Trading Greenhouse Emissions: Some Australian Perspectives

Report

A collection of contributions by leading Australians in the field, this publication presents a range of perspectives on domestic and international trading of greenhouse emissions. It contains a high-level view of Article 17 of the Kyoto Protocol and associated negotiations, and explains current Australian programs and policies with respect to reducing greenhouse emissions and generating carbon sinks.

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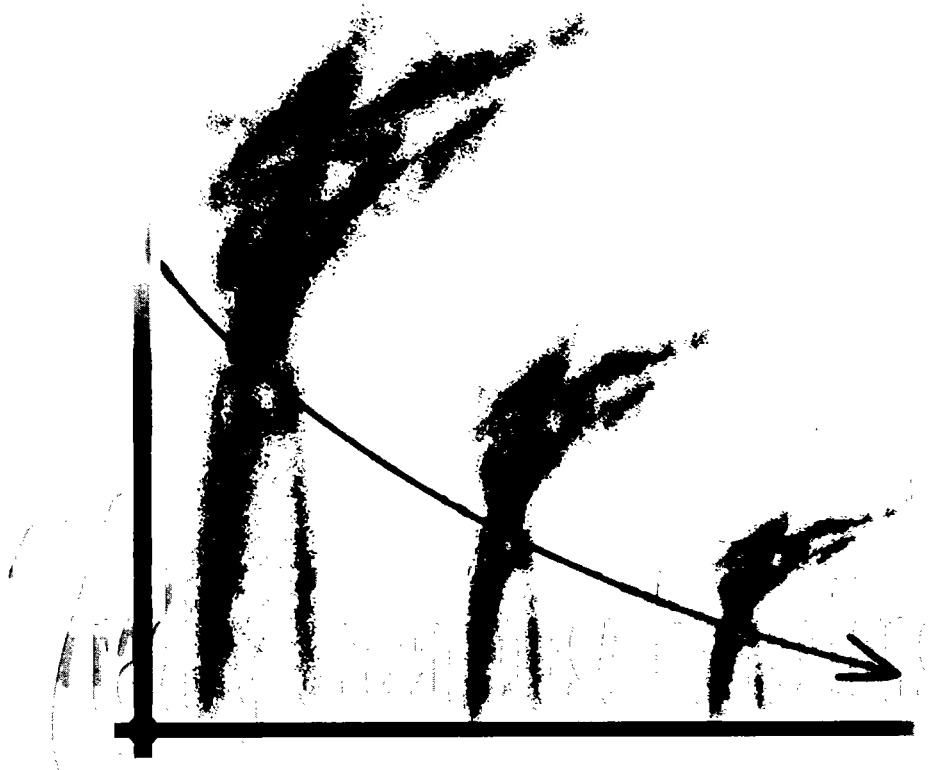
AUSTRALIA

Trading Greenhouse Emissions:
Some Australian Perspectives



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PREFACE

Although trading in sulfur dioxide emission rights in the USA is probably the best known scheme, Australia also has a significant history of using tradable permits. Examples include bluefin tuna fishing rights, water rights in the Murray-Darling Basin, taxi licences, the Hunter River Salinity Trading Scheme, and the Hawkesbury/Nepean sewerage treatment bubble.

Following international agreement on the Kyoto Protocol in December 1997, there is now also a serious prospect of trading greenhouse emissions on a global scale.

Subject to its entry into force, the Protocol has the potential to affect international economies in an unprecedented way. Yet few details are available as to the form that emissions trading schemes might take. At the same time, international negotiators are faced with the problem of settling the framework for emissions trading without knowing the potential effects and pitfalls that may arise in practice.

A major aim of this publication is therefore to serve as a source of information and ready reference for negotiators at international conferences. It is also intended that the various perspectives presented will help inform public debate and discussion.

Authorship of each chapter is separate. However, the contributors come from a range of government, academic, and private sector backgrounds. The enthusiastic cooperation of the individuals involved has permitted coverage of an important policy issue that is both complex, and covers a very broad range of subject matter.

On behalf of the authors, thanks are extended to the following for their assistance in a variety of ways: Brett Bayly, Anthony Casey, Sandra Collett, David Cosgrove, Jane Freebury, Greg Harper, Dr David Harrison, Linda Hillier, Alison Laird, Paul Palmer, Deanne Perry, Karen Subasic, Shayleen Thompson, Kate Woffenden, and the staff of the Trace Library in the Department of Transport and Regional Development.

Dr Leo Dobes
Research Manager

Bureau of Transport Economics
Canberra
October 1998

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ABSTRACT

A collection of contributions by leading Australians in the field, this publication presents a range of perspectives on domestic and international trading of greenhouse emissions. Following an overview that provides readers with a high-level view of Article 17 of the Kyoto Protocol and associated negotiations, the first chapter explains current Australian programs and policies with respect to reducing greenhouse emissions and generating carbon sinks. Dissident views on the Kyoto approach are presented in chapters on the McKibbin-Wilcoxen proposal, and on international trade problems of the Protocol, while two chapters focus on the economic and political preconditions required for an emissions trading system to work. The Umbrella Group's 'market-based' approach, presented to the Framework Convention on Climate Change (FCCC) in June 1998, is reproduced in full with a short explanatory note. Global economic impacts based on simulations using a special-purpose general equilibrium model of the world economy show the relative economic benefits of using emissions trading to achieve reductions by Annex B countries. Sectoral issues are addressed in chapters on the business perspective, prospects for Australian industry with clean development mechanisms in the Asia-Pacific region, the transport sector, and the international movement of people (including a possible means of tackling emissions from international aviation). A method of accounting for carbon sequestration in temporary sinks, such as tree plantations, is presented as an alternative to current provisions in the Protocol. Appendixes reproduce in full the Kyoto Protocol and the FCCC, and provide values of Global Warming Potentials.

DR BRIAN S. FISHER

Brian Fisher was first appointed ABARE's Executive Director in November 1988. During 1984–85, Dr Fisher was chief research economist, then Deputy Director, of the former Bureau of Agricultural Economics. He was appointed to the chair in Agricultural Economics at the University of Sydney in 1985, becoming Dean of the Faculty of Agriculture at the University in 1987.

In 1993 Dr Fisher was appointed one of the experts completing the socioeconomic assessment of climate change for the United Nations Intergovernmental Panel on Climate Change Second Assessment Report. He became a member of the Australian Academy of Science's National Committee for Climate and Global Change in 1996. More recently, Dr Fisher played an integral role in the international climate change negotiations as economic adviser to Australia's negotiating team in the leadup to, and at, the Third Conference of the Parties to the Climate Change Convention, held in Kyoto in 1997. He will again be fulfilling this role at the fourth Conference of the Parties in Buenos Aires in November 1998.

Dr Fisher has published over 180 papers and monographs. He received the Farrer Memorial Medal in August 1994 and became a Fellow of the Academy of Social Sciences in Australia in November 1995. Dr Fisher holds a PhD in agricultural economics from the University of Sydney.

STUART BEIL

Stuart Beil is a senior economist in ABARE's Trade and Global Change Branch. He holds responsibilities for economic research and policy analysis of international climate change issues.

Prior to taking up his current position, he was with the Greenhouse Response Branch in the Department of Primary Industries and Energy in Canberra. In that capacity, he undertook and managed government policy formulation, analysis and advice on Australia's approach to the international climate change negotiations. He was a member of Australia's negotiating team at the Third Conference of the Parties to the Climate Change Convention, held in Kyoto in December 1997.

Stuart has also worked as an economist in ABARE's minerals and energy economics branches. He has been responsible for minerals and energy commodity forecasting and economic research and policy analysis on minerals and energy sector issues. He holds Honours and Masters degrees in agricultural economics from the University of Queensland.

THE ROLE AND FUTURE OF INTERNATIONAL EMISSIONS TRADING

BRIAN S. FISHER AND STUART BEIL

A new market for trading in a new commodity—defined as greenhouse gas emission permits—was potentially created on 11 December 1997 when the international community adopted the Kyoto Protocol to the United Nations Framework Convention on Climate Change.

Climate change represents a market failure on a global scale. The coordinated intervention of world governments at Kyoto represents an early but important step in the process of addressing this market failure. Innovative cooperative strategies are needed to achieve, in a cost-effective manner, the commitments set out in the Kyoto Protocol. International emissions trading represents such a strategy.

A free-standing legal right exists in Article 17 of the Kyoto Protocol for developed countries listed in Annex B of the Protocol to use emissions trading as a policy instrument to assist them to meet their greenhouse target commitments.

The Protocol has the potential to lead to profound changes to individual country economies as well as the wider global economy. The Protocol therefore constitutes one of the most extensive internationally coordinated environmental interventions in the operation of market economies ever seriously proposed. Considerable opportunities and challenges now confront those who may be involved in the design and operation of any international emissions trading market and the related domestic markets that will also arise.

THE ECONOMICS OF EMISSIONS TRADING

Trading schemes are increasingly being considered and used for the cost-effective management of a number of environmental problems.

Economists have concluded that there are significant benefits that such schemes can deliver—see, for example, Fisher et al. 1996; Joshua 1996; Brown et al. 1997; Cornwell, Travis and Gunasekera 1997; Dudek et al. 1997; Mullins and Baron 1997; and Hinchy, Fisher and Graham 1998. Also, such schemes are now being seen more widely as providing a practical solution in environmental policy (US Environmental Protection Agency 1997). While quota trading schemes are not without their shortcomings, many experts and policy makers prefer trading schemes to the 'command and control' approach that has been widely adopted in the past to address environmental problems.

The Kyoto Protocol took two initial steps toward the creation of a viable international emission permit trading scheme:

- The definition of an overall 5.2 per cent reduction cap for emissions by Annex B Parties and the 2008–12 timeframe over which the cap will operate—thereby defining an environmental objective.
- The division of the cap into country targets—thereby establishing an initial allocation of emission permits among Annex B Parties.

Achieving the Kyoto Protocol targets set for Annex B countries will not be costless. The economic cost of the Kyoto Protocol will vary from country to country and from sector to sector. However, the total economic cost will be greater if countries choose to meet targets independently than if countries cooperate in meeting targets through an international emissions trading regime.

Although the total reduction in emissions would be the same in aggregate for Annex B countries with or without emissions trading, the potential to achieve the Kyoto targets in a least-cost manner is significantly increased with emissions trading because trading allows abatement to occur in least-cost locations. Emission permits generated from relatively low-cost abating countries can be sold to high-cost abating countries. High-cost abating countries would find it cheaper to buy permits than to undertake all the abatement necessary to meet their target. Low-cost abating countries would continue to undertake abatement until the additional (marginal) cost of undertaking one extra unit of abatement equalled the world price of an emission permit (allowing for transaction costs).

In an emissions-constrained world economy where some economies (Annex B) are simultaneously reducing output to reduce emissions, the volume of international trade will decline. The effects of emission constraints in Annex B economies will spread to non-Annex B economies

through international trade effects and the volume of production in the latter economies will decline as well. Thus, over the medium term, emission targets in Annex B economies will result in a reduction in world production and international trade relative to an emissions-unconstrained world economy. In the long term, such relationships may be broken as the benefits from abatement (in terms of the benefits from reducing adverse climate change) outweigh the costs of mitigation.

Emissions trading has the effect of reducing the decline in world production and international trade that would otherwise occur in meeting given emission targets. For such trade to be mutually beneficial, the buying economy must be able to increase its output of goods and services by more than the reduction in output in the selling economy. An increase in combined output is required to enable increased consumption in both economies. Unless such an increase were possible, the quota exchange would not be mutually beneficial.

Since there are zero transport costs incurred in international trade in emissions, it should be possible theoretically to come close to the cost-minimising goal of equalising marginal costs of reducing emissions (marginal production costs) across economies (Hinchy, Hanslow, Fisher and Graham 1998). Emissions trading allows international specialisation in the production of abatement. As a result of the accompanying increase in world production and international trade relative to the situation without emissions trading, there is increased international specialisation in the production of all goods and services. Unrestricted emissions trading is in keeping with efforts to liberalise world trade, while any restrictions on emissions trading would work in the opposite direction.

Any restrictions on the extent to which international emissions trading can be used to meet Annex B country targets will increase the economic cost of fulfilling Protocol commitments. Such an outcome would increase carbon leakage; that is, the tendency for emission-intensive industries, such as nonferrous metals, and iron and steel, to relocate to non-Annex B countries would increase, thus undermining the environmental effectiveness of the Protocol.

Emissions trading can occur with permits allocated to Parties or generated from abatement activities across the range of gases and sectors included in the Protocol. There are six types of greenhouse gases covered by Annex A of the Protocol. The most significant are carbon dioxide, methane and nitrous oxide. Sequestration of carbon dioxide through enhanced sink activity, such as forestry, is also provided

for in the Protocol to help Parties meet their commitments. Credits generated by removals of carbon by sinks, subject to certain limitations and future agreement on rules and methodologies, may also become available for trade. Indeed, some speculative forward trading in carbon removal by sinks has already begun. There are some environmental and potential commercial benefits associated with sequestration, but while the specific rules and guidelines governing such activity remain unresolved, such actions remain speculative and carry a degree of risk.

LINKS TO OTHER FLEXIBILITY PROVISIONS

The Kyoto Protocol provides for 'when', 'where' and 'how' flexibility.

Emissions banking, or 'when' flexibility, is provided for in Article 3.13 of the Protocol. With banking, emission reduction credits achieved in one commitment period may be transferred to a subsequent commitment period. Emissions trading confers 'where' and 'how' flexibility. Emission reductions that generate permits for trade can take place in different locations and by the use of a range of policies and measures.

The Kyoto Protocol provides for other 'where' flexibility mechanisms in addition to emissions trading. These include joint implementation (Article 6) and the Clean Development Mechanism (Article 12). Both Joint Implementation and the Clean Development Mechanism (CDM) are project-based mechanisms. Greenhouse emission reduction credits generated from abatement projects between Annex B Parties (Joint Implementation) and between Annex B and developing country Parties (CDM) can be used by Annex B countries to help meet their target commitments. Recipient countries stand to gain in terms of technology transfer. Investing countries stand to gain by securing low-cost emission credits which would be available for trade.

If an Annex B emissions trading scheme becomes operational, it is possible that it will reduce the incentive to undertake joint implementation projects. The same is not likely to hold for CDM activities as the CDM provides the only link between developing countries, with low marginal abatement costs, and Annex B commitments. In addition, the Protocol specifies that credits generated from CDM activities from the year 2000 can be used to assist Annex B countries meet their target commitments. This provision will create incentives for early participation in CDM projects. Thus, the CDM also confers 'when' flexibility.

There are a number of reasons why the incentive to become involved in Joint Implementation projects is likely to diminish once emissions

trading becomes operational. The key reason is that Joint Implementation activities are likely to be less cost effective and more complicated than emissions trading. The barriers to Joint Implementation that add to its cost and complexity include identifying overseas projects, negotiating agreements between participating countries, raising investment capital, foreign exchange risk, sovereign risk, establishing agreed baselines, monitoring, reporting, verifying, and continuing repair and maintenance of the project. Emissions trading does not involve as many of these complexities and is therefore likely to have lower associated transaction costs than Joint Implementation. In addition, there are no provisions in the Protocol for Joint Implementation credits prior to 2008. This apparent restriction on 'when' flexibility will further reduce the incentives for Joint Implementation relative to emissions trading.

Another important issue to be considered relates to whether, and on what terms, some countries choose to implement their commitments jointly. The European Union has indicated that it will use Article 4 provisions which allow it to fulfil its commitment jointly as a European Union 'bubble'. A coalition of countries known as the 'Umbrella Group', consisting of Australia, the United States, Japan, Canada, New Zealand, Norway, Iceland, Russia and the Ukraine, has formed to progress post-Kyoto issues of mutual interest. Such issues include consideration of the operational details of the flexibility mechanisms, such as emissions trading, and may also include consideration of Article 4 provisions.

DESIGNING AN INTERNATIONAL EMISSIONS TRADING SYSTEM

A key unresolved issue from the Kyoto Protocol negotiations relates to how and on what basis international emissions trading will be designed and implemented.

The Kyoto Protocol negotiations almost broke down completely in the early hours of 11 December 1997 when an impasse was reached between those countries favouring some articulation of the rules and guidelines which would govern emissions trading, and those countries that did not favour such an approach. The impasse was eventually broken when all Parties decided to defer seeking an agreement to the principles, modalities, rules and guidelines for emissions trading. The Conference of the Parties has been charged with seeking such an agreement.

Much work has already been undertaken, and is underway, to build the analytical and negotiating framework that will assist the Conference of

the Parties reach agreement to the rules and guidelines for emissions trading.

In May 1998, ABARE hosted an international emissions trading conference. The conference brought together leading authorities from around the world to define and explore the most important policy and technical issues associated with international trading. The key findings from the conference include:

- Restrictions on trading will reduce its cost-effectiveness;
- Government involvement in the market should be kept to a minimum. However, government involvement will be required for setting the rules for trading, allocating quotas and acting as a regulator, including monitoring compliance;
- Allowing many entities to trade will create market depth and liquidity and will help minimise the potential for participants to exercise anti-competitive market power;
- The commodity traded should be defined in carbon dioxide equivalents and denominated in units of one tonne;
- The scheme should be simple, and designed to minimise transaction and compliance costs;
- There should be appropriate monitoring, reporting, verification and compliance provisions to ensure market confidence;
- Involvement of the finance sector can reduce transaction costs and spread investment risk;
- Domestic schemes could evolve in parallel with an international scheme. If this occurs, it would be desirable for the two types of systems to be as compatible as possible;
- An international scheme should have fully comprehensive provisions. Domestic schemes need only include those gases, sectors and sinks which are cost effective to include;
- Early commencement of a domestic scheme would provide first mover advantage and more certainty for investment decisions, though this would have to be weighed against international competitiveness concerns and the development of possibly different rules governing an international emissions trading regime;
- Trading schemes should be designed to allow access to the Clean Development Mechanism, and Joint Implementation credits;

- Key stakeholders should be involved in the design and implementation of any scheme; and
- Emissions trading was generally supported as a cost effective and certain way of achieving Kyoto targets in comparison to regulations and taxes.

THE ROAD AHEAD FOR EMISSIONS TRADING

The decisions taken at Kyoto have changed the growth path of the world economy for ever. Governments have already moved to implement policies to reduce emissions, and industries have already responded. But a great deal remains to be done in designing policies, such as emissions trading, that minimise the economic costs of achieving the targets already agreed.

The Conference of the Parties has been charged with agreeing to the principles, modalities, rules and guidelines for emissions trading. Securing such agreement will take time and involve a great deal of skilled negotiating and diplomacy. While there is considerable support, both internationally and domestically, for an international emissions trading regime, its introduction is still some way off.

Whether or not an emissions trading scheme is introduced, there will be economic costs associated with meeting the target commitments set out in the Kyoto Protocol. With emissions trading, the economic costs of meeting targets will be reduced, and the environmental effectiveness of the Protocol enhanced. The prize for securing agreement to an effective international emissions trading regime is indeed significant. Therefore, the acceptance and effective implementation of the so-called flexibility mechanisms, such as emissions trading, will be one of the primary keys to the success of the Kyoto Protocol.

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GWEN ANDREWS

Gwen Andrews was appointed Chief Executive Officer of the newly formed Australian Greenhouse Office on 9 March 1998.

She was previously General Manager, Budget, in the Department of Finance and Administration, where she was responsible for providing policy advice to the Government on budget outlays. Gwen's other experience in the Australian Public Service (APS) includes senior appointments in the Spectrum Management Agency and the Department of Communications and the Arts, where she dealt with issues as diverse as arts policy, media ownership policy and the development of a market in radio frequency spectrum. Prior to joining the APS, Gwen worked in the Canadian Public Service.

1

AUSTRALIAN PROGRAMS AND POLICIES FOR REDUCING GREENHOUSE EMISSIONS AND GENERATING CARBON SINKS

GWEN ANDREWS

The Hon. John Howard, Prime Minister of Australia, in his 20 November 1997 Statement *Safeguarding the Future: Australia's Response to Climate Change*, outlined a package of measures to address greenhouse gas emissions across many sectors—residential, industry, transport, energy, agriculture, forestry and government operations. Through the package, the Government is providing $180 million over five years for these measures. Most of this expenditure is aimed at new measures, while some existing programs are to be substantially expanded.

ESTABLISHMENT OF THE AUSTRALIAN GREENHOUSE OFFICE

An important element of the package was the creation of the Australian Greenhouse Office (AGO) to be responsible for the coordination of national climate change policy and for managing the delivery of major new and existing Commonwealth greenhouse programs.[1] The AGO was established in April 1998 as the lead Commonwealth agency on greenhouse matters, taking responsibility for driving the $180 million worth of initiatives announced in the Prime Minister's statement.

EMISSIONS TRADING

One mechanism for limiting emissions that has already received considerable public attention, and is currently being explored by a team within the AGO, is that of tradable emission permits.

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1 At the time of the Prime Minister's Statement, the Office was to be called the Commonwealth Greenhouse Office.

In his Statement, the Prime Minister said:

> Australia also believes that an international emissions trading regime would help minimise costs of reducing emissions. We would support emissions trading on the basis of a satisfactory initial allocation of emission entitlements and a practical resolution of administrative difficulties involved.

The AGO has the responsibility of providing advice to the Government on policy options for the introduction of a national emissions trading system.[2]

To assist in this task, the AGO has established a number of consultative mechanisms, including an Experts Group on Emissions Trading and a Commonwealth/State Government working group. Also, the AGO will consult with a wide range of industry bodies and interested parties on the issues involved in establishing a national emissions trading system. Through these mechanisms, the AGO will then produce a series of public discussion papers and conduct seminars to allow for public feedback on the issues.

An introductory paper titled 'A National Trading System on Greenhouse Gas Emissions: Principles and Framework' is expected to be released towards the end of 1998. This paper will be followed by a series of discussion papers during 1999.[3]

The Commonwealth Government will decide on the use of emissions trading in addressing greenhouse gas emissions in the light of outcomes from this process of analysis and consultation.

However, the importance of encouraging early action on greenhouse gas emission abatement cannot be over-emphasised if Australia is to achieve its international targets in a least-cost manner and minimise industrial dislocation. And any emissions trading scheme that might be introduced is some years off at this stage. For this reason, emissions trading is only one of a suite of response options outlined in the Prime Minister's Statement.

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2 Development of policies on an international emissions trading system, as provided for in the Kyoto Protocol, is handled through the Foreign Affairs and Trade portfolio.

3 Information on the discussion papers and progress by the AGO in analysing the issues can be obtained from the AGO Internet site: http://www.greenhouse.gov.au

KEY PRINCIPLES OF AUSTRALIA'S GREENHOUSE POLICY

The principles which have guided the development of the initiatives set out in the November 1997 Statement by the Prime Minister, and which are likely to guide governments as they proceed with implementation, are:

- the need for Australia to have a strategic and comprehensive greenhouse response which is tailored to address our particular national interests and circumstances;
- the need to integrate greenhouse considerations with other government commitments;
- the pursuit of greenhouse action consistent with equity and cost-effectiveness and with multiple benefits;
- recognition of the importance of partnerships between governments, industry and the community in delivering an effective greenhouse response; and
- the need for action to be informed by research.

With these principles in mind, the Prime Minister's November 1997 Statement flagged a number of new measures to complement existing greenhouse policies in encouraging greenhouse gas emission reduction activities across the Australian community. Furthermore, it integrated greenhouse measures into other major policy initiatives, such as the National Heritage Trust.

Australia's response to the greenhouse problem consists of a broad menu of actions, some of which will be implemented by governments acting individually, some by joint intergovernmental initiatives, and some through partnerships between government, various stakeholders, and the community. All Australian governments will participate in arrangements designed to facilitate implementation, monitoring and reporting of outcomes, as well as the review and ongoing development of Australia's greenhouse policies.

GOALS OF AUSTRALIAN GREENHOUSE POLICY

The goals of Australia's greenhouse policies are to:

1. foster knowledge and understanding of greenhouse issues;
2. limit net greenhouse gas emissions in accordance with our international commitments; and
3. lay the foundations for adaptation to climate change.

Following is a summary of the components of Australia's greenhouse response, with a brief description of the key measures within those components.

FOSTERING KNOWLEDGE AND UNDERSTANDING OF GREENHOUSE ISSUES

Australia is committed to enhancing knowledge and understanding of the greenhouse effect and related issues. There are two components to Australia's policy in this area. First, Australia has a strong commitment to further continuing research into climate change science, with a particular focus on abatement and adaptation strategies, and greenhouse sources and sinks. The second component of Australia's policy in this area involves communicating this information to policy makers and the community.

Profiling Australia's greenhouse gas emissions

Information on national greenhouse gas emissions is essential for monitoring progress with our greenhouse response, and for the ongoing development and refinement of response actions.

Key measures are:

- *Reducing uncertainties in the land use change and forestry sector.* The aim is to reduce the uncertainty regarding land use change and forestry data in the National Greenhouse Gas Inventory. The inclusion of emissions from the land use change and the forestry sector in calculations for Australia's target under the Kyoto Protocol makes it essential that current levels of uncertainty be reduced.
- *Development of a National Carbon Accounting System for land based sources and sinks.* The aim is to improve our knowledge about the carbon storage capacity of vegetation. The development of the National Carbon Accounting System will provide the comprehensive framework and scientific services necessary to account for greenhouse gas emission reduction and sink enhancement programs.

Understanding and communicating climate change and its impacts

A key driver of international and Australian greenhouse responses is the growing scientific understanding of the mechanisms and potential scale and impacts of climate change. Australia plays a critical role in providing a Southern Hemisphere contribution to global research efforts. Ongoing research is needed both to better understand the

global climate system, and to assess the potential impacts of climate change on Australia.

Community understanding of the implications of climate change for Australia, and the context within which governments are pursuing action, is a prerequisite for gaining community acceptance of programs to attack the greenhouse problem and for engaging individuals and communities in such programs.

LIMITING GREENHOUSE GAS EMISSIONS

Policies designed to limit emissions represent the core of Australia's greenhouse response, and are central to meeting our commitments under the Framework Convention on Climate Change (FCCC).

Measures to limit net greenhouse gas emissions have been developed in the context of the opportunities and constraints for Australia. In particular, the measures reflect the systemic nature of the greenhouse issue and the need for a comprehensive approach which addresses all greenhouse gases, sources and sinks, and all sectors of the economy.

The measures also seek the most cost-effective ways to reduce net greenhouse gas emissions. As well as being a significant step forward in our national greenhouse response, the actions deliver substantial non-greenhouse benefits to Australia. These include reduced energy costs (which will enhance our international competitiveness and standard of living) and the promotion of ecologically sustainable agricultural and forestry systems.

Tradable emission permits are only one of a number of options that are being considered for limiting Australia's greenhouse gas emissions. Other elements of the Government's approach include the following:

Partnerships for greenhouse action: governments, industry, community

While action by, and cooperation among, all governments in Australia is a cornerstone of the greenhouse response, it is recognised that action by governments alone can never be sufficient. The cooperation of industry and the broader community is fundamental to the strategy's success. Active partnerships across all segments of the community are to be encouraged.

Key measures include:

- *Reducing greenhouse emissions from government operations* which will see governments leading by example and reducing greenhouse gas emissions from their own operations.
- *Local Government Greenhouse Action* which will assist local councils to quantify their greenhouse emissions and develop local government and community wide action plans.
- *Extension and expansion of the Greenhouse Challenge* program to increase the number of large and medium size companies in the program, and to engage small businesses through a 'Greenhouse Allies' program.
- *Household Greenhouse Action* which will bring together the various spheres of government, key industries, the community and professional organisations in a consortium to develop integrated, consistent and effective strategies addressing residential greenhouse emissions.

Efficient and sustainable energy use and supply

The largest single source of Australia's greenhouse emissions is the production and consumption of energy. Stationary (ie. non-transport) energy contributed 45.5 per cent of Australia's net greenhouse gas emissions in 1995. A major focus of Australia's greenhouse response is, therefore, the pursuit of efficient and sustainable energy use and supply. Energy market reforms will be accelerated to improve the economic efficiency of energy supply. Energy performance codes and standards relating to domestic and industrial equipment, and residential and commercial buildings, will be enhanced and increased.

Stimulation of the renewable energy sector, with a major focus on the commercialisation of renewable energy technologies, is a key feature of Australia's greenhouse response. In addition, the strategy specifically targets an additional 2 per cent of electricity use from renewable and specified waste-product energy sources.

Key measures are:

- *Accelerating and monitoring energy market reform* provides for an expansion and acceleration of micro-economic reform of the energy market to promote the delivery of environmental as well as economic benefits.

- *Efficiency standards for power generation* provide for improved efficiency in the use of different fossil fuels so as to deliver reductions in the greenhouse gas intensity of energy supply.
- *Strategic development of renewable energy* through programs which will support the commercialisation and application of renewable energy technologies. The proportion of electricity from renewable or specified waste-product sources will be increased.
- *Energy efficiency standards for residential and commercial buildings, and energy performance codes for domestic appliances and commercial and industrial equipment* will be expanded and strengthened.

Efficient transport and sustainable urban planning

The transport sector contributed 14.4 per cent of Australia's net greenhouse gas emissions in 1995. Energy-efficient transport and sustainable urban planning are a key component of Australia's strategy for long-term greenhouse gas mitigation.

Measures in this area can simultaneously deliver greenhouse benefits, improve local air quality, reduce congestion, improve access to public transport and facilities, and reduce infrastructure costs.

Key measures are:

- *Traffic management,* which is a state and local government issue, can optimise greenhouse outcomes by introducing guidelines and management systems, and incorporating greenhouse considerations in air quality and congestion management strategies.
- *The Environmental Strategy for the Motor Vehicle Industry* in the Prime Minister's package which will make a significant contribution to reducing greenhouse gas emissions by, among other actions, introducing a 15 per cent fuel efficiency improvement target by 2010, mandatory fuel efficiency labelling, and bringing forward the phasing out of leaded fuel.

Greenhouse sinks and sustainable land management

Vegetation clearance for land use change (particularly for agriculture), and agricultural production activities are major sources of Australia's greenhouse gas emissions, each contributing approximately 18 per cent of national net emissions in 1995. On the other hand, managed forests, pasture improvement and vegetation regrowth on some cleared

land remove carbon dioxide from the atmosphere. These greenhouse sinks removed carbon dioxide equivalent to around 10 per cent of national net emissions.

Sustainable land management in forestry, vegetation management and agriculture, together with cleaner production in agricultural activity, provide important opportunities for emissions reduction and greenhouse gas sink enhancement. In addition to their greenhouse gas mitigation benefits, these practices generate other environmental, economic and social benefits. These include improved natural resource management and quality such as soil stability, reduced salinity and greater productivity, as well as more efficient production with reduced resource inputs and wastes.

Key measures are:

- Plantations for Australia: The 2020 Vision which aims to treble the nation's plantation estate by the year 2020, and will work to remove impediments and enhance investment and profitability in plantation-based industries.
- National principles for sustainable management and retention of native vegetation will be developed and agreed, particularly for native woody vegetation.
- Giving effect to national principles for sustainable native vegetation management and retention under which guidelines and policies will be developed and implemented at a regional level.

Greenhouse best practice: industrial processes and waste management

Key manufacturing, petroleum, minerals and minerals-processing industries are significant emitters of greenhouse gases from industrial processes, in addition to being major consumers of energy. Excluding emissions resulting from the consumption of energy, industrial processes contributed 1.8 per cent of Australia's net greenhouse gas emissions in 1994. Greenhouse emissions from waste were responsible for 3.4 per cent of Australia's net emissions in that year.

Greenhouse best practice in industrial processes and waste management, pursued through partnerships and the encouragement of cleaner production and innovation, is an important component of Australia's greenhouse response. These areas provide important opportunities to address non-CO_2 greenhouse gas emissions—other opportunities occur in the agricultural sector.

Key measures are:

- *Environmental management strategies for the synthetic gases* will be developed with industry for HFCs, PFCs and SF_6, the three synthetic gases included in the Kyoto Protocol.
- *Methane emissions from landfill and wastewater* measures will work to minimise organic waste at landfill sites, and increase capture and utilisation of landfill and wastewater methane emissions.

LAYING THE FOUNDATIONS FOR ADAPTATION TO CLIMATE CHANGE

Regardless of how effectively Australia and other countries limit their greenhouse gas emissions, global concentrations of greenhouse gases are certain to increase over coming decades, making some degree of climate change inevitable. Adaptation to climate change is, therefore, an essential part of our national greenhouse response. It is important to begin planning for adaptation to climate change as soon as possible. In particular, current planning processes and strategies could be reviewed and sectoral adaptation requirements and plans could be developed.

CONCLUSION

The importance of responding to the greenhouse problem was emphasised in the Prime Minister's Statement of 20 November 1997. If realised, emissions trading has the potential to form an important part of a strategy to achieve Australia's international commitments on emission abatement. Nevertheless, for reasons of timing, coverage and effectiveness, it would represent only one element of a coordinated suite of greenhouse response measures, components of which are already in place.

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2

ESSENTIAL ELEMENTS OF TRADABLE PERMIT SCHEMES

DON GUNASEKERA AND ANTONIA CORNWELL[1]

This paper discusses some of the economic issues likely to be encountered when establishing an emissions trading scheme and highlights some design options for Australia. Some of the material in this paper has been drawn from Cornwell, Travis, and Gunasekera (1997), Mullins and Baron (1997), Fisher et al. (1995) and EPA Victoria (1995).

DEFINING THE PRODUCT

The first step in implementing an emissions trading scheme would be to define the nature of the tradable permit. Considerations would need to include: the duration of the permit; the allowable emissions per permit; the overall emission cap; and the greenhouse gases (GHGs) covered under the scheme.

DURATION OF PERMITS

In an emissions trading scheme, a designated central authority would issue permits to any number of potential market participants. The frequency with which permits expire and are re-issued can influence both the cost-effectiveness of the scheme and its ability to mitigate any adverse environmental consequences associated with GHG emissions.

The duration of permits will, to some extent, depend on the overall time frame in which it is desired to reduce emissions to a certain level.

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1 *The opinions expressed are those of the authors and should not be attributed to, or taken as representing the views of, the Productivity Commission. This paper draws heavily on Cornwell, Travis and Gunasekera (1997).*

The duration of permits would need to represent a balance between the requirement to allow the designated central authority sufficient control over the desired level of emission abatement and the need to provide participants flexibility in meeting reduction targets.

The advantage of a short-lived permit is that it gives the central authority greater control over ensuring the achievement of a desired level of emission reduction. The advantage of a longer-lived permit is that it provides participants with a higher degree of certainty and more flexibility to comply with the emission limit and so enables them to plan, for example, the required capital investment on abatement measures to achieve future emission abatement commitments. An emissions trading scheme needs to be designed from the outset to be flexible enough to facilitate any changes that might be required to the overall emission limit and yet still allow sufficient time for planning and implementing GHG abatement strategies.

EMISSION LOAD

The emission load is the amount of GHGs that a single permit entitles its holder to emit over a period of time (the 'permit period'), and this can take various possible forms. For instance, a load can be expressed as a rate of emissions, or as an amount of emissions that can be emitted at any time over a multiple-year period.

The advantage of having an emission load based on a rate of emissions is that the central authority can tightly control the flow of pollutants. The advantage of a multiple-year emission load is that it provides participants with greater flexibility in meeting their emission reduction targets, because they can pollute at whatever annual rate suits their operation, provided the total level of their emissions over the designated number of years does not exceed the allowable level.

The emissions allowable under each permit could be a single, measurable unit of emissions (such as one tonne of carbon dioxide (CO_2) equivalent) or multiple units of emissions (such as 100 000 tonnes of CO_2 equivalent). However, in a sense this decision is arbitrary.

EMISSION CAP

The emission cap is the level of total emissions that can be emitted nationally during a permit period. The central authority would have the power to change the emission cap over time, either in accordance with a predetermined plan of emission reduction (for example, agreed upon as a result of international climate change negotiations) or in

response to changes in technology or information concerning any environmental consequences of emissions of various GHGs.

Changes in the emission cap could most easily be achieved at the time at which a stock of permits is retired and a new stock issued. However, it may be desirable to introduce changes during a permit period. In this case options include:

- empowering the central authority to announce changes in the emissions allowed under each permit;
- empowering the central authority to repossess compulsorily a number of permits from permit holders at any time (where compensation could be considered) or to issue more permits to holders; and
- having the central authority actively participate in the market, buying and/or selling emission permits until the allowable total emission load is changed to the desired level (EPA Victoria 1995).

However, confidence in the market may be undermined by large and unexpected changes to the emission cap. This may reduce the willingness of buyers and sellers to engage in trading, and may result in the hoarding of permits to guard against possible reductions in future total emission caps (or quick use if increases are anticipated) (EPA Victoria 1995).

COVERAGE OF GREENHOUSE GASES

As well as defining duration, permits should specify the type of emission they represent. Permits would ideally be standardised so that they are fully exchangeable (Mullins and Baron 1997). In the United States sulfur dioxide (US SO_2) emissions trading scheme, each permit represents one tonne of SO_2 which may be emitted during the permit's life span of one year.

The challenge for an emissions trading scheme for GHGs is that there are several gases that need to be covered. A solution is to have a weighting index which translates GHGs into CO_2 equivalent units for trading, given that CO_2 represents the majority of GHGs emitted. Ideally, all sources of GHGs should be included in an emissions trading scheme. From an economic perspective, the total cost to all the participants in an emissions trading scheme of achieving a certain reduction in emissions would be lower because the burden would be spread across more sources. Furthermore, from an equity and polluter-pays

perspective, including all sources in the scheme would ensure that all sources are treated in the same way and all participants are made to take responsibility for the environmental impact of their activities (EPA Victoria 1995).

On the other hand, a comprehensive trading scheme would be more difficult to monitor and could have higher transaction costs than, for example, a trading scheme covering only CO_2 from fossil fuel combustion (Mullins and Baron 1997). Furthermore, the sources and sinks of methane and nitrous oxide emissions are as yet poorly understood (Fisher et al. 1995). It may be necessary to start with a less comprehensive scheme in which participants are limited to trading only in CO_2 and allow trades in other GHG sources and sinks, such as those associated with agriculture, land use change and forestry, once their GHG emissions and removals can be adequately verified and monitored.

MARKET PARTICIPANTS

In defining the market, the widest number of participants should be allowed to trade. Experience from the United States has shown that, in cases where markets have been narrowly defined, few transactions have taken place and the commensurate gains have been less than they could have been. The question of who participates in an emissions trading scheme is also a key determinant in whether the number of traders in the market will be large enough to ensure competition (IC 1997).

There can be two types of market participant—compulsory and voluntary.

Compulsory participants

Compulsory participants are those who are required by legislation to hold permits to cover their emissions of specified GHGs. In principle, emission permits should be linked to the level of GHGs actually released into the atmosphere. In this way, all emitters would have an incentive to reduce their emissions. Therefore, an ideal GHG emissions trading scheme would target all emitters of GHGs. However, in practice this would involve everyone in the community. Obviously, monitoring emissions from so many individual sources with current technology is not practicable.

There are likely to be significant administrative advantages if participation in the permit market is restricted to large emission sources. The challenge is to achieve an economical balance between

the number of participants (and associated administrative costs), emission coverage and abatement opportunities. For example, targeting energy suppliers (such as petroleum refineries) rather than end users of energy (such as motorists) may result in efficiency losses, but these may be outweighed by the lower administration, monitoring and transaction costs associated with an emissions trading scheme.

Given that energy-related CO_2 emissions are the easiest of all GHG emissions to measure and monitor, it is worth considering how permits might be issued initially to cover these emissions. Permits could be issued to energy producers and suppliers, namely electricity generators, petroleum refineries, oil and gas suppliers and other fuel transformers. Under this scenario, permits would cover not only emissions released during the generation and transformation processes but also emissions resulting from fuel combustion by end users. The fact that energy producers and suppliers are easily identified is a significant administrative advantage in setting up a permit scheme. An alternative is to issue permits to large emitters within the sector. For example, permits could be issued to electricity generators, the transport sector and industry (particularly iron and steel producers and cement manufacturers).

If a comprehensive scheme is not established initially, the introduction of other sources and gases at a later stage would need to be clearly identified and work toward their gradual introduction encouraged.

Voluntary participants

Voluntary participants include any other parties who wish to participate in the permit market. Voluntary participants could include:

- relatively low cost emitters who are not required to be participants initially;
- individuals who have an opportunity to 'earn' permits by sequestering carbon; and
- any person or entity who wishes to buy, sell and hold permits—for example, brokers facilitating the trading of permits, public interest and environmental groups wishing to purchase permits to reduce the overall level of GHG emissions and investors wishing to purchase and hold permits for future sale.

ALLOCATING PERMITS

Once the nature of the permit, the total number of permits and the compulsory participants are determined, permits would need to be allocated amongst the compulsory participants. This simply means that participants would need to be informed of the number of tonnes of emissions they are permitted to emit or trade in the first permit period, whether this has been determined through auctioning permits, distributing permits free of charge or by other measures.

With a perfectly competitive domestic emissions trading scheme, no matter to whom the initial permits are allocated, equilibrium permit prices will be the same and the final allocation after domestic trade will be the one that minimises the cost of reducing emissions. Emitters will want to buy permits if abatement costs exceed the permit price and sell permits in the opposite case. Trade will continue until all firms reach a position of indifference between buying and selling permits. When this state is reached, an ex-post distribution of permits that minimises the costs of reducing emissions has also been reached (Fisher et al. 1995).

There are two main methods by which permits may be allocated initially. Auctioning involves selling permits to the highest bidders, and thus involves payment of money by purchasers to government. Alternatively permits may be issued free of charge (or at low cost) to incumbent emitters. There is a number of ways in which free permits could be issued. Permits could be 'grandfathered', whereby incumbent emitters are allocated permits based on their emissions in an historical period. In principle, permits could also be issued free of charge (or at low cost) based on some other historical record such as marginal costs of emission abatement.

Auctioning permits

Under auctioning, each emitter would determine its optimal emission control strategy in order to decide how many permits to purchase and how much to invest in emission control measures. As a result of the initial allocation of permits being more closely aligned with relative abatement costs, few external trades would be expected to take place following an auction.

Permits may be auctioned in a variety of ways. Examples of different auction methods include the English, Dutch and Vickrey methods (for a discussion of these methods see McAfee and McMillan 1987). Auctioning of permits would continue until all available permits have been sold.

There is also the issue of how big should be the block of permits auctioned at any one price call. The system of auction of permits in the US SO_2 emissions trading scheme allows for any number of permits to be bought, down to single units.

If permits are auctioned, the impact of the permit scheme on the economy may depend on what government does with the revenue. There is a number of options available to government. For example, government could use auction revenue to offset cuts in other taxes such as income taxes or payroll taxes (this is called 'revenue recycling'). No direct impact on government revenue would occur if the tax revenue were to be redistributed to emitters, or if permits were grandfathered (Fisher et al. 1995).

Auctioning permits is likely to be resisted by some potential participants of an emissions trading scheme as the method of allocating the initial stock of permits. To sell permits removes the 'property right' which emitters have had in the past. Emitters are likely to be more amenable to a system of initially issuing permits to existing emitters free of charge (or at low cost). However, even if such grandfathering were a significant basis of allocation, auctions could still have an important role in making available, to participants and the public, extra permits on a regular basis to stimulate trade. In the US SO_2 emissions trading scheme the percentage of total permits held for auction is about 3 per cent.

Issuing permits free of charge

Issuing permits free of charge (or at low cost) explicitly recognises the property rights which emitters have had in the past. This recognition is reflected in the value of the permits to existing emitters. There are different ways of allocating permits free of charge.

Some have argued that, under the approach of issuing permits free of charge, because new (and expanding) firms who manage to enter the market are required to purchase all necessary permits, incumbent firms may have a distinct competitive advantage. All else being equal, it is argued that incumbent firms will be able to produce a given level of output for a lower unit cost than potential new entrant firms. This reduction in the competitiveness of new entrants is called 'new source bias'.

However, this discussion of new source bias does not appear to take opportunity costs into account. New firms will have to purchase permits, which is a cost. Incumbent emitters, with the permits, have an asset they can sell—the permits. Choosing not to sell the permits and to use

them incurs a cost—the forgone revenue from not selling them. There is no efficiency bias necessarily associated with whom the permits are allocated to. When opportunity cost is taken into account, the costs of new and incumbent firms will not differ according to who receives the permits.

ADMINISTERING THE SCHEME

There is a need for a designated central authority to administer an emissions trading scheme. Where possible, use should be made of existing institutions and infrastructure to administer the scheme, rather than setting up new institutional structures which are likely to add to the cost of the scheme. The administrative set up would need to be clearly set out in legislation relating to the scheme.

Once the scheme is operating the administering authority would have three main tasks: to keep track of permits; to keep track of emissions; and to respond to violations of the scheme in a way which ensures that it is always in the interests of participants to comply.

Monitoring permits and emissions

In keeping track of permits the central authority would need to record the number of permits issued and held by participants (and in reserve), permits deducted for compliance purposes and transfers of permits between participants.

The process for monitoring emissions could utilise existing methods, if appropriate, which are currently in place in some states to monitor emissions of other pollutants. For example, the New South Wales Environment Protection Authority already has in place a system of monitoring air and water pollutants (including sulfur oxides, nitrous oxides and particulates in the air and nitrogen, phosphorus and salinity in water) for its load-based licensing scheme. This system involves polluters filling in a compliance return giving details of the monitoring they have undertaken and the results from this monitoring. The returns may be subject to audit. In the United States, participants in the SO_2 emissions trading scheme already monitor and report CO_2 emissions along with their emissions of SO_2 (DFAT 1997).

Enforcing compliance

Spot checks of emissions from participants could be conducted on a regular basis with a dual purpose—to ensure that monitoring systems are working well and that participants are on track to match emissions with permits at the end of the period. It may be necessary, in order to avoid the risk of too many participants having large deficits of permits

at the end of period reconciliation, for there to be a rule relating to the size of the deficit (between permits held and emissions) that a participant is allowed to run in any given year without penalty.

