrialised nations, Canada, like Australia, is more dependent on the extraction and processing of natural resources than on manufacturing. Canada enjoys an abundance of energy resources, including coal, natural gas, uranium, and oil. More so than Australia, Canada has an abundance of opportunities to pursue hydro-electricity activity to supply its energy demands. While exports of manufactured products has increased in recent years, Canada continues to rely heavily on the export of energy-intensive natural resources. Greenhouse gases associated with these exports are attributed to Canadian sources. To complete the picture, Canada has had the highest rate of population growth and economic growth among industrialised countries in the 1990s.

Canadian policy on climate change mitigation is also similar to that of Australia. As in Australia and the USA, Canada's National Action Program on Climate Change is built around voluntary challenge initiatives involving both government and industry, and voluntary registration of emission reductions. This program is coordinated by Environment Canada, a Federal Government agency, which has produced a "living", "flexible" plan to cover a wide range of opportunities to address climate change, including actions related to energy efficiency, renewable energy resources, carbon sinks, research and development, education, and international cooperation.[178]

Canada is an active supporter of AIJ, and recently hosted an international conference titled "Technologies for Activities Implemented Jointly", which attracted delegates from 41 countries to Vancouver BC. At this conference, the need for regulation was discussed, with industry members indicating that only firm regulation would enable JI to progress beyond the pilot phase. One Canadian development suggests that regulation is not necessarily required to significantly alter practices that emit CO_2. Telecom Canada decided to phase out ozone-depleting chlorofluorocarbons (CFCs) irrespective of government or international initiatives. Not only did the company reap huge public relations kudos as a result, it also became a leader in CFC replacement technology.[179] This example is a timely reminder that the 'power of one' exists, and one need not wait for governments to lead the way.

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[177] Environment Canada. (1995). *Canada's national action program on climate change.* [On-line]. Available: http://www.ec.gc.ca/climate/resource/cnapcc/

[178] *ibid.*

[179] Ross, *op. cit.*

7.3.2 European Union

The March 1997 session of the Berlin Mandate talks triggered an important political advance in Europe. The European Union finally reconciled the differing interests of its member states in a unified negotiating position. In the leadup to the third Conference of the Parties in December, the EU proposal contains a numerical target for emissions reductions, being 15% below 1990 levels by 2010.[180] The EU Council of Ministers that produced this proposal decided that an emission index for each of the member States would guide the determination. This proposal has received some criticism, not least of which is that it allows for differentiated responses within the EU, and calls for undifferentiated responses from the rest of the world's nations.

The choice of 1990 as a baseline year for Climate Convention targets will be favorable to **Germany**. German reunification occurred in 1990, and over the next year economic activity in the former DDR contracted by 23%.[181] Changes in the energy sectors towards greater efficiency and less dependence on fossil fuels are also responsible for Germany's impressive scorecard. Data records to 1994 show that there has been a general declining trend in emissions levels since 1979. Although burning of solid fuels accounts for the largest fraction of emissions (41% in 1994), the use of coal has been in general decline since 1950, at which time coal burning produced about 97% of total emissions. Natural gas burning first contributed over 1% in 1968, and is now 17% of the total.[182]

The **United Kingdom** is also favored by the "grandparenting" of 1990 emission levels. The privatization of the electricity sector in 1990 and the demise of the coal mining industry resulted in a substantial shift to gas. This transition has made reductions in CO_2 emissions much less difficult for the UK, as gas produces fewer emissions per unit of electricity generated, and new combined cycle generation lifts conversion efficiencies up by around 10%, reducing CO_2 emissions by 60% compared with coal.[183]

The Carbon Storage Trust of Oxford, England, is a new organization selling CO_2 offsets to the retail public. In June 1997, the Trust invited project proposals to develop a portfolio of acceptable projects and proposals which it can fund. The criteria provides for applicants with forest-based mitigation proposals

> Afforestation projects should demonstrate management plans in the "very long" term and not just for a fixed period of time. .. [they] should consider whether or not harvesting for commercial return displaces timber products from elsewhere. Any investment of timber in durable products must show a clear and unequivocal expansion in the market for these products caused by the scheme.[184]

Another agency in the United Kingdom investigating the role that forests can play in climate change mitigation is the International Energy Agency (IEA). While its primary focus is energy cooperation among the OECD member countries, the IEA has an active Greenhouse

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[180] EU Council of Ministers (1997, March 3). EU conclusions on climate change. [On-line]. Available: http://www.ji.org/usiji/events/eu30397.shtml

[181] Kellow, A. (1997, August). The political economy of FCCC: Who wins? Who loses? In *Countdown to Kyoto: The consequences of mandatory CO2 emission reductions*. Conference conducted at the Australian APEC Study Centre, Canberra.