At the end of each permit period there would need to be a reconciliation of permits held against emissions over the period for each emitter. If a participant's emissions are less than the number of permits it holds, the remaining permits could be carried forward (or 'banked') into the following period's account. If a participant's emissions are greater than the number of permits held there could be a penalty, in the form of a fine per excess tonne of emissions and/or a requirement to surrender permits for the following year equivalent to the excess of emissions. In the US SO_2 emissions trading scheme the fine is about 20–30 times the market price for permits (DFAT 1997).

'Borrowing' permits from future periods could potentially introduce a number of problems relating to participants meeting their emission abatement commitments. However, these problems would need to be weighed up against the benefits in terms of flexibility to participants and potentially lower economic costs. A possibility is to allow borrowing to occur, but to place limits on the number of permits that could be borrowed from future permit periods and to impose a charge on borrowing. The United States has suggested, in the context of an international GHG emission trading scheme, that a charge, or interest rate, of 20 per cent per annum might be applied on borrowings from future periods (DFAT 1997).

MARKET ISSUES

A number of market issues need to be considered when designing an emissions trading scheme. These include the market mechanisms which will facilitate trading and market power.

Market mechanisms which facilitate trade in emission permits are likely to emerge once a scheme's rules have been finalised. So long as participants notify the central authority of their level of emissions and their trade in permits, there is no reason for the central authority to be concerned how trade in permits actually takes place.

The Sydney Futures Exchange and the Australian Stock Exchange are examples of existing market mechanisms which could serve as a trade centre. Permits could then be traded in the same manner as other commodities. It is likely that initially permits would be traded in a cash (or spot) market, but that eventually the market would develop to include derivatives such as swaps, futures and options. Brokers and information

exchanges are likely to arise in response to the establishment of the permit market. However, particularly in the initial stages of the tradable permit scheme, there may be an additional role for government to enhance information flows to facilitate the establishment and operation of the permit market.

INCORPORATING CARBON SEQUESTRATION

Not only are GHGs such as CO_2 emitted into the atmosphere from a variety of activities, such as burning fuels, but CO_2 is also absorbed (or sequestered) by 'carbon sinks'. Carbon sinks include vegetation (such as forests), which absorb carbon through their biomass, and soil.

Vegetation absorbs carbon so long as it is growing. When vegetation decomposes, while still in the soil or once removed, the stored carbon is released back into the atmosphere. Soil releases carbon when it is disturbed, such as through cultivation.

There are several key issues that would need to be addressed in incorporating sequestration in an emissions trading scheme. These are outlined below.

Defining the activities for which emission permits may be earned

Permits could be earned for tree planting alone, or for both tree planting and improved agricultural practices. This could be determined in a contract between the regulatory body and the proprietor of the sequestering activity.

Defining the number of permits to be earned from different activities

The number of permits earned would be related to the rate at which the activity chosen sequesters CO_2 over time and the total amount of carbon the sink will sequester in its lifetime. For example, different trees have different store values of carbon and sequester CO_2 at different rates over time.

An issue that arises with tree plantations is how to deal with the continual planting and harvesting of trees that occurs with managing a commercial plantation. Whilst a new plantation will absorb a net amount of carbon in the set up phase, a mature plantation has, on average, a zero net effect on the level of CO_2 in the atmosphere. The issue, then, is when in the life cycle of the plantation to recognise the sequestration benefits and issue permits.

The Intergovernmental Panel on Climate Change (IPCC) and the United Nations Framework Convention on Climate Change (FCCC) Secretariat have yet to make firm recommendations on when in the life cycle of sequestration activities carbon permits should be issued.

Establishing methods of verifying amounts of carbon sequestered

Accurate monitoring is important for the integrity of an emissions trading scheme. Currently there is uncertainty in the measurement of carbon sequestered from activities relating to forestry, agriculture and land use change. However, the measurement of sequestration is improving, mainly due to the availability of improved data (NGGIC 1996).

Whilst accurate measurement of sequestration is difficult at present, it is possible to obtain rough figures. There are numerous studies which provide estimates for the amount of CO_2 that is sequestered by various sinks—see IPCC (1996) for a discussion of some of these studies.

As well as obtaining adequate estimates of the carbon sequestered by various activities, it is important that methods of measuring and monitoring are cost-effective—that is they are not too costly for the effect they achieve. Where methods are too costly they may outweigh the benefits from including sequestration in an emissions trading scheme.

It is likely that improved and more cost-effective measuring techniques will develop with the establishment of an emissions trading scheme and the associated incentives to include carbon sequestration. Therefore, it is important that a scheme is flexible enough to incorporate new methods of measuring as they become available and new sequestering activities as measuring improves.

Establishing provisions for natural disasters

Natural disasters, such as bushfires, may destroy sequestering activities, such as tree planting, which have been established to earn emission permits. This could be a problem for the authorities if permits had already been given to the owner of the sequestering activity. However, where there is a contract between the central authority of the permit scheme and the owner of the sequestering activity, this contract may specify some form of repayment of the permits to the central authority in the case of the activity owner not meeting the requirements of the contract. It is also likely that, as a permit market develops, the market may increase the value of fire prevention and owners of sequestering activities may seek to implement measures to reduce

the risk of damage and/or to insure their activities against natural disasters. There may also be a role for financial instruments, such as options, in hedging risks.

AREAS FOR FURTHER WORK

There are a number of issues relating to a domestic GHG emissions trading scheme that require further work and analysis. Some of these issues would require ongoing work, even after the introduction of an emissions trading scheme. Other issues would need to be resolved before the implementation of an emissions trading scheme.

Areas of ongoing research in the main revolve around the need to develop more reliable methods of measuring and monitoring GHG emissions, of all types from all sources, and carbon sequestration. It would be desirable to have a comprehensive emissions trading system as this would allow the market to realise the greatest efficiencies in reducing emissions and thus achieve overall emission reductions at least cost to participants and the economy.

Some of the important issues that would need to be resolved before the implementation of an emissions trading scheme include:

- the permit period and the schedule of emission reductions over periods;
- the initial participants;
- the method of allocating permits initially; and
- the trading environment, including the type and level of government involvement required and the need for, and level of involvement of, a stock or futures exchange or other financial trading body.

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3

TRADABLE PERMITS: TERMS AND TAXONOMY

JOE MOTHA*

In broad concept, emissions trading can involve a number of different schemes and activities. Some existing approaches and proposals involving trading schemes are outlined briefly below.

Permits versus credits

Emissions trading programs can basically be of two types: permit trading or 'credit' trading. Credit trading is also referred to as emission reduction credits (ERCs).

In a permit trading scheme (also called allowance or quota trading, 'cap and trade', or emissions permit system—EPS) emitters have to possess permits before they can pollute. That is, polluters receive an ex-ante allocation of rights. A target level of emissions (a 'cap') is established. This level of emissions is then apportioned among individual emitters by means of permits, allowing the permit holder a specified amount of emissions. Examples of tradable permit schemes are the US sulfur dioxide trading program, the Los Angeles RECLAIM (Regional Clean Air Incentives Market), the New Zealand Individual Transferable Quotas (ITQ) scheme for commercial fishing, and the Australian ITQ system for Southern Bluefin Tuna.

In a credit trading scheme, emitters that meet regulatory requirements do not require permits to operate. Emission reduction credits (ERCs) are created when emissions are reduced below levels required by regulation (an ex-post allocation of rights). These credits are required only for new emission sources to commence, or for existing sources

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* The opinions expressed are those of the author and do not necessarily reflect those of the Bureau of Transport Economics.

to expand. (In a tradable permit system, ERCs can be used to generate new permits.) Examples of ERC schemes include the US lead phasedown scheme and the US emissions credit trading program for major criteria pollutants. Because ERC schemes are project-specific, trades need to be individually verified, approved and monitored. Transaction costs are therefore substantial. ERC schemes are also inherently risky because trades are approved only after emission reductions have been achieved.

Permit and credit systems can be implemented together, or introduced independently. The suitability of each scheme may depend on specific circumstances. ERC schemes in the USA have not performed as well as tradable permit schemes because of their relatively higher transaction costs and greater risk in securing government approval (Hahn and Hester, 1989a).

BOX 3.1 HOW TRADABLE PERMITS MINIMISE ABATEMENT COSTS

Suppose there are two people, Mr Smith and Ms Jones, each emitting 20 units of carbon dioxide per year. Together, they emit 40 units of emissions. Suppose also that a regulator requires them to reduce their total annual emissions by 10 units, to 30 units. One means of achieving this would be to compel Mr Smith and Ms Jones to reduce their emissions by the same proportion, to 15 tonnes each annually. In a sense, this seems fair, because both are forced to reduce emissions by the same amount (in this case both in absolute terms and as a percentage).

But unless it costs Mr Smith and Ms Jones the same amount to reduce their emissions, this method could be needlessly costly. Suppose it costs Mr Smith $100 per unit to reduce emissions, and that it costs Ms Jones only $50 per unit. If Mr Smith and Ms Jones reduced their emissions by 5 units each, the cost to each would be $500 and $250 respectively, amounting to a total of $750 for the reduction of 10 units.

However, with a system of tradable permits, the total cost could be reduced.

To limit total emissions to 30 units, the regulator could allocate 15 permits each to Mr Smith and Ms Jones (1 permit = 1 unit). Now Mr Smith would probably be willing to buy permits instead of reducing emissions, provided the price was less than $100 per unit. Ms Jones would be willing to sell permits and reduce emissions provided the price was more than $50 per unit. Suppose the market price was $70. Ms Jones would reduce emissions by 10 units (costing $500), and would emit 10 units. Ms Jones would also sell 5 of her 15 permits to Mr Smith for $350. Mr Smith would purchase Ms Jones's permits, and would not need to reduce emissions. The total cost of abatement would then be $500, which is less than the $750 it would cost them to reduce their emissions by the same proportion.

Trading balance sheet

	Mr Smith	Ms Jones
Cost of emissions reduction without trading	$500	$250
Cost of emissions reduction with trading	0	$500
Less: sale of permits	0	$350
Add: purchase of permits	$350	0
Net cost with trading	$350	$150
Benefit from trading	$150	$100

The sharing of costs between traders depends on the initial allocation of permits. In this example, Ms Jones faces a net cost of $150, while Mr Smith bears costs of $350. However, the regulator may decide that it would be more equitable to give Mr Smith 17 permits, and Ms Jones 13 permits (still 30 in total). Were the market price still $70, Ms Jones would still reduce emissions by 10 units (costing $500), but would only be able to sell the 3 permits held for $210. Ms Jones would bear a net cost of $290. Mr Smith, on the other hand, would purchase 3 permits from Ms Jones for $210, and would not need to reduce emissions. The total cost for both is still $500, but the costs are shared between them in a different way.

Source Based on BTCE (1998).

At an international level, emissions trading could conceptually operate between governments or between individual emitters. Article 17 of the Kyoto Protocol states that Annex B Parties may participate in emissions trading, thereby legitimising intergovernmental trading. Trading between emitters in different countries would stimulate competition by increasing the number of trading opportunities and provide incentives for emitters to adopt emission reducing technology.

Permits plus taxes or fees

Taxes determine the costs of emission abatement, but prediction of the level of abatement may be less certain; whereas tradable permits determine the level of abatement, but involve less certain prior estimates of the prices. Hybrid policies have been proposed in cases where there is uncertainty about costs and benefits of emissions control (Roberts and Spence, 1976; Weitzman, 1978). Because hybrid policies combine the features of both tax and permit systems, they should, in principle, perform at least as well as either system.

Hybrid policies involve an initial distribution of tradable permits to determine a target level of emissions, with the option of purchasing additional permits from the government at a specified 'trigger' price.

A hybrid system operates much like a permit system by placing a ceiling on emissions when the price of a permit is lower than the trigger price. However, the system operates like a tax by fixing the cost when it reaches the trigger price. When the trigger price is set at a relatively high level, the hybrid operates like a permit system, because additional permits are not purchased. However, when the number of permits issued is small, the hybrid operates like a tax system, as additional permits need to be purchased.

McKibbin and Wilcoxen (1997) and McKibbin (Chapter 4 in this publication) express grave doubts that a conventional international emissions trading program would be workable. The 'McKibbin-Wilcoxen proposal' for a hybrid scheme to control greenhouse emissions stems from concern relating to issues of high abatement cost, difficulties in international monitoring and enforcement, and substantial wealth transfers that would be associated with a pure permit trading scheme.

McKibbin and Wilcoxen (1997) argue that a system involving permits and fees is more practical, flexible, and politically viable than a pure international permit trading system. In effect, their proposed scheme is an internationally coordinated system of domestic policies rather than an international policy. They also argue that their proposal differs

from a carbon tax, because permits for 1990 emission levels can be given away for free, and a fee would be charged only for emissions above 1990 levels.

Kopp, Morgenstern and Pizer (1998) suggest a hybrid scheme similar to the McKibbin-Wilcoxen proposal, but mainly from the perspective of uncertainties about the costs and benefits of abatement. Their proposal is an attempt at compromise, to satisfy both environmentalists (who believe that risks of climate change are very high, and costs of current action relatively low) and business (which believes that climate risks are too uncertain, and costs too high, to justify drastic action).

The hybrid system proposed by Kopp et al. (1998) would establish a fixed number of permits based on the emissions target and provide additional permits at a pre-specified trigger price. For environmentalists, the approach ensures that emissions will not exceed the permit limit provided the price of permits does not exceed the trigger price. If environmentalists' claims are correct, and abatement costs turn out to be low, the permit price will never reach the trigger price and emissions will remain capped. On the other hand, businesses are guaranteed that the cost of control per unit of emissions cannot exceed the trigger price for additional permits (and could also be less). Business therefore has the assurance of a specified and predictable cost structure, although it may still believe that benefits are not commensurate with costs.

Ross (1998) proposes an added stimulus to emissions trading in fostering the introduction of low emissions technologies. Annex I countries could agree to set a 'technology fee' assessed annually on each member's emissions over its assigned amount. Each country would need permits to cover its emissions each year, and these permits would need to be purchased to the extent that actual emissions exceeded assigned amounts. But, in addition to these purchases, and as long as the excess persisted, the special technology fee would be payable. The fee would be paid into a fund providing prize money to entities that produce significant new technology. Ross (1998) notes that the fund is likely to be very large, and suggests that offering prize money would be a powerful incentive for breakthrough innovations.

BOX 3.2 EFFICIENCY CRITERIA FOR TRADABLE PERMITS

The economic literature on emissions trading suggests that, in order to function efficiently, tradable permit schemes should satisfy the following criteria:

- The number of permits should be limited and clearly defined to give them a value that can be precisely estimated.
- Unrestricted trading of permits should be possible, thus enabling those who value the permits most to acquire them. Trading by private entities which are able to introduce new energy-saving technology would improve the efficiency of permit trading.
- Permits should be capable of storage to maintain their utility during periods of low market activity. However, unlimited temporal validity of permits may increase the ability of some traders to gain market power and for future governments to dishonour permits.
- Transaction costs of permit trading should be minimised to make market entry easier. There are three sources of transaction costs in markets for tradable permits (Stavins, 1995). One source of cost involves searching for a trading partner. Brokers can facilitate this process for a fee. Another source of costs involves bargaining. When buyers and sellers become involved in negotiations, they incur various costs, including fees for legal and insurance services. A third source of costs involves monitoring and enforcing the trading process, and is borne by governments rather than permit traders.
- Penalties for non-compliance should exceed the permit price to deter violation of trading rules and conditions.
- Permits should not be expropriated by governments (except in exceptional circumstances) to maintain market stability. Under the Australian Constitution, legislated property rights would ensure that permits could not be expropriated by governments without fair compensation.
- Sellers of permits should be allowed to retain profits from permit sales.

Ross (1998) concedes that the proposal would be criticised as a carbon tax, but considers that its very small level, combined with its potential effectiveness, would raise its political attractiveness.

Zhang (1998) proposes a transactions tax on permit trades as a means of limiting trading in 'hot air'. The proposal involves a tax on buyers at rates set by the Conference of the Parties. The tax would be imposed at differential rates, with a zero or low rate for transactions among developed countries, but at a high rate between them and countries with economies in transition. The tax would be internationally imposed, but administered and collected by buyer countries. The proceeds of the tax could be used for research, to subsidise the transfer of climate-friendly technologies to non-Annex I countries, or to buy and retire some of their emissions permits or hot air from the market. Zhang (1998) argues that the transactions tax differs from a carbon tax because firms that opt to meet emission limits only by taking domestic actions would not pay the tax.

AN EMISSIONS TRADING LEXICON

Emissions trading issues are generating a rapidly expanding vocabulary. Because the precise meanings of some of the terms are still not entirely clear or agreed, they may be subject to differing interpretations from those presented below.

Additionality is a concept used in the Kyoto Protocol in relation to joint implementation and trading of emission reduction units (Article 6.1b)

and the Clean Development Mechanism (Article 12.5c). The requirement is that reductions in emissions generated by projects should be additional to what would have otherwise occurred. Although the Protocol requires emissions additionality for Joint Implementation and Clean Development Mechanism projects, it does not require project additionality in the sense that credit could be obtained for projects that would have occurred anyway (Rolfe, 1998).

Determining additionality involves defining a baseline to estimate the amount of emissions reduction that would have occurred without the project. UNCTAD (1988) suggests three possible rules for determining a baseline: the 'what would have happened otherwise' rule; the marginal external cost rule; and the international benchmark rule. Dobes, Enting and Mitchell observe (Chapter 13 in this publication) that 'intentionality' (demonstration that the primary motivation for the project is greenhouse abatement) or 'financial additionality' (profitable projects cannot be counted as they would have happened anyway) are too difficult in practice to be used as tests of additionality.

Annex I in the United Nations Framework Convention on Climate Change (FCCC) comprises 36 Parties (including the European Economic Community). Annex I Parties comprise OECD countries (except South Korea and Mexico) and countries undergoing the process of transition to market economies (the former Soviet Union and eastern European countries) The FCCC is reproduced in Appendix C of this publication.

Annex B in the Kyoto Protocol comprises 39 Parties (including the European Community) which are essentially the Annex I Parties in the FCCC with a few changes (Croatia, Lichtenstein, Monaco, Slovakia and Slovenia are in Annex B but not in Annex I, while Belarus and Turkey are in Annex I but not in Annex B). Annex I and Annex B are now regarded as identical and the transition from Annex I to Annex B makes it possible for a developing country to engage in emissions trading, if it adopts an emissions target and is inscribed in Annex B (UNCTAD, 1998). The Kyoto Protocol is reproduced in Appendix A of this publication.

Assigned amounts in the Kyoto Protocol (Article 3) refer to required emission reductions for each Annex I country. The amounts have been defined in terms of percentage reductions or increases from 1990 levels to be achieved as an annual average over 2008–2012 (Annex B). For example, the assigned amounts are 1990 emissions minus 7 per cent for the USA and plus 8 per cent for Australia. The Protocol permits trading in assigned amounts among Annex B Parties (Article 17).

Banking originated in 1979 as part of the US emissions trading program for air pollutants. The issue of banking can arise in respect of emissions within a commitment period or between such periods. Banking enables firms to save emissions rights for future use or sale. Article 3.13 of the Kyoto Protocol permits banking of emissions within the 2008–2012 period for use in a subsequent commitment period. However, the Protocol has no provision for banking of the emissions achieved prior to the commencement of the first commitment period. Article 12.10 of the Protocol permits certified emission reductions obtained through the Clean Development Mechanism between 2000 and 2007 to be banked for use in meeting commitments during the first commitment period of 2008–2012.

Baseline shifting is a term used to describe the effects of trading emission reduction units among Annex B countries, and involves some reallocation of assigned amounts among countries. For example, if country X closes an energy-intensive plant and opens an energy-saving plant in country Y, country X would require credits for reducing emissions, while country Y would want to increase its emissions to compensate (Hamilton, 1998).

Borrowing refers to the bringing forward of part of the emissions allowed in a future period for use in an earlier period. The Kyoto Protocol does not provide for borrowing against future emissions quotas.

Bubble is a term derived from the concept of placing an imaginary bubble over several emission sources. All emissions are assumed to exit from a single point in the bubble. A bubble enables a firm (or group of countries) to aggregate the emissions from individual sources, and to adjust the level of control applied to the different sources, provided the total is not exceeded. The bubble concept originated in 1979 when it was introduced into the US emissions trading program for air pollutants. Although the Kyoto Protocol does not use the term 'bubble', the concept has been embodied in Article 4. The bubble concept is sometimes referred to as 'trading without rules' because it reduces restrictions on trading between parties. The bubble principle will enable formally organised groups of countries such as those of the European Union, or groups of countries formed voluntarily, to jointly meet obligations under the Protocol.

Buyer beware refers to a trading system where buyers buy permits subject to the risk that they may be invalidated or discounted if the seller is later found to be non-compliant with emissions restrictions. The onus is placed on the buyer to ensure that sellers are meeting their

obligations. Zhang (1998) points out that one disadvantage of buyer beware liability is that the permits would not be fungible, as each permit would need to refer to the country of origin, thereby increasing transaction costs (see also *seller beware*).

Certified Emission Reductions (CERs) refer to projects by Annex I countries implemented in non-Annex I countries under the Clean Development Mechanism resulting in certified credits. CERs are additional to assigned amounts in determining Annex I countries' total allowed emissions (Article 3.12 of the Kyoto Protocol).

Clean Development Mechanism (CDM) is a term created in the Kyoto Protocol (Article 12) referring to a voluntary process by which Annex I countries can jointly undertake projects with non-Annex I countries to reduce emissions in the latter. The emissions reduced can be taken into account by Annex I countries in meeting their emission reduction commitments, provided meaningful baselines can be established to measure such reductions. CERs generated by joint projects should be additional to any emission reductions that would have otherwise occurred. CERs obtained from the year 2000 up to the beginning of the first commitment period (2008–2012) can count towards compliance in the first commitment period.

Commitment period in the Kyoto Protocol (Article 3) refers to the five-year (first) commitment period 2008–2012, during which the emission targets set out in Annex B for individual countries are to be achieved.

Differentiation refers to different circumstances faced by each country that may require different emission reduction obligations. Article 10 of the Kyoto Protocol refers to 'common but differentiated responsibilities' of Parties. The concept of differentiation can apply between Annex I countries, as well as between Annex I and non-Annex I countries.

Downstream permit trading systems tend to target individual emitters, such as car drivers (Zhang, 1998). Such systems would maximise incentives on individual polluters, but would be relatively difficult to administer (see also *upstream* and *hybrid* permit trading systems).

Emission Reduction Units can be traded among Annex I countries in projects involving sources or sinks subject to credits being additional to any that would otherwise occur (Article 6 of the Kyoto Protocol). ERUs are not additional to a country's assigned amounts (Article 3).

Flexibility mechanisms in the Kyoto Protocol are of three types: 'when', 'what' and 'where'. 'When' flexibility takes the form of a multi-year commitment period (2008–2012) with averaging of emissions over the period, and allowance for emissions banking. 'What' flexibility involves the inclusion of six greenhouse gases (increases in some can be offset against decreases in others, having regard to the global warming potential of each gas) and certain carbon absorbing sinks, particularly afforestation and reforestation. 'Where' flexibility involves emissions trading, Joint Implementation and the Clean Development Mechanism.

Free riding occurs when countries benefiting from global emissions abatement do not contribute to it. Incentives to free ride will occur when participation in global emission abatement programs is voluntary rather than compulsory, leading to a less than optimal level of total abatement.

Fungibility of tradable permits refers to their mutual equivalence or substitutability. Each permit represents a defined unit of emissions without reference to the source of emission reduction associated with the permit or its place of origin. In other words, they can be exchanged freely because they are equal in value, just like currency notes or coins.

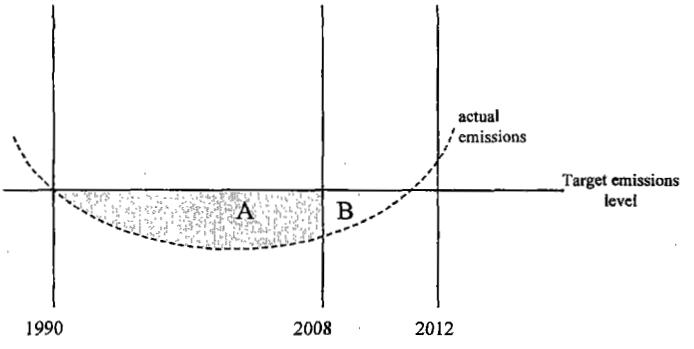
Grandfathering is a process by which emitters are given permits in proportion to their historical emissions (or fuel sales). Rolling grandfathering refers to a process by which allocations of permits are made by a rolling average over successive periods.

Hot air is a term that is used to describe the difference between a country's actual emissions during the commitment period 2008–2012 (or some part of it) and its target level (set with reference to the base period) in the Kyoto Protocol, when the actual emissions are below the target level. Figure 3.1 shows a possible emissions path for a country whose actual emissions are below the target level. Area B, which represents tradable emission rights under the Kyoto Protocol, is referred to as 'hot air' (see also *superheated air*).

Hot spots are localised geographic areas with high concentrations of pollution. Hot spots can occur with non-uniformly mixed pollutants such as sulfur dioxide.

Hybrid permit trading systems (Zhang, 1998) are similar to downstream systems in the sense that regulated energy users are limited to utilities and large industrial sources. However, like an upstream trading system, a hybrid system requires fuel distributors to

FIGURE 3.1 HOT AIR AND SUPERHEATED AIR



hold allowances on behalf of small fuel users. As a result they pass on their costs to users as a mark-up on the fuel price. Small fuel users therefore avoid the transaction costs of holding allowances, but the increase in fuel price will create incentives to reduce fuel consumption or to switch to alternative fuels with lower carbon content (see also *upstream* and *downstream* permit systems, and BTCE, 1998).

Joint Implementation (JI) is a concept expressed in both the FCCC (Article 4.2a) and the Kyoto Protocol (Article 6). It involves cooperation between two Annex I countries (X and Y), with country X funding emissions reduction in country Y, to help meet country X's emission reduction commitments. At the Berlin Conference of the Parties in 1995 it was decided to use the term 'Activities Implemented Jointly, (AIJ), instead of JI, during the pilot phase up to 2000 during which no crediting of emissions reduction is allowed. The Kyoto Protocol requires emissions reduced by JI projects to be additional to any that would otherwise occur (Article 6.1b) and for emission reduction units acquired to be supplemental to domestic actions to meet commitments (Article 6.1d).

Leakage refers to the decrease in emissions in a regulated geographic area being offset by an increase in an unregulated area. This can occur when emissions abatement by countries which are part of a cooperative abatement program (like Annex B countries) alter relative world prices

in a manner that encourages non-participating countries to increase emissions. An emissions abatement program by participating countries could make the production of emissions-intensive goods more competitive in non-participating countries, thereby increasing their production, or encouraging industries to relocate to these countries.

For example, a cooperative emissions abatement program can reduce the demand for fossil fuels and depress their world prices. Emissions can rise in non-participating countries because of the greater usage of such fuels. Similarly, higher energy costs in Australia due to implementation of Kyoto commitments may reduce the international competitiveness of our aluminium industry. If the industry relocates to a non-Annex B country, emissions 'leakage' will occur.

Netting originated in 1974 as part of the US emissions trading program for air pollutants. It allows a firm that creates a new source of emissions to avoid the stringent emission limits that would normally apply, by reducing emissions from another source. Netting therefore involves internal trading only. Netting became the most commonly used emissions trading activity relative to bubbles, banking and offsets which were also part of the US emissions trading program (Hahn and Hester, 1989b).

Offsets originated in 1977 as part of the provisions of the US emissions trading program for air pollutants. Offsets allow new or expanding emission sources to locate in 'non-attainment' areas (regions that do not meet a specified air quality standard). New sources are required to offset their emissions by reducing emissions from existing sources. The new or expanding source is required to buy sufficient credits to cover more than their intended emissions. Trading therefore results in an emissions reduction. Offsets can involve both internal and external trading. New emissions sources, by purchasing credits, effectively finance emission reduction efforts of existing emission sources.

Seller beware refers to a trading system where a country or individual purchasing permits need not be concerned about whether or not the selling government is in compliance with emission restrictions. A seller beware system needs strict monitoring and enforcement to be workable (see also *buyer beware*).

Superheated air is a term that refers to the emissions of some countries whose actual emissions between 1990 and 2008 are below target levels (set with reference to the base period) in the Kyoto Protocol. Figure 3.1 shows a possible emissions path for a country

whose actual emissions are below the target level. Area A, which represents non-tradable emission rights under the Kyoto Protocol, is referred to as 'superheated air' (see also *hot air*).

Supplementarity is a concept used in the Kyoto Protocol but not precisely defined (Articles 6 and 17). Supplementarity refers to the requirement that using international emissions trading and Joint Implementation to achieve the emissions reductions stipulated in the Protocol should be in addition to domestic emission reduction efforts. The concept of supplementarity derives from proposals made by some countries that a percentage limitation be imposed on the use of emissions trading to meet emission reduction commitments. Such a limitation would have restricted gains from trading in emission permits and increased the costs of achieving Kyoto target commitments.

Umbrella Group is a loose coalition of nine countries, including Australia, which are Parties to the FCCC, formed to advance common aims, particularly in relation to emissions trading. The other members are of the group are Canada, Iceland, Japan, New Zealand, Norway, Russian Federation, Ukraine and the United States.

Upstream permit trading systems target large entities such as producers and importers of fossil fuels (Zhang, 1998). Such schemes would be relatively easy to administer because of a smaller number of regulated entities, but would reduce incentives on individual (downstream) polluters (see also *downstream* and *hybrid* permit systems).

TRADING IN NON-UNIFORMLY MIXED POLLUTANTS

Uniformly mixed pollutants are those such as carbon dioxide, whereas non-uniformly mixed pollutants are those that cause regional air pollution such as sulfur dioxide. The greenhouse effect is generally considered to involve only uniformly mixed pollutants[1]. This means that the emission of greenhouse gases has the same effect, irrespective of where they are emitted. The corollary is that abatement action has the same effect irrespective of location.

1 However, some commentators such as Hanley, Shogren and White (1997) consider this a simplifying assumption because the precise origins and potential effects of global warming are subject to substantial scientific uncertainties.

In the case of uniformly mixed pollutants, permit trading will be at a 'one-for-one' rate between trading partners. For example, a single permit could represent one tonne of emissions.

However, in the case of non-uniformly mixed pollutants such as sulfur dioxide and carbon monoxide, both the amounts discharged and their spatial distribution may be matters for concern. The use of conventional one-for-one emissions trading for non-uniformly mixed pollutants can have adverse consequences for local air quality standards, because one emitter may be located in a more emissions-sensitive area than another. A trading system appropriate to non-uniformly mixed pollutants is often called an ambient permit system (APS).

APS markets are considerably more complex than markets for uniformly mixed pollutants. In the APS system, permits relate to damage at receiving points or receptors. Emitters can affect several receptors and they therefore have to trade in the various receptor markets affected by their emissions. Transaction costs would tend to increase with the number of markets in which emitters trade. An APS market can result in several problems, including low levels of competition due to a small number of traders in each market, long-range transfer of pollutants, and an increase in total emissions (Hanley, Shogren and White, 1997).

Various trading rules have been proposed to deal with problems arising from APS systems. The pollution offset system (Krupnick, Oates and Van Der Verg, 1983) imposes a rule on trades prohibiting the violation of predetermined air quality standards at any receiving point. However, serious disadvantages of the pollution offset are that it allows a decrease in air quality (not exceeding the prescribed standard) and an increase in total emissions.

The non-degradation offset (Atkinson and Tietenberg, 1987) applies an additional condition to the pollution offset: total emissions cannot increase as a result of trading. The modified offset (McGartland and Oates, 1985) permits trading, provided that the air quality level before trading, or the target emissions level (whichever has the higher standard), is not adversely affected. The relative cost-effectiveness of the modified and non-degradation offset systems has to be evaluated on a case-by-case basis (Atkinson and Tietenberg, 1987).

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4

THE MCKIBBIN-WILCOXEN PROPOSAL FOR GLOBAL GREENHOUSE ABATEMENT

WARWICK MCKIBBIN

The fundamental problem with the Kyoto Protocol is the focus on achieving rigid 'targets and timetables' for emission reductions at any cost, rather than substantial reductions at reasonable cost, in spite of the enormous uncertainties surrounding climate change. The move away from uniform targets for every country was forced at Kyoto because this was seen to be very inefficient and politically infeasible. The fundamentally important point to stress is that any fixed targets, even *differentiated targets*, are likely to be inefficient because we really do not know what these will cost over the long period of time being discussed[1]. Now that fixed targets have been enshrined in the Kyoto Protocol, negotiators are moving towards implementation of this Protocol using economic instruments such as international permit trading to achieve these targets at lowest cost.

In a series of papers (McKibbin and Wilcoxen 1997a, 1997b) we have pointed out that a global permit trading system with caps on the number of permits is a dangerous way to move forward. In an attempt to overcome the potential flaws in this scheme, we have proposed an alternative policy that would achieve real greenhouse gas reductions without the potentially disruptive political and economic problems of a global permit trading scheme built around fixed targets and timetables. Our proposal is an approach that Richard Cooper (1996) has called 'agreed actions' rather than an agreed targets approach. This paper first outlines how a global permit scheme would work, and identifies potential problems. The McKibbin-Wilcoxen proposal is then introduced in the context of addressing the problems of the more conventional

1 See McKibbin and Wilcoxen (1997a) and Kopp et al (1997) for arguments about the difference between price and quantity caps under uncertainty.

scheme. I should stress that the problems identified for a global permit trading scheme may or may not cripple the scheme, but under some circumstances global permit trading schemes are vulnerable to collapse. The economic crisis in Asia has clearly illustrated how poorly the future can be predicted with any certainty, even over relatively short time frames. In climate change research the horizon is many decades. The success of any international policy regime should not be contingent on a particular prediction of the future but should be robust to a range of possible outcomes.

How do permit systems work?

The basic idea behind a tradable permit system is simple: any firm emitting carbon dioxide (or for a broader range of gases, the carbon dioxide equivalent) would be required to own permits equal to the amount of carbon it produces. For example, a firm emitting one hundred tons of carbon would have to own one hundred permits. The permits would be allocated among countries by treaty, and it would be up to each government to decide how to distribute its permits domestically. Once distributed, the permits could be bought and sold without restriction on a world market. It would be illegal to burn fossil fuels without having purchased a permit, and it would be up to each government to enforce the treaty within its own borders.

Permit systems have three key features as a method of pollution control. First, they provide a firm upper bound on emissions. This feature of permits makes them attractive to those who believe that decisive action needs to be taken on climate change.

Second, because the permits can be traded, pollution abatement will be done at the minimum possible cost to the economy. Firms that can clean up cheaply will end up doing the abatement: they will be able to make a profit by cutting their emissions and selling their extra permits. Firms that find it very expensive to reduce emissions will buy permits instead.

Third, permits will ensure that the marginal cost of reducing carbon emissions is the same in all countries that participate in the scheme.

Presumably, if a global permit system was implemented following the Kyoto Protocol, countries would be allocated an initial stock of permits equal to their targets. For example, Australia would get 108 per cent of 1990 emissions whereas the United States would get 93 per cent of 1990 emissions. These would be allocated within countries and then firms could trade with each other in a global market.

What could go wrong in practice?

Permit systems have worked well when used to control domestic environmental problems. The best-known example is the sulfur emissions trading scheme in the United States, introduced by the 1990 amendments to the Clean Air Act. It has been a tremendous success: electric utilities, the principal industry affected by the program, have been able to reduce the cost of controlling sulfur emissions to one-tenth of the minimum cost projected when the Act was adopted. For controlling carbon dioxide emissions in an international context, however, several practical problems arise that ensure that a treaty based on an international permit trading scheme would never be ratified and implemented in the United States.

The first problem is that the Kyoto Protocol would force emissions back below 1990 levels and hold them there without regard to the costs and benefits of doing so. However, studies to date suggest that the global costs exceed the benefits, perhaps substantially. Estimates of the cost of holding emissions constant range from -0.5 per cent (an increase in GDP) to 2 per cent of GDP annually; most fall in the 1 to 2 per cent range. Considerably less is known about the benefit of stabilizing emissions.

In a nutshell, current evidence does not give clear support to a policy of holding emissions constant. The costs and benefits of stabilizing emissions are not known with much precision, but most studies of costs arrive at estimates that are higher than the highest estimates of benefits. Moreover, these costs would have to begin to be paid now in order to avert damages far in the future. Given these considerations, it is difficult to imagine that the US Congress would ratify a treaty based on reducing emissions below 1990 levels. There is, however, enough evidence to make a clear case for taking steps to slow the growth of emissions. A better policy would focus on this more modest goal.

A second problem with a global permit system is that it would generate large transfers of wealth between countries. Supporters of a permit system regard this as an advantage because it would allow developed countries to compensate developing countries for reducing their emissions. This would be a significant political problem for the US Congress. But more importantly this could put enormous stress on the world trade system. The balance of trade for a developed country importing permits would deteriorate substantially. This would lead to substantial volatility in exchange rates and distortions in the world trade system. Equally serious problems would be created for developing

countries. Massive exports of permits would lead to exchange rate appreciation and a decline or collapse in exports other than permits. Also, the permit revenue comes with strings attached: much of it would have to be invested in improved energy technology in order to reduce emissions and free up the permits in the first place. This is unlikely to be an ideal strategy for long-term economic development and would make the policy unattractive to developing countries.

In fact, developing countries have been so unenthusiastic about the policy that the Kyoto meeting produced support for an Umbrella Group to trade emission permits (including Australia, New Zealand, Canada, Norway, Iceland, Japan, Russia, Ukraine and the United States). However, this is a compromise that essentially eliminates the main reason for having internationally tradable permits in the first place: the potential gain from trade in emissions rights between industrialized and developing countries. Permit trading would do little to lower abatement costs when the participating countries have fairly similar marginal abatement costs. Moreover, this umbrella system may not even reduce emissions, because Russia and the Ukraine are well below their 1990 emission levels and would be able to sell their unused permits within the umbrella group. In that case, the permit system would really amount to nothing more than an elaborate accounting mechanism for counting increases in emissions in countries like the United States against the 1990 allocation for Russia. There would be little or no overall reduction.

But under a plausible alternative scenario in which Russia grows strongly between now and 2008, the demand for permits within Russia would increase, sharply driving up the umbrella price of permits. This could add an ironic twist to an international permit policy: if Russia were to grow quickly, the United States could soon become the developed world's low-cost emissions abater. In that case the United States would be a net seller of permits, and the rest of the industrial world would end up paying it to reduce its emissions. Under the scenario outlined, this is exactly the outcome that efficiency would dictate, but it would be politically deadly to the Kyoto Protocol in the United States.

Finally, one further problem with the Kyoto Protocol, and any permit trading system that follows, is that no individual government would have any incentive to police the agreement. It is easy to see why this is so: monitoring polluters is expensive, and punishing violators imposes costs on domestic residents in exchange for benefits that will accrue largely to foreigners. There would be a strong temptation for governments to look the other way when firms were exceeding their

emissions permits. For the treaty to be viable, however, each participating country would need to be confident that all of the other participants were enforcing it. This would require an elaborate and expensive international mechanism for monitoring and enforcement.

All in all, an international permit system aimed at stabilizing emissions would not be politically viable in developed countries, could distort or compromise the world trade system, would be unattractive to developing countries, and would be difficult to monitor and enforce. It is an *impractical policy focused on achieving an unrealistic goal.*

A better alternative to a global emission permit scheme

Elsewhere[2] we have advocated a policy that gets around the potential problems of a global permit trading scheme discussed above. In many ways our approach is a small movement away from the global permit scheme, retaining many of the advantages but removing crucial problems. However, philosophically our approach is a long way from the degree of centralization implicit in a global permit scheme which has very different political implications. Our proposal has become known as the McKibbin-Wilcoxen Proposal in the international debate, but for whatever reason has been called the McKibbin Tax in the Australian debate (inappropriately in our view because we are not advocating a standard carbon tax). Our proposal, as originally designed, is an internationally coordinated system of national permits and emissions fees for carbon dioxide although it could easily be extended for carbon dioxide forcing equivalence, so as to incorporate the 6 greenhouse gases identified in the Kyoto Protocol (carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6)) . Under this system, all emitters of these greenhouse gases would be required to own permits equal to their total emissions of these gases. Countries would be allowed to distribute a specified number of permits to their domestic users in any way they like, including handing them out for free. Additional permits could be purchased from each government at a stipulated international price, say $10 per tonne. Because the total number of permits can rise if abatement turns out to be expensive, the policy has a built-in safety valve that would limit the economic damage that the policy could inflict. Since the policy does not focus on achieving a specified target at any cost, it would be far more likely than a more rigid approach to be

2 McKibbin and Wilcoxen (1997a,1997b).

ratified by more countries. The key point is that the price is internationally negotiated and held fixed between negotiations.

Once an industry receives its initial allocation of permits it would have to decide whether to buy additional permits, sell some of its allocation, or stay with exactly the number it was given. If it does not buy or sell permits, it can continue with its existing practices at no additional cost (although there is a significant opportunity cost from not selling permits). If it needs to increase its carbon-emitting activities, however, it would have to buy additional permits at a price of $10 per tonne, giving it a clear incentive to avoid increases in emissions. At the same time, if the firm could reduce its emissions, the permit system would give it a strong incentive to do so: avoided emissions could be sold on the permit market at a price of $10 per tonne. For example, if an electric utility could shift some of its load from coal to natural gas for a cost of $6 per tonne of carbon, it could emit less carbon and make a profit of $4 per tonne by selling its excess permits. Indeed, many firms have claimed they are willing to undertake low-cost carbon abatement. The permit system we propose will reward firms for these endeavours. The more effort a firm puts into reducing carbon emitting activities at low cost, the higher its profits will be.

This policy is not simply a carbon tax as it is often portrayed. Only marginal emissions above the target are subject to a direct charge (the price of permits) but most of this is a transfer within industry rather than between industry and government. Indeed existing emitters are implicitly given subsidies to change their behavior because the opportunity cost of continuing with their activities is the permit price. If firms do nothing, they are not subject to any direct cost increase but are awarded profit in proportion to their success at reducing emissions. New industry is not unfairly treated because the marginal costs for both old and new activities will be the same. Existing emitters receive lump sum compensation for the change in the system where this compensation is proportional to how much abatement they achieve.

In principle, the issue of sinks of greenhouse gases could also be dealt with in this system by allowing producers of sinks (land use changes, tree planting, etc) to be awarded permits for their activities that they can then sell into the permit market. There are serious issues of measurement that need to be overcome to make sure the system is not debased but in principle a generalized McKibbin-Wilcoxen system would be possible. One key problem with the Kyoto Protocol is that emissions and sinks are added together whereas the two are very different. Once a power station burns coal, carbon dioxide is emitted and stays in the

atmosphere for a very long time. If a farmer plants a tree, then while the tree grows, it absorbs carbon dioxide. Once finished growing, there is not a permanent reduction in emission rates. If the tree is harvested or burns, then the emissions sink is lost. To make the system workable, there would need to be a monitoring program that ensures that sinks are maintained and appropriate charges imposed for sink destruction.

The McKibbin-Wilcoxen proposal as extended here has a number of advantages:

- The same price will be charged for each new permit in each country, as well as for any permits that are traded in domestic permit markets. Thus, the marginal cost of reducing carbon emissions will be equalized within and across all countries that participate. This makes the system efficient because the cheapest emissions reductions will be undertaken first. Environmentalists and engineers often argue that many low-cost options are available for reducing energy demand. If so, these low-cost options will be exploited under this policy, and without needing to be specifically identified in advance by the government. On the household side, for example, the increase in energy prices will encourage households to demand more energy-efficient vehicles and appliances.
- The policy contains built-in mechanisms to encourage enforcement. Governments will have an incentive to monitor the system because they will be able to collect revenue from selling permits. Firms will have an incentive to monitor each other because any cheating by one firm would put its competitors at a disadvantage and would also affect the value of permits held by other firms.
- The system is flexible and decentralized. New countries can join by setting up their own permit system and agreeing to charge the stipulated world price for additional permits.
- Transfers associated with the permit system are largely between firms or between firms and households, rather than between the private sector and the government. It also minimizes transfers across borders, avoiding serious economic and political problems. Unlike the experience of the 1970s, increases in energy prices under this policy would not lead to massive transfers of wealth between countries.
- The policy also could be revised easily as more information becomes available. After setting up the system and agreeing on the price of permits, participating countries could meet every five years to

evaluate the extent to which carbon emissions have been abated as well as to re-evaluate the extent of climate change and its consequences. If it becomes clear that more action is required, the permit price could be raised. If climate change turns out to be less serious than it appears today, the permit price could be lowered. To minimize the costs of these price changes, future markets could be developed in permits so that risks are effectively shared.

Overall, the advantage of the McKibbin-Wilcoxen proposal for a permit and fee system over targets and timetables is simply that it is far more practical. It is ratifiable by key countries because it limits the cost of compliance and does not require governments to commit themselves to achieving a given target at any cost. It is transparent to households and firms because it spells out exactly how the policy will work, rather than specifying the target and leaving the policy undefined. It is more credible than a targets and timetables policy because it is not so draconian that countries will be tempted to renege, and because the revenue from selling additional permits will give governments an incentive to enforce it. Moreover, because it contains a built-in mechanism for limiting economic costs, the risk of setting ambitious emissions targets—which could significantly reduce economic growth if abatement proves to be expensive—is eliminated. This would remove the single most important obstacle to reaching a realistic international climate policy.