[182] Marland & Boden. (1997), *op. cit.*

[183] Kellow, *op. cit.*

[184] The Carbon Storage Trust. (1997, June 23). Preliminary request for project proposals. *JIOnline*. [On-line mailing list]. Available E-mail: JIOnline@eei.org

Gas R & D Programme that does examine all opportunities for avoiding and sequestering CO_2, including work on enhancing the sink capacity of oceans by "fertilization" with nitrates. An IEA discussion paper on CO_2 capture, storage and future activities stated that:

> more effective management of forests could sequester substantial amounts of carbon at relatively low cost [50-100 billion tonnes over the next 50 years, at a cost of $5-20 per tonne of carbon]. However, the long-term fate of forests planted specifically for this purpose needs further examination, as do the political aspects of establishing such forests in countries different from those emitting the CO_2.[185]

The Netherlands is home to an international program of reforestation and afforestation for climate change mitigation that has received widespread acclaim. The FACE Foundation (Forests Absorbing Carbon dioxide Emissions) was established in 1990 by the Dutch Electricity Generating Board (Sep N.V), a cooperative body of power producers responsible for the reliable generation of electricity under socially acceptable conditions at the lowest possible cost. *Sep N.V. provided FACE with a mandate to coordinate the establishment and maintenance of forest-based carbon offsets to compensate wholly or partly for the CO_2 emissions from power stations in the Netherlands*. Their pilot project is the planting of forests to offset the emissions of a new 600MW coal fired power plant. These emissions amount to approximately three million tonnes a year over a technical life of 25 years; it was calculated that 150,000 hectares of new forest would be required.[186]

FACE does not buy land or trees. It invests in one single forest function: the ability to sequester CO_2. Other parties, including the forest owner, contribute by extracting other yields from the forest: wood, fruit, biodiversity conservation, and soil protection. FACE is entitled to sell its share of the CO_2 sequestered to third parties. Sep N.V. has undertaken the FACE initiative on a voluntary basis, and annually invests about US$8 million. Until 1997, Sep N.V. was the only financier. A German organisation is now investing in the foundation.[187]

FACE recognises that it best achieves its objectives if the afforestation would not have taken place without their funding : only in such cases is there a demonstrable and direct relationship between CO_2 emission, FACE funding and CO_2 sequestration in the new forests. Their projects are carefully selected and generally small in scale. Cost-effectiveness is an important criterion for FACE, but the continuing maintenance of forest ecosystems is of paramount importance. FACE therefore targets those areas where re/afforestation is necessary, and where there are widespread positive ancillary benefits. The first FACE-funded tree was planted in 1992. Projects are now established in The Netherlands, Czech Republic, Ecuador, Uganda and Malaysia. The establishment of FACE projects will run from 1992 to 2008, and current re/afforestation projects cover about 170,000 hectares. [188]

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185 Reimer, P. (1995). Greenhouse gas mitigation technologies: An overview of CO_2 capture, storage and future activities of the IEA greenhouse gas R&D programme. In *IEA greenhouse gas mitigation options conference,* London.

186 Verweij, J.A. (1997, May). *Re/afforestation and the market for joint iImplementation.* [On-line]. Available: http://www.facefoundation.nl

187 *ibid.*

188 Verweij, *op. cit.*

It is worth noting a study of the economics of carbon sequestration in forests on agricultural land in the Netherlands by Slangen and Van Kooten in 1996. They concluded that :

> there is likely little room for this [climate change mitigation] option in the Dutch government's policy arsenal as there certainly must exist methods for reducing CO_2 emissions that are better in terms of having lower net social costs, a smaller negative impact on economic activity, and a smaller budgetary impact. Alternative disposal/surplus schemes were noted, but additional research is needed to determine their costs.[189]

High agricultural land values are the primary reason why sequestration costs in the Netherlands are so large. This factor contributes to the reason why only 5,000 hectares of the 170,000 hectares being planted by FACE are in the Netherlands. In developing countries, land and labour costs are lower, and opportunities to improve forest management provide for cost-effective carbon sequestration.

Countries in **Scandinavia** are actively addressing the threat of global warming with economic instruments. Sweden and Norway have signaled a willingness to adopt a unilateral carbon tax by adopting small carbon taxes, which are imposed on fuel sources, such as coal and petroleum, based on expected carbon emissions.[190] The Norwegian Government has also established a climate fund in addition to their conventional overseas aid. Since 1991, this fund has allocated about US$20 million to AIJ. Their AIJ portfolio includes reforestation in Costa Rica, as well as fuel switching in Poland and energy sector development in Burkina Faso.[191]

In 1990, Finland became the first country in the world to introduce a CO_2 tax.[192] Initially, the tax was imposed on fossil fuels, except automotive fuels, according to carbon content. The tax was reformed in early 1997 to take into account the liberalization of the energy markets and to maintain the competitiveness of Finnish electricity generation. Taxes on the input fuels for electricity generation were removed, and a uniform tax was imposed on all electricity consumed. The electricity tax is differentiated between sectors. Industry and professional glasshouse growers are now entitled to pay tax at a rate approximately equal to the rate effective in the former system. For all other users of electricity, the rate was almost doubled.

In the utilization of bioenergy, Finland leads the industrialized world. The biofuels used in Finland include wood, peat, agricultural biomass and biowaste. In 1995, bioenergy accounted for 21% of total energy consumption and 17% of electricity production.[193] It is the declared goal of the Finnish Government to increase the use of bioenergy by at least 25% by the year 2005. The forest industry is the largest consumer of wood-based energy in Finland, while district heating systems utilise the extensive peat resources available.

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189 Slangen, L.H.G. & van Kooten, G.C. (1997, May). Economics of carbon sequestration in forests on agricultural land in the Netherlands. In *Western Forest Economists Conference,* Welches, OR.

190 Repetto & Austin, *op. cit.*

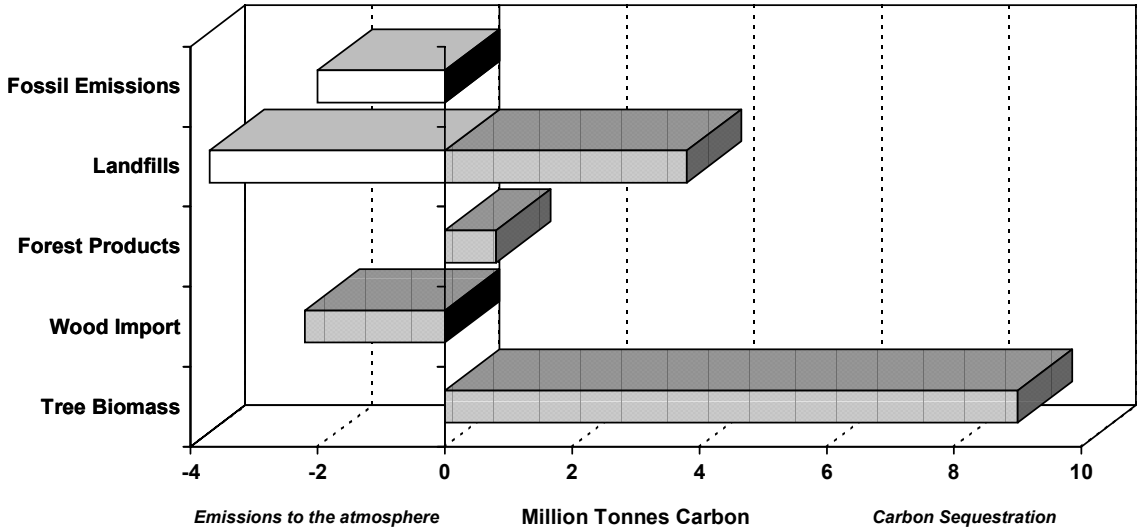
191 Adams, D. (1997, July). Technologies for activities implemented jointly. *Greenhouse Issues* [On-line serial], *31*. Available: http://www.ieagreen.org.uk/july31.htm

192 Ministry of the Environment. (1997). *Finland's second report under the framework convention on climate change.* Helsinki, Finland: Author

193 *ibid.*

In their 1996 study of the 'greenhouse impact' of the Finnish forest sector, Pingoud et al. identified waste management practices as a major factor to be taken into account in climate change mitigation.[194] The contribution of landfills to greenhouse gas emissions is illustrated in Figure 6.