SUMMARY

The Kyoto Protocol complicates the process of achieving a realistic approach to greenhouse gas abatement. It has created a great deal of uncertainty about how and whether countries are going to achieve the strict quantity targets that have been set by 2008 to 2012. The international community had an opportunity to put in place a credible instruments-based approach that would begin to reduce emissions at low cost wherever possible, in addition to giving flexibility to the time frame and burden sharing arrangements. Policy makers now have to turn to economic instruments within a target regime that has many potential risks. For the world economy it has presented many crucial challenges. Our goal from here should be to make the system that develops as de-centralized as possible and to ensure that Australia does not commit to a significant loss in economic well-being while we wait for the United States to ratify the treaty. The best way forward for Australia would be a domestic version of the McKibbin-Wilcoxen proposal with allowance for sinks (where possible) in which the permit

price is fixed (and modest) and the market is used to determine the extent of abatement at a known cost.

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5

EMISSIONS TRADING—MAKING IT WORK?

JIM HAGAN[1]

This paper discusses two views underlying much of the debate on reducing greenhouse gas emissions:

- that it is possible to avoid adjustments; and,
- that this can be brought about through the design of international and domestic measures.

The main propositions of the paper are that adjustment follows inevitably from constraining emissions growth, and the policy objective is to minimise the impacts of that adjustment on peoples' well being[2]. Emissions trading provides a major way of minimising the cost to welfare. However, some of the approaches to emissions trading advocated by key players risk raising the costs of adjustment and increasing the impact on living standards.

The objective of an emissions trading system is to cap emissions of greenhouse gases either internationally or domestically over a given period (possibly long-term) to meet an environmental objective. Its claimed advantage over command and control measures is that it can achieve the objective at a lower economic cost.[3] The efficiencies are obtained because capping emissions puts a price on emitting, which

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1 Disclaimer: This paper is the work of the author and does not purport to represent the views of the Commonwealth Government or the Treasury.

2 The terms 'well being', 'standard of living' and 'welfare' are used interchangeably in the paper to include the benefits of consuming market and non-market goods and services. This recognises that there are benefits both from achieving an environmental objective and from monetary income.

3 See Working Group on CO_2 Policy (1996) for an accessible discussion of this issue.

feeds through the economy and prompts changes in consumption and production in response to changes in relative prices.

Much of the claimed benefit of emission trading derives from analysis in a textbook setting. It is inevitable that there will be pressures in the real world to depart from the textbook model. The departures can occur in the design of the trading system, trading rules, the allocation and design of emission allowances, and the inclusion of countries, gases and sectors.

Such departures have both static and dynamic costs. Given that global emissions reduction is a long-term issue, the pressure for economies to adjust to reduce emissions will be sustained. In this context, initial design of emission trading will have an important influence on the evolution of the system and its potential to deliver least-cost means of reducing emissions.

The practical policy question we face is: can we design a system that delivers the advantage over other approaches in the face of the pressures to diverge from the text book model? Casual observation says that this is possible. The success of the sulfur dioxide trading regime in the United States of America is a case in point. Closer inspection indicates that benefits can be lost and markets killed, depending on the rules of the game.

This paper first sets out the context of emissions trading at the international and domestic level, and then briefly covers the text book model of trading and design parameters. This provides the basis to then examine the various pressures on emission trading system design, raising some questions about claims made for some of the compromises, and offering some 'rules of thumb' in system design.

THE CONTEXT OF EMISSIONS TRADING

This section sketches the existing framework and pressures surrounding the current international negotiations on greenhouse gas emission limitation and reduction. It is not a comprehensive survey.[4] The paper discusses emissions trading at both the domestic and the international level. Many of the issues are related. One important distinction between the two is that allowances to emit are allocated free of any direct charge at the international level, while governments have a choice about how they allocate.

4 See ABARE (1998) for a more detailed discussion of the context of emissions trading in international negotiations and as a domestic measure.

The current framework would commit a group of industrialised and other (Annex B) countries to reduce their emissions of greenhouse gases to no more than the annual equivalent of a 1990 baseline for one period 2008—12. The framework also makes provision for negotiating commitments for future periods. Major greenhouse gases are covered by the framework, with provision to aggregate them in terms of their global warming potential.[5] Key Annex B countries have not yet ratified the Protocol. In this sense, the bargaining over the design of the trading system continues.

The countries making commitments made up around 67 per cent of world emissions of greenhouse gases in 1990. These countries also account for about 80 per cent of world output. Countries not taking on commitments include China (13.5 per cent of world total emissions and second biggest emitter) and India (about 4 per cent of total emissions and fifth biggest emitter). Projections indicate that by 2020 total greenhouse gas emissions by countries not currently making commitments will exceed those of the Annex B countries[6], raising substantial questions about the effectiveness of emission reductions in the medium term and the evolution of a sustainable trading system.

The Kyoto Protocol makes provision for international emissions trading among Annex B countries (Article 17). The rules for trading are yet to be established. In addition, there is a form of emissions trading allowable under Article 4 used by the European Union, as well as the Clean Development Mechanism (Article 12) which allows the purchase of emission offsets by Annex B countries from non-Annex B countries in return for emission-reducing investments. Further, countries will be able to claim credits for carbon sequestration under certain circumstances.

There are mixed views on international emissions trading among both Annex B and non-Annex B countries as envisaged under Article 17. It is not relevant to speculate here on the extent to which those opposing emissions trading are driven by suspicion of markets, domestic agendas, opposition to the implied ownership of the atmosphere, negotiating strategies, or perceived commercial advantage. The upshot is that there are substantial pressures to constrain the development of international trading in emissions.

5 The gases are listed in Annex A of the Protocol, reproduced in Appendix A of this book. Refer also to Appendix B.

6 ABARE (1995).

The international framework allows countries flexibility about how they meet their commitments within their borders, leaving open the possibility of domestic emissions trading. However, within countries contemplating emissions trading, government and non-government groups are positioning themselves to influence the design and evolution of a trading system as well as allocation of allowances.[7]

Allocation of allowances will be an issue regardless of whether trading is adopted. Any system that imposes a binding cap on emissions means that all affected groups have an interest in gaining the greatest quantity available at the lowest possible direct price to themselves. This may be via exemption from the domestic cap (an implicit allocation) or through the direct allocation which may or may not be traded.

THE EMISSIONS TRADING MODEL

This section describes a basic 'textbook' model of emissions trading and design rules as a baseline to illustrate the benefits of an emissions trading market relative to non-market based measures to reduce or cap emissions. This then allows a comparison of variations from the textbook.[8]

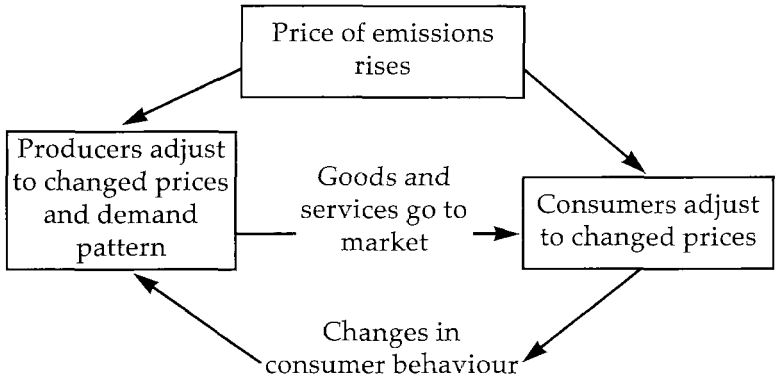
The basic characteristics of an efficient market can be characterised as:

- certainty about the nature of the asset being traded—the right or allowance to emit is well defined;
- an asset with a positive value—the cap on emissions signified by the total of allowances issued is binding;
- openness—participation in the market is not restricted to only those who need to surrender allowances when emissions are deemed to occur;
- clear rules—so that the point at which an allowance has to be surrendered is certain, as are the rules concerning who may enter the market for allowances and the timing of their use (for example, the nature of any banking or borrowing);

7 See ABARE (1998) and IBC (1998).

8 See Hinchy et al (1998) for a detailed discussion of the economics of international emissions trading.

FIGURE 5.1 ADJUSTMENT CYCLE



- credibility–enforcement of the rules and obligations is certain, so that the probability of the market being cornered or 'spoiled' by any one player is low;
- informed–market players can obtain price information; and
- lower costs–the costs of operating in the market (administrative and compliance) are lower than the next best alternative arrangement.

The above characteristics are not exhaustive, nor are they mutually exclusive. For example, the credibility of the market is going to be related not only to the behaviour of market participants, but also to the certainty surrounding the asset being traded and the information in the market place.

It is not the quantitative restriction embodied in the allowance that brings about the changes in the economy at least cost, but the price effect which seeks out responses. The quantitative restriction simply ensures that the commitment to a particular level of emissions is met.

The gain in efficiency from trading emission allowances derives from the scarcity value of the allowance. Scarcity gives the allowance a value that works its way through the economy. If the price of emitting goes up relative to other activities, actors in the economy are faced with the choice of either paying the higher price or looking for some way to avoid the additional cost. For consumers this can mean lowering consumption of the higher priced good or service through substitution (eg walking instead of driving) or less consumption (turning off the light on leaving the room). For producers this means changing the technology

of production, or changing the mix of inputs (or outputs) to offset the price effect. These adjustments are reflected in a new output price which sets up a choice for the potential consumer of that product to react to. The cycle of adjustment is depicted in figure 5.1.

The final feature of the simple model of emissions trading is the result that the initial distribution of the allowances is irrelevant to the final (and efficient) pattern of emissions. This arises because a potential emitter has a choice: either to emit, requiring the purchase of an allowance; or to avoid emitting and save the cost of the allowance. The choice will depend on the relative cost of avoiding emissions relative to the price of the allowance. A decision to purchase an allowance will occur where the cost of the additional allowance is less than the value of the additional unit of production (or consumption) that can be obtained using that allowance (net of other costs). Thus allowances will move to the higher valued uses.

DEALING WITH REALITY

The model

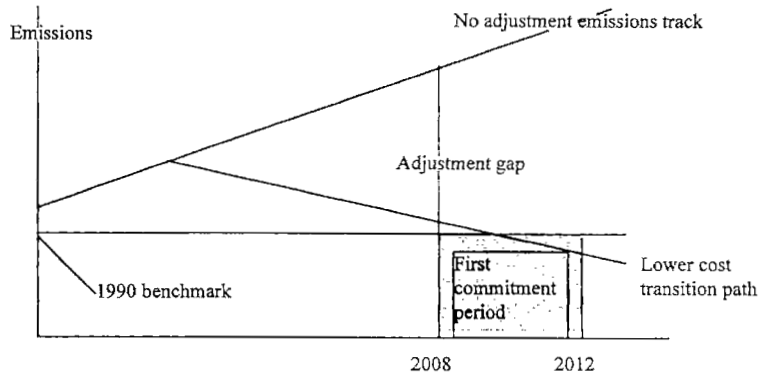
The text book model assumes that we essentially begin with a clean piece of paper. Obviously this is not the case in the current context. While a scarce asset has been literally created out of thin air by the Kyoto Protocol, interested parties have been treating it as an economic good for some time as can be seen in the negotiating behaviour of countries and speculative activities in the private sector.[9]

A market does not generally simply come into being. It evolves, there is experimentation, and successful operation often depends on conventions and institutional memory. Markets for new products can draw on experience in related types of markets as rules develop (black letter law and informal disciplines). Last, the simple model ignores the importance of the distribution of allowances at both the international and domestic level. As discussed in sections below, allocation is a key issue affecting positions being taken on design issues.

The design issues for international emissions trading are substantial. There is limited direct institutional experience to draw on and the capability of the bureaucracies involved in negotiating the details of the framework (let alone the details of market rules) is unknown. In addition, the ability to discipline market players (that is, apply the rules) in a timely manner is complicated by the cross-jurisdictional nature of

9 See IBC (1998).

FIGURE 5.2 HIGH- AND LOW-COST TRANSITION PATHS



market arrangements. Given this, the risks of the negotiations setting up an inefficient or unsustainable international emissions trading framework are non-trivial.

While the purpose of this chapter is not to anticipate all possible problems, there are some policy prescriptions that can raise the chances of success. Design should:

- promote openness:
- minimise the restrictions on the movement of allowances within and between economies;
- allow participation by non-government entities;
- keep the framework simple (and therefore easy to understand); and
- minimise the role of bureaucracy in directing trades.

The credibility of trading will be enhanced by an open approach. Freedom of movement of allowances and wide participation promotes the flow of information into and out of the market and limits the ability of players to dominate the market. The last bullet point is important. It is based on the argument that those with direct knowledge of the relative benefits of buying and selling allowances are best placed to make such decisions. Bureaucracies do not have a direct stake in the outcome of

trading and are therefore likely to be less informed and thus not in a position to make efficient trades.

At the international and domestic levels uncertainty is a major constraint on the development of an efficient trading system. Only one period of restraint is currently agreed to and the evolution of the system in terms of inclusion of additional countries and the level of future restraints of emissions is unresolved. This lowers the ability of economic agents to plan investments and thus reap the benefits of trading (or indeed other strategies to reduce emissions).

At the domestic level, the costs of uncertainty can also be viewed in terms of the transition path of the economy, not just once binding commitments have begun (see figure 5.2). The greater the level of certainty that the binding commitments will be imposed and its conditions, the greater the adjustment that will occur prior to the commitment period. Long-lived investments will be made 'now', taking account of the likely future conditions.

The policy problem facing countries still negotiating the details of their future commitments is how to achieve a low-cost adjustment path by delivering domestic certainty on policy without compromising their negotiating position. This is important given the ongoing nature of negotiations.

IMPLICATIONS FOR POLICY

This section examines some international and domestic policy issues and some of the political economy involved.

A theme underlying some policy debates is that, somehow or other, Australia can avoid the need to adjust to emission constraints. This is a fallacy. First, the emission allowances available are less than the level of emissions based on forecast tracks—so someone has to find additional allowances, or miss out[10]. This implies adjustment in the medium term,[11] if not in the short term. Second, as noted earlier, a substantial portion of world production is produced by countries with

10 I am assuming that additional allowances derived from afforestation and activities such as the Clean Development Mechanism will not fully meet the demand for allowances. It is also an open question whether allowances will flow from eastern Europe and Russia.

11 One optimistic view in the current domestic debate is that the current package of State and Federal measures will be enough to ensure sufficient allowances for growth industries without the need for additional measures such as trading. If one takes the view that reduction commitments will extend beyond 2012, then it is difficult to believe this position could hold if the economy continues to grow.

binding emission constraints. This means that there will be terms of trade effects simply from the direct response to a higher price for emitting greenhouse gases, which will force adjustments on economies. Third, the positive value of emission allowances will generate incentives for investments in different technologies and products, creating adjustment pressures on any economy that trades with the rest of the world. Fourth, at least for the moment, some significant economies are not entering into emission limitations undertakings and so will provide an opportunity for investors to exploit the difference.

INTERNATIONAL

The larger the allocation of allowances, the smaller the adjustment that is needed

In the international negotiations a large amount of time is spent in arguing over the size of reductions in emissions a country should make. By implication, the smaller the commitment, the larger the emission allowance. While the environmental objective is part of that debate, a second and substantial part concerns the economic impact of the emissions target.[12] While it is true that a smaller reduction target (or larger allowance) lowers the economic cost of adjustment, it does so indirectly and does not prevent adjustment.

If an economy faces the international price of emissions its industries and consumers will be forced to adjust for the reasons set out in the introduction of the section. The value of the international allocation of emission allowances is that they reduce the wealth transfer required to obtain the allowances from other parties. The issue then becomes one of the efficiency of government and how the value of the allowances translates into offsetting the costs of adjustment.

International allowances are important to the level of adjustment where the quantity of allowances for an economy is fixed (eg credits for Clean Development Mechanisms or afforestation are insignificant) and allowances cannot move across borders. In such a case, the adjustments in economies are real (and a higher economic cost) and a risk-averse negotiator would seek as large an allowance as possible.

DOMESTIC MEASURES SHOULD BE A PRECURSOR TO EMISSIONS TRADING

Sceptics of international emissions trading have argued that domestic measures should form the mainstay of an economy's adjustment of

12 The other major group of arguments concern the legitimacy of historically based allowances.

emissions to achieve its targets.[13] This reflects a view that international emissions trading is a means of a country avoiding adjustment. Such an argument seems to confuse the objectives with the means of achieving it, as well as misunderstanding how emissions trading and prices work.[14] It is also difficult to see how such a requirement could be made operational without raising the costs of meeting the commitment.

As noted earlier the application of a binding cap on emissions gives the allowance a scarcity value that creates a chain of consequences in an economy and consequently a series of adjustments. This is not changed by how a government achieves those adjustments. The advantage of an emissions trading system is that it is an efficient mechanism for finding the least-cost adjustments in the economy and in a global sense.

If we were to define 'domestic measures' to meeting commitments in terms of reductions in domestic emissions relative to some baseline, then the risk is that the cost of adjustment is increased firstly as the domestic economy adjusts without trade and then secondly as it adjusts when opened to trade. If we consider that the United States of America was one of the countries targeted by that restriction in the Protocol and take into account the relative size of the United States economy, double adjustments could have significant effects on other economies. Such an approach also assumes that the only reason to hold allowances is to use them to emit. This does not take account of situations where allowances may simply be held as trading stock and so perform an important role increasing the number of participants in emissions trading and allowing sellers to find high-value uses for allowances.

Alternatively, if we were to define 'domestic measures' in terms of the number of interventions in the operation of the economy, this would favour the less efficient (higher cost) command and control mechanisms that trading can replace. Trading is one measure, but can generate adjustment throughout the economy.

13 Article 17 of the Protocol states '... Any such trading shall be supplemental to domestic actions for the purpose of meeting quantified emission limitation and reduction commitments under that Article'.

14 This view was put forward by the European Union during the negotiation of the Kyoto Protocol.

While there may be domestic reasons for adopting a range of market and non-market based measures to meet different concerns, constraining the mix of measures available at the international level contributes to neither environmental nor wider economic and social objectives. From the point of view of countries that might be in a position to sell allowances, it also reduces the ability of those countries to fund their adjustment policies.

DOMESTIC

Emission allowances should be allocated free

Access to emission allowances is a major issue in the domestic debate. In a sense it is an issue that underlies any policy response to capping emissions, as regardless of the policy instruments used there is an allocation of allowance and consequent burden of adjustment. However, the claims for allowances often conflict with the objective of minimising the economy-wide costs of adjustment. This can be illustrated at both the conceptual and the practical level.

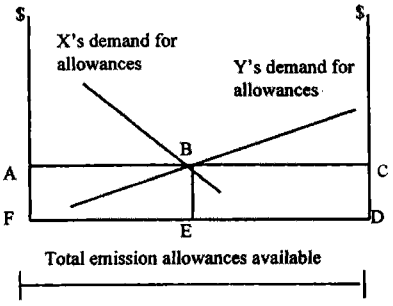
A claim commonly made is that current emitters should have free access to emission rights to reduce the costs of adjustment and that export-based industries have a greater claim than industry producing for the domestic market.

At a conceptual level, a free allocation of allowances is the equivalent of gifting an asset to particular groups in the economy. Given that the allowances will have a positive value, the recipients are then able to either expend those allowances by emitting or to realise their value in the market for emission allowances. The argument in favour of this approach is that holders of the allowances are then able to fund the necessary adjustments to reduce emissions by selling allowances. They can sell to advantage where the value of the allowance is greater than the cost of adjustment or use the allowance where the cost of the adjustment is greater than the value of the allowance.

The counter argument is that the sale of emission allowances by government (eg by auction) provides revenue for government to alleviate the costs of adjustment through sector/industry-specific adjustment programs or by simply using the revenue to lower the costs of government.

The second strand of the argument advocating a free allocation of allowances rests on the view that it is necessary to offset the effects of emission reductions on the competitiveness of exports, particularly emission-intensive exports. Such exports compete in a market of

FIGURE 5.3 TRADING—WHO BEARS THE COST AND WHO GETS THE REVENUE?



This diagram illustrates how allowances will move between parties who value them. After trade, X holds FE allowances, and Y holds ED - with a price per unit of ABC. If all the allowances were allocated to X (FED) then X would sell ED to Y for ABC on the basis that X can make reductions for a lower price than Y is prepared to pay. This gives X a windfall gain of BCDE which is the cost of adjustment for Y. The total cost to government of revenue is ABCDEF. The model does not take account of the costs faced by up- and downstream customers

exporters without emission reduction targets. This effect has been picked up in modelling work that has identified the 'leakage' of industry to other countries.

The corollary to this is the argument that assistance is needed for industries that compete with imports from countries not bound by emission reduction commitments. Again, this raises the issue of burden shifting and the cost of adjustment upstream and downstream.

Leakage is a manifestation of the wider problem of entering into an international agreement that binds some countries and exempts others. Its extent is a function of the size of the adjustment required relative to a business-as-usual emission track, the costs (to a business) of locating an industry offshore and the composition of a domestic economy.

In both the above cases the arguments derive from an attempt by sectors, quite understandably, to avoid the costs of adjustment for their own specific activities. The problem, given the objective of minimising the impact of emission reductions on overall welfare, is that adjustment has to take place somewhere, and that the impact on welfare is minimised by adjustment taking place at the least cost. Excluding some activities (like the emissions of some countries) shifts the burden to other sectors and raises the risk of making the adjustment at a higher cost.

There are a number of practical considerations in dealing with allocation. Much of this centres on the fact that adjustment takes place throughout the economy regardless of the allocation. Free allocation

to any particular groups means that others groups will face the full costs of adjustment, or that government will need to fund that adjustment by raising higher revenue with its associated higher deadweight efficiency costs, which again shifts the burden to other groups. It is difficult to conceive of a free allocation mechanism that would see the allocation of allowances matching the burden of adjustment. Governments (and business) do not have that sort of information and all private sector parties have the incentive to push their own particular cause.

A second set of practical issues surrounding the allocation of rights derives from the on-going nature of emission limitations. If international environmental objectives are to be achieved there will be commitment periods beyond 2008–12. This raises the issue of how an allocation system of allowances to incumbents can be sustained. Today's incumbents may cease to exist, and today's new entrants are tomorrow's incumbents. It suggests that, over time at least, the system of allocation would move to the sale of allowances by government.

The third practical issue concerning the allocation of allowances derives from the nature of the emissions trading scheme adopted. Some participants in the debate have assumed a need for all businesses with a connection to emissions to be allocated allowances.[15]

In designing an emissions limitation regime a distinction needs to be drawn between the actual source of the emission (eg the exhaust pipe of a car) and the point at which the system is applied. Given the objectives of minimising the administrative and compliance costs of a regime, the point of application of the system may not be at the actual source of the emission. For example, the system in the case of car emissions may be applied at the fuel depot. The impact of an emission allowance will be felt by the driver via a higher price of fuel. It would be the same price that the driver would face if s/he had to purchase the equivalent emission allowance (excluding administrative and compliance costs).[16]

In the above case, gifting allowances to those who would need to surrender them would constitute a transfer of economic rent to a sector that was only part of the adjustment story. The implication of this

15 For example, at the ABARE International Conference on Greenhouse Gas Emissions Trading, 21–22 May 1998 and the IBC Emissions Trading Conference, 18–19 June 1998.

16 I am abstracting to some extent from the issues identified by Dobes relating to the transport sector (Chapter 9 in this publication).

consideration is that it may be not only more efficient, but politically acceptable, for government to auction allowances and then use the funds to assist adjustment elsewhere in the economy.

Targeting specific sectors

It has been argued that production-or consumption-specific measures will be needed to supplement market-based measures such as emissions trading with more direct regulation. The apparent failure of an activity to reduce emissions in response to an increase in the price of emitting does not necessarily constitute a market failure. It may simply reflect that this is the least costly impact on welfare relative to other emission reduction options. That is, the activity which does not change is a higher value use of emissions.

The argument for targeted interventions has been based on a view that some activities should change (that is, reduce substantially) if emission targets are to be met. Such arguments ignore (or forget) that the quantitative cap of the emissions reduction commitment ensures that the overall target is met. The price signals deriving from emissions trading are simply selecting how it is met. Emissions from motor vehicles provide a case in point.

Greenhouse gas emissions from passenger cars contribute around 12 per cent of CO_2 equivalent emissions in Australia.[17] Empirical evidence suggests that drivers are not particularly responsive to changes in fuel prices in terms of their driving habits within the range of price variations they have faced so far. This has been used as evidence of market failure and as an argument in favour of applying efficiency and emission standards to vehicles, rather than allowing a higher price of fossil fuels to lead drivers to make the response that minimises their welfare loss (such as buying lower emission vehicles, changing driving habits or lowering consumption elsewhere). Direct measures also raise the cost of meeting emission targets by undermining the ability of the private sector to respond in cost-efficient ways.

What such approaches to non-market measures are assuming is an ability to pick the least-cost response to meet the emission target. Such interventions also override the market signal that the (unresponsive) activity is higher valued relative to the alternatives.

17 Drawn from data in BTCE (1996) and Australia (1997).

CONCLUSION

The previous sections have examined conceptual and practical issues associated with the design and operation of international and domestic emission trading regimes. They suggest some guidelines for policy makers who are not blessed with perfect foresight, and have incomplete knowledge of existing circumstances. These are:

- Domestic economies cannot avoid the effects of a global emission limitation regime - indeed investors are already responding to perceived opportunities. Thus, the earlier that uncertainty concerning the future evolution of emissions reduction can be reduced, the greater the time, and the lower the cost, for an economy's transition to the commitment period;
- Initial design of both the international framework and trading rules is important to their future evolution. Poor initial design can undermine the environmental object and impose greater costs on welfare than is necessary;
- The advantage of market-based instruments is that they use the pervasive effects of prices to discover the least (welfare) costly means of meeting a cap on emissions. The cap ensures that the target is met. Lack of response by one activity to a price change does not necessarily imply a market failure, rather a signal that changes in that activity have a higher welfare cost relative to other options;
- The system of domestic allocation of allowances should not be divorced from the design of the emission reduction regime. The implication of this is that it may be most efficient for government to auction allowances and then use the funds to assist adjustment in the economy; and
- Compensating particular activities (e.g. through the allocation of allowances) risks shifting the costs of adjustment to other activities at a higher welfare cost.

The rationing of allowances to emit gases embodied in a binding emissions cap creates an incentive for virtually all players to argue a case for special treatment. The problem for policy makers is how to weigh up those claims to achieve the greater good. This article demonstrates that some of the solutions proposed do not clearly serve this end.

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6

EMISSIONS TRADING FROM A BUSINESS PERSPECTIVE

TONY BECK*

Most of the business sector now recognises the need to address the greenhouse problem and in particular to meet Australia's Kyoto target. However, this attitude does not diminish concerns about the possible adverse impact of greenhouse policies. Business is well justified in seeking and expecting greenhouse policies that are cost-effective and equitable in their impact.

Framing a regime to deliver efficient outcomes for greenhouse gas abatement while limiting transaction/administration/compliance costs will be a challenging balancing act, whether it is attempted at the domestic or international level. The risk is that, in trying to limit the costs of the regime, a wide range of distortions will be created.

To be effective and acceptable to business and the community, greenhouse policies, including emissions trading, must fulfill a range of environmental and economic requirements:

- *Efficiently deliver improved environmental outcomes*. Policies that impose costs without substantially improving environmental outcomes will not be acceptable.
- *Protect the competitiveness of Australian business*. Australian industry remains vulnerable to any policies that increase its costs relative to cost conditions in other countries.

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- *Meet the need for growth in the Australian economy and its constituent parts.* Australia cannot achieve acceptable levels of employment and community prosperity if economic growth is restricted.
- *Be cost-effective.* Administration costs, transaction costs and economic disruption should be minimised.
- *Maximise the certainty for business and others in the community to plan and invest.* Uncertainty has an adverse effect on business planning and investment.
- *Be equitable both internationally and domestically.* Economic costs borne by Australia must be equitable relative to those borne by other countries. Any costs borne internally within Australia must also be borne fairly—that is, costs should be borne across the whole community and not disproportionately by any one firm or sector.
- *Be comprehensive in terms of gases, sources and sinks.* This will enable the achievement of desired outcomes with greatest equity and at lowest cost.

The theoretical potential for emissions trading to come closest to meeting these policy requirements is well recognised by industry. However, the problem of converting a theoretical ideal into a practical, efficient reality is seen as a serious challenge. A number of key aspects of emissions trading are of concern to industry and are considered in this paper: international compliance issues, international market operation and Australia's interface with it, and domestic trading issues.

INTERNATIONAL TRADING

The rules and institutional arrangements for an international trading regime will take some time to finalise. For a start it must be recognised that a range of other relevant aspects of the Protocol, such as the compliance and enforcement provisions and the operation of the Clean Development Mechanism and Joint Implementation, will also take time to resolve.

Compliance and enforcement

Kyoto failed to address the contentious issue of compliance and enforcement provisions for the Protocol. Further negotiations will determine 'appropriate and effective procedures and mechanisms to determine and address cases of non-compliance'.

In this process, countries will be negotiating on the penalties that they will incur if they fail to meet their emission limitation commitments. Not surprisingly, initial indications are that tough compliance provisions are not being favoured.

But weak compliance provisions will not be conducive to an effective emissions trading regime. When millions, and possibly billions, of dollars will be changing hands in exchange for emission credits, effective compliance provisions in some form or another will be necessary.

An alternative to rigorous international enforcement is enforcement at the national level. This has the advantage of making enforcement a matter for parties to manage themselves but opens up the scope for different standards of enforcement across parties. Incentive structures in the trading regime would need to provide an incentive for effective national enforcement if international trading is to develop into a fully functioning market. In particular, the allocation of risk between the buyer and the seller of credits will be important.

INTERNATIONAL MARKET OPERATION

Participation

The non-participation of developing countries in agreed emissions targets remains a fundamental flaw in the Kyoto Protocol and poses an ongoing issue for emissions trading. The full potential for emissions trading cannot be realised without access to low-cost emissions abatement opportunities in developing countries. More generally, having some countries free of binding commitments potentially threatens the competitiveness of those countries that have made commitments.

Accordingly, to optimise environmental and economic outcomes, any international trading regime should seek to ultimately include all countries. Achieving this should remain a key objective of Australia's medium-term international negotiating strategy.

Market structure and price

With Annex I countries trading only, it seems most likely that the US and Japan will be major buyers with Russia being the major seller. The scale of transactions between these giant players will inevitably mean that Australia would be a price taker in what could be a distorted permit market. To protect our interests in the development and operation of such a market we need a much better understanding of the structure of the market, likely prices and volumes of trade and whether Australia could expect to be a net buyer or seller.

Early assessments indicate that demand from the US and Japan could outstrip supply from Russia, forcing up prices. Others claim that there will be a plentiful supply of low cost credits once there is an incentive to generate them. SO_2 emissions trading in the US might suggest that prices could start high and decline over time as cost-effective ways of reducing emissions are developed and adopted, but as yet we have not seen any comprehensive analysis to cast light on this issue.

Australia's projections of emissions growth under our 'business-as-usual' scenario would suggest that we could well be permit buyers, at least in the medium term, but there remains good scope for cost-effective emission reduction, so our stance in an international market remains unclear.

We need to quickly develop a better understanding of where we would fit in an international market and how best to position ourselves to take advantage of market and policy developments.

AUSTRALIA'S INTERFACE WITH INTERNATIONAL TRADING

A crucial question for Australia is how we should interface with the international market:

- Could we ignore it and do our own thing, if we thought we could meet our target through cost-effective domestic action?
- Could we restrict involvement, perhaps just have the Government trade internationally?
- Would a domestic trading regime, with flexibility for firms to trade internationally, provide a more cost effective way of meeting our commitments?

If international prices are high and Australia is likely to be a net buyer of credits some might argue that we should use regulation to isolate our market, and use our lower cost credits domestically rather than have them sold off internationally.

No doubt potential credit sellers would oppose such a constraint on trade, but in any case such isolation is unlikely to be feasible. Various forces would lead to the local credits being bid up to the international price anyway.

It is more likely that Australia's interests would be best served by an open, transparent and liquid international market with maximum buyer and seller participation, together with a seamless interface with a

domestic market. This would lead to low transaction costs and an efficient, readily accessible market for both buyers and sellers.

Compatible domestic policies needed

Preparing to deal with the emerging international market in emissions credits or permits needs to be addressed quickly by government and industry. In particular, we need to be conscious that a lack of compatibility between domestic and international policies could make it much more difficult to meet our commitments.

For example, if an *international* market for emission credits develops (as is already happening) but there is no corresponding domestic market, what will be the consequences? Understandably, emission credit sellers in Australia would be keen to sell their credits overseas, but in doing so these credits could not be used to meet Australia's target.

Such one-way transfers of credits would make it doubly difficult for us to meet our Kyoto commitments. Given that it is likely to be both undesirable and infeasible to prohibit the international sale of credits from Australia, there needs to be some basis established to allow local credits to have a local value and be utilised locally. Domestic trading would be one way of allowing this to happen.

DOMESTIC TRADING

The Prime Minister's domestic greenhouse policy package of 20 November 1997 will supposedly enable Australia to meet its commitments for the first commitment period (2008–2012). The question therefore arises as to whether there is any need for a domestic permit trading regime, and, if there is, what role it would play, and what relation it would have to other policies.

It is necessary to take a longer-term perspective beyond the first target period to consider this question. Faced with the possibility of more stringent targets in subsequent periods, any domestic response strategy must facilitate a smooth adjustment to changes in the national commitment.

A trading regime must also meet the need for continuing growth in the Australian economy. Accordingly, it must provide a policy environment which allows as much certainty as possible to facilitate future business operations and investments.

In the medium to long term, domestic trading, if well managed, would be preferable in this regard to ad hoc and possibly arbitrary regulatory measures. However, a range of issues will need to be addressed in relation to any domestic trading scheme, including allocation of permits and comprehensiveness of coverage.

Allocation of permits and allowance for future growth

A critical aspect of a tradable permit regime is the allocation of permits. As with the international allocation of targets, this is a major issue related to equity and economic competitiveness. Inequitable allocation would adversely affect the competitiveness of individual businesses, sectors and regions, with consequent impacts on national economic efficiency.

To prevent distortions and adverse effects on the costs of Australian business, permits would need to be allocated free to firms operating in Australia. Any domestic tradable permit regime should not be developed as a revenue gathering exercise.

A range of factors, including availability of verifiable data, liquidation of some firms and birth of others, and recognition for abatement efforts already undertaken, would need to be considered. Permit allocation would also need to account for past and present abatement successes, so that these efforts would not be in vain nor, perversely, become a liability.

In addition to the issues associated with the initial allocation of permits, further critical issues which must also be subject to detailed consideration and consultation include:

- how to allocate for economic (and emissions) growth in a way that is equitable and does not unduly restrict or distort investment and growth in the economy or within individual sectors;
- how to allocate permits to new entrants in the economy (and the permits market) - or to those that have no operating/emissions history or quantifiable baseline emissions (say, for example, emissions at any stipulated base year);
- how to define to what, or where, permits are allocated—legal entities (which may have operations in Australia but be registered in another country), permits for emissions (from disparate and multitudinous sources) or permits for activities that give rise to emissions (such as livestock numbers kept, or units of fossil fuel sold), permits for particular sites, operations, plants or projects, particular sources

of emissions, the point of measurement of emissions (at the well-head or point of import), etc.

- how to define and allocate permits to accommodate the expected emissions during the full economic life of a particular project or activity, and thus provide certainty for long-term projects. This is particularly important for the many industries that have planning horizons covering multiple target periods ;
- how to allocate permits for, or how to accommodate, short-term fluctuations in emissions from those originally estimated or calculated as part of the initial allocation methodology;
- how to allocate and account for changes to Australia's target from one commitment period to the next.

Comprehensiveness

Much of industry sees a danger that a trading regime (and greenhouse policy generally) will be focused on sectors where emissions are easily measured, with other sections of community exempt. This would be neither efficient nor equitable.

In considering domestic trading, it should not be assumed that activities involving diffuse sources, or those associated with farming and forestry, for example, could not be brought within the scope of a trading regime. Relevant data associated with a wide range of such activities is already collected and they are already subject to various regulatory regimes.

One approach (but not the only one) to extending policy coverage would be a 'baseline and credit regime' in which areas that were not within a 'cap and trade' regime could earn credits by demonstrating greenhouse gas abatement and/or sequestration over some accepted 'base line'. Such credits could then be sold into the 'cap and trade' regime. Innovative projects could be captured where it was impracticable to capture them within a full 'cap and trade' regime. This, and other options for ensuring comprehensiveness, need to be evaluated.

CONCLUSIONS

A wide range of critical issues remain to be resolved both internationally and domestically if successful trading regimes are to be established. Australian interests will be best served by Australia seeking to shape the terms of international debate on the emerging international tradable permit regime, recognising that we will be a small player in a large and possibly distorted market.

Particular attention needs to be given quickly to the issue of how Australia should interface with the emerging international market in emission credits. Failure to institute appropriate domestic policies could make it more difficult and costly to meet our commitments.

Any move to establish a domestic trading scheme would need to resolve a number of contentious issues such as permit allocation and comprehensiveness of coverage before proceeding.

Further study of all the relevant issues associated with emissions trading is warranted. Such a study should involve the participation of all potential parties to a trading regime from the earliest stages, and should include (but not be restricted to):

- modelling the implications of the Kyoto Protocol and emissions trading on international trade and on Australia's terms of trade in particular;
- analysing the implications of Australia's target on the economy in general and on key sectors, under various scenarios including with and without domestic emissions trading.

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7

PROSPECTS FOR AUSTRALIAN INDUSTRY INVOLVEMENT IN THE ASIA-PACIFIC REGION WITH CLEAN DEVELOPMENT MECHANISMS

DON GUNASEKERA AND DEO MWESIGYE*

In recognition of the need for a global response to the greenhouse issue, the Kyoto Protocol to the United Nations Framework Convention on Climate Change (FCCC) in December 1997 has established a number of provisions including what is known as the 'Clean Development Mechanism' (CDM) to help Parties meet their greenhouse target commitments. In general, CDM allows developed country Parties (Annex B Parties to the Protocol) to use certified emission reductions (CERs) resulting from projects and activities in developing country Parties, subject to the authority and guidance of the Conference of the Parties (Box 7.1). The establishment of a CDM presents countries, including Australia, with an opportunity to demonstrate the viability of such cooperative mechanisms as a practical means of helping to reduce greenhouse gas emissions.

This chapter examines the scope for CDM as a cost-effective measure to reduce greenhouse gas emissions between countries with a particular emphasis on Australia's potential CDM involvement in the developing countries of the Asia-Pacific region.

CDM AS A GREENHOUSE GAS ABATEMENT MEASURE

The basic economic principle underlying CDM as a policy tool is that, until the marginal costs of abatement have been equalised across all countries, further investments in CDM projects would lead to an

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* Productivity Commission and AusAid respectively. The opinions expressed are those of the authors and should not be attributed to, or taken as representing the views of, the Productivity Commission or AusAid. This paper draws on BIE (1996).

improvement in global social welfare associated with minimising the global cost of greenhouse gas abatement.

Several recent studies provide empirical evidence supporting the existence of marginal abatement cost differences between countries. The United Nations Environment Program (UNEP) Greenhouse Gas Abatement Costing Studies find significant differences in abatement costs between countries (Swisher and Villavicencio 1995). The UNEP studies reveal that developing countries appear to have a significant number of low cost abatement options and perhaps negative cost or 'no-regrets' measures for reducing emissions from the energy sector.

BOX 7.1 CLEAN DEVELOPMENT MECHANISM

The Kyoto Protocol includes a new way of linking emission reduction with economic development. A 'Clean Development Mechanism' (CDM) shall be set up, which has been defined only rather vaguely (Art. 12). It leads to the creation of 'certified emission reductions' (CERs) (Art. 3.12). Art. 12.3 states that countries that fund projects through the CDM get credit for CERs from these projects, provided 'benefits' accrue to the host country (Art. 12.3a). Crediting shall be allowed only until a certain percentage of the emission target—which remains to be defined—is reached (Art. 12.3b). It is unclear whether crediting up to this quota is in full, or only partial.

Article 12.10 of the Kyoto Protocol specifies that CERs obtained under CDM during the period 2000–2008 can be banked for later use in meeting Annex I countries' commitments during the first commitment period 2008–2012. This banking clause provides the incentive for private firms in Annex I countries to invest in emissions reductions in developing countries prior to the beginning of the first commitment period.

Both emissions trading under Article 17 and joint implementation under Article 6 involve the transfer of assigned amounts of emission reduction units, creating an enforceable standard that ensures the environmental integrity of the trading systems and the overall cap on emissions. No similar system exists for emission reduction units created under the CDM, so an additional level of accountability, such as insurance or certification, is needed for such credits.

Article 12 provides that Annex I countries can acquire the certified credits obtained from emission reduction projects with non-Annex I countries under the CDM. According to UNCTAD (1998) only certified credits from CDM projects with developing countries can be incorporated into an international emissions trading scheme.

Source: UNCTAD (1998, pp. 15, 16, 34, 66 and 67)

This result validates the argument that a least-cost emission strategy could involve measures in developing countries which are not bound by existing emission reduction commitments under the FCCC.

Two Australian studies made similar findings. Hinchy, Thorpe and Fisher (1993) estimated the marginal cost of reducing emissions from the energy sectors of eleven countries—Australia and the ten countries which had the largest carbon dioxide (CO_2) emissions in 1989. The results indicate that the marginal costs of reducing CO_2 emissions are highest in Italy and Australia and lowest in China and the Commonwealth of Independent States (CIS). The overall finding of Hinchy et al (1993) is that the marginal costs of reducing CO_2 emissions vary significantly between countries and tend to be lower in developing than developed countries. Hinchy, Hanslow and Fisher (1994) estimated the relative marginal costs of reducing CO_2 emissions at 10 per cent below base period emissions in a group of developed and developing countries. The results of the study indicate that the marginal costs of reducing emissions tend to be lower in developing than developed regions. Marginal costs of reducing emissions are highest in Australia, reflecting the heavy dependence on fossil fuels and limited fuel substitution possibilities.

ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS IN THE ASIA-PACIFIC REGION

In the absence of significant energy conservation programs, the developing countries in the Asia-Pacific region are projected to continue to significantly increase their share of global energy consumption in the remainder of the 1990s and beyond. Based on EIA (1995) projections, developing Asia will account for about 22 per cent of global energy consumption by 2010, with China alone accounting for almost 12 per cent.

Much of this increased energy demand growth is projected to result from further increased use of fossil fuels. By 2010, it is estimated that China's consumption of coal will be approximately twice its present consumption and India's approximately three times the present level of consumption (IEA 1994). The industry and electricity sectors, particularly new power generation, are projected to be responsible for much of this growth in energy consumption. In fact, the Asian region is expected to account for up to 50 per cent of total world power generation equipment orders over the next 10 years (Charters 1996).

Growing energy demand and a heavy reliance on fossil fuels is likely to result in rapidly increasing greenhouse gas emissions from these

countries. By 2010, assuming a high economic growth scenario, the IEA (1994) projects the contribution of greenhouse gases from China, South Asia and East Asia to be around 29 per cent of global emissions compared to 19 per cent in 1990.

This strong emission growth scenario is linked directly to inefficient energy generation and use in these countries. The developing Asian economies typically use more than double the amount of energy to produce a unit of GDP compared with more efficient energy users such as Australia and Japan. The reasons for this include the existence of underpriced energy resources which distort energy usage, the limited use of state-of-the-art technology, the lack of technical expertise at plant level, and the limited availability of appropriate infrastructure in the energy sector.

As a consequence, the potential for energy, and hence emission, savings in Asian developing countries is substantial. For example, if India were to install all new coal-fired power plants with available technology it could save between 76 and 110 million tonnes (Mt) of CO_2 by the year 2010 (IEA 1995). Similarly, if energy transmission and distribution losses in the Asian developing region were cut by one-tenth, this would reduce the need for investment in generating capacity during the 1990s by about US$8 billion (World Bank 1992).

OPPORTUNITIES FOR CDM IN THE ASIA-PACIFIC REGION

The growing energy sector in developing countries in the Asia-Pacific region is likely to be the major contributor to potentially large future greenhouse gas emissions in these countries. Therefore, improving the efficiency of the energy sector in these countries is likely to be an important area for CDM activity.

The thermal efficiency of power generation is generally low in the developing countries of the region compared with that of developed countries. For example, thermal efficiency of power plants in China, India and Indonesia averaged less than 30 per cent during the 1980s. In contrast, the thermal efficiency of power plants in Japan averaged close to 40 per cent over the same period (Ishiguro and Akiyama 1995). Improving the thermal efficiency of these power plants is a potential area for technology transfer through CDM.

Renovating and modernising power plants can reduce the net coal consumption rate and improve the efficiency of plants, thus reducing greenhouse gas emissions. Many developing countries have recognised the importance of such activities, and both China and India have

incorporated renovation and modernisation of power plants into their formal planning for the electricity industry. However, limited investment funds for power plant renovation and modernisation programs indicates that there are likely to be significant CDM opportunities in this area.

Significant improvements in boiler energy efficiency and hence reduction in greenhouse gas emissions could be achieved in the region through CDM. For example, industrial boilers used outside the power sector consumed more than 350 Mt of coal in China in 1990, accounting for 35 per cent of the country's coal use and about 30 per cent of greenhouse gas emissions from energy consumption (World Bank et al 1994). These industrial boilers operate with an average energy efficiency of 55 per cent compared to an average boiler energy efficiency of over 80 per cent in developed countries.

There are significant opportunities to design, construct and operate new highly efficient power plants in developing Asian countries through CDM. Projections for coal-fired generating capacity for selected Asia-Pacific countries indicate that substantial increases will occur by 2010, particularly in China and India. The World Bank et al (1994) noted that China will need to build an additional 700 gigawatts of electric power capacity between 1990 and 2020, equivalent to the completion of 39 new 600 megawatts (MW) units each year. While new generating capacity will increase greenhouse gas emissions in absolute terms, building highly efficient plants through CDM will reduce the emission intensity of coal-fired power generation.

The transfer of technical training through CDM will make it possible for coal-fired plants to be operated with optimal technical efficiency. This is likely to lead to reduced coal consumption per unit of energy produced and hence reduced greenhouse gas emissions.