Figure 6. Net 'greenhouse impact' of the Finnish forest sector in 1990[195]



7.3.3 South America

The international conference on AIJ technologies held in Canada in May 1997 identified **Costa Rica** as the most active host country for AIJ investments.[196] As previously discussed, Costa Rica is now selling government-backed certifiable tradable offset (CTO) certificates. More than 200,000 tonnes of carbon have been purchased by international investors in 1997, generating a revenue of over US$2 million for the government. An important result of this activity from a global perspective is that a mechanism is now established that allow tradable units of CO_2 on the stock exchange, providing a gateway for more market-driven advances in climate change mitigation.

CTOs are a product of a determined effort by the Costa Rican Government to encourage land owners to opt for forestry-related land uses. They are doing this by providing incentives of direct payment for environmental services, such as CO_2 fixation, and the protection of water quality, biodiversity and landscape beauty.[197] Initial financial resources for these direct payments have been generated through the implementation of a new 15% tax on fossil fuel use, and loans from agencies such as the World Bank. Having secured these environmental gains, or at least the processes that will provide them, the government plans to sell the value of these new gains. As previously demonstrated, investors will pay for units of CO_2 sequestered. The timber produced by sustainable forest production should also provide financial returns. Costa Rica is also working on ways to charge the economic sectors which benefit most from these services. An example is a proposed system to charge hydroelectric

194 Pingoud, et al., *op. cit.*
195 *ibid.*
196 Adams, *op. cit.*
197 Moura-Costa, P., (personal communication, September 18, 1997).

plants for the conservation of their water catchments, with the charges being delivered as direct payment to farmers engaged in sustainable forestry activities in these catchments.[198]

In contrast to the open arms of Costa Rica, **Brazil** currently objects to the concept of AIJ.[199] There are however various climate change mitigation projects working on a regional level. The World Business Council for Sustainable Development has incorporated carbon sequestration in its objectives for sustainable forestry projects. IMAFLORA, an extension arm of the University of Sao Paulo is coordinating a multi-disciplinary effort to re-cover the forest fragments along the Corumbatai River Basin in the Atlantic moist forest. The Corumbatai River is the water source of almost 500,000 inhabitants of cities which are willing to undertake a co-participation with several non-profit organisations, the private sector, and local administrations. The objectives of this project are to:

- achieve "balance zero" : carbon emitted in the region = carbon sequestered in the region
- improve water quality for treatment, which would decrease treatment costs
- increase biodiversity values in the basin by linking forest fragments
- increase community stewardship with implementation of environmental education programs

IMAFLORA hopes that the results of this project will provide steps towards solutions to government uncertainty to participate in JI programs for climate change mitigation.[200]

7.3.4 New Zealand

A recent legislative decision in New Zealand promises to kick-start the use of its excellent growth rates to offset CO_2 emissions. Under the Resource Management Act, the primary environmental statute in New Zealand, the new Tarankaki Combined Cycle power station, which will replace an older thermal plant, must fully offset any increase in CO_2 emissions attributable to its operation.[201] This zero net emissions condition is part of the consent for the station to discharge CO_2 to the atmosphere. The station must report annually its CO_2 emissions and how they have been mitigated. Forest planting has been approved as a valid offset option.