Electricity transmission and distribution losses are up to 30 per cent of total generation in some developing countries compared to around 6 per cent in developed countries. Reducing these losses is likely to result in reduced required generating capacity, and hence reduced emissions. Possible measures suitable for CDM to reinforce and modernise overloaded transmission and distribution systems in the developing countries of the Asia Pacific region could include: expansion and looping of trunk grid systems; upgrading of system voltage and simplification of voltage steps; improving the power factor by installing static condensers; reactive power compensation by providing capacitors near load centres; reduction of transformer losses; and computerisation

of management of transmission and distribution systems (Ishiguro and Akiyama 1995).

AUSTRALIAN CAPABILITIES IN ENERGY-EFFICIENT TECHNOLOGIES

As a large producer, consumer and exporter of coal, Australia has a wide variety of internationally competitive technologies and expertise focused on coal production and utilisation. These range from new coal-fired power plant construction, and the rehabilitation and modernisation of existing power plants, to efficient coal-handling techniques and the supply of high-quality Australian coal (BIE 1996).

Australia is a world leader in the construction and operation of large-sized black coal- and brown coal-fired power plants. Over the past two decades, Australia has constructed and commissioned more than 20 black-coal and lignite-fired power plant units of 350 MW or more. Approximately 70 per cent of the equipment used for construction of these power plants has been manufactured in Australia and all power plant construction and implementation has been undertaken by Australian industry (DPIE 1994).

Australia also has experience in the construction and operation of small- to medium-sized coal-fired power plants, particularly for large industrial users and smaller electrical utilities. This experience is particularly relevant for many developing countries in the Asia-Pacific region where current electricity demand and system capacities are too small to be able to support large units. Australian industry has already been involved in several coal-fired power plant projects in the Asia-Pacific, many of which have characteristics that could potentially qualify them as CDM projects.

Australia has developed strong domestic expertise in improving the energy efficiency of existing coal-fired power stations through the rehabilitation and modernisation of power plants and equipment. This expertise covers assessment and survey techniques to identify the most beneficial life extension and performance improvement options, and the actual development and cost-effective implementation of the desired plant improvement works.

Australian utilities, research organisations, consultants and manufacturers have been involved in the successful rehabilitation and modernisation of plants throughout the country which have resulted in operational performance and thermal efficiency improvements, as well as increases in electricity-generating capacity, in some cases, from

60–70 per cent to 80–90 per cent. Such capabilities and expertise could potentially be used in CDM projects in countries such as China, India and Vietnam. This would not only improve the thermal efficiency of older plants in the region, but could also lower maintenance costs and improve power availability.

Australia provides a wide range of internationally competitive training and educational services in coal-fired electricity generation that could potentially be used in CDM projects in the region. This expertise could lead to more cost-effective and energy-efficient power generation in both new and existing facilities in the region. Australian training and educational programs and facilities in coal utilisation cover issues including coal technology and power station principles, boiler operation and maintenance, turbine operation and maintenance, maintenance management, and power station safety procedures. The delivery of these programs ranges from on-the-job education to both internal and external training programs (DPIE 1994). Australia already exports its educational and training services and expertise to several developing countries in the region.

Australia has developed advanced technologies and expertise for improving the thermal efficiency of coal-fired industrial boilers. Australian industrial boiler technologies include efficient fluidised-bed combustion boilers. These new industrial boilers (which can improve boiler energy efficiency from about 60 per cent to 75 per cent or higher) are being used in China in new installations and to replace old coal-fired industrial boilers.

Australia is a world leader in the development of more advanced and efficient power generation technologies from low-rank coal. A particular technology, known as Integrated Drying Gasification Combined Cycle, being developed in Australia could result in greenhouse gas emission reductions from power generation of up to 25 per cent in countries currently using low-rank coals.

Australia also has a wide range of internationally competitive technologies, services and expertise in energy transmission and distribution. This capability has been built on the design and construction of a vast local transmission and distribution network, which covers areas of widely varying climatic conditions and populations. Transmission and distribution losses from Australia's transmission and distribution network are among the lowest in the world. Australian transmission and distribution technology and expertise has been exported to many developing countries in the Asia Pacific region and has

mostly involved the upgrade of existing transmission and distribution equipment and the design and construction of new systems.

CONCLUDING REMARKS

While developed countries account for the majority of past and present greenhouse gas emissions, emission growth in developing countries is increasing rapidly, particularly in Asia. It is estimated that well before the middle of next century developing countries will be responsible for over half of global greenhouse gas emissions. While many developed countries are currently implementing strategies to reduce the growth of their greenhouse gas emissions, the gains that these strategies may deliver will be far outweighed by the growth in emissions in developing countries. An effective response to the greenhouse problem will, therefore, require the cooperation of both developed and developing countries.

In recognition of the global response required to stabilise greenhouse gas emissions in the atmosphere, the FCCC allows for international cooperation on greenhouse gas abatement through a cost-effective mechanism called CDM under the Kyoto Protocol.

Developing countries in the Asia-Pacific region appear to offer substantial low cost greenhouse gas abatement opportunities suitable for CDM. This is due to a number of factors including inefficient energy generation and use, rapidly growing energy demand and a heavy reliance on fossil fuels. These factors have contributed to significant growth in greenhouse gas emissions from these countries, particularly China and India.

Energy generation in many developing countries is dominated by coal-fired power plants which are relatively inefficient compared to those in developed countries. Some of these countries such as China, India and Indonesia have large indigenous coal resources while others, such as South Korea and Taiwan, are highly dependent on coal imports. Given that coal will remain an important resource into the foreseeable future and is a major source of greenhouse gas emissions, the greatest CDM opportunities are likely to involve increasing the efficiency of coal-based energy generation and use.

Australia's ability to supply technologies and expertise that will increase energy efficiency is considerable. Australia already transfers some of these technologies and expertise through exports, investment and aid funding to many developing countries in the Asia-Pacific region. The

links and experience formed through these transfers can potentially assist Australian firms to develop CDM projects within the region.

Australia's main capabilities in greenhouse gas abatement technologies and expertise include coal-fired power plant construction and refurbishment, modernisation of transmission and distribution systems, consulting services in energy management, and renewable energy technologies for remote area power supply.

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Darren Kennedy is a project leader in the Trade and Global Change Branch of ABARE, with two major research priorities. The first is to develop ABARE's general equilibrium model of the world economy, GTEM, to track methane and nitrous oxide emissions. This will enable ABARE to undertake more detailed analysis of the economic impacts of the Kyoto Protocol. The second is to undertake an assessment of the economic consequences of global warming, with an emphasis on agricultural impacts.

Since joining ABARE in 1995, Mr Kennedy has analysed a variety of policy issues, including the implications of population ageing for global savings, estimating the impact of APEC trade policy reform on Australia's agricultural exports, and assessing the economic consequences of OECD greenhouse gas stabilisation policies. His research has often involved application of GTEM. Prior to joining ABARE, he was an employee of the Reserve Bank of Australia where he analysed alternative methods of forecasting the CPI.

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Since joining ABARE as a graduate in 1997, Cain Polidano has undertaken research into the economic impacts of greenhouse emission reductions. Such research has been focused on analysing the effects of greenhouse emission abatement policies on global trade, agricultural production and employment. This research is conducted using GTEM, a dynamic general equilibrium model of the world economy.

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Mr Tulpulé joined ABARE in 1989. He has published research on a wide range of topics, including the benefits of scientific research, international trade issues and the economics of climate change policy. In his current position he is responsible for research on the economics of climate change policy. This research draws extensively on ABARE's dynamic general equilibrium model of the world economy, GTEM. He participates regularly in international conferences and forums that address the economics of climate change policy.

Mr Tulpulé holds Honours and Masters degrees in economics from the Australian National University.

DR BRIAN S. FISHER

Brian Fisher was first appointed ABARE's Executive Director in November 1988. During 1984–85, Dr Fisher was chief research economist, then Deputy Director, of the former Bureau of Agricultural Economics. He was appointed to the chair in Agricultural Economics at the University of Sydney in 1985, becoming Dean of the Faculty of Agriculture at the University in 1987.

In 1993 Dr Fisher was appointed one of the experts completing the socioeconomic assessment of climate change for the United Nation's Intergovernmental Panel on Climate Change Second Assessment Report. He became a member of the Academy of Science's National Committee for Climate and Global Change in 1996. More recently, Dr Fisher played an integral role in the international climate change negotiations as economic adviser to Australia's negotiating team in the leadup to, and at, the third Conference of the Parties in Kyoto. He will again be filling this role at the fourth Conference of the Parties in Buenos Aires in November 1998.

Dr Fisher has published over 180 papers and monographs. He received the Farrer Memorial Medal in August 1994 and became a Fellow of the Academy of Social Sciences in Australia in November 1995. Dr Fisher holds a PhD in agricultural economics from the University of Sydney.

8

GLOBAL ECONOMIC IMPACTS OF THE KYOTO PROTOCOL

DARREN KENNEDY, CAIN POLIDANO, JAEKYU LIM, VIVEK TULPULÉ, AND BRIAN S. FISHER

On 11 December 1997 the international community adopted the Kyoto Protocol to the United Nations Framework Convention on Climate Change (FCCC). If the Protocol enters into force it will represent a strengthening of the post-2000 commitments of Annex I[1] countries to address climate change, and thus achieve the objective of the Berlin Mandate negotiating process. The Protocol will enter into force when it has been ratified by at least 55 Parties to the Convention and by Annex I countries representing at least 55 per cent of carbon dioxide emissions in 1990 from Annex I countries.

In the leadup to the third Conference of the Parties at Kyoto in December 1997, Australia argued that abatement commitments should be based on the principle of fairness and equity. For this reason Australia argued for differentiated emission reduction targets and a comprehensive approach to the coverage of all sources, sinks and gases associated with global warming. These features were successfully incorporated into the Protocol.

A considerable amount of negotiation remains before the Protocol can become operational. For example, much detail remains to be negotiated on issues including sinks (Articles 3.3 and 3.4), joint implementation between Annex I countries (Article 6), details of the

1 Parties to the Framework Convention can be categorised into two groups, Annex I and non-Annex I Parties. The Annex I group consists of OECD economies (with the exception of South Korea and Mexico) and the economies in transition (the former Soviet Union and eastern European countries). Non-Annex I countries are generally characterised as developing countries. (A list of Annex I countries appears in Appendix C.)

operation of the clean development mechanism (Article 12), procedures for dealing with noncompliance (Article 18) and emissions trading (Article 17).

In this chapter the potential implications of implementing the Kyoto Protocol are examined using a model of the world economy. The particular focus is on the use of emissions trading to reduce the costs of abatement.

THE KYOTO PROTOCOL

Targets

Developed countries, as listed in Annex B of the Protocol, have collectively agreed to reduce their greenhouse gas emissions to at least 5 per cent below 1990 levels for the commitment period, 2008–12.

TABLE 8.1 KYOTO PROTOCOL TARGET COMMITMENTS FOR ANNEX B COUNTRIES

Party	*Target (percentage of base year or period)*	*Party*	*Target (percentage of base year or period)*
Australia	108	Lithuania	92
Austria	92	Luxembourg	92
Belgium	92	Monaco	92
Bulgaria	92	Netherlands	92
Canada	94	New Zealand	100
Croatia	95	Norway	101
Czech Republic	92	Poland	94
Denmark	92	Portugal	92
Estonia	92	Romania	92
European Community	92	Russian Federation	100
Finland	92	Slovakia	92
France	92	Slovenia	92
Germany	92	Spain	92
Greece	92	Sweden	92
Hungary	94	Switzerland	92
Iceland	110	Ukraine	100
Ireland	92	United Kingdom of Great Britain and Northern Ireland	92
Italy	92	United States of America	93
Japan	94		
Latvia	92		
Liechtenstein	92		

Source United Nations (1998).

To achieve this objective, individual countries negotiated differentiated targets. The abatement targets specified in Annex B of the Kyoto Protocol are shown in table 8.1. Japan, the United States and members of the European Union have commitments to reduce greenhouse gas emissions to 6, 7 and 8 per cent below 1990 levels respectively in the first commitment period, 2008–12. Australia's target was set at 8 per cent above the 1990 level, which is comparable with the emission reduction commitments agreed by other Parties when compared with projected 'business as usual' emission growth paths.

Anthropogenic sources of six greenhouse gases are to be included in national greenhouse gas emission inventories, including emissions from land use change. However, emissions from land use change are not included when defining the emission targets (shown in table 1) unless land use changes were a net source of emissions in 1990. The six greenhouse gases covered by the Protocol are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride.

Whether a country meets its commitments will be assessed by comparing its target with its emissions inventory averaged over the period 2008–12. An average is used to reduce the influence of annual fluctuations in emission levels that can arise from external shocks or circumstances such as unusual weather conditions or a cyclical increase in economic activity.

Flexibility mechanisms

There are a number of provisions in the Protocol that, if implemented, could reduce the costs of meeting these abatement targets. Emissions trading, banking, the clean development mechanism, joint implementation and sequestration activities all provide greater flexibility in the way in which Annex B countries can meet their commitments.

Articles 6 and 17 of the Protocol allow for emission reduction credits to be traded between Parties to the Protocol. Trading emission credits allows countries with lower marginal abatement costs to reduce their emissions below their commitment level and then sell the credits to countries with higher marginal abatement costs. The net result of such trade is that overall emissions for Parties in Annex B would be maintained within the emissions cap but at lower economic cost than if there were no emissions trading.

Emission abatement policies tend to have a negative impact on production and trade in abating regions. Many studies, for example

Hinchy et al. 1998, Jacoby et al. 1997, and Brown et al. 1997, indicate that emissions trading can reduce these negative impacts. If emissions trading is restricted, the beneficial effects will be reduced. One of the provisions of the Protocol is that emissions trading shall be 'supplemental' to domestic actions. If this provision were to be used to limit the extent to which a country could utilise trading in meeting its abatement commitments it would serve only to increase the economic costs of reaching its emissions target.

The clean development mechanism allows for abatement to be conducted on a project-by-project basis in developing countries where the marginal cost of emission reduction is low. Similarly, joint implementation allows emission reduction projects to be conducted by Annex B countries within other Annex B countries on a project-by-project basis. Again, this mechanism will encourage foreign investment where the marginal cost of emission abatement is low.

FRAMEWORK OF ANALYSIS

The analysis of emission reduction scenarios in this paper is based on simulation results from the Global Trade and Environment Model (GTEM). GTEM is a dynamic general equilibrium model of the world economy developed at ABARE to address climate change policy issues. GTEM is an ideal tool for analysing international policies with wide ranging intersectoral ramifications because of its explicit modelling of world trade and investment flows and its detailed regional and sectoral coverage.

Currently, GTEM is suitable for analysing policies to abate carbon dioxide emissions from fossil fuel combustion. While the Kyoto Protocol covers emissions from all greenhouse gases and sinks, the modelling analysis undertaken for the purposes of this paper examines carbon dioxide emissions from fossil fuel combustion only. At this stage, data constraints prevent analysis of policies affecting emissions of carbon dioxide from non-fossil fuel sources, other greenhouse gases and greenhouse gas sinks. The results in this paper are indicative only of the economic impacts that may occur when all gases and sinks are modelled. ABARE is in the process of extending the model to include additional greenhouse gases and sinks to enable a more comprehensive assessment of the Kyoto Protocol.

At its most disaggregated level, GTEM models 50 industries in 45 countries or regions. However, for the present purposes the data have been aggregated to 16 commodity groups and 19 regions, with a focus on the energy and energy-intensive sectors (table 8.2). The simulations

in the paper are based on the emission abatement commitments made by Annex B regions in the Kyoto Protocol but applied only to energy related carbon dioxide emissions. The targets for the aggregated regions—eastern Europe and the former Soviet Union—are the summation of individual country commitments under the Kyoto Protocol weighted by energy related carbon dioxide emissions in 1990.

In GTEM, industries combine factors of production (land, labour and capital) and intermediate inputs, including energy inputs, to produce a single commodity. Substitution is permitted between labour and capital, thereby allowing industries to adjust the labour intensity of production in response to movements in real wages (relative to the price of capital).

TABLE 8.2 REGIONAL AND COMMODITY COVERAGE

Regions		*Commodities*	
1	Australia	1	Coal
2	New Zealand	2	Oil
3	United States	3	Natural gas
4	Canada	4	Other minerals
5	Japan	5	Petroleum products
6	European Union (15) [a]	6	Chemicals, plastics
7	EFTA b	7	Nonmetallic minerals
8	South Korea	8	Iron and steel
9	China	9	Nonferrous metals
10	Chinese Taipei	10	Fabricated metal products
11	Indonesia	11	Electricity
12	Other ASEAN	12	Primary agriculture
13	India	13	Processed agriculture
14	Mexico	14	Resources processing
15	Brazil	15	Manufacturing
16	Rest of Asia	16	Services
17	Former Soviet Union		
18	Central European Associates c		
19	Rest of world		

a Comprises Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, Sweden and the United Kingdom.

b Comprises Switzerland, Norway and Iceland.

c Comprises Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia.

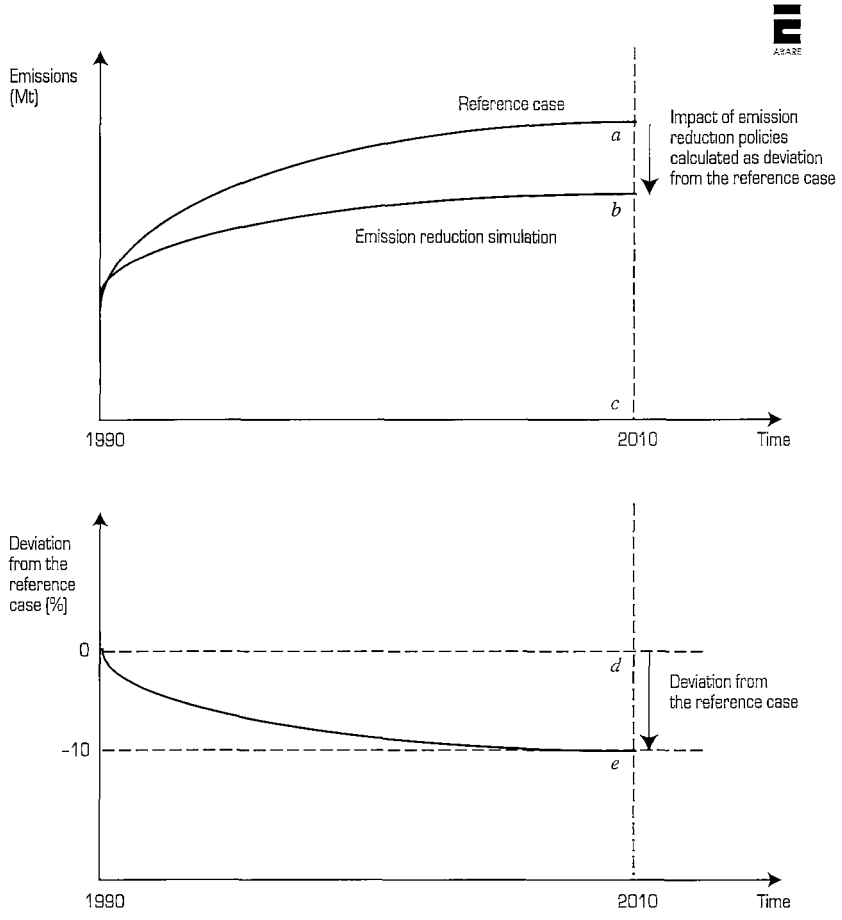
Substitution between non-energy and capital inputs is not permitted, to prevent unrealistic substitutions. However, the GTEM model allows for interfuel substitution and substitution between fuel and capital, a process by which industries can enhance their energy efficiency through the purchase of new capital or reduce carbon dioxide intensity by moving to less emission-intensive energy sources.

GTEM uses a unique 'technology bundle' approach to modelling electricity and iron and steel production. Electricity can be generated from coal, petroleum, gas, nuclear, hydro- or renewable-based technologies, while iron and steel can be produced using a blast furnace or electric arc technology. Explicitly modelling these alternative methods of production enables the electricity and iron and steel industries to substitute between technologies in response to changes in relative prices. It is important to account for technology substitution possibilities in energy-intensive industries since this is a primary method of reducing emissions in response to greenhouse gas abatement policies.

GTEM is an intertemporal model which permits growth in variables to be tracked over time. Population growth and capital accumulation are determined within the model. This is in contrast to comparative static models, which compare two equilibriums, one before a policy change and one following, but with no growth in the factors of production. The intertemporal nature of GTEM is important when analysing climate change policies since both the timing of policy changes and the adjustment path that the economy follows are highly relevant in the policy debate. (A discussion of issues surrounding timing of policy changes and optimal hedging strategies can be found in Manne and Richels 1992.)

Being intertemporal, GTEM requires a reference case simulation with which to compare simulations representing policy changes. The reference case simulation projects growth in labor and capital in each country or region, and the associated growth throughout the rest of the economy, in the absence of any policy changes. The results of a policy simulation are then interpreted as deviations from the reference case and represent the influences of the policy change. For example, the influence of an emission reduction policy can be isolated by comparing emissions growth in the simulation with emissions growth in the reference case scenario, as illustrated in figure 8.1. Hence, the effect on emission reductions may be reported, for example, as a 10 per cent reduction from the reference case projection for 2010.

FIGURE 8.1 DEVIATION FROM THE REFERENCE CASE IN A GTEM SIMULATION



Source ABARE

In the model simulations, countries are assumed to gradually reduce national emissions until they reach their Kyoto target in the year 2010. Model specification requires that a particular year be defined as the time at which the Kyoto targets are met. In practice, countries must meet their emissions target over an average of the years 2008–12. (The year 2010 rather than 2012 was chosen because if countries only just attain their targets in 2012, average emissions over the years 2008–12 would be in excess of the target.)

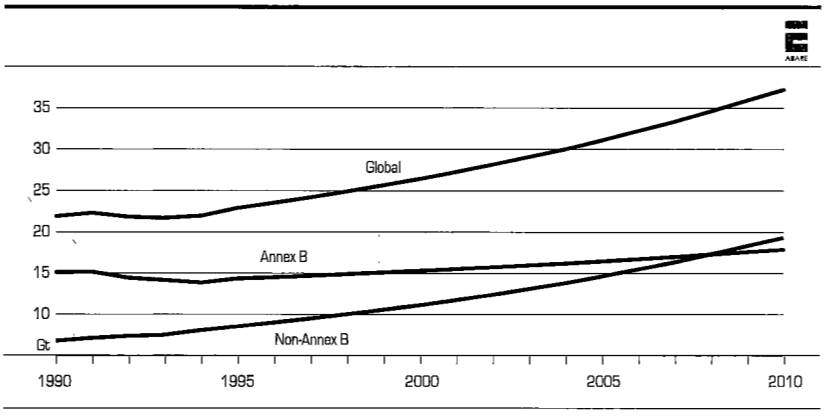
REFERENCE CASE PROJECTIONS

In the absence of abatement measures, global anthropogenic emissions of carbon dioxide are projected to grow by approximately 70 per cent between 1990 and 2010 (figure 8.2). This is equivalent to an increase of around 15 billion tonnes of carbon dioxide. The reference case does not include energy policies that are currently being either implemented or negotiated in response to climate change. For example, the Australian Government announced a $180 million package of greenhouse gas reduction initiatives on 20 November 1997 (Howard 1997). The emission reductions from this package are excluded from Australia's reference case projection in this paper.

Emissions growth tends to be positively correlated with both economic and population growth. Another important factor determining emissions growth in a particular country is the emissions intensity of output. Emissions intensity is defined as the volume of carbon dioxide emissions per unit of output. The emissions intensity of a country is largely determined by the current and projected mix of technologies used to produce electricity. A country projected to continue to rely heavily on coal-fired electricity generation in the reference case would be expected to maintain a high emissions intensity of output compared with a country that is projected to retire coal-fired electricity capacity and replace it with gas.

Emissions from developing countries are projected to increase more rapidly than emissions from Annex B countries over the projection

FIGURE 8.2 CO_2 EMISSIONS FROM FOSSIL FUEL COMBUSTION, REFERENCE CASE



Source ABARE

period in the reference case. On average, emissions from Annex B countries grow at 0.8 per cent a year over the period 1990–2010, compared with 5.4 per cent a year for developing countries. Accordingly, the Annex B share of world emissions is projected to fall from 71 per cent in 1990 to 48 per cent in 2010. The projected global share of Annex B emissions in 2010 has been revised downward from previous estimates (Brown et al. 1997), a key reason being lower projected economic growth in the former Soviet Union. The strong projected emissions growth in developing countries is largely a result of the strong projected economic growth in these regions following an assumed recovery from current crisis conditions by 2001 for most Asian economies and the associated increase in fossil fuel demand.

The projected reference case emissions growth in Australia of 42 per cent between 1990 and 2010 is the highest among developed countries (table 8.3). A number of factors contribute to Australia's relatively high growth in emissions, including higher rates of population and economic growth, continued strong reliance on fossil fuels (particularly coal) in electricity generation, and strong projected growth in exports from the energy-intensive industries of iron and steel and non-ferrous metals. In particular, the projected population growth of 26 per cent for Australia between 1990 and 2010 is significantly greater than that projected for other developed countries. As shown in table 3, the increase in Australia's emissions is comparable with other Annex B countries on a per person basis.

TABLE 8.3 ANNUAL AVERAGE GROWTH IN EMISSIONS, POPULATION, GDP AND EMISSIONS PER PERSON, FOR 1990–2010 FOR SELECTED ANNEX B REGIONS IN THE REFERENCE CASE

	Emissions	*Population*	*Output (GDP)*	*Emissions per person*
	%	%	%	%
Australia	1.8	1.2	3.4	0.6
New Zealand	1.8	0.7	3.0	1.1
United States	1.3	0.7	2.7	0.6
Canada	1.6	0.9	2.7	0.6
Japan	1.4	0.2	3.2	1.1
European Union	1.1	0.2	2.8	0.8
Former Soviet Union	-0.1	0.4	0.8	-0.5
Eastern Europe	1.0	0.3	2.5	0.7

EU emissions growth is projected to be only 1.1 per cent a year between 1990 and 2010—the smallest of all Annex B countries apart from the former Soviet Union and eastern European associates—largely as a result of low population growth. This takes no account of any future changes in membership of the European Union and therefore does not include emission reductions likely to be achieved through restructuring in the formerly centrally planned economies of eastern Europe.

In all countries, a significant proportion of greenhouse gas emissions is from electricity generation. Consequently, the reference case projections for emissions from the electricity sector are highly relevant to the economic costs of meeting Kyoto commitments. The emissions intensity of Australian electricity is projected to fall slightly due to a projected increase in the market share of gas-fired electricity, which has a lower emissions intensity than coal-fired electricity. However, coal-generated power is projected to remain the dominant power source in the reference case, with a market share of 75 per cent in 2010.

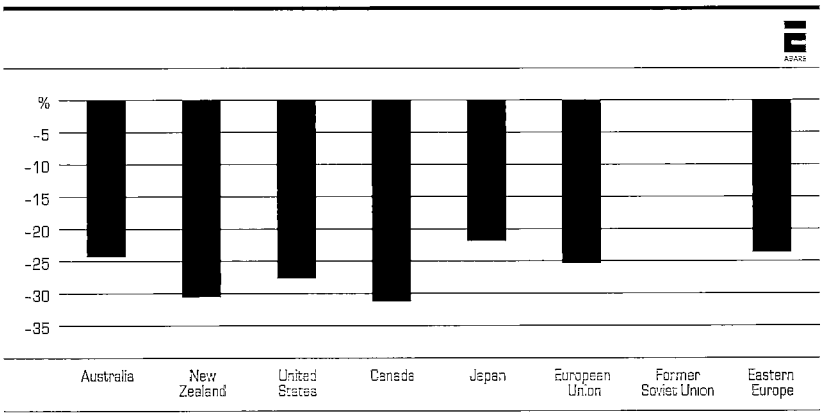
In the European Union, Japan and Canada, the emissions intensity of electricity production is projected to decline significantly in the reference case, owing to higher rates of growth of electricity generated from natural gas and renewables than from coal. This trend for significant emission reductions on a per unit basis is expected to occur even before abatement measures are introduced, principally because of the relative cost-effectiveness of using gas relative to coal in electricity generation in these countries.

EMISSION REDUCTIONS UNDER THE KYOTO PROTOCOL

The magnitude of the abatement task each country must undertake in order to meet its Kyoto obligations independently is determined by two factors: its projected emissions growth in the reference case (table 8.3); and its Kyoto target (table 8.1). Estimates of the abatement tasks required for Annex B countries to meet their commitments are presented in figure 8.3.

As shown in figure 8.3, the former Soviet Union is not required to undertake any further abatement in order to meet its Kyoto commitments. This is because reference case emission levels in the former Soviet Union in 2010 are projected to be 1.5 per cent below the Kyoto target because of the collapse of the Russian economy.

FIGURE 8.3 ABATEMENT TASKS AT 2010 FOR ANNEX B COUNTRIES TO MEET KYOTO TARGETS INDEPENDENTLY, RELATIVE TO REFERENCE CASE



Source ABARE

POLICY INSTRUMENTS

Two policy options for limiting greenhouse gas emissions are analysed here: independent abatement, where Annex B countries each meet their Kyoto commitments without emissions trading; and a scheme of tradable emission quotas, where Annex B countries can use emissions trading to assist in meeting their Kyoto targets.

It is assumed that, in achieving emission reductions independently, governments adopt policy instruments that impose the smallest possible cost on their economies. A discussion of efficient approaches to reducing carbon dioxide emissions within a country can be found in Fisher et al. (1996). If least-cost approaches are not adopted, the estimated economic costs of implementing the Kyoto Protocol will be higher than those reported here.

In GTEM, least-cost modelling of emission abatement involves imposing a tax on carbon dioxide emissions in each period for which emission restrictions apply. The tax represents the broad class of least-cost economic instruments that could be used by governments to reduce emissions. For example, this includes domestic emissions trading. The tax raises the costs associated with emission-producing activities and encourages a shift of resources into less emission-intensive activities, thereby reducing emissions. The tax can be interpreted as the marginal cost to the economy associated with any least-cost policy designed to achieve a given level of emission abatement. The marginal cost of

achieving a given emission reduction can be referred to as a carbon emission penalty.

Revenue from the tax is assumed to be returned to the economy in a lump sum fashion, thereby having a neutral effect on the economy. In practice, changing the way in which revenue is returned to the economy can alter estimates of the implications of emission abatement. For example, some analysts have shown that using the revenue from a carbon tax to reduce government budget deficits or to replace highly inefficient taxes can confer benefits on an economy (see, for example, McDougall and Dixon 1996). Critics of such conclusions, including de Mooij (1996), point out that estimates of such benefits are very sensitive to the type of models used for the analysis and to the underlying assumptions. Further, the changes in income distribution implied by the shift in revenue base can render the reform of highly inefficient taxes using environmentally based taxes politically infeasible. Last, such approaches to the treatment of emissions tax revenue do not permit the impacts of emission abatement to be separated from the impacts of taxation or budgetary reforms and therefore can provide a distorted picture of the impacts of emission abatement on economies.

In this paper, changes in gross national product (GNP) are used to measure the aggregate economic impact of policies. GNP is equal to gross domestic product (GDP) plus foreign income transfers and therefore provides a complete measure of the flow of income available to an economy for consumption and saving. In the context of international emissions trading, for example, changes in GNP from reference case levels account for both the income transfers associated with quota purchases and sales and changes in GDP resulting from increases in the cost of emitting carbon.

EMISSIONS TRADING

Emissions trading is a market-based instrument that potentially allows countries to meet their Kyoto commitments more cost-effectively than command and control policy approaches. The Kyoto target commitments represent an initial allocation of 'rights to emit', or emission quotas, that can then be traded between countries. For example, if Australia purchased emissions quotas from the Russian Federation, it would be conceptually equivalent to paying the Russian Federation to include some of Australia's greenhouse gas emissions in its inventory.

Unlike independent action, international emissions trading allows more abatement to be undertaken in countries where the marginal cost of

abatement is lowest, thus reducing the cost of Annex B compliance. If the marginal cost of abatement in a country exceeds the quota price, it is more cost-effective for that country to purchase a unit of quota than to abate. Conversely, if the marginal cost of abatement is less than the price of the quota, it is possible to undertake the abatement and then sell the emission credit on the world market at a profit. These activities will occur until marginal abatement costs plus marginal transaction costs are equalised across abating countries and a quota price emerges which is equal to the Annex B marginal abatement cost.

A number of design and implementation issues are critical to achieving a least-cost outcome in an emissions trading scheme (see, for example, Hinchy et al. 1998). Ensuring that the market for tradable permits is competitive and that transaction costs are minimised are central to these design issues.

The market for quotas may be not be competitive if the number of buyers or sellers of quotas is small. Should a seller be able to exercise market power, the price of a permit would be higher than the cost of abatement, thereby preventing marginal abatement costs from being equalised across activities. Similarly, if a buyer of emission credits possessed market power, the buyer would bargain down the quota price, which would reduce the number of abatement options that would be profitable. With greater numbers of participants, quota prices and trade volumes are more likely to approach levels that could be achieved in a competitive market.

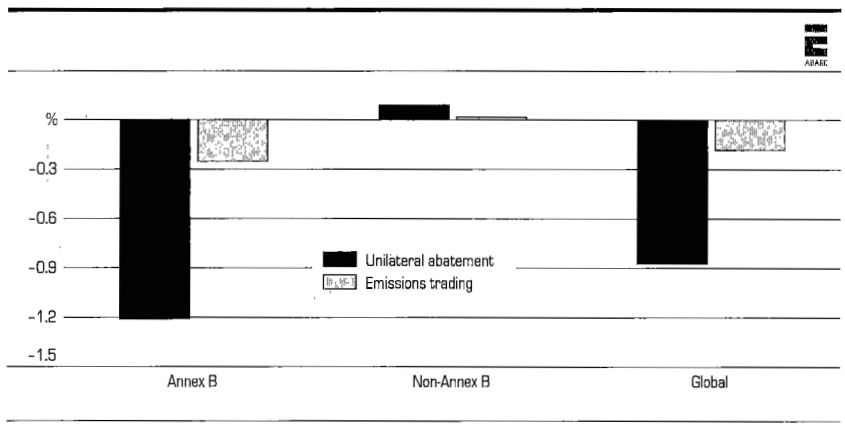
Under competitive market conditions the allocation of quotas within economies should not affect the cost-effectiveness of international emissions trading. In this paper it is assumed that the entire quota for a region is allocated to households, which use proceeds from quota sales to fund consumption, savings and expenditure on government services. In practice such an allocation process could lead to a substantial income transfer to households depending on the number of quotas transferred to them and the price at which quotas trade.

GLOBAL IMPACTS OF THE KYOTO PROTOCOL

Impacts of policies on economies

The introduction of an emissions trading scheme is projected to greatly reduce the economic cost to Annex B countries as a whole of meeting their Kyoto commitments (figure 8.4). The projected economic cost to Annex B countries at 2010 under a trading scheme is around a

FIGURE 8.4 CHANGE IN REAL GNP UNDER THE KYOTO PROTOCOL AT 2010, RELATIVE TO THE REFERENCE CASE



Source ABARE

third of that projected under the assumption of meeting Kyoto commitments without emissions trading.

The key source of the economic costs of meeting the abatement targets in Annex B countries is an increase in industrial production costs and consumer prices as emission restrictions force producers and consumers in Annex B countries to move away from carbon-intensive fossil fuel use into more expensive alternatives. The increased costs to industry tend to dampen economic activity. The resulting decline in demand for labour and capital reduces real returns to labour and capital (defined as the gains in output associated with adding an extra unit of capital and labour, respectively, to an economy), in turn, leading to reduced aggregate income and lower levels of economic activity.

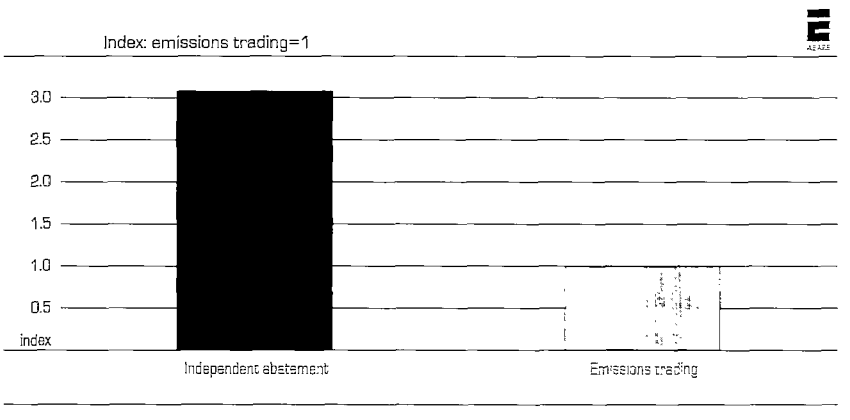
The impacts of Annex B policies under the Kyoto Protocol on international trade can also be an important determinant of economic costs. For example, abatement policies will tend to reduce global demand for fossil fuels, thereby exerting downward pressure on global fossil fuel prices. Revenue from fossil fuel exports from Annex B (and non-Annex B) regions can therefore be expected to decline. Also, Annex B countries which export fossil fuel-intensive products, such as iron and steel or aluminium, could face a reduction in export demand as these industries begin to relocate to developing countries. The tendency to relocate is discussed in more detail below, but occurs because energy-intensive products become more price-competitive in

countries that do not have quantitative reduction targets under the Protocol.

Because of trade links between Annex B and non-Annex B countries, abatement policies in Annex B countries will affect non-Annex B welfare. Overall, non-Annex B GNP is projected to rise annually under the Kyoto scenario by 0.02 per cent and 0.09 per cent with and without emissions trading respectively. Two largely offsetting influences drive these results. First, production in non-Annex B industries does not carry an emissions penalty, providing these goods with a competitive advantage over Annex B products. This will tend to increase GNP in non-Annex B countries that rely heavily on exports of fossil fuel-intensive products. Second, increased costs of Annex B production are passed on to consumers in non-Annex B regions through more expensive imports. This, combined with a reduction in demand for fossil fuel exports (as for Annex B countries), will tend to reduce non-Annex B GNP.

All these effects arise from the imposition of a carbon penalty in Annex B countries. Consequently, the effects will be smaller under emissions trading because the average emissions penalty is lower than without emissions trading (figure 5). For example, South Korea is a net exporter of fossil fuel-intensive products (mainly iron and steel) and has been shown (Donovan et al. 1997) to benefit from Annex B emission abatement policies. On the other hand, in Indonesia, which exports

FIGURE 8.5 AGGREGATE ANNEX B CARBON EMISSIONS PENALTY UNDER THE KYOTO PROTOCOL AT 2010



Source ABARE

significant quantities of fossil fuels, particularly oil and coal, GNP is projected to decline following Annex B emission abatement.

For the Annex B regions in aggregate, the economic cost tends to be correlated with the magnitude of the carbon emission penalty in place (figure 8.5). Under abatement without emissions trading, each country must meet its emission target domestically, irrespective of cost. The average carbon penalty is significantly higher in this case than with emissions trading, as regions with higher abatement costs require a higher penalty to induce abatement.

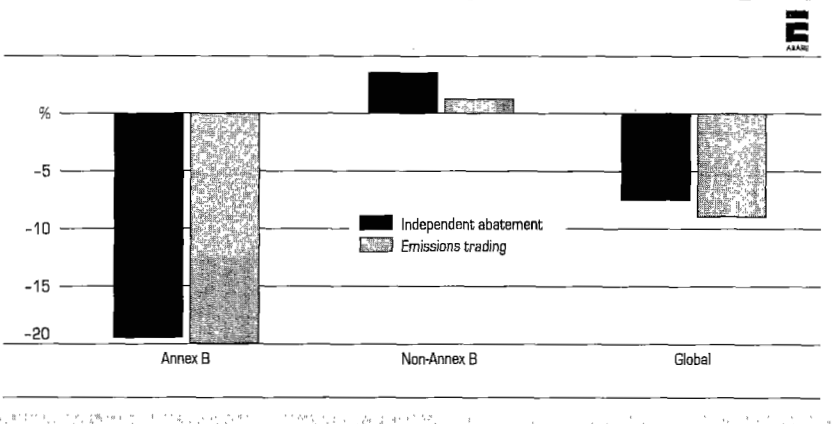
In contrast, emissions trading reduces the average carbon emission penalty because it permits abatement activities to occur wherever they are least expensive within Annex B countries.

At a global level, abatement commitments met independently are projected to reduce GNP by around 0.9 per cent relative to reference case projections. Emissions trading reduces the projected GNP loss to 0.2 per cent.

Impacts on emissions

Annex B emissions are projected to fall by 20 per cent under the Kyoto Protocol relative to the reference case at 2010 (figure 8.6), equivalent to a reduction in emissions of carbon dioxide of 4 billion tonnes. Regardless of whether emission reductions are undertaken

FIGURE 8.6 CHANGE IN CO_2 EMISSIONS UNDER THE KYOTO PROTOCOL AT 2010, RELATIVE TO THE REFERENCE CASE



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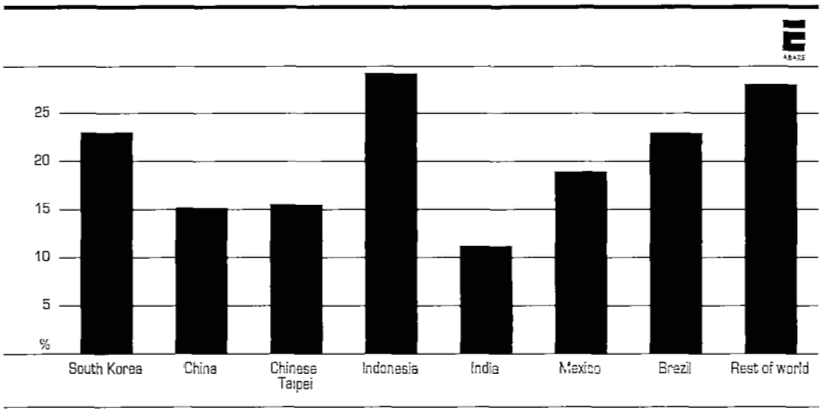
independently or with the use of trading, the same level of abatement must be undertaken to comply with the Kyoto Protocol.

Non-Annex B emissions are projected to increase under the Kyoto Protocol by 3.4 per cent and 1.2 per cent, without and with emissions trading respectively, relative to the reference case at 2010.

The partial offsetting of emissions reductions in abating countries by increases in emissions in nonabating countries is known as carbon leakage. Leakage occurs because emission abatement increases the cost of fossil fuel use in Annex B countries, thereby increasing the price of fossil fuel-intensive products such as iron and steel and non-ferrous metals. As a result, non-Annex B producers of fossil fuel-intensive products gain a competitive advantage over producers in Annex B countries. In response, there is a partial shift in emission-intensive industries from Annex B to non-Annex B countries. For example, figure 8.7 shows significant projected increases in iron and steel production in non-Annex B countries as a result of the Kyoto Protocol without emissions trading.

The extent of carbon leakage is correlated with the size of the carbon emission penalty. The greater the penalty, the greater the impost on energy-intensive production in Annex B countries and the greater the loss of competitiveness against developing countries. In the scenario

FIGURE 8.7 CHANGE IN IRON AND STEEL PRODUCTION IN NON-ANNEX B REGIONS AT 2010 RELATIVE TO THE REFERENCE CASE, WITH INDEPENDENT ABATEMENT



Source ABARE

without emissions trading, where average carbon emission penalties are high compared with the emissions trading scenario, global carbon leakage is projected to be 20 per cent. That is, for every million tonnes of emission reduction in Annex B countries, emissions in non-Annex B countries are projected to increase by 200 000 tonnes. Carbon leakage under emissions trading is projected to be only 6 per cent, as a consequence of the lower carbon emission penalty in Annex B countries.

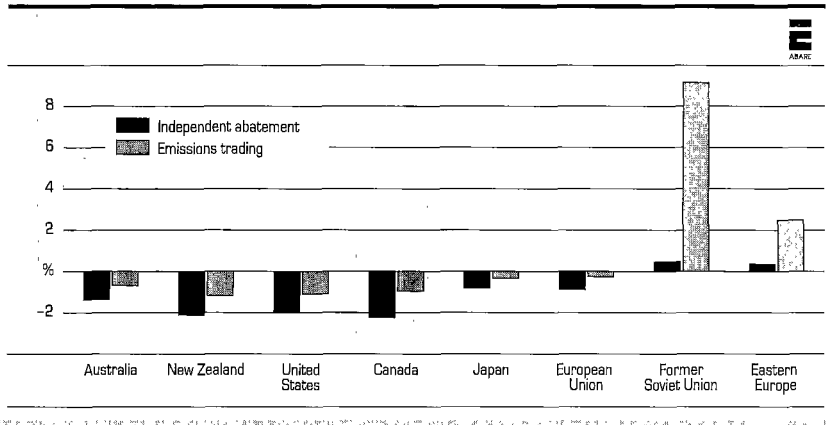
Lower rates of carbon leakage reduce global emissions, thereby enhancing the environmental effectiveness of the Protocol. Global emissions are projected to be 534 million tonnes lower at 2010 under an emissions trading regime than they would be without emissions trading. This difference is equivalent to a 1.6 per cent reduction in global emissions.

Economic impacts on Annex B regions

The projected economic costs for Annex B regions of meeting the Kyoto targets by reducing fossil fuel-related carbon dioxide emissions are presented in figure 8.8. For each Annex B region, GNP is projected to be higher under emissions trading than it would be in the absence of emissions trading.

One important determinant of the economic costs of emission abatement in each Annex B country is the size of the carbon emission penalty that is needed to be put in place to discourage emission

FIGURE 8.8 CHANGE IN REAL GNP IN ANNEX B REGIONS UNDER THE KYOTO PROTOCOL, RELATIVE TO THE REFERENCE CASE



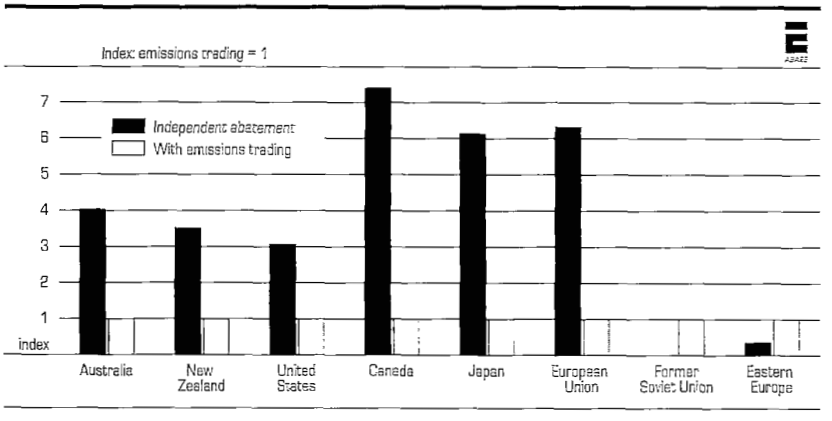
Source: ABARE

generation. The carbon emission penalties projected under the Kyoto Protocol at 2010 with and without emissions trading are presented in figure 8.9.

Without emissions trading, the size of the carbon emission penalty projected for a region depends on the magnitude of the abatement task and the ease of substitution between fuel sources. When acting independently, countries utilise the least costly methods of reducing emissions first. Consequently, as the size of the emission abatement task is increased, the marginal abatement cost will tend to increase, as lower cost-abatement possibilities become increasingly scarce. Regions with the highest projected emission abatement tasks under the Kyoto Protocol (without trading) include Canada and New Zealand.

The imposition of a carbon emission penalty will result in consumers and producers attempting to substitute into less emission-intensive fuel sources. For each region the cost and availability of substitution possibilities in the electricity generation sector are important in determining the eventual carbon penalty. Substitution possibilities can be limited if a region already uses technologies that are relatively less emission-intensive. For example, Canada relies heavily on hydroelectricity (and to a lesser extent nuclear power) and therefore has less scope for low-cost emission reductions in the electricity sector than countries that are less reliant on hydroelectricity. This would imply a need to reduce emissions in the transport and industrial sectors, where

FIGURE 8.9 CARBON EMISSION PENALTIES FOR ANNEX B REGIONS UNDER THE KYOTO PROTOCOL AT 2010



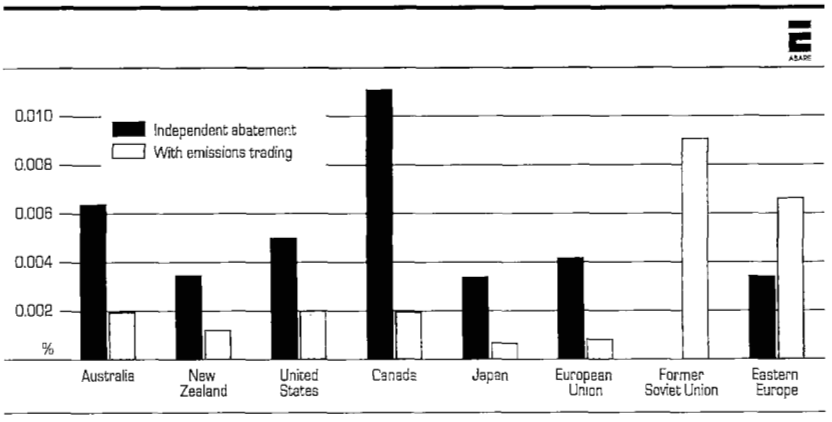
Source ABARE

substitution possibilities tend to be more limited and where higher carbon penalties are required to encourage emission abatement.

Under independent abatement, regions are required to achieve all their emission reduction tasks domestically, regardless of the abatement cost differentials that exist between regions. In contrast, tradable quotas allow emission reductions to take place in least-cost locations. In particular, the former Soviet Union and eastern Europe are low-cost emission abaters under independent abatement, which is reflected in their relatively low projected carbon emission penalties without trading compared with other Annex B countries. The low carbon emission penalty required in the former Soviet Union and eastern Europe to meet their targets independently is due mainly to low reference case emissions growth and the existence of considerable substitution possibilities away from emission-intensive activities. As a result these countries can gain by selling emission rights to the relatively high-cost abatement regions in Annex B. This process continues until low-cost abatement opportunities in the former Soviet Union and eastern Europe are exhausted, implying that the marginal costs of abatement (adjusted for transaction costs) are equated across countries. Accordingly, the carbon penalty is projected to be higher in both the former Soviet Union and eastern Europe with emissions trading than with independent abatement.

An important feature of the results presented here is that the economic costs to regions are only partly correlated with the size of the carbon emission penalty projected under the Kyoto Protocol, with or without emissions trading. For example, without emissions trading the carbon penalties projected for Japan and the European Union are higher than those projected for Australia and the United States. However, the projected economic costs to Australia and the United States are higher than for Japan and the European Union. This is because, although the size of the carbon penalty is important in determining the economic costs of emission abatement, the extent to which a particular country relies on fossil fuels in the production structure of its economy is also important. The greater a region's emission intensity of output, the more widespread the economic impacts of a penalty on the use of fossil fuels are likely to be. This implies that a more accurate measure of the impacts of a carbon penalty is the size of the carbon penalty for the economy as a whole (carbon penalty multiplied by emissions) as a percentage of GNP (figure 8.10). This measure captures the combined effects of the carbon emission penalty and emission intensity of output.

FIGURE 8.10 TOTAL CARBON PENALTY AS A PERCENTAGE OF GNP UNDER THE KYOTO PROTOCOL



Source ABARE

The availability of relatively inexpensive fossil fuels in Australia and the United States has led to high fossil fuel intensity in these economies. In particular, there is a heavy reliance on coal-fired electricity generation. Consequently, the imposition of a carbon penalty will result in relatively high increases in electricity prices, which will have widespread impacts throughout these economies leading to greater economic costs. On the other hand, Japan is relatively less emission-intensive because of significant advances in energy efficiency made in recent decades. These previous advances now limit the availability of further low-cost emission reductions, and this is reflected in a higher carbon emission penalty (figure 8.9). However, the high penalty associated with reducing fossil fuel use is offset to an extent by the low energy dependence of the economy and therefore has more limited flow-on effects on competitiveness across the economy and hence production.

Under an emissions trading scheme the former Soviet Union and eastern Europe make significant gains in income despite facing a larger carbon penalty than without emission trading. This is because, in the process of trading quotas at the international quota price, these countries are compensated by the remaining Annex B regions for undertaking a greater proportion of Annex B emission abatement. Sales of emission quotas generate significant foreign income for the former Soviet Union and eastern Europe, leading to the projected increase in GNP relative to the reference case under emissions trading.

CONCLUSION

There is still significant uncertainty surrounding the Kyoto Protocol for a number of reasons. First, much of the detail in the Protocol remains to be negotiated. For example, the details of emissions trading and the way in which the clean development mechanism will work are yet to be formulated. Much also remains to be done in terms of defining the way in which sinks will be used in assisting countries to meet their targets. Second, uncertainty still remains about the timing of the entry into force of the Protocol and the implications that may have for the size of the adjustment costs associated with meeting the target for the first commitment period.

Despite the uncertainty, the decisions taken at Kyoto have changed the growth path for the world economy forever. Governments have already moved to implement policies to reduce emissions and industries have already responded. But a great deal remains to be done in designing the policies that minimise the economic costs of achieving the targets already agreed. Emissions trading, and the other flexibility mechanisms allowed for in the Protocol, provide one way of minimising the costs and coincidentally increase the environmental effectiveness of the Protocol. The acceptance of the so-called flexibility mechanisms as legitimate instruments is one of the primary keys to the successful implementation of the Kyoto Protocol.

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9

THE TRANSPORT SECTOR: IS A CARBON TAX BETTER?

LEO DOBES[1]

Probably because of their ubiquity and role in everyday life, cars (and sometimes trucks) are identified in the popular mind as the major sources of urban smog, as well as of greenhouse emissions.

However, the transport sector is far more complex than this simple portrayal. Freight can be carried by road, rail, sea, air or pipeline, utilising different vehicles and fuels, and therefore emitting different mixes of greenhouse gases. Passengers can utilise any combination of cars, buses, motorcycles, aircraft, walking, bicycles, light commercial vehicles, trams, ships, or trains.

All forms of domestic transport are characterised in particular by mobility of emission sources, and the provision of services that are not traded internationally. Elasticity of demand (responsiveness of demand to changes in price) for fuel is generally low.

Emissions of greenhouse gases from transport vehicles constitute about 12 per cent of Australia's output from all sources. Passenger traffic (mainly by car) is currently responsible for about 55 per cent of CO_2 equivalent emissions from the transport sector. As table 9.1 below shows, however, this proportion will fall to about 48 per cent during the commitment period of 2008–2012 as the share of emissions from light commercial vehicles and trucks increases.

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1 This paper draws heavily on BTCE (1998) and Dobes (forthcoming). The author's views do not necessarily reflect those of the Bureau of Transport Economics.

TABLE 9.1 CO_2 EQUIVALENT EMISSIONS FROM AUSTRALIAN TRANSPORT
(thousand tonnes)

Emission source	*1980*	*1990*	*2000*	*2008–2012 (mean)*
Car	35474	43599	47893	49993
Motorcycle	395	399	334	334
Bus	623	1208	1220	1316
Light commercial vehicle	5979	8055	12328	19859
Rigid and other truck	4965	5266	5703	6555
Articulated truck	4397	6291	7693	10154
Rail [a]	3260	3759	4122	4864
Air	3307	3347	5377	7758
Sea [b]	4248	2420	1805	1732
Pipeline [c]	2235	2644	3280	4121
Total	64883	76987	89755	106686

a includes electricity generation for trains and trams

b does not include pleasure and fishing craft

c does not include fugitive gas losses

Sources BTCE (1996), BTCE (1995), BTE estimates, Apelbaum (1997), Bush, Holmes, and Ho Trieu (1995).

COVERAGE OF TRANSPORT EMISSIONS

The 6 greenhouse gases listed in Annex A of the Kyoto Protocol include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Each is radiatively active, and can be referred to as a 'direct' greenhouse gas because it absorbs and re-emits infra-red radiation. Indirect greenhouse emissions do not themselves absorb infra-red radiation, but can influence the concentration of some direct greenhouse gases through atmospheric chemistry.

Composition of transport emissions

Direct greenhouse gases form the bulk of emissions from the transport sector. Although there are differences between transport modes and countries, CO_2, a direct greenhouse gas, is the major emission (about 90 per cent of total tonnes of emissions produced annually by passenger cars in Australia). The proportions of CH_4 and N_2O, both direct greenhouse gases, are very small. But carbon monoxide (CO), oxides of nitrogen (NO_x), and volatile organic compounds are about 8

per cent, 0.5 per cent, and 1 per cent respectively by mass of total Australian car emissions (BTCE 1996, appendix III).

Article 5 of the Kyoto Protocol stipulates that each country's commitment in terms of emission reductions is to be aggregated in carbon dioxide equivalents (the summed mass of net greenhouse gases produced, weighted by the Global Warming Potential (GWP) of each gas). While it does not directly address the issue, permits traded either nationally or internationally would presumably also be denominated in terms of CO_2 equivalents of the gases listed in Annex A of the Protocol (reproduced in Appendix B of this publication).

If any scheme for emissions trading is to be fully effective, there needs to be an agreed methodology for including indirect greenhouse gases. What matters from the perspective of the greenhouse effect is total radiative forcing, not merely direct forcing. The aggregation of indirect atmospheric effects may well be as important as radiative forcing due to emissions of direct greenhouse gases. And an efficient system of reducing emissions (whether or not through tradable permits) requires each country to have as broad a choice as possible of the gases to be reduced.

However, the Intergovernmental Panel on Climate Change (IPCC) does not currently provide numerical values for the Global Warming Potentials (GWP) of indirect greenhouse gases, such as carbon monoxide. Due to the short atmospheric lifetime of most indirect greenhouse gases, and scientific uncertainty about the complex chemical processes involved in their effects, GWP values have not been specified in recent IPCC reports.

Carbon monoxide results from incomplete combustion in internal combustion engines. If it is not included in the gases targeted by a tradable permit scheme, it is possible that cars would be tuned solely to optimise fuel consumption, rather than to minimise total exhaust emissions. Emissions of CO could increase. Equally important, CO is a noxious gas. In urban areas, up to 90 per cent of CO emissions are due to motor vehicles (BTCE 1995, p.137). Any increase in concentration in urban areas could add to adverse health effects, particularly circulatory and respiratory disorders.

Targeting directly radiative greenhouse gases alone may also result in other perverse consequences. For example, catalytic converters reduce the output of noxious emissions such as CO and oxides of

nitrogen (NO_x). Nitrogen dioxide (NO_2) is not only an ozone precursor but can cause lung damage, increased susceptibility to asthma, and damage to plants and buildings through acid rain. Three-way catalytic converters, which have been standard on Australian cars since 1988, reduce emissions of CO, NO_x and hydrocarbons. However, the use of catalytic converters can increase fuel consumption in cars. Some motorists could be unintentionally encouraged to disengage catalytic converters in order to reduce fuel consumption.

Uncertainty created by the omission of indirect greenhouse gases from a tradable permit scheme may also have an adverse effect on the scheme itself. The prices of current permits may be discounted to allow for the risk of possible devaluation if additional gases are introduced into a tradable permit scheme in the future. Or the permits will be used quickly rather than being 'banked'.

Localised effects

A potential problem of some tradable permit schemes is the localisation of effects. EPAV (1995, p. 24) points out that in the case of a scheme covering noxious emissions:

> ...permit purchasing patterns will be determined by the comparative emission reduction costs faced by individual emitters. It is possible that an individual firm, or a group of firms in close proximity to each other, may buy a large proportion of the available NO_x emissions permits and this might lead to localised pollution problems. The nature of dispersal of the pollutant to the particular airshed is also a factor in causing localised effects.

Not all emissions that affect radiative forcing (the determinant of the 'Greenhouse Effect') are fully miscible in the atmosphere. However, greenhouse gas emissions are generally more of a global, rather than a geographically local, concern.

Nevertheless, it is possible that unforeseen, non-greenhouse gas, localised effects could occur. For example, a greenhouse gas emission trading scheme could induce residents of cities where public transport services are poor to buy more than their proportionate share of greenhouse emission permits because of the lack of alternatives to car transport. Congestion, noise, or noxious emissions in such areas might increase relative to other parts of the city.

International transport

A major unresolved issue in international negotiations that is particularly relevant to geographically isolated countries such as Australia is the attribution of bunker fuel used by ships and aircraft on international routes. A similar problem could be faced by some central European countries which sell fuel to transit traffic, or operators of hub airports such as Bangkok or Singapore. To ensure that all fuel use is accounted for, the Intergovernmental Panel on Climate Change (IPCC), the principal international body investigating greenhouse issues, recommends that countries should 'record separately [from domestic usage] the quantities of fuel uplifted' by international ships and aircraft (IPCC/OECD 1994, p. 1.11).

Unless an international agreement can be reached, fuel used by international transport would presumably be excluded from the ambit of any emissions trading scheme. The obvious distortion would occur, with trips from Sydney to Bali or Singapore becoming relatively more attractive than those to Darwin or Perth. Depending on relative prices, it may even become cheaper to fly from Sydney to Darwin via Bali. Domestic emissions may fall, but total global emissions probably would not be reduced by as much as they might have been.

Concomitant carbon leakage

Where a country takes measures to reduce greenhouse emissions in a way that increases costs of production, then its exports (or domestic sales) of the commodity involved may become uncompetitive. If production is transferred to another, lower-cost country which has not taken similar abatement measures, there is said to be emissions or carbon 'leakage'. Where leakage migrates to a country that is less efficient in emission output, the net result of abatement measures taken in the first (abating) country may nevertheless be a global increase in emissions.

Because domestic transport services are not traded internationally, 'carbon leakage' is unlikely to be a problem in terms of transport services per se. However, it could be relevant to other sectors from which demand for domestic transport services is derived. An example is the highly energy-intensive aluminium smelting industry. If an aluminium smelter 'migrates', for instance, from Australia to a country that has an associated transport system that uses more fuel than would have been used to transport bauxite or aluminium in Australia, 'concomitant carbon leakage' will also occur in terms of domestic transport services.

Even in terms of domestic transport, therefore, an effective international tradable permit scheme requires that all countries (not just the Annex I group) accept emission reduction obligations.

ALLOCATION OF PERMITS

A number of approaches have been proposed for allocating emission permits within the transport sector. However, there appears to be no obviously superior system. Each approach has its own specific advantages and disadvantages.

Vehicle manufacturers

Motor vehicle manufacturers could be permitted to build any combination of polluting or non-polluting vehicles, subject to an overall permit quota of total emissions. Producers of 'gas-guzzler' cars would need to acquire more permits than those making more fuel-efficient vehicles. This concept can be extended to buyers or sellers of motor vehicles, and to other transport vehicles such as buses, planes or ships. Wang (1994) and others have advocated such schemes for light commercial and passenger vehicles.

Allocation of permits to manufacturers of transport vehicles has two major drawbacks from a policy perspective. Expected fuel efficiencies based on new vehicle performance offer a very unreliable guide to actual, in-service emissions because of significant differences in the driving behaviour of individual drivers, as well as differences in the maintenance and tuning of the vehicles themselves. Moreover, any increase in the price of new vehicles due to an emissions trading scheme would encourage owners to continue operating older (perhaps less fuel-efficient) vehicles longer than they would otherwise have done. Such uncertainties mean that allocating permits to vehicle manufacturers could not reliably attain specific reductions in emissions.

By destination

BIE (1992, p.27) raises the possibility of a tradable permit system based on commuters' destinations. This approach involves defining the destination as the source of emissions, because it can be argued that a destination's output is dependent upon the number of commuters travelling to it. Destinations such as businesses, theme parks, or beaches would effectively be required to reduce visitors' vehicular emissions through strategies such as providing company buses, rationing parking spaces, imposing parking taxes, and so on. A very blunt instrument, this measure offers substantial scope for evasion (such as parking on nearby streets), and would be likely to involve large enforcement costs.

Allocation to individuals

Allocating permits to individual motorists (or operators of trains, ships or aircraft) is attractive primarily because it would provide a direct incentive to reduce fuel consumption by influencing choice of vehicle, patterns of travel behaviour (including mode choice), residential location, and driving behaviour such as acceleration at traffic lights.

But there are a number of disadvantages which would probably outweigh any direct efficiency advantages of allocation of permits to individual users of transport.

The most significant disadvantage would be the substantial implementation, administration, monitoring and enforcement costs incurred if individuals were the main players in the tradable permit market. Without a clear understanding of the scheme that may ultimately be proposed, it is impossible to be accurate about such transaction costs. However, BTCE (1998) provides estimates of cost items such as a centralised electronic system to track sales (and additional purchases) of permits, and public education campaigns.

If permits in the transport sector were 'grandfathered' to individuals (issued free, approximately on the basis of past usage of fuel or kilometres travelled), special arrangements would need to be made for migrants, new car owners, new bus companies or train operators, and possibly tourists. (Car ownership per head, for example, has grown about 1.5-2 per cent per annum in recent years.) A less equitable, but nevertheless efficient approach would be to allocate all permits to past users of fuel, forcing new users to purchase permits from others, just as past users would need to purchase additional permits if they needed to use more fuel than in the past.

In any case, the first year of permit issue would pose the problem of determining and validating past usage of fuel. It is not difficult to imagine strategic behaviour occurring, with motorists deliberately using more fuel in the base year to ensure a greater allocation in future years, if they thought that the extra fuel cost would be outweighed by the future value of permits acquired. Apart from the inefficiency involved, greenhouse emissions would increase, at least temporarily. Grandfathering could be based on past vehicle ownership. But this may lead some people to purchase cheap cars simply in order to obtain additional permits. One alternative is to allocate an equal number of permits to each Australian resident.

Some degree of equivalence would need to be established to facilitate exchange of permits between modes of transport. For example, how would a train passenger be allocated permits? And what if the train is only half full? The easiest method of overcoming this problem would seem to be to allocate permits to *operators* of all vehicles. Train operators, rather than individual travellers, would then be required to buy and sell permits, thus also reducing transaction costs.

Fuel wholesalers or refiners

Allocation to sellers or producers of fuel offers an alternative. Most importantly, transaction costs would be lower. (Stavins (1995) argues that the success of any tradable permit scheme may be dependent on transaction costs.) Any scope for evasion at the retail level would also be reduced, with the effect of limiting fuel usage through permits being passed on to all vehicle operators in the form of higher prices. Allocating permits to fuel sellers would thus fit easily into a national scheme in which individuals would not need to hold permits for their day-to-day activities.

Commentators such as Cornwell, Travis and Gunasekera (1997, p.19) warn that imperfect competition could result from allocation just to a few large participants. However, competition policy monitoring would probably provide a sufficiently robust safeguard. Because fuel sellers would also be able to buy emission permits from other industries, the need for regulatory intervention would probably be minimal.

Grubb (1990, pp.101-103) makes an important point about tradable permits for CO_2. Unlike the case of pollutants such as lead, or SO_2, which form only a relatively minor component of relevant emissions, carbon cannot be removed from the fuel without changing the nature of the fuel. Control of carbon through tradable permits would thus be equivalent to rationing fossil fuels.

Where there is no close substitute, demand for a fossil fuel is generally inelastic. This is particularly true of petrol. Any restriction in supply will increase price. If the initial allocation of permits is free and directed at wholesalers or producers of fuel, then large companies could reap significant windfall profits. Under this scenario, the share prices of the large oil companies might actually rise, contrary to commonly held expectations about the effect on them of greenhouse abatement measures.

Auctions

If the initial allocation of permits were auctioned (either to individuals or fuel sellers) rather than grandfathered, then the price paid would reflect the value to the buyer of any likely windfall gains. In this case, the Government would skim off any gains immediately and more fully. Regard for new arrivals and people gaining vehicle licences would be required, perhaps by staging auctions at regular intervals during the year.

Revenue from auctions could be used to reduce other forms of taxation, leading to potential efficiency gains by replacing less efficient taxes. If a revenue-neutral approach is not adopted, then auctions will simply represent a new form of taxation. To the extent that aggregate demand is reduced by such a tax, demand for transport services could be expected to fall.

MARKET MECHANISMS

There is no reason in principle why a system of tradable emission permits should not operate on the basis of market principles in the transport sector. However, a number of specific considerations would be relevant to the successful implementation of a scheme.

Time limits

It is sometimes suggested that time limits should be imposed on the use of permits, although this does not appear to be necessary in the case of the Kyoto Protocol. Article 13 allows the Parties to claim credit in 'subsequent commitment periods' for emission levels below their 'assigned amount'.

Imposing time limits on the use of tradable permits offers a convenient administrative mechanism for monitoring and controlling emissions on an annual basis. Permits issued at the beginning of a year would simply expire at the end of the year, and new ones would be issued for the next period. Governments would be aware of the exact level of permitted annual emissions, assuming no cheating.

But if permits are valuable assets, they will tend to be used relatively quickly (unless there is an expectation of appreciation in real value), or be sold. Otherwise, the holder will incur an opportunity cost similar to holding cash at home rather than in an interest-bearing deposit. In any case, there may be global climate benefits in encouraging the postponement of emissions to which a permit holder is entitled. Time limits could also generate large movements in fuel prices at various

times of the year, although allocations or auctions at frequent intervals during the year could help alleviate the problem.

Microeconomic reform

There may be some advantage in accelerating microeconomic reform in transport, and other sectors, prior to the introduction of tradable permits or other greenhouse-related restrictions. Economically rational urban road user charges, for example, would reduce emissions significantly (BTCE 1996, pp. 309–318) at negative social cost: a 'no regrets' measure. Such reductions would reduce the total reduction required to meet Australia's commitments under the Kyoto Protocol, thereby minimising overall resource costs to the community.

Taxation

Grandfathering of permits involves the issue, free of charge, of permits to individuals or other legal entities. Because the supply of permits issued would be less than the amount demanded (permits allocated would allow only for about 8 per cent above 1990 levels of emissions, on average, between 2008 and 2012), permits would command positive prices, probably well above the rate of inflation. Legal entities that receive such grandfathered rights to emit would therefore be able to realise windfall gains.

Capital Gains Tax may therefore apply if individuals or fuel sellers receive permits free, and sell them later. Under current laws applicable to fishing licences, it is likely that the tax would be payable on the wholesale price (P. Brady, Australian Taxation Office, pers. comm. 25 February 1998). Taxi plates (an example of tradable permits, or tradable licences) are similarly subject to Capital Gains Tax.

If windfall gains were taxed, companies would pass on a large proportion of the taxes to individual buyers because demand for fuel is relatively inelastic. Final prices of fuel would be higher than warranted solely under a theoretical system of tradable permits.

IS A CARBON TAX AN ALTERNATIVE?

Allocation of permits to individuals is likely to involve high transaction costs. The only practical alternative—that of allocation to sellers of fuel—will result in increased costs of fuel being passed down to individuals. The final effect is thus akin to a tax.

It could therefore be argued that a carbon tax would be preferable to tradable permits in the transport sector. A particular attraction with

a carbon tax is that administrative costs would be low compared to a system of tradable permits.

On the other hand, proponents of emissions trading schemes argue that taxation is not precise enough to achieve a target specified in terms of quantity of emissions. Moreover, a carbon tax would not affect non-carbon emissions such as nitrous oxide, although emissions of this gas from the transport sector are negligible (BTCE 1996, p. 377).

However, in the absence of a highly detailed and costly administrative superstructure, it is unlikely that a system of domestic emissions trading will be able to achieve surgical precision overall.

While our knowledge of various elasticities of transport fuel usage is not very good, estimates would be improved significantly over the five-year commitment period. Any initial mis-estimation of the level of taxation required could be corrected fairly easily between 2008 and 2012. Similar corrections would probably be required in other sectors. Prices established in other sectors of the economy could also be used as a guide to the price of emission reductions in the transport sector.

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10

THE INTERNATIONAL TRADE PROBLEMS OF THE KYOTO PROTOCOL

ALAN OXLEY

The presumptions behind the Kyoto Protocol to the United Nations Framework Convention on Climate Change (FCCC) are that the world energy market can be divided in two, and that it is feasible in one of those markets to control carbon generation by suppression of demand for energy with plurilateral rationing policies or taxes. Implementing the Kyoto Protocol is likely to generate pressure to restrict trade in energy-intensive products between industrialised and eastern European economies on the one hand, and developing economies on the other. The Kyoto emissions trading regime may well also undermine global efforts to increase global prosperity by building open global markets.

Once again, the international environmental policy community seems disposed not to devise approaches that harmonise with the open global trading system, despite professions of intent to the contrary.

THE OPERATING PREMISES OF THE KYOTO PROTOCOL

The Kyoto Protocol introduces two key principles which will affect global energy mineral prices and divide the world energy market into two. They arise from obligations which the Protocol imposes on parties which are listed in Annex B of the Protocol. (These countries are mostly industrialised economies, although it includes some eastern European 'transition' economies.)

The first principle is that each party has to curtail carbon emissions to the specific target to which each Annex B Party has committed. The second principle is that each Party is committed to develop and adopt a system to enable these Annex B Parties to have to impose constraints on trade in emission rights between them, at least as a supplementary measure to internal controls. It is generally accepted that each Party

will have to impose some constraint on consumption of energy to reach the proposed levels of reduction. If it is presumed that Annex B countries, and/or corporations within them, can buy and sell carbon emission permits with the Annex B group, then the economic harm which will follow the suppression of demand for energy throughout the Annex B group will be minimised. The application of these principles will result in different prices for the products of consumed carbon, notably electricity and transport services, in Annex B countries and the rest of the world.

It is expected that all Annex B countries will need to reduce demand for energy in order to meet the targets to which they have committed in the Kyoto Protocol. Each party will select its own methods of carbon withdrawal. It is commonly presumed among analysts that some form of tax, or tax equivalent, will be applied which will be set according to the amount of carbon dioxide emitted in the energy production process. If this occurs, most of these countries will have to lift energy prices to constrain consumption.

It is not at all clear how a system of trading CO_2 emission permits will operate. The presumption among most analysts is that some system will be devised.[1] For the sake of this discussion it will be assumed that a significant trade in CO_2 permits takes place within Annex B countries. The pattern of energy consumption within these countries will be determined by the cost of obtaining these permits.

It is inevitable that the average price of energy production among Annex B countries would be higher than among non-Annex B states. The latter do not accept the principles laid out in the Protocol to suppress consumption of carbon and are under no obligation to reduce greenhouse emissions or to participate in a system of trading in carbon emission permits.

Hence it is clear that the Kyoto Protocol envisages division of the world energy market into two markets—one comprising industrialised and some eastern European transition economies (the Annex B Parties) who will increase the domestic cost of energy in domestic markets to

1 This analyst considers that the number of issues to be resolved and the degree of innovation in international public policy necessary to develop a system that will work are too great for a successful system to be developed. How the credits are allocated and who allocates them are extremely difficult issues. Resolution of them requires a level of supranational governance which does not exist and is unlikely to be created out of existing international institutions.

reduce greenhouse emissions; and the other comprising the other Parties to the FCCC who will mostly be developing countries who are under no such constraints.[2]

IMPLICATIONS FOR THE STRUCTURE OF WORLD TRADE

There are two prospective implications for the world trading system from implementation of the Kyoto provisions. The first arises from the consequences of one group of countries opting to increase energy costs when other countries with whom they trade do not. The second arises from the implications of one group of countries creating a plurilateral system of regulation to try to influence the consumption of products (particularly coal) which are globally traded.

It is clear that, if the Annex B countries increase the cost of consuming carbon, and therefore of energy in their economies, they will increase the cost of products in which there is a high energy input. Well known examples of such products are aluminium, magnesium, copper, steel and other base metals. These are globally traded products. As a broad generality, these products are likely to be more competitively produced in non-Annex B countries if energy costs in the Annex B economies increase. Most non-Annex B countries are developing economies and include the newly industrialising economies in Asia and Latin America.

Post-war experience demonstrates that industrialised economies react to protect their own markets when confronted with exports from more competitive producers in developing countries. The most outstanding example is world trade in agriculture where a number of countries historically have erected high trade barriers to prevent more competitive exports entering their markets. This has happened in most economies in Europe, Japan and in some agricultural sectors in the United States.

2 Many analysts assume that the sum of the measures of the Framework Convention on Climate Change (FCCC) and of the Kyoto Protocol does create a global system for managing energy. They point to two provisions which create mechanisms which would result in implementation of measures to constrain consumption of carbon in developing countries. The first is the provision in the FCCC for Joint Implementation (Article 4.2. (a)) and the second is the provision to create a Clean Development Mechanism (Article 12 of the Protocol). Neither of these provisions entails obligations on developing countries to participate. Both envisage systems which may create benefits for developing countries. Any assessment of the impact of the mechanisms of the FCCC and the Kyoto Protocol must be based on the effect of the provisions which entail compulsory obligations. This is the only effective way to assess the substantive impact on the behaviour of states when they acceded to international treaties.

An entirely separate point is whether or not mechanisms of any significance will ever be developed under these provisions. The Clean Development Mechanism in particular is a very ill-defined concept.

The other major example of the systematic use of trade barriers by a number of industrialised economies is the imposition of restrictions on imports of garments and textiles from developing countries. The US and European economies impose quotas which set limits on the amount of garments and textiles which could be imported from developing countries. They have no such controls on imports from industrialised economies.

In both of these areas of trade, the US and the EU (European Union) ensured for several decades that the basic principles of the GATT trading system (see footnote 3) did not apply to these two sectors. They accepted that this had to change in the Uruguay Round of multilateral trade negotiations. There is now international agreement to phase out these arrangements which discriminate against the trade interests of developing countries.

The second consequence is more complex. If Annex B countries create a system to trade CO_2 emission permits, they will attempt to create a sub-global market for energy. Permits may only be traded among the countries listed in Annex B and the concept presumes the total amount of emissions permitted will be finite. Some supranational institution has to quantify that amount, allocate permits and supervise trading of them. Assuming this is done (see footnote 1), Annex B countries will have to implement a system of regulation to enforce the use of permits and prevent generation of CO_2 without the required permit.

This system seeks to suppress demand for carbon-based energy within this sub-global market. It has to set a limit on the production of CO_2 emissions, and therefore of consumption of energy fuels. The price of energy will be increased because of the artificial cap on emissions. Because of increased prices, demand will be reduced. The slope of the demand curve has yet to be determined.

Contrast it with an open market. Supply and demand interact to set the price. If the price falls, consumption would expand, and the more competitive producers of the product would benefit more. The fundamental point of the rules of the GATT is to build global markets which work on that principle. The GATT rules give all countries an opportunity based on their competitive strength to participate in global markets. This is how global markets for mineral fuels and energy-intensive products operate today.

This does not happen in the sub-global market with the high energy costs. The level of consumption is constrained by the imposition of a limit

on the amount of CO_2 that will be produced following consumption of those products. The sum of the emissions is set by the Annex B countries. It has to be much less than their projected emissions if they are to attain their Kyoto targets.

In this market, non-Annex B suppliers who previously supplied Annex B countries are likely to win less benefit from trading into these markets because the price of energy will be artificially increased significantly and the demand (and therefore the price) for energy minerals will fall. Their capacity to supply the market at levels commensurate with their standards of competitiveness will be reduced.

It is beyond the scope of this paper to attempt to quantify the effect. By looking at world trade in minerals we can see that non-Annex B countries had significant trade with Annex B countries. In 1996, 51 per cent of world fuels were exported from non-Annex B countries. Annex B countries imported 73 per cent of world fuel imports. (World Trade Organisation 1997, *Annual Report*, WTO, Geneva)

Have non-Annex B countries implicitly endorsed a system which is likely to reduce the opportunities to trade into global markets? It seems that they have. There is no evidence that this was their intention. Indeed, Article 3.5 of the Framework Convention on Climate Change stipulates that measures should support the open trading system and not constitute unjustifiable discrimination or a disguised restriction on international trade. And the rhetoric of representatives at the UN meetings at which these international instruments were developed emphasised that actions by industrialised countries should not adversely affect the economic and trade interests of the non-Annex B countries.

USE OF TRADE BARRIERS FOR ENVIRONMENTAL CONTROLS

There will be those who will argue that there is nothing wrong with Annex B countries acting in ways which may lead to restrictions on trade with non-Annex B countries, if that helps protect the environment. There is a running debate on this issue. Developing countries are adamant that measures to protect the environment should not restrict trade, but environmental officials in some major industrialised governments take a contrary view.

The relationship between trade and the environment was comprehensively reviewed at the 1992 UN Conference on Environment and Development (UNCED) held at Rio de Janeiro. There was a consensus that trade restrictions should not be used to manage the environment. Policy makers were evidently concerned about the rising

incidence of the use of environmental trade restrictions. The United States has more than once justified unilateral trade restrictions on environmental grounds. And a practice has developed of creating an obligation on parties to environmental treaties to impose trade restrictions on countries which are not parties to the treaty. The most prominent examples are the convention to restrict trade in endangered species (CITES), the convention to protect the ozone layer (the Montreal Convention) and the convention to restrict transboundary movements of hazardous wastes (the Basle Convention).

This is a relatively recent innovation in treaty making. The purpose is to put pressure on the non-parties to behave in a manner which is consistent with the obligations assumed by the treaty parties. The effect is a form of international coercion. Pressure is put on non-parties to join the treaty to obviate the trade restrictions.

It is recognised that these approaches conflict with established approaches to international law. They generally put members of these treaties in conflict with their obligations under the World Trade Organisation (WTO).[3]

Notwithstanding the consensus at UNCED, use of trade measures for environmental purposes has continued. The US has continued to impose trade restraints on trading partners who do not comply with US environmental policies. In 1996, the European Union proposed amendment of the WTO to legitimise use of trade restrictions for environmental purposes and members of the EU promoted an amendment to the Basle Convention that requires members of the OECD not to trade in materials for recycling, specified in the Convention, with non-OECD countries.

It is easy to imagine that policy makers in a number of Annex B countries will choose to regard other environmental agreements as precedents if they want a justification for the use of trade restrictions to protect the Kyoto Annex B energy market. The fact that such an approach would

3 The General Agreement on Tariffs and Trade (GATT) is one of the WTO Agreements. It lays out a set of international rules for use of trade restrictions which respect the principle of international sovereignty. When countries accede to the GATT, they agree to trade with each other on terms set out in the treaty and commonly accepted by parties to the treaty. GATT does not permit countries to restrict trade if parties do not apply measures specified by one party. Trade may be restricted only in accordance with principles commonly agreed upon in the treaty.

be at odds with the trade and environment principles adopted at the Rio Summit is unlikely to trouble them.

THE FUNDAMENTAL FLAW

If the professed aim of policy makers was to support an open economy and avoid unnecessary trade restrictions (as declared in Article 3.5 of the FCCC) how is it possible that the Kyoto Protocol lays down principles that are likely to conflict with that aim?

The basic problem is that the Kyoto principles are binding on some economies only. This is the fatal flaw of the FCCC, and is repeated in the Kyoto Protocol. The ambition is to find a global solution to a global problem, but the solution is not global. There is no requirement for developing economies to be part of this system. The presumption is that world energy markets can be divided, and that in one market, the consumption of energy, through a system of CO_2 emission suppression, mitigated slightly by international trading, can be reduced.

This outcome would run against the tide of current efforts to shape the global trading system so that it creates the maximum benefit for all economies. It would be a remarkable act of folly if the international community, in a rush to achieve environmental objectives, proceeded with measures which were fatally flawed, and incidentally created regulations which weakened the WTO global trading system which has created such significant benefits for the global community.

As in earlier multilateral environment treaties, it seems that the international community is once again going to ignore its own counsel and implement measures which may unnecessarily create conflicts of interest with the global trading system. In the event this occurs, no doubt the result would be proposals to amend the WTO rules to make room for restrictions on trade, rather than to focus efforts on developing environmental management mechanisms that will actually work.

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Meg McDonald was appointed as Ambassador for the Environment in September 1997. This position is based in Canberra, located in the International Organisations and Legal Division of the Department of Foreign Affairs and Trade (DFAT). The Ambassador's principal functions include promoting Australia's national interests and policies on global environment issues overseas and in Australia.

Previously, Ms McDonald was the Assistant Secretary, Climate Change Task Force (1997) and before that was Assistant Secretary, Environment and Antarctic Branch, DFAT (1995-6). During 1992-94 she was Adviser to the Australian Minister for Foreign Affairs and Trade on trade, aid and environment matters, and trade policy Adviser to the Australian Minister for Trade.

Ms McDonald has extensive international negotiating experience. She had responsibility for several areas of the Uruguay Round trade negotiations and was Counsellor at the Australian Permanent Mission to the GATT (1987-90). Ms McDonald has also represented Australia at APEC, OECD and UN meetings.

Prior to joining DFAT Ms McDonald worked in several domestic economic policy portfolios on transport, communications, finance and industry policy issues.

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11

THE UMBRELLA GROUP: A MARKET-BASED APPROACH

PROVIDED BY THE DEPARTMENT OF FOREIGN AFFAIRS AND TRADE, CANBERRA

International negotiations commenced in January 1991 for a United Nations Framework Convention on Climate Change (FCCC). The text (reproduced at Appendix C of this publication) of the Convention adopted at the United Nations Conference on Environment and Development held in Rio de Janeiro in June 1992 was signed by more than 150 countries, including Australia. In December 1992, Australia ratified the convention, which entered into force on 21 March 1994, following ratification by the requisite 50 countries.

Australia is one of nine Parties to the FCCC which have formed a loose coalition—called the Umbrella Group—in order to advance their common aims, particularly in relation to emissions trading. The other members of the group are Canada, Iceland, Japan, New Zealand, Norway, the Russian Federation, the Ukraine and the United States.

The 'non-paper' reproduced below was submitted by Canada, on behalf of the Umbrella Group, to the FCCC on 3 June 1998, during the 2 to 12 June 1998 meeting of the Subsidiary Bodies to the FCCC in Bonn. (The Subsidiary Bodies involved were the Subsidiary Body for Scientific and Technological Advice and the Subsidiary Body for Implementation.)

The term 'non-paper' indicates that the document is a discussion paper only, and does not necessarily represent the official views of the individual countries concerned. Nevertheless, the non-paper will be an important input into the discussions and negotiations on emissions trading at the Fourth Conference of the Parties to the FCCC, which will be held in Buenos Aires from 2 to 13 November 1998.

Each major negotiating session in the FCCC climate change process is called a Conference of the Parties (COP). The first COP was held in Berlin in 1995, twelve months after the entry into force of the FCCC, the second in Geneva in July 1996, and the third in Kyoto in December 1997. COP3 saw the adoption of the Kyoto Protocol to the FCCC. Annex B to the Protocol specifies legally binding emission abatement targets for the industrialised countries. The Kyoto Protocol itself will enter into force 90 days after it has been ratified by at least 55 Parties to the FCCC, and as long as those countries ratifying it account for at least 55 per cent of the total 1990 carbon dioxide emissions of the countries listed in Annex I of the FCCC.

The Umbrella Group concept was first proposed in the final stages of the COP3 negotiations in Kyoto. Facing an apparent stalemate in their negotiations with the EU (European Union) at Kyoto, several like-minded countries decided to form a loose coalition in order to advance their common interests in securing an open and transparent international emissions trading regime.

Countries participating in the Umbrella Group emphasise a market-based approach to trading. They want to see full private sector participation, minimum transaction costs, and minimum institutional regulation, other than that necessary to ensure the integrity of the framework. In working to achieve these aims, the Umbrella Group acts as a counter to what has been the EU's more restrictive approach to emissions trading.

At this stage, the rules for international emissions trading have yet to be agreed among the Parties to the FCCC, and we know that not all countries share the Umbrella Group's views on the importance of ensuring an efficient, market-driven system. However, Australia is working actively and cooperatively to keep up the momentum for effective implementation of the Kyoto Protocol. In this context, progress on rules for trading is one of Australia's priorities for COP4.

Further information is available on the Internet at the Official Web Site of the Climate Change Secretariat http://www.unfccc.de/

The following version of the Umbrella Group submission to the United Nations Framework Convention on Climate Change (FCCC) was provided by the Australian Department of Foreign Affairs and Trade. A number of annotations have been inserted in square brackets to assist readers in interpreting the terms used.

NON-PAPER ON PRINCIPLES, MODALITIES, RULES AND GUIDELINES FOR AN INTERNATIONAL EMISSIONS TRADING REGIME

(in particular for verification, reporting, and accountability)

1 PURPOSE

1 This paper sets out the preliminary views of Australia, Canada, Iceland, Japan, New Zealand, Norway, Russian Federation and the United States of America on the principles, modalities, rules and guidelines which provide the framework for international emissions trading. It is intended to facilitate on-going discussion on the development of an open international emissions trading system. Participation in the international trading system would be entirely voluntary.

2 The focus of the paper is on key technical design features which are necessary to provide for an effective and efficient trading system. The key objectives of the design features are to keep the system as simple and transparent as possible and minimise the transaction costs of trading while at the same time remaining consistent with the Protocol's environmental objective of achieving at least a 5 per cent overall reduction below 1990 levels of greenhouse gas emissions by 2008-2012 for Annex B Parties. *['Annex B Parties' refers to those countries that have quantified emission limitation or reduction commitments for the first commitment period (2008 to 2012) specified in Annex B of the Kyoto Protocol]*

3 A summary of the international emissions trading system proposed in this paper is contained in Appendix A *[of this non-paper]*

2 INTRODUCTION

4 In December 1997, the Kyoto Protocol established emission targets for Annex B Parties. International trading is established in Article 17 of the Protocol[1]. *[A copy of the Protocol is reproduced at Appendix A of this publication.]* The Conference of the Parties is authorised to decide on principles, rules, modalities and guidelines, in particular for verification, reporting and accountability.

5 Domestic measures associated with international emissions trading are for individual Parties to determine and, as such, are not addressed in this paper (beyond the need for national recording systems). However, an important consideration in designing an international emissions trading system is not to restrict the right of each Party to put in place the domestic measures it chooses. Issues such as whether and how trading is devolved to legal entities and how revenue from trading might be treated have not been addressed as these are matters for individual Parties to decide.

3 WHAT IS EMISSIONS TRADING?

6 Emissions trading is a market based approach which enables participants to cooperatively minimise the costs of achieving an environmental objective. In the case of the Kyoto Protocol, an environmental objective has been established as the aggregate total of all individual quantified emission limitation and reduction commitments, as set out in Annex B of the Protocol for the first commitment period (2008–2012). *[For the period from 2008 to 2012, Australia's average anthropogenic carbon dioxide equivalent emissions of greenhouse gases would be limited under Annex B of the Kyoto Protocol to 108 per cent of their 1990 level, plus (less) any net purchases (sales) of emission reduction and assigned amount units in accordance with Article 6 or Article 17, or any certified emission reductions acquired through Article 12.]*

1 Any reference to an 'Article' or 'Articles' in this paper refers to Articles of the Kyoto Protocol. Similarly, any reference to a 'Party' or 'Parties' refers to Parties of the Protocol.

7 Through emissions trading, a market price for emissions abatement will emerge which reflects the marginal cost of emissions abatement[2] across all market participants. When participants have exhausted the opportunities available for domestic emission reductions, or sink enhancement as per Article 3(3), at a cost below the international market price, they can elect to purchase the requisite 'assigned amounts' from other Parties (or entities). In this way, the environmental benefits are achieved, irrespective of where the reductions take place, and at a lower cost than if trading was not available. *[An explanation of 'assigned amounts', and the ways in which parts of these amounts can be transferred between Parties, is set out in Article 3 of the Kyoto Protocol.]*

8 Since emissions trading is entirely voluntary, each trade will be to the mutual benefit of both participants to the trade[3]. Cooperation between countries in this manner will lower the aggregate cost of emission abatement to below that which would be incurred by countries acting alone. Thus, the incentives provided by trading will facilitate the achievement of the Protocol's environmental objective; and at a lower cost than would be incurred without trading[4].