New Zealand is also promoting a review of current notions about "net emissions", and moving towards a stock based approach rather than a flow based assessment of net emissions. This approach is the same one that the USA is proposing to other signatories of the Climate Convention. Rather than assess the relative difference in rates of removal, being the focus of the existing Convention protocol, New Zealand and the USA would assess the absolute increase in CO_2 stocks, or cumulative removals. These countries advocate this approach on the basis that it is absolute concentrations rather than rate that will bring about climate change, and that mitigation options such as CO_2 sequestration by forests bring about discrete rather than continuous removals based on forest area, particularly in areas of fast growth rates, such as New Zealand.[202]

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198 *ibid.*

199 Moura-Costa, P., (personal communication, September 18, 1997).

200 Manfrinato, W., Azevedo, T., & Viana, V. (1997, May). Moist forest restoration in Brazil: A locally based project of CO2 sequestration, biodiversity conservation and watershed protection at Corumbatai River Basin. In *Technologies for Activities Implemented Jointly*. Conference conducted by IEA Greenhouse Gas R& D Programme, Vancouver, B.C.

201 Sapsford, R., (personal communication, July 23, 1997).

202 Calman, S., (personal communication, September 11, 1997).

8. IMPLICATIONS FOR FOREST-BASED MITIGATION IN AUSTRALIA

With regard to CO_2 emissions and responsibility for slowing global climate change, Australia's position stems from a unique set of circumstances. These circumstances, relating to factors such as wealth, population growth, economic growth and natural resource endowments, are often quite different from those of other nations, though notably similar to those of the United States and Canada. It is prudent of Australia to observe how other nations are avoiding, reducing or sequestering CO_2, but subsequent plans for reducing national CO_2 emissions must be fully conscious of its unique circumstances, and the balance between inefficient trailblazing and inactivity through over-cautiousness.

Regarding CO_2 sequestration and conservation, the implications of this report are :

- There appears to be significant potential for forest-based mitigation options around the world, including Australia. The Plantations for Australia 2020 Vision program that was launched in 1997 aims to treble the effective area of Australia's plantations by 2020, which will be achieved by planting an average of 80,000 hectares a year for almost 25 years. Based on calculations of biomass accumulation by Barson and Gifford (1989) and Grierson et. al. (1992), the realisation of this vision would sequester in the order of 150 millon tonnes of carbon by 2020, which is approximately double Australia's CO_2 emissions from the energy sector in 1995.

- There already exists sufficient incentives for governments and stewards of the global environment to adopt forest-based mitigation projects:
  - Increased forest establishment, conservation and enhancement, as well as the substitution of wood for more energy-intensive and or non-renewable materials will 'buy time' until CO_2 emissions from energy consumption and production are dramatically reduced.
  - Systems are in place to calculate, record and monitor the carbon benefits from forest-based mitigation projects, notably in the USA, the Netherlands, and Costa Rica, and trading systems have been created, despite the absence of United Nations coordination.
  - Forest-based mitigation projects provide ancillary benefits, particularly in areas where conservation and sustainability are critical issues. These other benefits can dramatically increase the cost-effectiveness of such projects, and can contribute to net profits from the projects.
  - Studies based in developed and developing countries show that between 50 and 90% of the technical potential for expansion of carbon stocks in forests may be tapped at a cost less than US$10 per tonne of carbon.

- There is limited cost-benefit information available to organisations considering whether or not to undertake mitigation activity. This lack of data could create further uncertainty for organisations to encourage organisations initially considering climate change mitigation on a voluntary basis. Pioneering organisations will recognise that unquantified benefits are still benefits that may, in their particular circumstances, provide tremendous value in the short or longer term.

- In the absence of economic instruments that generate carbon offset through regulation or incentives, the only incentives for Australian industry players to undertake forest-based mitigation projects at this stage is the public relations kudos, and the potential rewards for a pioneer in carbon offset developments when regulation and or public pressure forces their undertaking of this responsibility. These potential rewards include recognition for technical expertise, and the economic gain in harvesting 'low hanging fruit'. Increased activity by pioneering organisations and industries will foster public education and encourage further initiatives for climate change mitigation.

- In so far that Australia is a democratic society, the will of the government should reflect the will of the people. In this sense, the biggest obstacle to major reform is lack of public concern. Public education about global warming should place the issue in terms that are easily understood by the public. It is easier and probably more effective to encourage the public to "plant trees to reduce global warming" than it is to explain the complexities of "climate change mitigation".

- The Australian forest industry can only benefit from tree-based mitigation activities. Increasing forest areas and forest management responsibilities will increase the resource base, demand for expertise, and employment opportunities. If the general public increases their use of wood products in preference to competing materials on the basis of global warming concerns, the forest industry will benefit further.