4 DESIGN FEATURES

9 In developing a framework for international emissions trading, several simple design features need to be considered to enhance the integrity of the trading system and increase the level of certainty under which it operates. These design features should

2 The marginal cost of emissions abatement is the cost of undertaking the next cheapest unit of emissions abatement over and above the current level of abatement.

3 Use of the word 'trade' in this paper applies to acquisitions or transfers.

4 Experience with emissions trading, mainly in the United States, has demonstrated it to be a cost-effective tool for addressing air pollution problems. For example, in the sulphur dioxide (SO_2) trading regime, firms are reducing emissions in excess of requirements in Phase I of the programme and accumulating a large bank of allowances for use in Phase II that begins in January 2000. Additionally, the price of allowances is much lower than anticipated and the cost to industry of emission reductions has been dramatically less than projections by both industry and regulators anticipated before the adoption of the programme.

[A description of the United States sulphur dioxide trading scheme can be found in Department of Foreign Affairs and Trade 1997, Australia and Climate Change Negotiations: An Issues Paper, AGPS, Canberra, p. 113.]

facilitate the efficient operation of a competitive market which will enhance the achievement of the environmental objective.

10 Parties could trade directly and/or choose to devolve trading responsibility to legal entities. Devolving the ability to trade would be likely to increase the number of trades, thus enhancing competition in the market. Private sector legal entities would have direct knowledge of their abatement opportunities and costs and would likely be better placed to make decisions based on this information than would governments.

11 To enhance the efficiency of the market, the unit of trade should be clearly denominated and freely transferable amongst trading participants. Rules which encourage transparency and information disclosure and provide appropriate incentives for compliance can also aid the efficient operation of the market[5]. Comprehensively specified and certain rules assist in minimising the transaction, administration and compliance costs of trading. In order to be accountable and certain, the rules (including monitoring and enforcement mechanisms) would apply to all participating Parties. Rules should maintain enough flexibility to accommodate changes to the system in the future (e.g. new entrants).

5 WHAT IS THE TRADABLE UNIT?

12 Assigned amount units (AAUs) would be the standardised unit of trade. AAUs would represent a tradeable form of an Annex B Party's 'assigned amount'. Parties who wished to trade would issue tradeable AAUs from its 'assigned amount'. Parties would be required to identify the AAUs that they issued with a unique serial number which identified the country of origin and the relevant commitment period[6]. This would ensure that each AAU is unique internationally.

5 Transparency of the regime refers to public disclosure of information, more specifically, disclosure of emission levels, assigned amounts and transfers between trading participants. Disclosure of this information would be based on the public reporting of these data by Parties and reports by the FCCC *[Framework Convention on Climate Change]* Secretariat

6 It may be useful if a standardised format was used for serialisation. It would also simplify and enhance the 'book keeping' process for Parties when recording acquisitions and transfers of AAUs.

13 'Assigned amounts' can be traded, whether they derive from, for example, Articles 3(7), 3(3), 6 and/or 12. There would be no differentiation of AAUs on the basis of data certainty for gases or sources.

5.1 SPECIFICATION OF AAUs

14 Consistent with Article 3(1), AAUs would be denominated in 'CO_2 equivalent'. Consistent with Article 5(3), Global Warming Potentials (GWPs) would be used as the appropriate conversion factors to convert non-CO_2 gases into CO_2 equivalent terms and would be fixed for a commitment period. For the first commitment period (2008 to 2012), Parties should use the revised 1996 Guidelines for National Greenhouse Gas Inventories of the IPCC. GWPs used by Parties should be those provided by the IPCC in its Second Assessment Report based on the effects of the greenhouse gases over a 100-year time horizon, taking into account the inherent and complicated uncertainties involved in global warming potential estimates. *[These GWP values are reproduced at Appendix B of this publication.]*

15 An AAU would express one metric tonne of CO_2 equivalent emissions. All AAUs would be valid for the commitment period in which they are issued and indefinitely thereafter until used. An AAU could only be used once to offset emissions equal to the CO_2 equivalent value (i.e. AAUs are a consumable commodity)[7].

6 WHO CAN PARTICIPATE IN THE TRADING REGIME?

16 The participants in the international trading regime could be Parties (i.e. governments) and/or legal entities authorised by that Party to trade. Legal entities could include private individuals, companies, societies (which could include environmental and other non-governmental organisations), industry groups and brokers.

17 Devolution of the right to trade to legal entities would be at the discretion of each participating Party. However, responsibility

7 A Party could request that any AAUs not used within a current commitment period be banked forward into a subsequent period, consistent with Article 3(13). This procedure could become automatic at the end of each commitment period if requested by that Party.

for the Kyoto Protocol commitments would always remain with the Government as Party to the Protocol.

7 CONDITIONS TO TRADE 'ASSIGNED AMOUNTS' INTERNATIONALLY

18 Each Annex B Party will need to meet conditions to ensure the integrity of the system. These conditions are:

(a) Parties must comply with Articles 5 & 7 of the Kyoto Protocol.

(b) Parties must establish and maintain a national system for recording their 'assigned amount' and accounting and tracking AAUs held or traded by the Party and/or its legal entities.

19 Compliance with the conditions would be assumed to continue unless a breach of the conditions was established under the Protocol. Failure to maintain compliance with the conditions could result in suspension of the right for the Party and its legal entities to transfer AAUs internationally. However, the Party or its legal entities would not be precluded from acquiring AAUs.

8 HOW MUCH CAN BE TRADED?

20 Article 17 provides that trading is to be supplemental to domestic actions but does not quantify that term or authorise the Conference of the Parties to quantify it.

21 International emissions trading will be more effective in achieving emissions reduction at lowest cost if there are no restrictions on the quantity of AAUs able to be transferred or acquired to contribute to compliance with a Party's 'assigned amount'. The ability to trade without quantitative restriction would encourage ratification of the Protocol; encourage earlier emission reductions and minimise the overall cost of achieving the collective Annex B environmental objective.

22 Internationally mandated limits on the quantity available to be traded, by substantially reducing the benefits available from trading, would increase the cost of emission reductions; discourage ratification of the Protocol; and ultimately, in the long term, reduce the quantity of reductions that can be achieved, thus delivering less environmental benefit.

9 INSTITUTIONAL REQUIREMENTS

23 Markets play a central role in the efficient exchange of 'goods' such as commodities, shares, bonds and financial instruments. Existing international markets have a number of well-established practices for contracting, delivery and settlement. An issue for international emissions trading is whether it is necessary to establish a new official institution to facilitate trades. Given the large number of existing commercial market institutions that handle international transactions (both financial and commodity), there seems no benefit in establishing a new international forum/institution to cater for trades of AAUs[8]. The only additional function, over and above those required in the absence of trading, is a system to record ownership and transfers of AAUs at the national level. This system is discussed below.

9.1 NATIONAL RECORDING SYSTEM

24 The national recording system of a Party would record AAUs issued by the Party and transfers and acquisitions of AAUs by the Party, including those AAUs devolved to legal entities, and subsequent transactions by those entities. The national recording system would also be required to provide verification of ownership of AAUs. A Party could choose to maintain a list of all legal entities it authorises to trade.

25 By recording every change of legal ownership, the national recording system would protect against the possibility of counterfeit AAUs being generated and questions regarding legal ownership of legitimate AAUs[9].

26 Each Party would be required to report annually on trading activity to a designated authority approved by the FCCC COP[10] *[Framework Convention on Climate Change, Conference of the Parties]*. This report would identify the aggregate quantity of

8 For example, in the USEPA sulphur dioxide (SO_2) market, no forum or institution was established to facilitate the exchange of SO_2 allowances. Instead, several brokerages have emerged to facilitate private transactions.

9 "Contract trades" for transferring or acquiring AAUs at a specified time in the future would not need to be recorded until the actual trade occurred and the AAUs were officially transferred to the new owner (i.e. the legal ownership changed).

10 Reporting annual trading activity would complement annual emission inventories prepared by Parties under Article 7. Information from a Party's national recording system could be made publicly accessible more frequently.

international trades and any changes to the Party's 'assigned amount' pursuant to Articles 3(3), 3(10), 3(11) and 3(12). This would enable the designated authority to produce a synthesis report of each Party's 'assigned amount', including AAU holdings by each Party and transfers to, and acquisitions from, other Parties.

27 The synthesis report would confirm, at an aggregate level, that correct double-entry book keeping between Parties had occurred. In the event of discrepancies in the reports submitted by Parties, the designated authority would request that those Parties investigate and correct such discrepancies.

28 Two or more Parties could voluntarily consolidate their national recording systems into one system, provided that each individual Party's account was reflected. This might simplify tracking of AAU transfers and preparation of synthesis reports as well as reduce the possibility of discrepancies between Parties' reports on trading activity.

9.2 TRACKING AAU HOLDINGS

29 One way to track AAU trades by the Party and its legal entities would be for the national recording system to operate an account for the Party and accounts for all legal entities authorised to trade.

30 All trades of AAUs would result in a debit and credit to the relevant accounts (i.e. a simple double-entry accounting system). For international trades, the 'seller' would request that its national recording system remove the AAUs in question from its account and authorise the national recording system of the 'buyer' to credit the buyer's account with those AAUs. For domestic trades (i.e. those that did not cross national borders) only the national recording system in that country would need to be involved.

31 National recording systems would only be required to track the account from which AAUs are to be transferred from (or to) and the quantity of AAUs to be transferred (including the serial numbers for the purpose of verifying ownership). Contractual information beyond the number of AAUs transferred between participants would not have to be divulged. Participants could choose not to divulge price details of individual trades to protect commercially sensitive information. Average current prices would

be revealed through market mechanisms such as exchanges and brokers.

10 VERIFICATION AND ACCOUNTABILITY

32 The trading rules should provide appropriate compliance and enforcement mechanisms relevant to the trading system. Other compliance issues could be addressed under Article 18.

33 One enforcement mechanism under the trading rules could be to deny (or restrict) the right of a Party (and its legal entities) to transfer AAUs if they are found to be in breach of the trading rules and/or are no longer in compliance with the conditions for issuing AAUs (e.g. in breach of conditions to trade AAUs internationally).

10.1 ESTABLISHING COMPLIANCE

34 Each Party will be assessed for compliance at the end of the commitment period. For a Party to be found in compliance with Article 3, its emissions must be no more than its 'assigned amount'.

35 At the end of the commitment period and following finalisation of emission inventories, each Party would be required to submit a report to the designated authority[11]. This report would include emissions for the commitment period and aggregate information on the number of acquisitions and transfers of AAUs and any changes to a Party's 'assigned amount' pursuant to Articles 3(3), 3(10), 3(11) and 3(12) (i.e. a compilation of annual emission inventories and information on trading activity). Based on this information, the Party could ascertain whether it had exceeded its 'assigned amount'.

36 The report would also indicate the serial numbers of AAUs used by the Party for the purposes of contributing to compliance. AAUs used by the Party to contribute to compliance would no longer be valid and would be required to be removed from the Party's national recording system (i.e. AAUs are a consumable

11 The submission of final reports would depend on the speed in which national inventories could be prepared by each Party. It would be in the interest of an efficient process in this regard that Article 5.1 of the Protocol, pertaining to national inventories, addressed this issue and required inventories to be submitted within a relatively short timeframe.

commodity). At a Party's request, any AAUs not used to offset emissions or the remaining portion of its 'assigned amount' would be banked forward into the next commitment period pursuant to Article 3(13).

37 A Party that had exceeded its 'assigned amount' would be able to come into compliance during a short grace period (e.g. three months). To meet the shortfall, a Party could either purchase AAUs within the grace period and/or utilise other options to meet the shortfall. After the completion of the grace period, Parties would re-submit a (modified) report. Parties who were non-complying could face non-compliance consequences developed under Article 18.

11 FURTHER WORK

38 Some rules or a process to deal with instances of anti-competitive behaviour may be necessary. Issues regarding allocation of risk need to be further explored.

APPENDIX A—SUMMARY OF THE TRADING SYSTEM

1 International trading is established in Article 17 of the Kyoto Protocol.

2 Parties could elect to participate in the trading system.

3 The tradeable unit would be assigned amount units (AAUs) i.e. AAUs are the tradeable form of 'assigned amounts'.

4 AAUs would be denominated in CO_2 equivalent. The unit of trade would be one metric tonne. GWPs used to calculate CO_2 equivalence would be fixed for a commitment period.

5 Each Annex B Party could issue serialised AAUs from its 'assigned amount'.

6 Each AAU would have a unique serial number which identified the country of origin and the commitment period in which the AAUs were issued.

7 AAUs would be valid until used to offset emissions for the purposes of contributing to compliance (i.e. once used to offset emissions, AAUs would be removed from the trading system).

8 AAUs acquired by a Party with an 'assigned amount' would be added to the Party's 'assigned amount'. Similarly, AAUs transferred by a Party would be subtracted from its 'assigned amount'.

9 'Assigned amounts' can be traded, whether they derive from, for example, Articles 3(7), 3(3), 6 and/or 12.

10 Parties could authorise legal entities to acquire and/or transfer AAUs. Issues such as whether and how trading is devolved to legal entities and how revenue from trading might be treated are matters for individual Parties to decide.

11 Governments, as Parties to the Kyoto Protocol, would remain responsible for compliance with their 'assigned amount'.

12 Each Annex B Party who wanted to trade its AAUs internationally (and/or allow their legal entities to do so) will need to meet the following conditions:

(a) Parties must comply with Articles 5 & 7 of the Kyoto Protocol.

(b) Parties must establish and maintain a national system for recording their 'assigned amount' and accounting and tracking AAUs held, transferred or acquired by a Party and/or its legal entities.

13 The national recording system of a Party would be required to:

(a) record AAUs issued by the Party;

(b) record transfers and acquisitions of AAUs by the Party (including those AAUs transferred by the Party to legal entities, and subsequent transactions by those entities);

(c) provide verification that a legal entity transferring AAUs was the registered owner of the AAUs in question; and

(d) retire AAUs used to offset emissions.

14 Each Party would be required to report annually on trading activity to an authority designated by the COP identifying the quantity of international trades and any changes to its 'assigned amount' pursuant to Articles 3(3), 3(10), 3(11) and/or 3(12).

15 Each Party will be assessed for compliance at the end of the commitment period. For a Party to be found in compliance with

Article 3, its emissions must be no more than its 'assigned amount'. To assess compliance at the end of the commitment period (and following finalisation of emission inventories), each Party would be required to submit a report to the designated authority on emissions for the period and aggregate information on the number of acquisitions and transfers of AAUs and any changes to a Party's 'assigned amount' pursuant to Articles 3(3), 3(10), 3(11) and 3(12) (i.e. a compilation of annual emission inventories and information on trading activity).

16 Parties would inform the designated authority which AAUs (identified by serial number) were used to offset emissions. Such AAUs would no longer be valid for use in a subsequent commitment period.

17 A Party that had exceeded its 'assigned amount' would be able to come into compliance during a short grace period (e.g 3 months). To meet the shortfall, the Party could either acquire AAUs within the grace period and/or utilise other options to meet the shortfall.

18 After the completion of the grace period, Parties would re-submit a modified report. Parties who were non-complying could face non-compliance consequences developed under Article 18.

19 Any AAUs not used to offset emissions or remaining portions of a Party's 'assigned amount' not used could be banked forward into the following commitment period at the request of a Party (including on behalf of legal entities).

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12

THE INTERNATIONAL MOVEMENT OF PEOPLE: ADJUSTING FOR 'PERSONAL' EMISSIONS

LEO DOBES AND JOE MOTHA*

Surprisingly, the immigration and tourism aspects of tradable emission permits appear to have attracted little attention.

If countries of net immigration like Australia, Canada, or the United States of America are not to be disadvantaged, however, there is a need to take into account the international movement of people in accounting for greenhouse emission levels. Tradable permits offer a flexible means of doing so, both in terms of immigration, and in terms of emissions from international aviation.

PRODUCTION VERSUS CONSUMPTION: ATTRIBUTION OF EMISSIONS

Conceptually, greenhouse emissions could be attributed either from a consumption, or from a production, perspective.

Consider, for example, the manufacture of a cooking pot. If the pot has been made in a single country, then all the emissions generated in its manufacture (including extraction of iron ore, smelting, finishing, production of plastic handles, transport to the consumer, etc) can be attributed to the various sectors of the country of manufacture. This approach fits neatly with the concept of 'polluter pays' because countries that benefit from higher production and income levels also bear the associated international social costs. It is the 'production' concept that has formed the basis of international negotiations to date.

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* Views expressed in this chapter are those of the authors alone, and do not necessarily reflect views held by the Bureau of Transport Economics.

However, it would be equally valid to attribute emissions from the perspective of the consumer. In terms of the cooking pot, all of the emissions that have gone into its manufacture could be counted against the country or individual who is the final user. This 'embodied emissions' approach accounts for total emissions just as well as the 'production' approach'.

But, as noted in ABARE and DFAT (1995, p. 16), a production-based approach will favour countries such as Japan, or the European Union, that consume more embodied carbon emissions than they produce. Because only some countries (essentially the developed and the 'transition' countries) are Parties to the United Nations Framework Convention on Climate Change (FCCC) and the Kyoto Protocol to the Convention, they may have an incentive over time to import an increasing proportion of their energy-intensive goods from the non-Annex B countries (Appendix A, Annex A in this publication).

Burden sharing

Having accepted the 'production' approach to attributing emissions to specific countries, international negotiators needed to agree in Kyoto on how much each Annex B country would reduce its (attributed) level of emissions.

Emission reduction can be based on any number of options. The most commonly discussed alternatives include simply stabilising emissions at 1990 levels or some percentage thereof (essentially the Kyoto approach), reduction of national emission levels to equalise them on a per capita basis (favoured by a number of non-Annex B countries), equalising the marginal costs of abatement between countries (the economically efficient approach which minimises global costs), and equalising percentage reductions in per person welfare. Comparisons of these 'burden sharing' options are discussed in Epstein and Gupta (1990), BIE (1995), and ABARE and DFAT (1995).

Population growth and burden sharing

Table 3 in Kennedy, Polidano, Lim, Tulpulé and Fisher (Chapter 8 in this publication) shows that the projected annual average growth in Australian per capita emissions from fossil fuels is comparable to growth rates in Canada and the United States, and below those of Japan and the European Union over the period from 1990 to 2010. However, Australia's population will grow by 1.2 per cent over the same period, while population levels in Japan and the European Union will grow by only 0.2 per cent. Australia's larger growth rate in emissions will be caused by increasing population, growth in economic activity,

continued strong reliance on fossil fuels (especially in electricity generation), and growth in exports from the energy-intensive industries of iron and steel and nonferrous metals, rather than by profligacy in the personal consumption of energy.

The production-based 'polluter pays' concept is now accepted as the basis for international negotiations. But it can still be argued that some emissions are related more closely to population than indicated by the pure concept of production. (The concept of labour as purely a factor of production, with no human dimensions has always been an untidy one in economic theory because of the significant, but often intangible contribution of a higher population.) Even if nothing was produced in a country, for example, people would still generate emissions related to personal needs.

'Personal' emissions

An alternative way of looking at this proposition is to ask what emissions could be avoided by a country if a person left (apart from the emissions which had been generated by that person's involvement in productive activity). An unequivocal answer is not possible, but items that merit consideration include heating, air conditioning (possibly a luxury consumption item apart from intensive-care units in hospitals), lawn mowing, use of personal and public transport, fuel used for cooking, and emissions (such as methane) from human waste. Emissions related purely to human beings can be called 'personal' emissions.

Emissions from households are not trivial. According to the Minister for Environment, Senator the Hon. Robert Hill, 'every home can potentially save at least three or more tonnes of greenhouse gas and hundreds of dollars each year by sensibly reducing energy consumption' (Hill, 1998).

Adjustment for personal emissions under the Kyoto approach would be likely to require renegotiation of the Protocol itself. If renegotiation were possible, one option would be 'baseline shifting' along the lines of Joint Implementation projects. In the case of people, baseline shifting would mean that countries gaining population would add to their 1990 baseline the estimated personal emissions of the population gained through immigration between 1990 and 2012.

An alternative to baseline shifting may be the use of tradable permits as a flexibility mechanism to adjust for the movement of people between countries.

EMISSION TRADING AND THE INTERNATIONAL MOVEMENT OF PEOPLE

The allocation of individual rights to produce emissions within a country is a sovereign matter for each of the Parties to the Kyoto Protocol. However, it is likely that at least some countries will allocate tradable emission rights to their residents on the basis of past emissions ('grandfathering'). These allocations could be used in a flexible way to account for both international air travel, and for migration.

Short-term movement of people

Short-term movement of people between countries is generally restricted to tourists, international negotiators, students, conference attendees, and so on. While in a country, such visitors generate emissions in various ways, particularly through personal consumption of meals, heating, and transport. In the sense that their presence contributes to the production of goods and services within the receiving country, attribution of emissions to the receiving country would be both logical and consistent with the current international approach to attributing emissions.

International aviation

Aviation and marine bunker fuels are not currently included under the Kyoto Protocol, although Article 2.2 calls on the Parties to 'pursue limitation or reduction of emissions of greenhouse gases' through the International Civil Aviation Organization, and the International Maritime Organization. Nor is there an agreed method for accounting for emissions from international transport, although IPCC/OECD (1994, p. 1.11) calls on countries to 'record separately [from domestic usage] the quantities of fuel uplifted' by ships and aircraft on international routes.

Conceptually, emissions from international transport could be allocated in a number of ways, including on the basis of ownership of airlines or ships (consistent with the 'production' approach), or the sale of fuel (also consistent with the 'production' approach), or on the proportion of passengers from each country. However, each of these approaches involves complicated issues of equity, and would require significant effort and cost in terms of international negotiations.

The problem of attribution could be solved relatively easily, however, through the use of tradable emission permits allocated by each of the Parties to its residents. Residents of Annex B countries would be required to give up a specified amount of emission permits (based on distance travelled, average load factors for aircraft, average fuel used

on specific routes, etc) when purchasing tickets. Governments would need to purchase permits on the open market on behalf of officials travelling abroad. Because passports and the issue of airline tickets already involve regulatory mechanisms, administrative arrangements would be feasible.

Annex B countries where tradable emission permits are not issued to individuals could simply tax international travel on the basis of permit prices established domestically. Citizens of non-Annex B countries would not be affected.

Attribution of international emissions on this 'personal emission' basis would be relatively equitable. While Australians would continue to suffer from the tyranny of distance from major destinations, transatlantic travellers who make frequent flights would also be forced to take into account the greenhouse consequences of their travel choices. Citizens from Annex B countries would automatically take responsibility for emissions attributable directly to them, and total emissions would fall.

Long-term movement of people

Long-term migrants generally add to the productive capacity of a country. Their net contribution is positive (even on general employment levels) despite popular misconceptions based on the 'lump of labour' fallacy (Simon 1989, Dobes 1990). Nevertheless, as with other economic activity, migrants may generate negative externalities. Provided that the aggregate benefits outweigh the costs of any externalities (including personal greenhouse emissions), then continued immigration should be encouraged.

From this perspective, any emissions associated with increased production due to increased immigration should be attributed to the receiving country.

In the case of personal emissions, however, the issue of attribution is less clear. Unless countries of net immigration can have their allocated amounts adjusted to reflect increased population between 1990 and 2008–2012, they will be disadvantaged relative to the sending countries. Ideally, both sending and receiving countries should adjust either their 1990 emission baselines, or the emission limits specified in Annex B to the Kyoto Protocol.

Tradable emission permits could simplify the problem of adjusting for 'personal' emissions.

Permanent migrants could be required by the receiving country to have an allocation of emission permits to cover their expected personal emission levels, at least for a commitment period like 2008 to 2012. These permits would be transferred to the country of immigration. Where the sending country did not issue tradable permits to its residents as individuals, it, or the migrants themselves, would need to purchase them on the domestic or international market to ensure that total emission levels did not exceed Kyoto Protocol limits.

Domestic considerations

It may also be timely for countries of net immigration like Australia to consider the implications for them of immigration arrangements when devising domestic schemes for allocating emission permits. For example, should immigrants be required to bring with them sufficient permits to cover personal emissions until they are naturalised?

If emission permits for 'personal' emissions are to be transferred in conjunction with migration, then little action needs to be taken by the receiving country.

If sending countries do not agree to provide or transfer tradable permits, then governments in receiving countries will need to take account of immigration levels when allocating tradable permits to their residents. Provision could be made for future immigration levels to ensure that new arrivals are not disadvantaged compared with existing residents who may be entitled to grandfathered rights. Alternatively, the Government could purchase, through open market operations domestically or internationally, sufficient permits to cover the needs of those who have no 'grandfatherable' rights in their country of settlement.

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13

ACCOUNTING FOR CARBON SINKS: THE PROBLEM OF TIME

LEO DOBES, IAN ENTING, AND CHRIS MITCHELL[1]

Carbon sinks are mechanisms that sequester carbon extracted from the atmosphere. From a scientific perspective, direct human-induced sinks are a valid method of off-setting greenhouse emissions.

The main natural carbon sink is the dissolution of carbon dioxide (CO_2) in the world's oceans. Trees and other vegetation that use CO_2 through photosynthesis to produce wood and other forms of biomass, are an additional, albeit poorly quantified (on a global scale), sink.

PROVISION FOR SINKS IN THE KYOTO PROTOCOL

Sinks for carbon dioxide have gained prominence as a greenhouse abatement measure over the last few years, including through their acceptance as a way of offsetting greenhouse gas emissions under the Kyoto Protocol (reproduced in full as Appendix A in this publication). Individuals and commercial entities have been attracted in particular to the possibility under Article 17 of the Protocol of trading any 'carbon credits' generated through the creation of carbon sinks.

Attention has centred on tree plantations. But there may also be scope for Australian business to investigate the potential of other means of sequestering carbon, such as through the management of soil carbon in agricultural production systems (Hassall and Associates, 1997).

Given the complexities of the Protocol, it is worth quoting in full its main relevant provision, Article 3.3:

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1 The views of the authors do not necessarily reflect the views of CSIRO or the Bureau of Transport Economics.

> The *net changes* in greenhouse gas emissions from sources and removals by sinks resulting from *direct human-induced* land use change and forestry activities, 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 of each Party included in Annex I. The greenhouse gas emissions from sources and removals by sinks associated with those activities shall be reported in a transparent and *verifiable* manner and reviewed in accordance with Articles 7 and 8. (italics added for emphasis)

The terms highlighted in italics warrant careful consideration, particularly by those who envisage claiming or trading carbon credits.

Direct human-induced since 1990

There is still considerable debate internationally about the specific meaning of the term 'direct human-induced'. In essence, however, it expresses the concept that a sink needs to be the result of deliberate human activity, over and above natural sinks. In terms of carbon sequestration, natural forests would not normally be counted as a sink under Article 3.3, even if the carbon stock contained in such forests increases. Trees planted by humans after 1990 (Addendum B at the end of this chapter) would be counted. Trees planted after 1990 are sometimes referred to as 'Kyoto forests'.

Article 6.1 of the Protocol allows Annex I Parties to transfer to, or acquire from, other Parties emission reduction units resulting from projects that generate sinks, provided that such projects are 'additional to any that would otherwise occur' (Addendum B).

Changes in stocks

A reduced emission of CO_2 represents a changed (reduced) flux of the gas to the atmosphere. The same net change in flux can be achieved through an equal but opposite flux of the gas from the atmosphere into vegetation, where it is sequestered.

Because the direct human-induced fluxes of greenhouse gas from the atmosphere to vegetation are minuscule compared with natural fluxes, and because not all fluxes result in sequestration of carbon, measuring the direct results of human actions in terms of fluxes is impractical. However, the overall effect of the direct human-induced changes in the fluxes of carbon between the atmosphere and vegetation can be determined through examining *changes* in the stocks of carbon. A

change in stocks represents the cumulative net flux, and is thus a method for estimating the difference in flux from specific forests.

That is, in terms of radiative forcing (the greenhouse effect), an emission of a gas such as CO_2 can be offset only by an equivalent flux, rather than just a fixed stock or amount of carbon. Thinking in terms of a 'puff' of greenhouse gas emitted at some point in time, the 'puff' can be absorbed back out of the atmosphere by a tree only over a period of time, as the tree grows. A 'puff' of sequestered carbon must therefore be measured as an accretion over time.

Considerable confusion has resulted among those who have not been fully aware of the significance of the term 'changes in stocks'. The Kyoto Protocol provides credit only for that portion of carbon sequestration that occurs over a specified period of time (the commitment period). That is, credit is envisaged only for the growth in trees that occurs between two points in time, not for the total mass of carbon in the plantation. In other words, for those seeking carbon credits, it is the *addition* to stocks (during the commitment period) that counts; and then only in 'Kyoto forests'.

Commitment period

Except in the special case of the Clean Development Mechanism, where banking of credits is permitted, credit will be given only for the additional carbon sequestered between 2008 and 2012, the so-called 'first commitment period'.

In the analysis below, it has been assumed, as a working proposition, that the Kyoto Protocol will lead to commitments to reduce emissions and generate carbon sinks subsequent to the first commitment period.

Verifiable

Since some form of official, internationally-sanctioned verification and certification procedure will be required for carbon credits, it would be prudent for those considering entering the area of trading in carbon stocks to first consult the Australian Greenhouse Office (ph +61 2 6274 1888), as well as obtaining their own legal and other advice.

Specific rules and guidelines for accounting for sinks projects have yet to be determined through international negotiation. However, a comprehensive approach to greenhouse gas emission reduction, including through sinks, is consistent with the overall aim of the Protocol, and is therefore likely to be more fully developed over time.

DEVISING A PRACTICAL SYSTEM OF ACCOUNTING FOR CARBON CREDITS

By recognising the possibility of trading in greenhouse emissions or in carbon sinks, the Kyoto Protocol (subject to entry into force) has effectively created a new commodity. But a number of issues need to be resolved so that new commodities like carbon credits are properly defined, in order to permit measurement, and hence trading.

Timber versus carbon

A key concept is to separate conceptually the wood contained in a tree, and the carbon that it simultaneously embodies.

A plantation of trees can be harvested, and the timber sold in the normal way. However, where production of the timber also meets the conditions of the Kyoto Protocol, and is certified as having sequestered a certain amount of carbon, then any resulting 'carbon credit' that is issued by the relevant authority can potentially be traded separately. The producer can gain separately from selling each commodity (i.e. the timber and the carbon sink). Obviously, the regulatory regime adopted will need to resolve potential conflicts that may arise in the management of plantations where the interests of the owners of the two commodities diverge.

A major issue in the area of carbon credits is that of verification. Unless a system can be devised that ensures that credits reflect accurately the flux involved, then it is unlikely that they would be recognised internationally under Article 8 of the Protocol. Ideally, any system of verification and certification should be as simple as possible, in order to minimise administrative and other transaction costs.

Carbon as carbon

It needs to be stressed that it is the quantity of carbon, not wood, that is eligible for carbon credits under the Kyoto Protocol.

The National Greenhouse Gas Inventory Committee (1997, table 7, p. 26) recommends an Intergovernmental Panel on Climate Change default figure of 0.5 for converting forest biomass into carbon. However, the forest biomass needs to be converted first into 'dry matter' weight, free of moisture content. In other words, only a relatively small proportion of the weight of merchantable timber constitutes carbon. If the equivalence factor of 0.007 for temporary carbon sequestration (see below) were to be ultimately accepted, then the proportion of carbon claimable for plantation timber would be very low.

In terms of carbon credits destined for trading, the content of carbon in any particular wood will probably need to be determined on a species-specific basis because current default values are only approximate.

Those intending to offset emissions of CO_2 through timber plantations also need to understand the difference between the mass of CO_2, and the mass of carbon. In terms of relative atomic mass, the carbon atom (12) forms only about 27 per cent of the total molecular mass (12+16+16 = 44) of CO_2, because each of the two oxygen atoms is assigned a relative mass of 16. In other words, a kilogram of CO_2 sequestered has a value of only 0.27 kilograms of carbon. This fact needs to be taken into account in any calculation of how much carbon must be sequestered to compensate for a given emission of CO_2.

Sharing of risk

A major issue that will be of interest to both governments and commercial entities is: who should bear the risk of non-delivery of a sink for which a carbon credit has been issued, and how? Unless some method is used that takes into account the risk that carbon sinks may not be maintained in the future, then significant compliance and enforcement costs may be incurred by either growers or regulators in meeting international commitments.

A brief discussion of the various types of risk involved with carbon sinks appears in BTCE (1998). The major concern in terms of plantations appears to be fire. If carbon credits are given to growers at any time before scheduled harvesting, a mechanism needs to be found to ensure that the sink is replaced if a plantation is destroyed prematurely.

However, if future emissions are already taken into account at the time that a credit for (net) sequestration is granted, then the issue of risk does not arise. It is here that the annualised net benefit approach to measuring sequestration (discussed below) has a significant advantage over other accounting methods.

An alternative approach would be to use market or other insurance mechanisms to cover any risk of acts of god that destroy carbon sinks. Risk could be shared collectively, or managed by individual growers of trees. Either a nation-wide pooling system could be established, or individual growers could be left to make their own insurance and other arrangements.

The problem of time

If carbon credits are to be tradable, they need to be realisable at some specific point in time. However, sequestration of carbon through tree growth occurs over a period of time, rather than at any specific point in time.

Equally important, carbon that is sequestered is ultimately re-emitted into the atmosphere when the wood decays, either in the forest, or as some processed form away from the forest. If credit is to be given for carbon sequestration, then it is necessary to identify a means of attributing the net (growth minus decay) sequestration to a particular point, or points, in time.

It has been assumed that the unit of time to be used to account for carbon credits would be a year, because emissions are already specified in this way under the Protocol, and because some emitters may wish to gain offsetting credits within comparable time periods. However, the five options below could also be applied in terms of longer or shorter time units.

THE 'STEADY STATE' APPROACH

Many analyses of arboreal carbon sequestration estimate only the amount of carbon that is stored temporarily. Such studies are often, and sometimes disparagingly, said to represent a so-called 'buying time' option, because they are based on only one cycle of growth and decay. Criticism of such studies is warranted only if they seek to portray a single growth-decay cycle as an offset to emissions.

BTCE (1996, ch. 14), on the other hand, adopted a 'steady state' approach that assumed harvesting and replanting of trees in perpetuity. The 'steady state' concept used by the BTCE is analogous to the state of a natural, old growth forest. Over a long period, a natural, unharvested forest may be assumed to reach a state of equilibrium where the total amount of wood or carbon per unit area is, on average, constant. In this steady state (long run) equilibrium, the rate of growth (addition to the stock of wood) and the rate of decay (depletion of wood) would be equal.

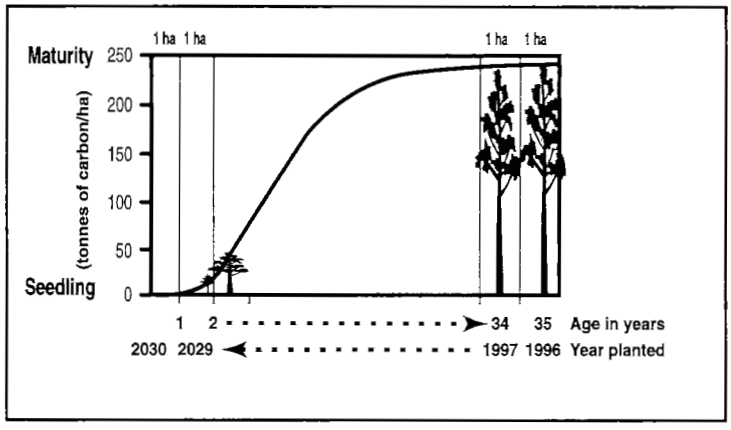
A natural forest comprises trees of different ages. In the case of plantations, individual annual plantings involve trees of identical ages, but the total plantation estate can be considered as if it were a forest of trees of mixed ages. Whereas trees in a natural forest will die at a biological limit, it can be assumed that trees in a plantation will be harvested at a commercially advantageous time. Immediate replanting

of the felled area is required to ensure maintenance of the steady state equilibrium. Maclaren (1996) demonstrates the concept in a forest management context.

The concept is illustrated in figure 13.1, which shows plantation strips of 1 hectare corresponding to one year's planting, with each strip containing trees of uniform age. Taking all the strips together, even in a different sequence from that shown in figure 13.1, results in a 'natural' mix of tree ages. The fact that timber is harvested, and that it decays in locations away from the forest (for example as paper), does not preclude envisaging the estate as a mixed-age natural forest. BTCE (1996) used three separate decay functions (to represent different wood products) as part of its 'steady state' calculations.

Figure 13.1 illustrates the sequestration of carbon in standing timber. The estate shown is assumed to involve trees that are harvested at 35 years of age. At the end of the year 2030, the largest trees (planted in 1996) are harvested. The '1996' area is replanted during 2031. (A new area could also be planted in 2031 to soak up emissions from fuel used in that year.) At the end of 2031, the '1997' plantation is harvested; it is replanted in 2032 and a new plantation for year 2032 emissions could be planted at the same time. Carbon credits for the original 35 ha plantation would be generated for the initial growth (1996–2030), but not thereafter, because no net change in stocks would be occurring.

FIGURE 13.1: SEQUESTRATION OF CARBON IN PLANTATIONS



Source BTCE (1996, p. 243)

Carbon sequestration estimates based on a steady state approach permit conceptually valid comparisons with (permanent) reductions in emissions. In practice, however, they would raise serious questions about compliance and enforcement, because those receiving credits would need to guarantee that replanting would continue into the indefinite future. This is clearly impracticable.

SIMPLE ANNUAL BUDGETING

A simple option is to account for sequestration on an annual basis, or at the close of a 'commitment period' under the Kyoto Protocol. The attraction of this option is its administrative simplicity, including the ease of verification.

Emitters of greenhouse gas emissions could be required to plant trees, and to demonstrate at the end of each annual accounting period that a certain amount of carbon had been sequestered during that year. A credit would be issued for the certified amount. The credit could simply be an emission permit indexed to those issued in proportion to the emission limit amount assigned to each Annex B Party.

While the simple annual budgeting approach is attractive from an accounting perspective, it obviously fails to take into account the subsequent decay of timber produced, and hence the re-emission into the atmosphere of the carbon sequestered. It is conceptually invalid, because permanent emissions of carbon would be credited fully in return for only temporary sequestration.

The 'simple annual budgeting' approach could be used, however, if there were a mechanism for imposing a penalty (carbon tax, need for permit etc) at the time when the carbon returned to the atmosphere. The administrative costs of checking on items such as furniture, or timber frames in houses, and assessing decay, would be very large. This approach is therefore impractical.

Young and Berger (1998) suggest that an area approach, rather than tree-by-tree accounting, would be simpler. Under this arrangement, landholders would enter into an agreement obliging them to maintain stocks above a nominated threshold. Credits would then be issued only for verified increases in the total stock.

DELAYED CREDITS

A third approach would be to grant carbon credits only after a forest had been harvested, and the use (and hence decay rate) of the wood products had been fully determined and certified.

Monitoring and enforcement would be made easier, but the risk of obtaining credits would be borne entirely by the plantation owner. On the other hand, the same is true of planters who seek to profit from the sale of timber, and face risks (and hence insurance costs) from fire and climate prior to harvest. However, realisation of carbon credits only after harvesting involves the additional, regulatory risk of potential changes in government policy, and the uncertainty of predicting the value of tradable permits or corresponding credits 20 or more years into the future. If harvesting were a precondition, then this approach would also be inconsistent with the desire of some people to plant native trees to contribute to the nation's biodiversity, as well as creating carbon sinks.

It is therefore unlikely that a 'delayed credits' approach would be commercially attractive. However, some benefit might be gained by commercially marginal plantation projects, where the possibility existed that revenue from timber production could be supplemented by additional revenue from tradable carbon credits.

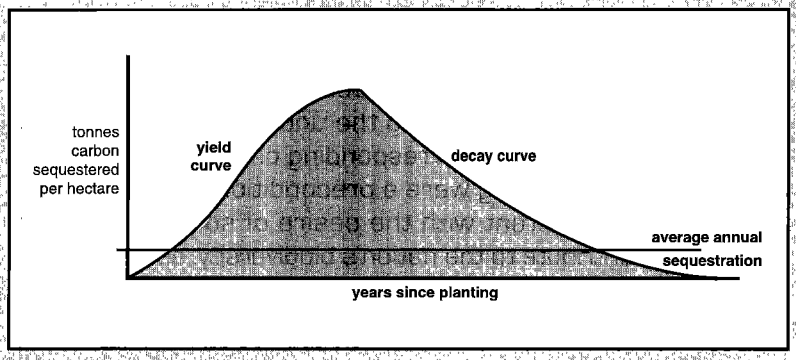
AVERAGE ANNUALISED CREDIT FOR TEMPORARY SEQUESTRATION

While a plantation of trees that is harvested without continued replanting will not sequester carbon permanently, it will remove it temporarily from the atmosphere. (For this reason, the option of planting trees is often referred to as a 'buying time' approach.) For the period that the carbon is absent from the atmosphere, radiative forcing (effectively the contribution to climate change) is reduced by a calculable amount. That is, the physical 'benefit' in terms of the greenhouse effect can be determined.

Plantation owners could be bound contractually to harvest their trees only after they had reached a certain size. They could also be bound contractually through a certification process to ensure that merchantable timber was used in pre-specified ways, so that future decay rates could be estimated with some confidence.

Prior knowledge of the total amount of carbon likely to be sequestered over time, as well as the decay rates involved, would provide sufficient information to determine the amount of carbon removed (temporarily) from the atmosphere over a given period of time. The average annual amount of carbon sequestered can be determined by dividing the total area under the curve (figure 13.2) by the number of years from planting to complete decay. Credited amounts would be expressed as 'annualised carbon tonne-years'.

FIGURE 13.2 CARBON SEQUESTRATION OVER A SINGLE PLANTING CYCLE



Source BTCE (1998)

This 'average annualised' approach proposed in BTCE (1998) has several practical advantages. In particular, the accounting procedures involved are relatively simple. A specific credit, known in advance, can be given annually, provided that the conditions of the contract are still being met. Alternatively, credits could be issued as soon as a plantation was established, because of the contractual undertakings obtained, thus providing producers with up-front incentives to plant trees.

Nevertheless, the 'average annualised' approach would still involve considerable administrative cost because of the need to issue credits on an annual basis, and to verify over the whole growth-decay cycle that the trees or timber were still in existence and complying with contractual conditions. A further potential problem is that the authority issuing the credits bears considerable risk in the earlier years of a plantation, because the 'average annualised' credit exceeds the actual amount of carbon sequestered in the period of initial tree growth (figure 13.2). If the plantation were to be destroyed in its early years, the owner would have received credits in excess of actual carbon sequestered. There must also be some doubt as to whether the annualised credits (based on sequestration levels beyond a commitment period) could be given under the Kyoto Protocol.

More importantly, the 'average annualised' approach cannot of itself be used to assign carbon credits. Because the 'average annual sequestration' is based on a single growth-decay cycle, it merely provides an estimate of the amount of carbon sequestered temporarily. Unlike the 'steady state' approach, it is not equivalent to offsetting a

given emission, because carbon sequestered is released back into the atmosphere as the wood decays over time. In other words, the net sequestration of carbon at the end of the growth-decay cycle is zero.

However, even temporary sequestration does remove carbon from the atmosphere over some period of time. While the 'average annualised' approach provides an estimate of this temporary sequestration, it does not provide a measure of its value in terms of any reduction in greenhouse effect (radiative forcing) achieved.

THE ANNUALISED NET BENEFIT APPROACH[2]

In order to address the difficulties identified in the discussion of the 'average annualised' approach, it is necessary to quantify the greenhouse benefit of the temporary sequestration of carbon. (The Kyoto Protocol does not recognise the greenhouse benefit of temporary sequestration, because it requires that credits be granted only for net changes in each commitment period.)

The 'annualised net benefit' approach is based on the physical relationship between emissions forgone (emission reductions) and carbon sequestered arboreally, assessed in terms of impact on the atmosphere.

One way to compare the effect of emission reductions with biological carbon sequestration is by assessing the impacts on *radiative forcing* at a particular point in time, or integrated over a nominated time horizon. Using changes in radiative forcing as the basis for comparing different actions has several advantages:

- as a concept, radiative forcing is well based within the underlying science of climate change (Shine et al., 1990; Houghton et al., 1996; Schimel et al., 1996);
- it is a good way of comparing different gases; and
- it is linked closely to the GWP concept adopted in the Kyoto Protocol.

Comparing emissions forgone with carbon sequestered is not straightforward for a number of reasons that relate to the physical characteristics of carbon in the earth/climate system. Two minor issues are:

2 This section is based on recent work carried out by Ian Enting at the Division of Atmospheric Research, CSIRO, Melbourne.

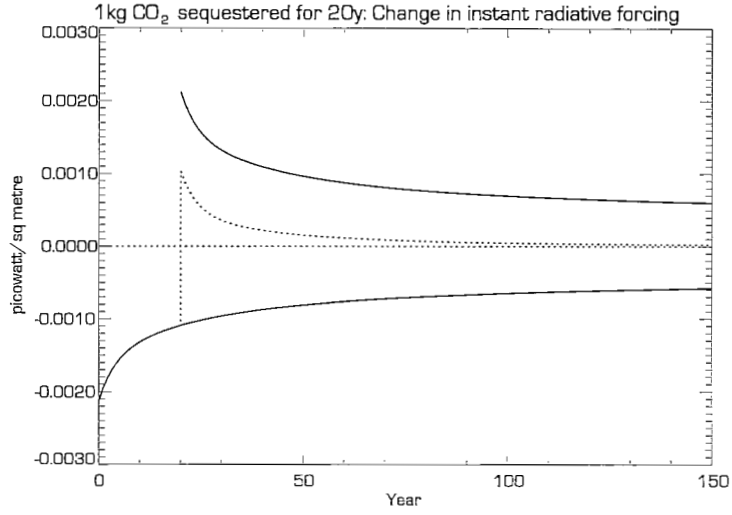
- carbon does not have a single lifetime in the global atmosphere. It is removed from the atmosphere through many processes that operate over many, often very different, timescales. However, uncertainties in the natural response of the carbon cycle to a human-induced perturbation can be defined much more confidently; and
- the effectiveness of a given quantity of CO_2 in warming the atmosphere is partly dependent on the background concentration of the gas (1 kg of CO_2 released when the concentration of CO_2 in the atmosphere is 300 parts per million by volume (ppmv) is more potent than the same amount released when the atmospheric concentration is 600 ppmv).