- The Australian government has already developed a broad framework to facilitate climate change mitigation in many industry and social sectors. It must continue to provide strong government support to accelerate the gains and maximise the potential benefits from responsive sectors. Determined lobbying from industry groups and/or the voting public will help generate this government support for appropriate mitigation activity.

- The forest industry could lose the potential benefits if the government is allowed to focus all its support on other options at the request of other industry lobbyists. This scenario would be a great shame for the forest industry and all Australians. Forest-based options for reducing global warming provide a cost-effective approach with many ancillary benefits, and there is a established workforce capable of exploring these options to their full potential.

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ADDENDUM

The draft of this report was completed before the third Conference of the Parties to the United Nations Framework Convention on Climate Change took place in Kyoto, Japan, from December 1-10, 1997. This conference has now concluded, having generated some historic agreements.

The report was not altered in light of the "Kyoto Protocol" agreements, as it was written to provide a picture of forest-based options that have or are currently being considered for global climate change mitigation. However, it is appropriate to summarise the outcomes of the Kyoto conference, which will reshape the political framework for utilising forest-based options to meet new emission reduction targets.

United Nations Framework Convention on Climate Change
Third Session, Conference of the Parties
Kyoto, December, 1-10, 1997

The "Kyoto Protocol" that was agreed to on December 10, 1997, was the result of two years of negotiations to strengthen the climate change treaty established in 1992 by setting legally-binding targets for greenhouse gas emission reductions.

THE ISSUES	THE KYOTO AGREEMENTS
Emission reductions	Under a differentiated target scheme, 38 industrialised nations are required to reduce their greenhouse gas emissions for a global reduction in emissions of 5.2% below 1990 levels by some time between 2008 and 2012. The European Union needs to reduce emissions by 8%, the USA by 7%, and Japan by 6%. Some other nations face smaller reduction targets, and a few do not face any legally-binding targets now. Australia was given special consideration for its unusual circumstances, and will need to limit emissions to no more than 8% above 1990 levels. Australia was also granted its request to count emissions from land clearing in its national inventory. Reductions in land clearing will therefore count as valid emission reductions for Australia. Developing countries, including China and India, are asked to set voluntary reduction targets.
Gases involved	Six greenhouse gases are targeted by the Kyoto Protocol : CO_2, methane, nitrous oxide, and three halocarbons used as substitutes for ozone-damaging chlorofluorocarbons.
Trading emissions	The Kyoto Protocol has adopted the practice of emissions-credits trading in principle and allows for experimental projects. However, the Conference of the Parties postponed the establishment of a detailed framework for an international emissions-credits trading system.

Forest-based options	The Kyoto protocol, which is subject to technical revisions, states: "The net change in greenhouse gas emissions from sources and removals by sinks resulting from direct human-induced land use change and forestry activity, limited to afforestation, reforestation, and deforestation since 1990, measured as verifiable changes in stocks in each commitment period shall be used to meet the commitments in this Article [3] of each Party included in Annex 1."
Enforcement	Parties to the treaty will meet later to determine how to sanction countries that violate their assigned emission reduction targets.
The next steps	The protocol will enter into force 90 days after the date on which not less than 55 Parties, representing 55% of 1990 CO_2 emissions, have signed their acceptance of the protocol. The protocol will be open for signatures between March 1998 and March 1999. The Australian Government has indicated that it will sign its acceptance of the protocol. The U.S. Government cannot sign a treaty until it is ratified by the U.S. Congress. The Congress Majority Leader has indicated that the Senate will reject the terms of this protocol, on the basis that it does not require developing nations to begin reductions. Rejection of the protocol by the U.S. would provide a significant obstacle for international negotiations to secure emission reduction commitments.

The conference in Kyoto has clearly illustrated how difficult it is to bring together many nations, with many different circumstances and objectives, in an effort to cooperatively create a plan that will generate benefits for the parties involved. An international agreement of this scope is a significant achievement in itself. Participants at the conference in Kyoto have signaled their satisfaction in reaching an agreement, but recognise that it is only an important step towards actual implementation of effective climate change mitigation programs around the world.