However, the main issue that must be considered is the 'permanence' of biological sequestration. Because it credits in full net changes in carbon stocks within a commitment period, but is silent on what happens in subsequent commitment periods, the Kyoto Protocol effectively treats all biological sequestration in the commitment period as being permanent. Assuming ongoing commitment periods, a subsequent release of the sequestered carbon (eg. forest harvesting, or fire) would presumably be treated as a separate emission event, as shown in figures 13.3 and 13.4. Slow 'leakage' due to decay from a biological stock could be treated in terms of verified stocks in subsequent commitment periods, or as annualised emissions in subsequent commitment periods.

It could be argued that this means that the Protocol gives a net credit only where new forest plantings absorb carbon during their active growth phase, reach maturity to create a standing stock (that is, reach equilibrium, or near equilibrium, in carbon terms) and are then maintained in this condition *in perpetuity* (the steady-state case described above). In physical terms, a deterioration in the carbon stocks of the forest leads to subsequent emissions, either directly, or as part of the wood products cycle.

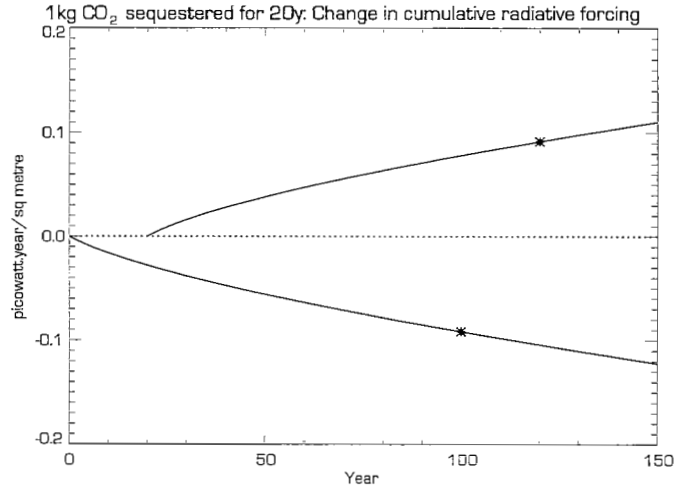
Treating instantaneous change in radiative forcing as two distinct fluxes gives the lower solid curve in figure 13.3 for the effect of a 1 kg CO_2 uptake and the upper solid curve as the effect of a 1 kg CO_2 release 20 years later. In each case, the magnitude of the perturbation decreases over time as natural processes act to partly restore the original carbon distribution between the atmosphere, oceans and vegetation. The net radiative effect is shown as the dotted curve.

FIGURE 13.3 THE INSTANTANEOUS CHANGE IN RADIATIVE FORCING FROM TEMPORARY SEQUESTRATION



Note See text for detail of curves

FIGURE 13.4 THE CUMULATIVE CHANGE IN RADIATIVE FORCING FOR 20 YEARS SEQUESTRATION OF 1 KG OF CO_2



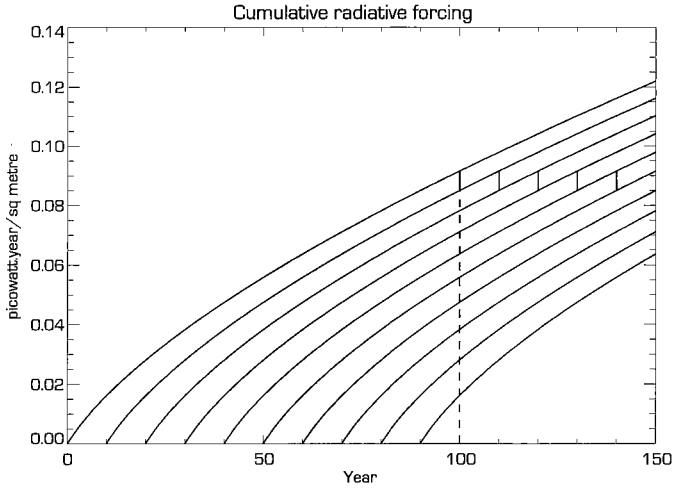
Note See text for detail of curves. Asterisked points on the curves represent 100 years from sequestration or release, as appropriate.

The curves in figure 13.4 are the integrals of the solid curves in figure 13.3. The asterisks show the times at which each component of the cumulative forcing is evaluated when using GWPs with a 100-year time horizon. Evaluating the effect in terms of two separate fluxes and a time horizon of 100 years from the time of the flux means that an initial credit will be exactly cancelled by the subsequent debit.

Global Warming Potentials (GWPs) were developed as a means of comparing the greenhouse potency of different gases. Article 5.3 of the Protocol refers specifically to their application in the calculation of 'the carbon dioxide equivalence of anthropogenic emissions by sources and *removals by sinks* of greenhouse gases ...' (italics added for emphasis).

Use of GWPs as mandated by the Kyoto Protocol means that a 100-year time horizon from the time of the flux is adopted as the period over which the relative warming potentials of different greenhouse gas fluxes are calculated. This approach gives no net credit for temporary sequestration, because, as shown in figure 13.4, the debit for release exactly cancels the credit for uptake. The effect of an uptake in 2010 (the curve below the horizontal) is determined for the period 2010 to 2110 while the effect of a release in 2030 is determined over the period 2030 to 2130. However, comparison of the two curves in figure 13.4 shows that at any single point of time there will be a net

FIGURE 13.5 SEQUESTRATION AS A SERIES OF DELAYED EMISSIONS



reduction in the cumulative radiative forcing. A simple and scientifically robust way of quantifying this reduction is to consider temporary sequestration as a delayed emission and quantify the greenhouse benefit of the delay.

Furthermore, figure 13.5 shows that temporary sequestration provides a benefit *at any specified point in time.* The simplest (and scientifically robust) way of considering temporary sequestration is to regard it as a *delayed emission.*

The solid curves in figure 13.5 show the changes in cumulative radiative forcing for successive 1 kg releases of CO_2 ten years apart. The intervals between the curves (shown as bold lines 100 years after the successive sequestration periods) show the benefit of delay. The basis for evaluating the benefit is a 100-year 'look ahead' which can be calculated *at any point in time.* The dotted line shows that, if assessment is anchored to the initial time of uptake, the credit for a decade of sequestration would depend on the age of the carbon that is being credited.

Given that there is a real, quantifiable benefit in delaying emissions by sequestering carbon in vegetation, even if only temporarily, the question becomes one of how to account for 'delay' in a regime where carbon credits are granted only for actions that reduce emissions. From this perspective, it is possible to quantify the difference between no sequestration, and temporary sequestration illustrated by figure 13.5. The key to evaluating the sequestration is to adopt a 100-year time horizon anchored (based) at the time for which the carbon is sequestered, not from the time of release. (The 100-year time horizon is a 'look ahead' time for evaluating the effect of a greenhouse gas flux, and does not refer to a period of sequestration.)

It is possible to quantify the difference between 'no sequestration' and 'temporary sequestration' by regarding the one year's sequestration as equivalent to a single year's delayed emission. The effect of a year's delay in emission can be calculated by using the absolute global warming potential (AGWP) to define the effect of a CO_2 reduction. Temporary sequestration can thus be treated as successive sequestration periods of 1 year, and these can be calculated from the AGWP.

When this is done using the Bern model (used by the IPCC to calculate the responses in radiative forcing used in the calculations of GWPs), it can be shown that *each year of temporary sequestration of 1 kg of CO_2 is equivalent to an emission reduction of 0.007 kg CO_2 for that*

year. Unlike the 'sequestration forever' assumption that appears to be implicit in the Kyoto Protocol, this equivalence assumes that the CO_2 sequestered within vegetation will ultimately be released, and the penalty for the release is already factored into the calculation of the (net) amount sequestered.

In other words *each year* of sequestration of 1 kg of CO_2 is equivalent to a 0.007 kg CO_2 emission reduction. On the basis of this calculation, it is possible to apply a credit of only 0.007 kg for each kilogram of CO_2 equivalent for each year, for as long as the carbon remains sequestered. (Similarly, for every 1 kg of carbon sequestered, a credit of 0.007 kg could be claimed for each year that it remains sequestered. Therefore, for every 1 kg of CO_2 sequestered, credit would be given for 0.27 x 0.007 = 0.002kg of *carbon*.) Significantly, there is no need for a corresponding 'debit' from the owner of the carbon at the time of release, because the 'annualised net benefit' calculation already takes into account the eventual release of carbon.

If the sequestered carbon were lost (for example in a forest fire), no further credit would be given for carbon sequestered in the past. The owner of the carbon would therefore be faced with an incentive to maintain carbon stocks. Unlike schemes where credit might be granted on the basis of carbon content of a forest at harvest, the annualised net benefit approach also avoids the need for indefinite monitoring into the future of stocks, and the enforcement of 'carbon loss' penalties where stocks have not been maintained. In other words, it offers the potential for a low-risk method to governments that grant carbon credits.

The 'annualised net benefit' approach therefore provides for a 'gain-as-you-go' system that automatically addresses any risk associated with forest fire, or other non-compliance.

While the 'annualised net benefit' approach quantifies a net benefit that is not recognised under the Kyoto Protocol, it does not preclude a national government from adopting it for domestic purposes.

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ADDENDUM A: EQUIVALENCE FACTOR FOR TEMPORARY CARBON SEQUESTRATION.

R(t) is the response function that specifies the proportion of CO_2 remaining in the atmosphere after time t, and xCO_2 is the radiative absorption efficiency of CO_2. We can use the absolute global warming potential (AGWP) to define the effect of a reduction in CO_2 emissions. The AGWP over a 100-year period is:

$$-x_{CO2}\int_0^{100} R(t')dt'$$

while the effect of a 1 year delay can be expressed as

$$\begin{aligned} & x_{CO_2}\left[-\int_0^T R(t')dt' + \int_1^T R(t'-1)dt'\right] \\ & = x_{CO_2}\left[-\int_0^T R(t')dt' + \int_0^{T-1} R(t')dt'\right] \\ & \approx -x_{CO_2}\frac{d}{dt}\int_0^t R(t')\,dt'\Big|_{t=T} \\ & = -x_{CO_2}R(T) \end{aligned}$$

Therefore the equivalence factor for a year of sequestration is

$$R(100)/\int_0^{100} R(t')dt'.$$

Using the responses from the Bern model gives 0.007 kg CO_2 reduction as being equivalent to a 1 year delay in 1 kg of CO_2 emissions, or equivalently 1 year of CO_2 sequestration.

ADDENDUM B: SINKS AND THE KYOTO PROTOCOL[3]

OVERVIEW

The presently allowed sink activities specified in Article 3.3 of the Kyoto Protocol for meeting national commitments are direct human-induced land-use change and forestry activities, limited to afforestation, reforestation and deforestation, since 1 January 1990. These are to be measured as verifiable changes in carbon stocks in each commitment period.

Afforestation and reforestation are defined in the Glossary of the 1996 IPCC Guidelines for National Greenhouse Gas Inventory Reporting Instructions (Houghton, et al., 1996). Since the Protocol refers to these guidelines for estimating emissions, it is possible that they will also apply to sinks.

Afforestation is referred to as establishment of forest where forest has not historically existed, and reforestation means establishment of forest where forest has historically existed, but where the land has been converted to another use. The length of time over which the 'other land use' must have been in place is not specified. Deforestation is not currently defined by the IPCC guidelines.

The precise meanings of afforestation, reforestation and deforestation are the subject of analysis through the IPCC, and will be negotiated between countries under the Framework Convention on Climate Change. The likely outcome of these negotiations is unclear. There is also no agreed definition of forest.

A potential consequence of the above is that, depending on the definitions finally adopted, emissions caused by degradation of forest areas would not be counted unless there is a change in land use. Conversely, areas of existing degraded forest which increase in biomass through human intervention would not give rise to accountable sequestration.

It is arguable that carbon accounting should be based on biomass and soil carbon stores and fluxes, rather than relying on definitions of forest

3 The authors wish to thank Mark Jackson, Greenhouse Challenge, of the Australian Greenhouse Office, for contributing the contents of Addendum B.

and land use change. The existing definitions certainly do not support a comprehensive approach to sinks accounting.

Nonetheless, it will be of benefit to the Parties to the Protocol who favour comprehensive inclusion of sink activities to demonstrate that measurement to reasonable levels of accuracy is feasible, and capable of verification (Article 8).

In recognition of the possibility of other sinks activities meeting the test of measurability and verifiability, Article 3.4 of the Protocol states that 'the Meeting of the Parties (the Conference of the Parties becomes the Meeting of the Parties following ratification by the required number of Parties to allow the Protocol to come into force) shall, at its first session or as soon as practicable thereafter, decide upon modalities, rules and guidelines as to how, and which, additional human-induced activities [besides afforestation, reforestation and deforestation] related to changes in greenhouse gas emissions and removals by sinks in the agricultural soils and land use change and forestry categories shall be added to, or subtracted from, the assigned amount for Parties included in Annex I'.

Any such decision will apply in commitment periods following the first, although Annex I Parties may choose to apply them in the first commitment period.

Additional categories which may be considered for early inclusion include forest management, rangeland management, and the impact of various land and agricultural management practices.

Provisions applying to international emissions trading and the Clean Development Mechanism also require considerable clarification before they can be operationalised.

JOINT IMPLEMENTATION

The Protocol allows Annex I Parties to transfer to, or acquire from, any other such Party emission reduction units resulting from projects aimed at reducing anthropogenic emissions by sources or enhancing anthropogenic removals by sinks of greenhouse gases in any sector of the economy, with some provisos, notably that 'any such project provides ... enhancement of removals by sinks, that is additional to any that would otherwise occur' (Article 6.1).

A current domestic interpretation of 'additional' in this sense is that the benefits of the project are evaluated by comparing the 'with project'

case to the 'without project' case. 'Intentionality' (demonstration that the primary motivation for the project is greenhouse abatement), or 'financial additionality' (projects which are profitable can not be counted as they would have happened anyway), are too difficult in practice to be supported as tests of additionality.

It is noteworthy that (Article 6.3) 'A Party included in Annex I may authorise legal entities to participate, under its responsibility, in actions leading to the generation, transfer or acquisition under this article of emission reduction units.' That is, the authorisation of the national government is required before international trading of credits can occur.

It should also be noted that Article 6.3 does not explicitly limit sinks projects to afforestation, reforestation and deforestation since 1990, potentially creating the anomalous situation of countries' gaining credit for activities in another country for which they could not gain credit if the activity were undertaken domestically.

EMISSIONS TRADING

Article 17 of the Protocol states that Parties included in Annex B may participate in emissions trading.

However, the Conference of Parties must define modalities, rules and guidelines for such trade. This will include negotiation on participation, and the types of activity that will be permitted to generate tradable allocations.

It is likely that private sector participation and sinks activity will be permitted under an international emissions trading regime.

THE CLEAN DEVELOPMENT MECHANISM

Under the Clean Development Mechanism (CDM), activities must be 'additional to those that would occur in the absence of the certified project activity'(Article 12.5). Sinks are, however, not specifically mentioned, with reference being made instead to reductions in emissions and real, measurable and long-term benefits related to the mitigation of climate change.

A significant advantage to Annex I Party participation under the CDM, which does not apply otherwise under the Protocol for the first commitment period, is that certified emissions reductions obtained from the year 2000 to the beginning of the first commitment period

may be used to achieve compliance in the first commitment period (banking of credits).

TIMETABLE FOR RESOLUTION OF OUTSTANDING ISSUES

Issues related to the Kyoto Protocol were considered by the Subsidiary Body on Scientific and Technical Advice (SBSTA) in Bonn in June 1998, and have been referred to the IPCC for further consideration. The IPCC is to prepare a special report on land use change and forestry for delivery between COP4 and COP 5 (1999). Other scientific and technical matters related to Land Use Change and Forestry may be dealt with in the IPCC Third Assessment Report, preparation of which has recently commenced.

In addition, SBSTA is to organise an experts' workshop on issues arising from Article 3.3 before COP4 and an experts workshop on issues arising from Article 3.4 before COP5.

Resolution of definitional issues under Article 3.3 and determination of issues relating to additional activities (Article 3.4) is unlikely to be possible before COP5, late in 1999.

Modalities, rules and guidelines, and procedures for implementation of both emissions trading and the operation of the Clean Development Mechanism are to be determined by the first Meeting of the Parties, or as soon as possible thereafter, following analysis and negotiation in the Convention Subsidiary Bodies.

CONCLUSION

Against the above background, companies should make their own judgements about the kind of sinks projects they become involved with. While no definitive guidance can be provided at this stage, it seems likely that afforestation and reforestation projects, undertaken since 1990, and involving land which has been under a different land use for an extended period, will produce sequestration which is countable during the first commitment period, provided that methodologies used for counting emissions and sequestration are not contrary to future relevant Conference of Parties decisions.

Management of existing forests, or plantations established before 1990, is currently not countable, although this may change, depending on the outcome of negotiations on additional activities that can be counted under Article 3.4.

This is also the case for rangelands management and soil carbon storage as a result of changed agricultural and land management practices.

Companies may choose to await clarification internationally and/or domestically of the issues involved before committing significant resources, although it should also be noted that because trees take some years to achieve good growth rates, a delay in commencement of sinks projects may compromise their ability to deliver significant offsets during the first commitment period.

APPENDIX A

KYOTO PROTOCOL TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE[1]

The Parties to this Protocol,

Being Parties to the United Nations Framework Convention on Climate Change, hereinafter referred to as "the Convention",

In pursuit of the ultimate objective of the Convention as stated in its Article 2,

Recalling the provisions of the Convention,

Being guided by Article 3 of the Convention,

Pursuant to the Berlin Mandate adopted by decision 1/CP.1 of the Conference of the Parties to the Convention at its first session,

Have agreed as follows:

ARTICLE 1

For the purposes of this Protocol, the definitions contained in Article 1 of the Convention shall apply. In addition:

1. "Conference of the Parties" means the Conference of the Parties to the Convention.
2. "Convention" means the United Nations Framework Convention on Climate Change, adopted in New York on 9 May 1992.

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1 United Nations 1997, *Kyoto Protocol to the United Nations Framework Convention on Climate Change*, Conference of the Parties, Third Session (Kyoto, 1-10 December 1997), FCCC/CP/L.7/Add.1, 10 December 1997. The version reproduced here was taken from the Internet site http://www.unfccc.de/fccc/docs/protintr.html on 25 September 1998. The Internet version includes some modifications to the 10 December 1997 text. For example, Article 16[bis] is now shown as Article 17.

3. "Intergovernmental Panel on Climate Change" means the Intergovernmental Panel on Climate Change established in 1988 jointly by the World Meteorological Organization and the United Nations Environment Programme.

4. "Montreal Protocol" means the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted in Montreal on 16 September 1987 and as subsequently adjusted and amended.

5. "Parties present and voting" means Parties present and casting an affirmative or negative vote.

6. "Party" means, unless the context otherwise indicates, a Party to this Protocol.

7. "Party included in Annex I" means a Party included in Annex I to the Convention, as may be amended, or a Party which has made a notification under Article 4, paragraph 2(g), of the Convention.

ARTICLE 2

1. Each Party included in Annex I, in achieving its quantified emission limitation and reduction commitments under Article 3, in order to promote sustainable development, shall:

   (a) Implement and/or further elaborate policies and measures in accordance with its national circumstances, such as:

      (i) Enhancement of energy efficiency in relevant sectors of the national economy;

      (ii) Protection and enhancement of sinks and reservoirs of greenhouse gases not controlled by the Montreal Protocol, taking into account its commitments under relevant international environmental agreements; promotion of sustainable forest management practices, afforestation and reforestation;

      (iii) Promotion of sustainable forms of agriculture in light of climate change considerations;

      (iv) Research on, and promotion, development and increased use of, new and renewable forms of energy, of carbon dioxide sequestration technologies and of advanced and innovative environmentally sound technologies;

(v) Progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the Convention and application of market instruments;

(vi) Encouragement of appropriate reforms in relevant sectors aimed at promoting policies and measures which limit or reduce emissions of greenhouse gases not controlled by the Montreal Protocol;

(vii) Measures to limit and/or reduce emissions of greenhouse gases not controlled by the Montreal Protocol in the transport sector;

(viii) Limitation and/or reduction of methane emissions through recovery and use in waste management, as well as in the production, transport and distribution of energy;

(b) Cooperate with other such Parties to enhance the individual and combined effectiveness of their policies and measures adopted under this Article, pursuant to Article 4, paragraph 2(e)(i), of the Convention. To this end, these Parties shall take steps to share their experience and exchange information on such policies and measures, including developing ways of improving their comparability, transparency and effectiveness. The Conference of Parties serving as the meeting of the Parties to this Protocol shall, at its first session or as soon as practicable thereafter, consider ways to facilitate such cooperation, taking into account all relevant information.

2. The Parties included in Annex I shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively.

3. The Parties included in Annex I shall strive to implement policies and measures under this Article in such a way as to minimize adverse effects, including the adverse effects of climate change, effects on international trade, and social, environmental and economic impacts on other Parties, especially developing country

7. In the first quantified emission limitation and reduction commitment period, from 2008 to 2012, the assigned amount for each Party included in Annex I shall be equal to the percentage inscribed for it in Annex B of its aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A in 1990, or the base year or period determined in accordance with paragraph 5 above, multiplied by five. Those Parties included in Annex I for whom land-use change and forestry constituted a net source of greenhouse gas emissions in 1990 shall include in their 1990 emissions base year or period the aggregate anthropogenic carbon dioxide equivalent emissions by sources minus removals by sinks in 1990 from land-use change for the purposes of calculating their assigned amount.

8. Any Party included in Annex I may use 1995 as its base year for hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride, for the purposes of the calculation referred to in paragraph 7 above.

9. Commitments for subsequent periods for Parties included in Annex I shall be established in amendments to Annex B to this Protocol, which shall be adopted in accordance with the provisions of Article 21, paragraph 7. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall initiate the consideration of such commitments at least seven years before the end of the first commitment period referred to in paragraph 1 above.

10. Any emission reduction units, or any part of an assigned amount, which a Party acquires from another Party in accordance with the provisions of Article 6 or of Article 17 shall be added to the assigned amount for the acquiring Party.

11. Any emission reduction units, or any part of an assigned amount, which a Party transfers to another Party in accordance with the provisions of Article 6 or of Article 17 shall be subtracted from the assigned amount for the transferring Party.

12. Any certified emission reductions which a Party acquires from another Party in accordance with the provisions of Article 12 shall be added to the assigned amount for the acquiring Party.

13. If the emissions of a Party included in Annex I in a commitment period are less than its assigned amount under this Article, this

difference shall, on request of that Party, be added to the assigned amount for that Party for subsequent commitment periods.

14. Each Party included in Annex I shall strive to implement the commitments mentioned in paragraph 1 above in such a way as to minimize adverse social, environmental and economic impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention. In line with relevant decisions of the Conference of the Parties on the implementation of those paragraphs, the Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, consider what actions are necessary to minimize the adverse effects of climate change and/or the impacts of response measures on Parties referred to in those paragraphs. Among the issues to be considered shall be the establishment of funding, insurance and transfer of technology.

ARTICLE 4

1. Any Parties included in Annex I that have reached an agreement to fulfil their commitments under Article 3 jointly, shall be deemed to have met those commitments provided that their total combined aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B and in accordance with the provisions of Article 3. The respective emission level allocated to each of the Parties to the agreement shall be set out in that agreement.

2. The Parties to any such agreement shall notify the secretariat of the terms of the agreement on the date of deposit of their instruments of ratification, acceptance or approval of this Protocol, or accession thereto. The secretariat shall in turn inform the Parties and signatories to the Convention of the terms of the agreement.

3. Any such agreement shall remain in operation for the duration of the commitment period specified in Article 3, paragraph 7.

4. If Parties acting jointly do so in the framework of, and together with, a regional economic integration organization, any alteration in the composition of the organization after adoption of this Protocol shall not affect existing commitments under this Protocol.

2. The Conference of the Parties serving as the meeting of the Parties to this Protocol may, at its first session or as soon as practicable thereafter, further elaborate guidelines for the implementation of this Article, including for verification and reporting.

3. A Party included in Annex I may authorize legal entities to participate, under its responsibility, in actions leading to the generation, transfer or acquisition under this Article of emission reduction units.

4. If a question of implementation by a Party included in Annex I of the requirements referred to in this Article is identified in accordance with the relevant provisions of Article 8, transfers and acquisitions of emission reduction units may continue to be made after the question has been identified, provided that any such units may not be used by a Party to meet its commitments under Article 3 until any issue of compliance is resolved.

ARTICLE 7

1. Each Party included in Annex I shall incorporate in its annual inventory of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol, submitted in accordance with the relevant decisions of the Conference of the Parties, the necessary supplementary information for the purposes of ensuring compliance with Article 3, to be determined in accordance with paragraph 4 below.

2. Each Party included in Annex I shall incorporate in its national communication, submitted under Article 12 of the Convention, the supplementary information necessary to demonstrate compliance with its commitments under this Protocol, to be determined in accordance with paragraph 4 below.

3. Each Party included in Annex I shall submit the information required under paragraph 1 above annually, beginning with the first inventory due under the Convention for the first year of the commitment period after this Protocol has entered into force for that Party. Each such Party shall submit the information required under paragraph 2 above as part of the first national communication due under the Convention after this Protocol has entered into force for it and after the adoption of guidelines as provided for in paragraph 4 below. The frequency of subsequent submission of information required under this Article shall be

determined by the Conference of the Parties serving as the meeting of the Parties to this Protocol, taking into account any timetable for the submission of national communications decided upon by the Conference of the Parties.

4. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall adopt at its first session, and review periodically thereafter, guidelines for the preparation of the information required under this Article, taking into account guidelines for the preparation of national communications by Parties included in Annex I adopted by the Conference of the Parties. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall also, prior to the first commitment period, decide upon modalities for the accounting of assigned amounts.

ARTICLE 8

1. The information submitted under Article 7 by each Party included in Annex I shall be reviewed by expert review teams pursuant to the relevant decisions of the Conference of the Parties and in accordance with guidelines adopted for this purpose by the Conference of the Parties serving as the meeting of the Parties to this Protocol under paragraph 4 below. The information submitted under Article 7, paragraph 1, by each Party included in Annex I shall be reviewed as part of the annual compilation and accounting of emissions inventories and assigned amounts. Additionally, the information submitted under Article 7, paragraph 2, by each Party included in Annex I shall be reviewed as part of the review of communications.

2. Expert review teams shall be coordinated by the secretariat and shall be composed of experts selected from those nominated by Parties to the Convention and, as appropriate, by intergovernmental organizations, in accordance with guidance provided for this purpose by the Conference of the Parties.

3. The review process shall provide a thorough and comprehensive technical assessment of all aspects of the implementation by a Party of this Protocol. The expert review teams shall prepare a report to the Conference of the Parties serving as the meeting of the Parties to this Protocol, assessing the implementation of the commitments of the Party and identifying any potential problems in, and factors influencing, the fulfilment of commitments. Such

reports shall be circulated by the secretariat to all Parties to the Convention. The secretariat shall list those questions of implementation indicated in such reports for further consideration by the Conference of the Parties serving as the meeting of the Parties to this Protocol.

4. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall adopt at its first session, and review periodically thereafter, guidelines for the review of implementation of this Protocol by expert review teams taking into account the relevant decisions of the Conference of the Parties. 5. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, with the assistance of the Subsidiary Body for Implementation and, as appropriate, the Subsidiary Body for Scientific and Technological Advice, consider:

   (a) The information submitted by Parties under Article 7 and the reports of the expert reviews thereon conducted under this Article; and

   (b) Those questions of implementation listed by the secretariat under paragraph 3 above, as well as any questions raised by Parties.

6. Pursuant to its consideration of the information referred to in paragraph 5 above, the Conference of the Parties serving as the meeting of the Parties to this Protocol shall take decisions on any matter required for the implementation of this Protocol.

ARTICLE 9

1. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall periodically review this Protocol in the light of the best available scientific information and assessments on climate change and its impacts, as well as relevant technical, social and economic information. Such reviews shall be coordinated with pertinent reviews under the Convention, in particular those required by Article 4, paragraph 2(d), and Article 7, paragraph 2(a), of the Convention. Based on these reviews, the Conference of the Parties serving as the meeting of the Parties to this Protocol shall take appropriate action.

2. The first review shall take place at the second session of the Conference of the Parties serving as the meeting of the Parties

to this Protocol. Further reviews shall take place at regular intervals and in a timely manner.

ARTICLE 10

All Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, without introducing any new commitments for Parties not included in Annex I, but reaffirming existing commitments under Article 4, paragraph 1, of the Convention, and continuing to advance the implementation of these commitments in order to achieve sustainable development, taking into account Article 4, paragraphs 3, 5 and 7, of the Convention, shall:

(a) Formulate, where relevant and to the extent possible, cost-effective national and, where appropriate, regional programmes to improve the quality of local emission factors, activity data and/or models which reflect the socio-economic conditions of each Party for the preparation and periodic updating of national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties, and consistent with the guidelines for the preparation of national communications adopted by the Conference of the Parties;

(b) Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change and measures to facilitate adequate adaptation to climate change:

(i) Such programmes would, *inter alia*, concern the energy, transport and industry sectors as well as agriculture, forestry and waste management. Furthermore, adaptation technologies and methods for improving spatial planning would improve adaptation to climate change; and

(ii) Parties included in Annex I shall submit information on action under this Protocol, including national programmes, in accordance with Article 7; and other Parties shall seek to include in their national communications, as appropriate, information on

programmes which contain measures that the Party believes contribute to addressing climate change and its adverse impacts, including the abatement of increases in greenhouse gas emissions, and enhancement of and removals by sinks, capacity building and adaptation measures;

(c) Cooperate in the promotion of effective modalities for the development, application and diffusion of, and take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies, know-how, practices and processes pertinent to climate change, in particular to developing countries, including the formulation of policies and programmes for the effective transfer of environmentally sound technologies that are publicly owned or in the public domain and the creation of an enabling environment for the private sector, to promote and enhance the transfer of, and access to, environmentally sound technologies;

(d) Cooperate in scientific and technical research and promote the maintenance and the development of systematic observation systems and development of data archives to reduce uncertainties related to the climate system, the adverse impacts of climate change and the economic and social consequences of various response strategies, and promote the development and strengthening of endogenous capacities and capabilities to participate in international and intergovernmental efforts, programmes and networks on research and systematic observation, taking into account Article 5 of the Convention;

(e) Cooperate in and promote at the international level, and, where appropriate, using existing bodies, the development and implementation of education and training programmes, including the strengthening of national capacity building, in particular human and institutional capacities and the exchange or secondment of personnel to train experts in this field, in particular for developing countries, and facilitate at the national level public awareness of, and public access to information on, climate change. Suitable modalities should be developed to implement these activities through the

relevant bodies of the Convention, taking into account Article 6 of the Convention;

(f) Include in their national communications information on programmes and activities undertaken pursuant to this Article in accordance with relevant decisions of the Conference of the Parties; and

(g) Give full consideration, in implementing the commitments under this Article, to Article 4, paragraph 8, of the Convention.

ARTICLE 11

1. In the implementation of Article 10, Parties shall take into account the provisions of Article 4, paragraphs 4, 5, 7, 8 and 9, of the Convention.

2. In the context of the implementation of Article 4, paragraph 1, of the Convention, in accordance with the provisions of Article 4, paragraph 3, and Article 11 of the Convention, and through the entity or entities entrusted with the operation of the financial mechanism of the Convention, the developed country Parties and other developed Parties included in Annex II to the Convention shall:

(a) Provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in advancing the implementation of existing commitments under Article 4, paragraph 1(a), of the Convention that are covered in Article 10, subparagraph (a); and

(b) Also provide such financial resources, including for the transfer of technology, needed by the developing country Parties to meet the agreed full incremental costs of advancing the implementation of existing commitments under Article 4, paragraph 1, of the Convention that are covered by Article 10 and that are agreed between a developing country Party and the international entity or entities referred to in Article 11 of the Convention, in accordance with that Article.

The implementation of these existing commitments shall take into account the need for adequacy and predictability in the flow of funds and the importance of appropriate burden sharing among developed country Parties. The guidance to the entity or entities

entrusted with the operation of the financial mechanism of the Convention in relevant decisions of the Conference of the Parties, including those agreed before the adoption of this Protocol, shall apply *mutatis mutandis* to the provisions of this paragraph.

3. The developed country Parties and other developed Parties in Annex II to the Convention may also provide, and developing country Parties avail themselves of, financial resources for the implementation of Article 10, through bilateral, regional and other multilateral channels.

ARTICLE 12

1. A clean development mechanism is hereby defined.

2. The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3.

3. Under the clean development mechanism:

   (a) Parties not included in Annex I will benefit from project activities resulting in certified emission reductions; and

   (b) Parties included in Annex I may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments under Article 3, as determined by the Conference of the Parties serving as the meeting of the Parties to this Protocol.

4. The clean development mechanism shall be subject to the authority and guidance of the Conference of the Parties serving as the meeting of the Parties to this Protocol and be supervised by an executive board of the clean development mechanism.

5. Emission reductions resulting from each project activity shall be certified by operational entities to be designated by the Conference of the Parties serving as the meeting of the Parties to this Protocol, on the basis of:

   (a) Voluntary participation approved by each Party involved;

(b) Real, measurable, and long-term benefits related to the mitigation of climate change; and

(c) Reductions in emissions that are additional to any that would occur in the absence of the certified project activity.

6. The clean development mechanism shall assist in arranging funding of certified project activities as necessary.

7. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, elaborate modalities and procedures with the objective of ensuring transparency, efficiency and accountability through independent auditing and verification of project activities.

8. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall ensure that a share of the proceeds from certified project activities is used to cover administrative expenses as well as to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation.

9. Participation under the clean development mechanism, including in activities mentioned in paragraph 3(a) above and in the acquisition of certified emission reductions, may involve private and/or public entities, and is to be subject to whatever guidance may be provided by the executive board of the clean development mechanism.

10. Certified emission reductions obtained during the period from the year 2000 up to the beginning of the first commitment period can be used to assist in achieving compliance in the first commitment period.

ARTICLE 13

1. The Conference of the Parties, the supreme body of the Convention, shall serve as the meeting of the Parties to this Protocol.

2. Parties to the Convention that are not Parties to this Protocol may participate as observers in the proceedings of any session of the Conference of the Parties serving as the meeting of the Parties to this Protocol. When the Conference of the Parties serves as the meeting of the Parties to this Protocol, decisions

under this Protocol shall be taken only by those that are Parties to this Protocol.

3. When the Conference of the Parties serves as the meeting of the Parties to this Protocol, any member of the Bureau of the Conference of the Parties representing a Party to the Convention but, at that time, not a Party to this Protocol, shall be replaced by an additional member to be elected by and from amongst the Parties to this Protocol.

4. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall keep under regular review the implementation of this Protocol and shall make, within its mandate, the decisions necessary to promote its effective implementation. It shall perform the functions assigned to it by this Protocol and shall:

   (a) Assess, on the basis of all information made available to it in accordance with the provisions of this Protocol, the implementation of this Protocol by the Parties, the overall effects of the measures taken pursuant to this Protocol, in particular environmental, economic and social effects as well as their cumulative impacts and the extent to which progress towards the objective of the Convention is being achieved;

   (b) Periodically examine the obligations of the Parties under this Protocol, giving due consideration to any reviews required by Article 4, paragraph 2(d), and Article 7, paragraph 2, of the Convention, in the light of the objective of the Convention, the experience gained in its implementation and the evolution of scientific and technological knowledge, and in this respect consider and adopt regular reports on the implementation of this Protocol;

   (c) Promote and facilitate the exchange of information on measures adopted by the Parties to address climate change and its effects, taking into account the differing circumstances, responsibilities and capabilities of the Parties and their respective commitments under this Protocol;

   (d) Facilitate, at the request of two or more Parties, the coordination of measures adopted by them to address climate change and its effects, taking into account the differing circumstances, responsibilities and capabilities of

the Parties and their respective commitments under this Protocol;

(e) Promote and guide, in accordance with the objective of the Convention and the provisions of this Protocol, and taking fully into account the relevant decisions by the Conference of the Parties, the development and periodic refinement of comparable methodologies for the effective implementation of this Protocol, to be agreed on by the Conference of the Parties serving as the meeting of the Parties to this Protocol;

(f) Make recommendations on any matters necessary for the implementation of this Protocol;

(g) Seek to mobilize additional financial resources in accordance with Article 11, paragraph 2;

(h) Establish such subsidiary bodies as are deemed necessary for the implementation of this Protocol;

(i) Seek and utilize, where appropriate, the services and cooperation of, and information provided by, competent international organizations and intergovernmental and non-governmental bodies; and

(j) Exercise such other functions as may be required for the implementation of this Protocol, and consider any assignment resulting from a decision by the Conference of the Parties.

5. The rules of procedure of the Conference of the Parties and financial procedures applied under the Convention shall be applied *mutatis mutandis* under this Protocol, except as may be otherwise decided by consensus by the Conference of the Parties serving as the meeting of the Parties to this Protocol.

6. The first session of the Conference of the Parties serving as the meeting of the Parties to this Protocol shall be convened by the secretariat in conjunction with the first session of the Conference of the Parties that is scheduled after the date of the entry into force of this Protocol. Subsequent ordinary sessions of the Conference of the Parties serving as the meeting of the Parties to this Protocol shall be held every year and in conjunction with ordinary sessions of the Conference of the Parties, unless otherwise decided by the Conference of the Parties serving as the meeting of the Parties to this Protocol.

7. Extraordinary sessions of the Conference of the Parties serving as the meeting of the Parties to this Protocol shall be held at such other times as may be deemed necessary by the Conference of the Parties serving as the meeting of the Parties to this Protocol, or at the written request of any Party, provided that, within six months of the request being communicated to the Parties by the secretariat, it is supported by at least one third of the Parties.

8. The United Nations, its specialized agencies and the International Atomic Energy Agency, as well as any State member thereof or observers thereto not party to the Convention, may be represented at sessions of the Conference of the Parties serving as the meeting of the Parties to this Protocol as observers. Any body or agency, whether national or international, governmental or non-governmental, which is qualified in matters covered by this Protocol and which has informed the secretariat of its wish to be represented at a session of the Conference of the Parties serving as the meeting of the Parties to this Protocol as an observer, may be so admitted unless at least one third of the Parties present object. The admission and participation of observers shall be subject to the rules of procedure, as referred to in paragraph 5 above.

ARTICLE 14

1. The secretariat established by Article 8 of the Convention shall serve as the secretariat of this Protocol.

2. Article 8, paragraph 2, of the Convention on the functions of the secretariat, and Article 8, paragraph 3, of the Convention on arrangements made for the functioning of the secretariat, shall apply *mutatis mutandis* to this Protocol. The secretariat shall, in addition, exercise the functions assigned to it under this Protocol.

ARTICLE 15

1. The Subsidiary Body for Scientific and Technological Advice and the Subsidiary Body for Implementation established by Articles 9 and 10 of the Convention shall serve as, respectively, the Subsidiary Body for Scientific and Technological Advice and the Subsidiary Body for Implementation of this Protocol. The provisions relating to the functioning of these two bodies under the Convention shall apply *mutatis mutandis* to this Protocol. Sessions

of the meetings of the Subsidiary Body for Scientific and Technological Advice and the Subsidiary Body for Implementation of this Protocol shall be held in conjunction with the meetings of, respectively, the Subsidiary Body for Scientific and Technological Advice and the Subsidiary Body for Implementation of the Convention.

2. Parties to the Convention that are not Parties to this Protocol may participate as observers in the proceedings of any session of the subsidiary bodies. When the subsidiary bodies serve as the subsidiary bodies of this Protocol, decisions under this Protocol shall be taken only by those that are Parties to this Protocol.

3. When the subsidiary bodies established by Articles 9 and 10 of the Convention exercise their functions with regard to matters concerning this Protocol, any member of the Bureaux of those subsidiary bodies representing a Party to the Convention but, at that time, not a party to this Protocol, shall be replaced by an additional member to be elected by and from amongst the Parties to this Protocol.

ARTICLE 16

The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, as soon as practicable, consider the application to this Protocol of, and modify as appropriate, the multilateral consultative process referred to in Article 13 of the Convention, in the light of any relevant decisions that may be taken by the Conference of the Parties. Any multilateral consultative process that may be applied to this Protocol shall operate without prejudice to the procedures and mechanisms established in accordance with Article 18.

ARTICLE 17

The Conference of the Parties shall define the relevant principles, modalities, rules and guidelines, in particular for verification, reporting and accountability for emissions trading. The Parties included in Annex B may participate in emissions trading for the purposes of fulfilling their commitments under Article 3. Any such trading shall be supplemental to domestic actions for the purpose of meeting quantified emission limitation and reduction commitments under that Article.

ARTICLE 18

The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, approve appropriate and effective procedures and mechanisms to determine and to address cases of non-compliance with the provisions of this Protocol, including through the development of an indicative list of consequences, taking into account the cause, type, degree and frequency of non-compliance. Any procedures and mechanisms under this Article entailing binding consequences shall be adopted by means of an amendment to this Protocol.

ARTICLE 19

The provisions of Article 14 of the Convention on settlement of disputes shall apply *mutatis mutandis* to this Protocol.

ARTICLE 20

1. Any Party may propose amendments to this Protocol.

2. Amendments to this Protocol shall be adopted at an ordinary session of the Conference of the Parties serving as the meeting of the Parties to this Protocol. The text of any proposed amendment to this Protocol shall be communicated to the Parties by the secretariat at least six months before the meeting at which it is proposed for adoption. The secretariat shall also communicate the text of any proposed amendments to the Parties and signatories to the Convention and, for information, to the Depositary.

3. The Parties shall make every effort to reach agreement on any proposed amendment to this Protocol by consensus. If all efforts at consensus have been exhausted, and no agreement reached, the amendment shall as a last resort be adopted by a three-fourths majority vote of the Parties present and voting at the meeting. The adopted amendment shall be communicated by the secretariat to the Depositary, who shall circulate it to all Parties for their acceptance.

4. Instruments of acceptance in respect of an amendment shall be deposited with the Depositary. An amendment adopted in accordance with paragraph 3 above shall enter into force for those Parties having accepted it on the ninetieth day after the date of receipt by the Depositary of an instrument of acceptance by at least three fourths of the Parties to this Protocol.

5. The amendment shall enter into force for any other Party on the ninetieth day after the date on which that Party deposits with the Depositary its instrument of acceptance of the said amendment.

ARTICLE 21

1. Annexes to this Protocol shall form an integral part thereof and, unless otherwise expressly provided, a reference to this Protocol constitutes at the same time a reference to any annexes thereto. Any annexes adopted after the entry into force of this Protocol shall be restricted to lists, forms and any other material of a descriptive nature that is of a scientific, technical, procedural or administrative character.

2. Any Party may make proposals for an annex to this Protocol and may propose amendments to annexes to this Protocol.

3. Annexes to this Protocol and amendments to annexes to this Protocol shall be adopted at an ordinary session of the Conference of the Parties serving as the meeting of the Parties to this Protocol. The text of any proposed annex or amendment to an annex shall be communicated to the Parties by the secretariat at least six months before the meeting at which it is proposed for adoption. The secretariat shall also communicate the text of any proposed annex or amendment to an annex to the Parties and signatories to the Convention and, for information, to the Depositary.

4. The Parties shall make every effort to reach agreement on any proposed annex or amendment to an annex by consensus. If all efforts at consensus have been exhausted, and no agreement reached, the annex or amendment to an annex shall as a last resort be adopted by a three-fourths majority vote of the Parties present and voting at the meeting. The adopted annex or amendment to an annex shall be communicated by the secretariat to the Depositary, who shall circulate it to all Parties for their acceptance.

5. An annex, or amendment to an annex other than Annex A or B, that has been adopted in accordance with paragraphs 3 and 4 above shall enter into force for all Parties to this Protocol six months after the date of the communication by the Depositary to such Parties of the adoption of the annex or adoption of the amendment to the annex, except for those Parties that have

notified the Depositary, in writing, within that period of their non-acceptance of the annex or amendment to the annex. The annex or amendment to an annex shall enter into force for Parties which withdraw their notification of non-acceptance on the ninetieth day after the date on which withdrawal of such notification has been received by the Depositary.

6. If the adoption of an annex or an amendment to an annex involves an amendment to this Protocol, that annex or amendment to an annex shall not enter into force until such time as the amendment to this Protocol enters into force.

7. Amendments to Annexes A and B to this Protocol shall be adopted and enter into force in accordance with the procedure set out in Article 20, provided that any amendment to Annex B shall be adopted only with the written consent of the Party concerned.

ARTICLE 22

1. Each Party shall have one vote, except as provided for in paragraph 2 below.

2. Regional economic integration organizations, in matters within their competence, shall exercise their right to vote with a number of votes equal to the number of their member States that are Parties to this Protocol. Such an organization shall not exercise its right to vote if any of its member States exercises its right, and vice versa.

ARTICLE 23

The Secretary-General of the United Nations shall be the Depositary of this Protocol.

ARTICLE 24

1. This Protocol shall be open for signature and subject to ratification, acceptance or approval by States and regional economic integration organizations which are Parties to the Convention. It shall be open for signature at United Nations Headquarters in New York from 16 March 1998 to 15 March 1999. This Protocol shall be open for accession from the day after the date on which it is closed for signature. Instruments of ratification, acceptance, approval or accession shall be deposited with the Depositary.

2. Any regional economic integration organization which becomes a Party to this Protocol without any of its member States being a Party shall be bound by all the obligations under this Protocol. In the case of such organizations, one or more of whose member States is a Party to this Protocol, the organization and its member States shall decide on their respective responsibilities for the performance of their obligations under this Protocol. In such cases, the organization and the member States shall not be entitled to exercise rights under this Protocol concurrently.

3. In their instruments of ratification, acceptance, approval or accession, regional economic integration organizations shall declare the extent of their competence with respect to the matters governed by this Protocol. These organizations shall also inform the Depositary, who shall in turn inform the Parties, of any substantial modification in the extent of their competence.

ARTICLE 25

1. This Protocol shall enter into force on the ninetieth day after the date on which not less than 55 Parties to the Convention, incorporating Parties included in Annex I which accounted in total for at least 55 per cent of the total carbon dioxide emissions for 1990 of the Parties included in Annex I, have deposited their instruments of ratification, acceptance, approval or accession.

2. For the purposes of this Article, "the total carbon dioxide emissions for 1990 of the Parties included in Annex I" means the amount communicated on or before the date of adoption of this Protocol by the Parties included in Annex I in their first national communications submitted in accordance with Article 12 of the Convention.

3. For each State or regional economic integration organization that ratifies, accepts or approves this Protocol or accedes thereto after the conditions set out in paragraph 1 above for entry into force have been fulfilled, this Protocol shall enter into force on the ninetieth day following the date of deposit of its instrument of ratification, acceptance, approval or accession.

4. For the purposes of this Article, any instrument deposited by a regional economic integration organization shall not be counted as additional to those deposited by States members of the organization.

ARTICLE 26
No reservations may be made to this Protocol.

ARTICLE 27
1. At any time after three years from the date on which this Protocol has entered into force for a Party, that Party may withdraw from this Protocol by giving written notification to the Depositary.
2. Any such withdrawal shall take effect upon expiry of one year from the date of receipt by the Depositary of the notification of withdrawal, or on such later date as may be specified in the notification of withdrawal.
3. Any Party that withdraws from the Convention shall be considered as also having withdrawn from this Protocol.

ARTICLE 28
The original of this Protocol, of which the Arabic, Chinese, English, French, Russian and Spanish texts are equally authentic, shall be deposited with the Secretary-General of the United Nations.

DONE at Kyoto this eleventh day of December one thousand nine hundred and ninety-seven.

IN WITNESS WHERE OF the undersigned, being duly authorized to that effect, have affixed their signatures to this Protocol on the dates indicated.

ANNEX A

Greenhouse gases
Carbon dioxide (CO_2)

Methane (CH_4)

Nitrous oxide (N_2O)

Hydrofluorocarbons (HFCs)

Perfluorocarbons (PFCs)

Sulphur hexafluoride (SF_6)

Sectors/source categories
Energy
- Fuel combustion
  - Energy industries
  - Manufacturing industries and construction
  - Transport
  - Other sectors
  - Other
- Fugitive emissions from fuels
  - Solid fuels
  - Oil and natural gas
  - Other

Industrial processes
- Mineral products
- Chemical industry
- Metal production
- Other production
- Production of halocarbons and sulphur hexafluoride
- Consumption of halocarbons and sulphur hexafluoride
- Other

Solvent and other product use

Agriculture
- Enteric fermentation
- Manure management
- Rice cultivation
- Agricultural soils

Prescribed burning of savannas
Field burning of agricultural residues
Other

Waste
Solid waste disposal on land
Wastewater handling
Waste incineration
Other

ANNEX B

Party	Quantified emission limitation or reduction commitment (percentage of base year or period)
Australia	108
Austria	92
Belgium	92
Bulgaria*	92
Canada	94
Croatia*	95
Czech Republic*	92
Denmark	92
Estonia*	92
European Community	92
Finland	92
France	92
Germany	92
Greece	92
Hungary*	94
Iceland	110
Ireland	92
Italy	92
Japan	94
Latvia*	92
Liechtenstein	92
Lithuania*	92
Luxembourg	92
Monaco	92
Netherlands	92
New Zealand	100
Norway	101
Poland*	94
Portugal	92
Romania*	92
Russian Federation*	100
Slovakia*	92
Slovenia*	92
Spain	92
Sweden	92
Switzerland	92
Ukraine*	100
United Kingdom of Great Britain and Northern Ireland	92
United States of America	93

* Countries that are undergoing the process of transition to a market economy.

APPENDIX B

GLOBAL WARMING POTENTIAL (GWP) VALUES OF GREENHOUSE GASES

Species	*Chemical Formula*	*Lifetime and reference*	*Global Warming Potential (Time Horizon)*		
			20 years	*100 years*	*500 years*
CO_2	CO_2	Bern model	1	1	1
HFC-23	CHF_3	264	9100	11700	9800
HFC-32	CH_2F_2	5.6	2100	650	200
HFC-41	CH_3F	3.7	490	150	45
HFC-43-10mee	$C_5H_2F_{10}$	17.1	3000	1300	400
HFC-125	C_2HF_5	32.6	4600	2800	920
HFC-134	$C_2H_2F_4$	10.6	2900	1000	310
HFC-134a	CH_2FCF_3	14.6	3400	1300	420
HFC-152a	$C_2H_4F_2$	1.5	460	140	42
HFC-143	C_2H_3F3	3.8	1000	300	94
HFC-143a	$C_2H_3F_3$	48.3	5000	3800	1400
HFC-227ea	C_3HF_7	36.5	4300	2900	950
HFC-236fa	$C_3H_2F_6$	209	5100	6300	4700
HFC-245ca	$C_3H_3F_5$	6.6	1800	560	170
Chloroform	$CHCl_3$	0.51	14	4	1
Methylene chloride	CH_2Cl_2	0.46	31	9	3
Sulphur hexafluoride	SF_6	3200	16300	23900	34900
Perfluoromethane	CF_4	50000	4400	6500	10000
Perfluoroethane	C_2F_6	10000	6200	9200	14000
Perfluoropropane	C_3F_8	2600	4800	7000	10100
Perfluorobutane	$C4F_{10}$	2600	4800	7000	10100
Perfluoropentane	C_5F_{12}	4100	5100	7500	11000
Perfluorohexane	$C6F_{14}$	3200	5000	7400	10700
Perfluorocyclobutane	$c\text{-}C_4F_8$	3200	6000	8700	12700
Methane	CH_4	12.2±3	56	21	6.5
Nitrous oxide	N_2O	120	280	310	170
Trifluoroiodomethane	CF_3I	<0.005	<3	<1	<1

Notes

1 *Global Warming Potentials (GWP) provide a means of estimating the relative radiative effects of the various greenhouse gases. The GWP index is defined as the cumulative radiative forcing between the present, and some chosen later time 'horizon' caused by a unit mass of gas emitted now, expressed relative to some reference gas (CO_2 is used here). The future global warming commitment of a greenhouse gas over the reference time horizon is the appropriate GWP multiplied by the amount of gas emitted.*

2 *The time horizons of the GWP values in the table are 20, 100, and 500 years. A 100-year horizon is often used for policy purposes.*

3 *The typical uncertainty associated with GWP values is ±35 per cent, not including the uncertainty in the carbon dioxide reference. GWP values and their estimated uncertainties are intended to reflect global averages only, and do not account for regional effects.*

4 *The GWP concept is currently inapplicable to gases and aerosols that are unevenly distributed in the atmosphere, as is the case for tropospheric ozone and aerosols and their precursors.*

5 *The GWP for methane includes indirect effects of tropospheric ozone production and stratospheric water vapour production.*

Source Table based on Houghton, J.T., Meira Filho, L.G., Callander, B.A., Harris, N., Maskell, K., and Kattenburg, A. (eds) 1996, *Climate Change 1995 : the Science of Climate Change. Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, UK, p.121.

Acknowledging that the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions,

Recalling the pertinent provisions of the Declaration of the United Nations Conference on the Human Environment, adopted at Stockholm on 16 June 1972,

Recalling also that States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction,

Reaffirming the principle of sovereignty of States in international cooperation to address climate change,

Recognizing that States should enact effective environmental legislation, that environmental standards, management objectives and priorities should reflect the environmental and developmental context to which they apply, and that standards applied by some countries may be inappropriate and of unwarranted economic and social cost to other countries, in particular developing countries,

Recalling the provisions of General Assembly resolution 44/228 of 22 December 1989 on the United Nations Conference on Environment and Development, and resolutions 43/53 of 6 December 1988, 44/207 of 22 December 1989, 45/212 of 21 December 1990 and 46/169 of 19 December 1991 on protection of global climate for present and future generations of mankind,

Recalling also the provisions of General Assembly resolution 44/206 of 22 December 1989 on the possible adverse effects of sea-level rise on islands and coastal areas, particularly low-lying coastal areas and the pertinent provisions of General Assembly resolution 44/172 of 19 December 1989 on the implementation of the Plan of Action to Combat Desertification,

Recalling further the Vienna Convention for the Protection of the Ozone Layer, 1985, and the Montreal Protocol on Substances that Deplete the Ozone Layer, 1987, as adjusted and amended on 29 June 1990,

Noting the Ministerial Declaration of the Second World Climate Conference adopted on 7 November 1990,

Conscious of the valuable analytical work being conducted by many States on climate change and of the important contributions of the World Meteorological Organization, the United Nations Environment Programme and other organs, organizations and bodies of the United Nations system, as well as other international and intergovernmental bodies, to the exchange of results of scientific research and the coordination of research,

Recognizing that steps required to understand and address climate change will be environmentally, socially and economically most effective if they are based on relevant scientific, technical and economic considerations and continually re-evaluated in the light of new findings in these areas,

Recognizing that various actions to address climate change can be justified economically in their own right and can also help in solving other environmental problems,

Recognizing also the need for developed countries to take immediate action in a flexible manner on the basis of clear priorities, as a first step towards comprehensive response strategies at the global, national and, where agreed, regional levels that take into account all greenhouse gases, with due consideration of their relative contributions to the enhancement of the greenhouse effect,

Recognizing further that low-lying and other small island countries, countries with low-lying coastal, arid and semi-arid areas or areas liable to floods, drought and desertification, and developing countries with fragile mountainous ecosystems are particularly vulnerable to the adverse effects of climate change,

Recognizing the special difficulties of those countries, especially developing countries, whose economies are particularly dependent on fossil fuel production, use and exportation, as a consequence of action taken on limiting greenhouse gas emissions,

Affirming that responses to climate change should be coordinated with social and economic development in an integrated manner with a view to avoiding adverse impacts on the latter, taking into full account the legitimate priority needs of developing countries for the achievement of sustained economic growth and the eradication of poverty,

Recognizing that all countries, especially developing countries, need access to resources required to achieve sustainable social and economic development and that, in order for developing countries to progress towards that goal, their energy consumption will need to grow taking into account the possibilities for achieving greater energy efficiency and for controlling greenhouse gas emissions in general, including through the application of new technologies on terms which make such an application economically and socially beneficial,

Determined to protect the climate system for present and future generations,

Have agreed as follows:

ARTICLE 1—DEFINITIONS*

For the purposes of this Convention:

1 "Adverse effects of climate change" means changes in the physical environment or biota resulting from climate change which have significant deleterious effects on the composition, resilience or productivity of natural and managed ecosystems or on the operation of socio-economic systems or on human health and welfare.

2 "Climate change" means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

3 "Climate system" means the totality of the atmosphere, hydrosphere, biosphere and geosphere and their interactions.

4 "Emissions" means the release of greenhouse gases and/or their precursors into the atmosphere over a specified area and period of time.

5 "Greenhouse gases" means those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation.

6 "Regional economic integration organization" means an organization constituted by sovereign States of a given region which has competence in respect of matters governed by this Convention or its protocols and has been duly authorized, in accordance with its internal procedures, to sign, ratify, accept, approve or accede to the instruments concerned.

7 "Reservoir" means a component or components of the climate system where a greenhouse gas or a precursor of a greenhouse gas is stored.

8 "Sink" means any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere.

9 "Source" means any process or activity which releases a greenhouse gas, an aerosol or a precursor of a greenhouse gas into the atmosphere.

* Titles of articles are included solely to assist the reader.

ARTICLE 2—OBJECTIVE

The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, 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.

ARTICLE 3—PRINCIPLES

In their actions to achieve the objective of the Convention and to implement its provisions, the Parties shall be guided, INTER ALIA, by the following:

1 The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof.

2 The specific needs and special circumstances of developing country Parties, especially those that are particularly vulnerable to the adverse effects of climate change, and of those Parties, especially developing country Parties, that would have to bear a disproportionate or abnormal burden under the Convention, should be given full consideration.

3 The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost. To achieve this, such policies and measures should take into account different socio-economic contexts, be comprehensive, cover all relevant sources, sinks and reservoirs of greenhouse gases and adaptation, and comprise all economic sectors. Efforts to address climate change may be carried out cooperatively by interested Parties.

4 The Parties have a right to, and should, promote sustainable development. Policies and measures to protect the climate system against human-induced change should be appropriate for the specific conditions of each Party and should be integrated with national development programmes, taking into account that economic development is essential for adopting measures to address climate change.

5 The Parties should cooperate to promote a supportive and open international economic system that would lead to sustainable economic growth and development in all Parties, particularly developing country Parties, thus enabling them better to address the problems of climate change. Measures taken to combat climate change, including unilateral ones, should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade.

ARTICLE 4—COMMITMENTS

1 All Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, shall:

(a) Develop, periodically update, publish and make available to the Conference of the Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties;

(b) Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and measures to facilitate adequate adaptation to climate change;

(c) Promote and cooperate in the development, application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol in all relevant sectors, including the energy, transport, industry, agriculture, forestry and waste management sectors;

(d) Promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems;

(e) Cooperate in preparing for adaptation to the impacts of climate change; develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture, and for the protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification, as well as floods;

(f) Take climate change considerations into account, to the extent feasible, in their relevant social, economic and environmental policies and actions, and employ appropriate methods, for example impact assessments, formulated and determined nationally, with a view to minimizing adverse effects on the economy, on public health and on the quality of the environment, of projects or measures undertaken by them to mitigate or adapt to climate change;

(g) Promote and cooperate in scientific, technological, technical, socio-economic and other research, systematic observation and development of data archives related to the climate system and intended to further the understanding and to reduce or eliminate the remaining uncertainties regarding the causes, effects, magnitude and timing of climate change and the economic and social consequences of various response strategies;

(h) Promote and cooperate in the full, open and prompt exchange of relevant scientific, technological, technical, socio-economic and legal information related to the climate system and climate change, and to the economic and social consequences of various response strategies;

(i) Promote and cooperate in education, training and public awareness related to climate change and encourage the widest participation in this process, including that of non-governmental organizations; and

(j) Communicate to the Conference of the Parties information related to implementation, in accordance with Article 12.

2 The developed country Parties and other Parties included in Annex I commit themselves specifically as provided for in the following:

(a) Each of these Parties shall adopt national1 policies and take corresponding measures on the mitigation of climate change, by limiting its anthropogenic emissions of greenhouse gases and protecting and enhancing its greenhouse gas sinks and reservoirs. These policies and measures will demonstrate that developed countries are taking the lead in modifying longer-term trends in anthropogenic emissions consistent with the objective of the Convention, recognizing that the return by the end of the present decade to earlier levels of anthropogenic emissions of carbon dioxide and other greenhouse gases not controlled by the Montreal Protocol would contribute to such modification, and taking into account the differences in these Parties' starting points and approaches, economic structures and resource bases, the need to maintain strong and sustainable economic growth, available technologies and other individual circumstances, as well as the need for equitable and appropriate contributions by each of these Parties to the global effort regarding that

objective. These Parties may implement such policies and measures jointly with other Parties and may assist other Parties in contributing to the achievement of the objective of the Convention and, in particular, that of this subparagraph;

(b) In order to promote progress to this end, each of these Parties shall communicate, within six months of the entry into force of the Convention for it and periodically thereafter, and in accordance with Article 12, detailed information on its policies and measures referred to in subparagraph (a) above, as well as on its resulting projected anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol for the period referred to in subparagraph (a), with the aim of returning individually or jointly to their 1990 levels these anthropogenic emissions of carbon dioxide and other greenhouse gases not controlled by the Montreal Protocol. This information will be reviewed by the Conference of the Parties, at its first session and periodically thereafter, in accordance with Article 7;

(c) Calculations of emissions by sources and removals by sinks of greenhouse gases for the purposes of subparagraph (b) above should take into account the best available scientific knowledge, including of the effective capacity of sinks and the respective contributions of such gases to climate change. The Conference of the Parties shall consider and agree on methodologies for these calculations at its first session and review them regularly thereafter;

(d) The Conference of the Parties shall, at its first session, review the adequacy of subparagraphs (a) and (b) above. Such review shall be carried out in the light of the best available scientific information and assessment on climate change and its impacts, as well as relevant technical, social and economic information. Based on this review, the Conference of the Parties shall take appropriate action, which may include the adoption of amendments to the commitments in subparagraphs (a) and (b) above. The Conference of the Parties, at its first session, shall also take decisions regarding criteria for joint implementation as indicated in subparagraph (a) above. A second review of subparagraphs (a) and (b) shall take place not later than 31 December 1998, and thereafter

at regular intervals determined by the Conference of the Parties, until the objective of the Convention is met;

(e) Each of these Parties shall :

i) Coordinate as appropriate with other such Parties, relevant economic and administrative instruments developed to achieve the objective of the Convention; and

(ii) Identify and periodically review its own policies and practices which encourage activities that lead to greater levels of anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol than would otherwise occur;

(f) The Conference of the Parties shall review, not later than 31 December 1998, available information with a view to taking decisions regarding such amendments to the lists in Annexes I and II as may be appropriate, with the approval of the Party concerned;

(g) Any Party not included in Annex I may, in its instrument of ratification, acceptance, approval or accession, or at any time thereafter, notify the Depositary that it intends to be bound by subparagraphs (a) and (b) above. The Depositary shall inform the other signatories and Parties of any such notification.

3 The developed country Parties and other developed Parties included in Annex II shall provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in complying with their obligations under Article 12, paragraph 1. They shall also provide such financial resources, including for the transfer of technology, needed by the developing country Parties to meet the agreed full incremental costs of implementing measures that are covered by paragraph 1 of this Article and that are agreed between a developing country Party and the international entity or entities referred to in Article 11, in accordance with that Article. The implementation of these commitments shall take into account the need for adequacy and predictability in the flow of funds and the importance of appropriate burden sharing among the developed country Parties.

4 The developed country Parties and other developed Parties included in Annex II shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects.

5 The developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties. Other Parties and organizations in a position to do so may also assist in facilitating the transfer of such technologies.

6 In the implementation of their commitments under paragraph 2 above, a certain degree of flexibility shall be allowed by the Conference of the Parties to the Parties included in Annex I undergoing the process of transition to a market economy, in order to enhance the ability of these Parties to address climate change, including with regard to the historical level of anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol chosen as a reference.

7 The extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology and will take fully into account that economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties.

8 In the implementation of the commitments in this Article, the Parties shall give full consideration to what actions are necessary under the Convention, including actions related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures, especially on:

(a) Small island countries;

(b) Countries with low-lying coastal areas;

(c) Countries with arid and semi-arid areas, forested areas and areas liable to forest decay;

(d) Countries with areas prone to natural disasters;

(e) Countries with areas liable to drought and desertification;

(f) Countries with areas of high urban atmospheric pollution;

(g) Countries with areas with fragile ecosystems, including mountainous ecosystems;

(h) Countries whose economies are highly dependent on income generated from the production, processing and export, and/or on consumption of fossil fuels and associated energy-intensive products; and

(i) Land-locked and transit countries.

Further, the Conference of the Parties may take actions, as appropriate, with respect to this paragraph.

9 The Parties shall take full account of the specific needs and special situations of the least developed countries in their actions with regard to funding and transfer of technology.

10 The Parties shall, in accordance with Article 10, take into consideration in the implementation of the commitments of the Convention the situation of Parties, particularly developing country Parties, with economies that are vulnerable to the adverse effects of the implementation of measures to respond to climate change. This applies notably to Parties with economies that are highly dependent on income generated from the production, processing and export, and/or consumption of fossil fuels and associated energy-intensive products and/or the use of fossil fuels for which such Parties have serious difficulties in switching to alternatives.

ARTICLE 5—RESEARCH AND SYSTEMATIC OBSERVATION

In carrying out their commitments under Article 4, paragraph 1(g), the Parties shall:

(a) Support and further develop, as appropriate, international and intergovernmental programmes and networks or organizations aimed at defining, conducting, assessing and financing research, data collection and systematic observation, taking into account the need to minimize duplication of effort;

(b) Support international and intergovernmental efforts to strengthen systematic observation and national scientific and technical research capacities and capabilities, particularly in developing countries, and to promote access to, and the

exchange of, data and analyses thereof obtained from areas beyond national jurisdiction; and

(c) Take into account the particular concerns and needs of developing countries and cooperate in improving their endogenous capacities and capabilities to participate in the efforts referred to in subparagraphs (a) and (b) above.

ARTICLE 6—EDUCATION, TRAINING AND PUBLIC AWARENESS

In carrying out their commitments under Article 4, paragraph 1(i), the Parties shall:

(a) Promote and facilitate at the national and, as appropriate, subregional and regional levels, and in accordance with national laws and regulations, and within their respective capacities:

(i) The development and implementation of educational and public awareness programmes on climate change and its effects;

(ii) Public access to information on climate change and its effects;

(iii) Public participation in addressing climate change and its effects and developing adequate responses; and

(iv) Training of scientific, technical and managerial personnel.

(b) Cooperate in and promote, at the international level, and, where appropriate, using existing bodies:

(i) The development and exchange of educational and public awareness material on climate change and its effects; and

(ii) The development and implementation of education and training programmes, including the strengthening of national institutions and the exchange or secondment of personnel to train experts in this field, in particular for developing countries.

ARTICLE 7—CONFERENCE OF THE PARTIES

1 A Conference of the Parties is hereby established.

2 The Conference of the Parties, as the supreme body of this Convention, shall keep under regular review the implementation of the Convention and any related legal instruments that the Conference of the Parties may adopt, and shall make, within its mandate, the decisions necessary to promote the effective implementation of the Convention. To this end, it shall:

(a) Periodically examine the obligations of the Parties and the institutional arrangements under the Convention, in the light of the objective of the Convention, the experience gained in its implementation and the evolution of scientific and technological knowledge;

(b) Promote and facilitate the exchange of information on measures adopted by the Parties to address climate change and its effects, taking into account the differing circumstances, responsibilities and capabilities of the Parties and their respective commitments under the Convention;

(c) Facilitate, at the request of two or more Parties, the coordination of measures adopted by them to address climate change and its effects, taking into account the differing circumstances, responsibilities and capabilities of the Parties and their respective commitments under the Convention;

(d) Promote and guide, in accordance with the objective and provisions of the Convention, the development and periodic refinement of comparable methodologies, to be agreed on by the Conference of the Parties, inter alia, for preparing inventories of greenhouse gas emissions by sources and removals by sinks, and for evaluating the effectiveness of measures to limit the emissions and enhance the removals of these gases;

(e) Assess, on the basis of all information made available to it in accordance with the provisions of the Convention, the implementation of the Convention by the Parties, the overall effects of the measures taken pursuant to the Convention, in particular environmental, economic and social effects as well as their cumulative impacts and the extent to which progress towards the objective of the Convention is being achieved;

(f) Consider and adopt regular reports on the implementation of the Convention and ensure their publication;

(g) Make recommendations on any matters necessary for the implementation of the Convention;

(h) Seek to mobilize financial resources in accordance with Article 4, paragraphs 3, 4 and 5, and Article 11;

(i) Establish such subsidiary bodies as are deemed necessary for the implementation of the Convention;

(j) Review reports submitted by its subsidiary bodies and provide guidance to them;

(k) Agree upon and adopt, by consensus, rules of procedure and financial rules for itself and for any subsidiary bodies;

(l) Seek and utilize, where appropriate, the services and cooperation of, and information provided by, competent international organizations and intergovernmental and non-governmental bodies; and

(m) Exercise such other functions as are required for the achievement of the objective of the Convention as well as all other functions assigned to it under the Convention.

3 The Conference of the Parties shall, at its first session, adopt its own rules of procedure as well as those of the subsidiary bodies established by the Convention, which shall include decision-making procedures for matters not already covered by decision- making procedures stipulated in the Convention. Such procedures may include specified majorities required for the adoption of particular decisions.

4 The first session of the Conference of the Parties shall be convened by the interim secretariat referred to in Article 21 and shall take place not later than one year after the date of entry into force of the Convention. Thereafter, ordinary sessions of the Conference of the Parties shall be held every year unless otherwise decided by the Conference of the Parties.

5 Extraordinary sessions of the Conference of the Parties shall be held at such other times as may be deemed necessary by the Conference, or at the written request of any Party, provided that, within six months of the request being communicated to the Parties by the secretariat, it is supported by at least one third of the Parties.

6 The United Nations, its specialized agencies and the International Atomic Energy Agency, as well as any State member thereof or observers thereto not Party to the Convention, may be represented at sessions of the Conference of the Parties as observers. Any body or agency, whether national or international, governmental or non- governmental, which is qualified in matters covered by the Convention, and which has informed the secretariat of its wish to be represented at a session of the Conference of the Parties as an observer, may be so admitted unless at least one third of the Parties

present object. The admission and participation of observers shall be subject to the rules of procedure adopted by the Conference of the Parties.

ARTICLE 8—SECRETARIAT

1 A secretariat is hereby established.

2 The functions of the secretariat shall be:

(a) To make arrangements for sessions of the Conference of the Parties and its subsidiary bodies established under the Convention and to provide them with services as required;

(b) To compile and transmit reports submitted to it;

(c) To facilitate assistance to the Parties, particularly developing country Parties, on request, in the compilation and communication of information required in accordance with the provisions of the Convention;

(d) To prepare reports on its activities and present them to the Conference of the Parties;

(e) To ensure the necessary coordination with the secretariats of other relevant international bodies;

(f) To enter, under the overall guidance of the Conference of the Parties, into such administrative and contractual arrangements as may be required for the effective discharge of its functions; and

(g) To perform the other secretariat functions specified in the Convention and in any of its protocols and such other functions as may be determined by the Conference of the Parties.

3 The Conference of the Parties, at its first session, shall designate a permanent secretariat and make arrangements for its functioning.

ARTICLE 9—SUBSIDIARY BODY FOR SCIENTIFIC AND TECHNOLOGICAL ADVICE

1 A subsidiary body for scientific and technological advice is hereby established to provide the Conference of the Parties and, as appropriate, its other subsidiary bodies with timely information and advice on scientific and technological matters relating to the

Convention. This body shall be open to participation by all Parties and shall be multidisciplinary. It shall comprise government representatives competent in the relevant field of expertise. It shall report regularly to the Conference of the Parties on all aspects of its work.

2 Under the guidance of the Conference of the Parties, and drawing upon existing competent international bodies, this body shall:

(a) Provide assessments of the state of scientific knowledge relating to climate change and its effects;

(b) Prepare scientific assessments on the effects of measures taken in the implementation of the Convention;

(c) Identify innovative, efficient and state-of-the-art technologies and know-how and advise on the ways and means of promoting development and/or transferring such technologies;

(d) Provide advice on scientific programmes, international cooperation in research and development related to climate change, as well as on ways and means of supporting endogenous capacity-building in developing countries; and

(e) Respond to scientific, technological and methodological questions that the Conference of the Parties and its subsidiary bodies may put to the body.

3 The functions and terms of reference of this body may be further elaborated by the Conference of the Parties.

ARTICLE 10—SUBSIDIARY BODY FOR IMPLEMENTATION

1 A subsidiary body for implementation is hereby established to assist the Conference of the Parties in the assessment and review of the effective implementation of the Convention. This body shall be open to participation by all Parties and comprise government representatives who are experts on matters related to climate change. It shall report regularly to the Conference of the Parties on all aspects of its work.

2 Under the guidance of the Conference of the Parties, this body shall:

(a) Consider the information communicated in accordance with Article 12, paragraph 1, to assess the overall aggregated

effect of the steps taken by the Parties in the light of the latest scientific assessments concerning climate change;

(b) Consider the information communicated in accordance with Article 12, paragraph 2, in order to assist the Conference of the Parties in carrying out the reviews required by Article 4, paragraph 2(d); and

(c) Assist the Conference of the Parties, as appropriate, in the preparation and implementation of its decisions.

ARTICLE 11—FINANCIAL MECHANISM

1 A mechanism for the provision of financial resources on a grant or concessional basis, including for the transfer of technology, is hereby defined. It shall function under the guidance of and be accountable to the Conference of the Parties, which shall decide on its policies, programme priorities and eligibility criteria related to this Convention. Its operation shall be entrusted to one or more existing international entities.

2 The financial mechanism shall have an equitable and balanced representation of all Parties within a transparent system of governance.

3 The Conference of the Parties and the entity or entities entrusted with the operation of the financial mechanism shall agree upon arrangements to give effect to the above paragraphs, which shall include the following:

(a) Modalities to ensure that the funded projects to address climate change are in conformity with the policies, programme priorities and eligibility criteria established by the Conference of the Parties;

(b) Modalities by which a particular funding decision may be reconsidered in light of these policies, programme priorities and eligibility criteria;

(c) Provision by the entity or entities of regular reports to the Conference of the Parties on its funding operations, which is consistent with the requirement for accountability set out in paragraph 1 above; and

(d) Determination in a predictable and identifiable manner of the amount of funding necessary and available for the

implementation of this Convention and the conditions under which that amount shall be periodically reviewed.

4 The Conference of the Parties shall make arrangements to implement the above- mentioned provisions at its first session, reviewing and taking into account the interim arrangements referred to in Article 21, paragraph 3, and shall decide whether these interim arrangements shall be maintained. Within four years thereafter, the Conference of the Parties shall review the financial mechanism and take appropriate measures.

5 The developed country Parties may also provide and developing country Parties avail themselves of, financial resources related to the implementation of the Convention through bilateral, regional and other multilateral channels.

ARTICLE 12—COMMUNICATION OF INFORMATION RELATED TO IMPLEMENTATION

1 In accordance with Article 4, paragraph 1, each Party shall communicate to the Conference of the Parties, through the secretariat, the following elements of information:

(a) A national inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be promoted and agreed upon by the Conference of the Parties;

(b) A general description of steps taken or envisaged by the Party to implement the Convention; and

(c) Any other information that the Party considers relevant to the achievement of the objective of the Convention and suitable for inclusion in its communication, including, if feasible, material relevant for calculations of global emission trends.

2 Each developed country Party and each other Party included in Annex I shall incorporate in its communication the following elements of information:

(a) A detailed description of the policies and measures that it has adopted to implement its commitment under Article 4, paragraphs 2(a) and 2(b); and

(b) A specific estimate of the effects that the policies and measures referred to in subparagraph (a) immediately above

will have on anthropogenic emissions by its sources and removals by its sinks of greenhouse gases during the period referred to in Article 4, paragraph 2(a).

3 In addition, each developed country Party and each other developed Party included in Annex II shall incorporate details of measures taken in accordance with Article 4, paragraphs 3, 4 and 5.

4 Developing country Parties may, on a voluntary basis, propose projects for financing, including specific technologies, materials, equipment, techniques or practices that would be needed to implement such projects, along with, if possible, an estimate of all incremental costs, of the reductions of emissions and increments of removals of greenhouse gases, as well as an estimate of the consequent benefits.

5 Each developed country Party and each other Party included in Annex I shall make its initial communication within six months of the entry into force of the Convention for that Party. Each Party not so listed shall make its initial communication within three years of the entry into force of the Convention for that Party, or of the availability of financial resources in accordance with Article 4, paragraph 3. Parties that are least developed countries may make their initial communication at their discretion. The frequency of subsequent communications by all Parties shall be determined by the Conference of the Parties, taking into account the differentiated timetable set by this paragraph.

6 Information communicated by Parties under this Article shall be transmitted by the secretariat as soon as possible to the Conference of the Parties and to any subsidiary bodies concerned. If necessary, the procedures for the communication of information may be further considered by the Conference of the Parties.

7 From its first session, the Conference of the Parties shall arrange for the provision to developing country Parties of technical and financial support, on request, in compiling and communicating information under this Article, as well as in identifying the technical and financial needs associated with proposed projects and response measures under Article 4. Such support may be provided by other Parties, by competent international organizations and by the secretariat, as appropriate.

8 Any group of Parties may, subject to guidelines adopted by the Conference of the Parties, and to prior notification to the

Conference of the Parties, make a joint communication in fulfilment of their obligations under this Article, provided that such a communication includes information on the fulfilment by each of these Parties of its individual obligations under the Convention.

9 Information received by the secretariat that is designated by a Party as confidential, in accordance with criteria to be established by the Conference of the Parties, shall be aggregated by the secretariat to protect its confidentiality before being made available to any of the bodies involved in the communication and review of information.

10 Subject to paragraph 9 above, and without prejudice to the ability of any Party to make public its communication at any time, the secretariat shall make communications by Parties under this Article publicly available at the time they are submitted to the Conference of the Parties.

ARTICLE 13—RESOLUTION OF QUESTIONS REGARDING IMPLEMENTATION

The Conference of the Parties shall, at its first session, consider the establishment of a multilateral consultative process, available to Parties on their request, for the resolution of questions regarding the implementation of the Convention.

ARTICLE 14—SETTLEMENT OF DISPUTES

1 In the event of a dispute between any two or more Parties concerning the interpretation or application of the Convention, the Parties concerned shall seek a settlement of the dispute through negotiation or any other peaceful means of their own choice.

2 When ratifying, accepting, approving or acceding to the Convention, or at any time thereafter, a Party which is not a regional economic integration organization may declare in a written instrument submitted to the Depositary that, in respect of any dispute concerning the interpretation or application of the Convention, it recognizes as compulsory ipso facto and without special agreement, in relation to any Party accepting the same obligation:

(a) Submission of the dispute to the International Court of Justice, and/or

(b) Arbitration in accordance with procedures to be adopted by the Conference of the Parties as soon as practicable, in an annex on arbitration.

A Party which is a regional economic integration organization may make a declaration with like effect in relation to arbitration in accordance with the procedures referred to in subparagraph (b) above.

3 A declaration made under paragraph 2 above shall remain in force until it expires in accordance with its terms or until three months after written notice of its revocation has been deposited with the Depositary.

4 A new declaration, a notice of revocation or the expiry of a declaration shall not in any way affect proceedings pending before the International Court of Justice or the arbitral tribunal, unless the parties to the dispute otherwise agree.

5 Subject to the operation of paragraph 2 above, if after twelve months following notification by one Party to another that a dispute exists between them, the Parties concerned have not been able to settle their dispute through the means mentioned in paragraph 1 above, the dispute shall be submitted, at the request of any of the parties to the dispute, to conciliation.

6 A conciliation commission shall be created upon the request of one of the parties to the dispute. The commission shall be composed of an equal number of members appointed by each party concerned and a chairman chosen jointly by the members appointed by each party. The commission shall render a recommendatory award, which the parties shall consider in good faith.

7 Additional procedures relating to conciliation shall be adopted by the Conference of the Parties, as soon as practicable, in an annex on conciliation.

8 The provisions of this Article shall apply to any related legal instrument which the Conference of the Parties may adopt, unless the instrument provides otherwise.

ARTICLE 15—AMENDMENTS TO THE CONVENTION

1 Any Party may propose amendments to the Convention.

2 Amendments to the Convention shall be adopted at an ordinary session of the Conference of the Parties. The text of any proposed amendment to the Convention shall be communicated to the Parties by the secretariat at least six months before the meeting at which it is proposed for adoption. The secretariat shall also communicate

proposed amendments to the signatories to the Convention and, for information, to the Depositary.

3 The Parties shall make every effort to reach agreement on any proposed amendment to the Convention by consensus. If all efforts at consensus have been exhausted, and no agreement reached, the amendment shall as a last resort be adopted by a three-fourths majority vote of the Parties present and voting at the meeting. The adopted amendment shall be communicated by the secretariat to the Depositary, who shall circulate it to all Parties for their acceptance.

4 Instruments of acceptance in respect of an amendment shall be deposited with the Depositary. An amendment adopted in accordance with paragraph 3 above shall enter into force for those Parties having accepted it on the ninetieth day after the date of receipt by the Depositary of an instrument of acceptance by at least three fourths of the Parties to the Convention.

5 The amendment shall enter into force for any other Party on the ninetieth day after the date on which that Party deposits with the Depositary its instrument of acceptance of the said amendment.

6 For the purposes of this Article, "Parties present and voting" means Parties present and casting an affirmative or negative vote.

ARTICLE 16—ADOPTION AND AMENDMENT OF ANNEXES TO THE CONVENTION

1 Annexes to the Convention shall form an integral part thereof and, unless otherwise expressly provided, a reference to the Convention constitutes at the same time a reference to any annexes thereto. Without prejudice to the provisions of Article 14, paragraphs 2(b) and 7, such annexes shall be restricted to lists, forms and any other material of a descriptive nature that is of a scientific, technical, procedural or administrative character.

2 Annexes to the Convention shall be proposed and adopted in accordance with the procedure set forth in Article 15, paragraphs 2, 3 and 4.

3 An annex that has been adopted in accordance with paragraph 2 above shall enter into force for all Parties to the Convention six months after the date of the communication by the Depositary to such Parties of the adoption of the annex, except for those Parties

that have notified the Depositary, in writing, within that period of their non-acceptance of the annex. The annex shall enter into force for Parties which withdraw their notification of non-acceptance on the ninetieth day after the date on which withdrawal of such notification has been received by the Depositary.

4 The proposal, adoption and entry into force of amendments to annexes to the Convention shall be subject to the same procedure as that for the proposal, adoption and entry into force of annexes to the Convention in accordance with paragraphs 2 and 3 above.

5 If the adoption of an annex or an amendment to an annex involves an amendment to the Convention, that annex or amendment to an annex shall not enter into force until such time as the amendment to the Convention enters into force.

ARTICLE 17—PROTOCOLS

1 The Conference of the Parties may, at any ordinary session, adopt protocols to the Convention.

2 The text of any proposed protocol shall be communicated to the Parties by the secretariat at least six months before such a session.

3 The requirements for the entry into force of any protocol shall be established by that instrument.

4 Only Parties to the Convention may be Parties to a protocol.

5 Decisions under any protocol shall be taken only by the Parties to the protocol concerned.

ARTICLE 18—RIGHT TO VOTE

1 Each Party to the Convention shall have one vote, except as provided for in paragraph 2 below.

2 Regional economic integration organizations, in matters within their competence, shall exercise their right to vote with a number of votes equal to the number of their member States that are Parties to the Convention. Such an organization shall not exercise its right to vote if any of its member States exercises its right, and vice versa.

ARTICLE 19—DEPOSITARY

The Secretary-General of the United Nations shall be the Depositary of the Convention and of protocols adopted in accordance with Article 17.

ARTICLE 20—SIGNATURE

This Convention shall be open for signature by States Members of the United Nations or of any of its specialized agencies or that are Parties to the Statute of the International Court of Justice and by regional economic integration organizations at Rio de Janeiro, during the United Nations Conference on Environment and Development, and thereafter at United Nations Headquarters in New York from 20 June 1992 to 19 June 1993.

ARTICLE 21—INTERIM ARRANGEMENTS

1 The secretariat functions referred to in Article 8 will be carried out on an interim basis by the secretariat established by the General Assembly of the United Nations in its resolution 45/212 of 21 December 1990, until the completion of the first session of the Conference of the Parties.

2 The head of the interim secretariat referred to in paragraph 1 above will cooperate closely with the Intergovernmental Panel on Climate Change to ensure that the Panel can respond to the need for objective scientific and technical advice. Other relevant scientific bodies could also be consulted.

3 The Global Environment Facility of the United Nations Development Programme, the United Nations Environment Programme and the International Bank for Reconstruction and Development shall be the international entity entrusted with the operation of the financial mechanism referred to in Article 11 on an interim basis. In this connection, the Global Environment Facility should be appropriately restructured and its membership made universal to enable it to fulfil the requirements of Article 11.

ARTICLE 22—RATIFICATION, ACCEPTANCE, APPROVAL OR ACCESSION

1 The Convention shall be subject to ratification, acceptance, approval or accession by States and by regional economic integration organizations. It shall be open for accession from the day after the date on which the Convention is closed for signature. Instruments

of ratification, acceptance, approval or accession shall be deposited with the Depositary.

2 Any regional economic integration organization which becomes a Party to the Convention without any of its member States being a Party shall be bound by all the obligations under the Convention. In the case of such organizations, one or more of whose member States is a Party to the Convention, the organization and its member States shall decide on their respective responsibilities for the performance of their obligations under the Convention. In such cases, the organization and the member States shall not be entitled to exercise rights under the Convention concurrently.

3 In their instruments of ratification, acceptance, approval or accession, regional economic integration organizations shall declare the extent of their competence with respect to the matters governed by the Convention. These organizations shall also inform the Depositary, who shall in turn inform the Parties, of any substantial modification in the extent of their competence.

ARTICLE 23—ENTRY INTO FORCE

1 The Convention shall enter into force on the ninetieth day after the date of deposit of the fiftieth instrument of ratification, acceptance, approval or accession.

2 For each State or regional economic integration organization that ratifies, accepts or approves the Convention or accedes thereto after the deposit of the fiftieth instrument of ratification, acceptance, approval or accession, the Convention shall enter into force on the ninetieth day after the date of deposit by such State or regional economic integration organization of its instrument of ratification, acceptance, approval or accession.

3 For the purposes of paragraphs 1 and 2 above, any instrument deposited by a regional economic integration organization shall not be counted as additional to those deposited by States members of the organization.

ARTICLE 24—RESERVATIONS

No reservations may be made to the Convention.

ARTICLE 25—WITHDRAWAL

1 At any time after three years from the date on which the Convention has entered into force for a Party, that Party may withdraw from the Convention by giving written notification to the Depositary.

2 Any such withdrawal shall take effect upon expiry of one year from the date of receipt by the Depositary of the notification of withdrawal, or on such later date as may be specified in the notification of withdrawal.

3 Any Party that withdraws from the Convention shall be considered as also having withdrawn from any protocol to which it is a Party.

ARTICLE 26—AUTHENTIC TEXTS

The original of this Convention, of which the Arabic, Chinese, English, French, Russian and Spanish texts are equally authentic, shall be deposited with the Secretary- General of the United Nations.

IN WITNESS WHEREOF the undersigned, being duly authorized to that effect, have signed this Convention.

DONE at New York this ninth day of May one thousand nine hundred and ninety- two.

ANNEX I AND ANNEX II COUNTRIES

Annex I

Australia
Austria
Belarus a/
Belgium
Bulgaria a/
Canada
Czechoslovakia a/
Denmark
European Economic Community
Estonia a/
Finland
France
Germany
Greece
Hungary a/
Iceland
Ireland
Italy
Japan
Latvia a/
Lithuania a/

Luxembourg

Netherlands

New Zealand

Norway

Poland a/

Portugal

Romania a/

Russian Federation a/

Spain

Sweden

Switzerland

Turkey

Ukraine a/

United Kingdom of Great Britain and Northern Ireland

United States of America

a/ Countries that are undergoing the process of transition to a market economy.

ANNEX II

Australia

Austria

Belgium

Canada

Denmark

European Economic Community

Finland

France

Germany

Greece

Iceland

Ireland

Italy

Japan

Luxembourg

Netherlands

New Zealand

Norway

Portugal

Spain

Sweden

Switzerland

Turkey

United Kingdom of Great Britain and Northern Ireland

United States of America

ABBREVIATIONS

AAU	assigned amount unit/s
AA	assigned amount/s
ABARE	Australian Bureau of Agricultural and Resource Economics
AGO	Australian Greenhouse Office
AGPS	Australian Government Publishing Service
AGWP	absolute global warming potential/s
AIJ	Activities Implemented Jointly
ANU	Australian National University
APEC	Asia Pacific Economic Cooperation
APS	ambient permit system
APS	Australian Public Service
BIE	Bureau of Industry Economics
BTCE	Bureau of Transport and Communications Economics
BTE	Bureau of Transport Economics
CDM	Clean Development Mechanism
CER	certified emission reduction/s
CH_4	methane
CIS	Commonwealth of Independent States
CITES	Convention to Restrict Trade in Endangered Species
CO	carbon monoxide
CO_2	carbon dioxide
COP	Conference of the Parties
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DFAT	Department of Foreign Affairs and Trade

DPIE	Department of Primary Industries and Energy
EPA	Environment Protection Authority (NSW)
EPAV	Environment Protection Authority, Victoria
EPS	emissions permit system
ERC	emission reduction credit/s
ERU	emission reduction unit/s
EU	European Union
FCCC	Framework Convention on Climate Change
GATT	General Agreement on Tariffs and Trade
GDP	gross domestic product
GHG	greenhouse gas/es
GNP	gross national product
GTEM	Global Trade and Environment Model
GWPs	Global Warming Potentials
ha	hectare
HFCs	hydrofluorocarbons
IAC	Industries Assistance Commission
IC	Industry Commission
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
ITQ	Individual Transferable Quotas
JI	Joint Implementation
kg	kilogram
Mt	million tonnes
MW	megawatt/s
NO_x	oxides of nitrogen, other than nitrous oxide
N_2O	nitrous oxide
NGGIC	National Greenhouse Gas Inventory Committee
NSW	New South Wales
OECD	Organisation for Economic Co-operation and Development

ppmv	parts per million by volume
PFCs	perfluorocarbons
RECLAIM	Regional Clean Air Incentives Market
SBSTA	Subsidiary Body on Scientific and Technical Advice
SF_6	sulfur hexafluoride
SO2	sulfur dioxide
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Program
UNFCCC	see FCCC
US	United States (of America)
US EPA	United States Environmental Protection Agency
WMO	World Meteorological Organisation
WTO	World Trade Organisation