FRAMEWORK FOR GREENHOUSE EMISSION TRADING IN AUSTRALIA

Antonia Cornwell
Johanna Travis
Don Gunasekera

STAFF RESEARCH PAPER

December 1997

INDUSTRY COMMISSION

ISBN 0 646 33538 3

Inquiries about this and all other Industry Commission publications should be directed to:

Publications Officer
LB2 Collins Street East PO
MELBOURNE VIC 8003

Ph: (03) 9653 2183
Fax (03) 9653 2303

Communications Officer
PO Box 80
BELCONNEN ACT 2616

Ph: (02) 6240 3239
Fax: (02) 6240 3300

An appropriate citation for this paper is:

Cornwell, A., Travis, J. and Gunasekera, D. 1997, *Framework for Greenhouse Emission Trading in Australia*, Industry Commission Staff Research Paper, AGPS, Canberra, December.

ACKNOWLEDGMENTS

Ilias Mastoris and Adam Phillips provided valuable assistance in preparing this paper. Dr Don Gunasekera, Assistant Commissioner of the Economic and Environmental Studies Branch of the Industry Commission, supervised the project. The Commission's internal referees, Professor Richard Snape, Dr Lynne Williams and Brett Janissen, provided helpful comments on a draft of the paper.

December 1997

CONTENTS

Appendices

Tables

Boxes

ABBREVIATIONS

AAR	authorised account representative
AIJ	activities implemented jointly
C	carbon
CBOT	Chicago Board of Trade
CEM	continuous emissions monitoring
C_2F_6	perfluoroethane
CF_4	perfluoromethane
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
EPA	(New South Wales) Environment Protection Authority; (United States) Environmental Protection Agency
F&GC	forest and grassland conversion
FCCC	(United Nations) Framework Convention on Climate Change
GCO	Greenhouse Challenge Office
GHG	greenhouse gas
GJ	gigajoule (=10^9 joule)
GWP	global warming potential
JI	joint implementation
kg	kilogram
LUC&F	land use change and forestry
Mt	megatonne (=10^6 tonne)
N_2O	nitrous oxide
NGGIC	National Greenhouse Gas Inventory Committee
NMVOC	non-methane volatile organic compounds
NO_X	oxides of nitrogen

OECD	Organisation for Economic Cooperation and Development
ORF	other refined feedstocks
PFC	perfluorocarbon
PJ	petajoule (=10^{15} joule)
SO_2	sulphur dioxide
t	tonne
US	United States
USIJI	United States Initiative on Joint Implementation

SUMMARY

Australia's current greenhouse response strategy is based mainly on 'no regrets' measures — those which, in addition to reducing greenhouse gas (GHG) emissions, result in net benefits (or at least no net costs). However, it is evident that no regrets measures will be insufficient for Australia to meet the abatement target implied in the United Nations Framework Convention on Climate Change (FCCC), or any strengthened commitments. To satisfy GHG emission abatement commitments, additional measures will be necessary.

An international tradable permit, or emission trading, scheme has been promoted by some countries, such as the United States, as a mechanism to reduce the international cost of reducing GHG emissions. Recent Organisation for Economic Cooperation and Development analysis suggests that international emission trading would lower the cost of emission abatement to Australia by 50 per cent compared with having to meet an abatement target in the absence of an international trading scheme.

Emission trading could also be implemented at a domestic level as a tool for Australia to meet its GHG abatement commitments. Previous work by the Industry Commission suggests that the economic costs of reducing GHG emissions would be lower if a system of tradable permits existed instead of a regional or activity-specific reduction target. Furthermore, a national emission trading scheme would be less costly than a state based scheme in which each State independently tries to reduce GHG emissions by the same proportion.

This paper brings together several recent analyses of tradable permit schemes and attempts to provide a basic framework for setting up a practical domestic GHG emission trading system for Australia.

There are several issues that need to be considered in setting up a domestic emission trading scheme for GHGs. These include defining the permit and overall emission cap, the market participants, the method of allocating permits, the administrative structure and the role of carbon sequestration. Another important issue is the coverage of GHGs. Ideally, all sources of GHGs should be included in an emission trading scheme, as spreading the abatement burden across more sources will lower the cost of abatement. On the other hand, at the outset, a comprehensive trading scheme would be more difficult to monitor and could have higher transaction costs than, for example, a trading scheme covering only carbon dioxide (CO_2) from fossil fuel combustion. Therefore, it may be necessary to start with a less comprehensive scheme in which

participants are limited to trading in only CO_2 and allow trades in other GHG sources and sinks once their GHG emissions and removals can be adequately verified and monitored.

Some of the implementation issues that would need to be addressed if Australia were to adopt an emission trading scheme for GHGs include the role of existing initiatives to reduce GHG emissions, the schedule of emission reductions to be undertaken to meet a particular abatement target and the interface of a trading scheme with an international emission trading scheme.

One of the key initiatives to reduce domestic GHG emissions is the Greenhouse Challenge program, introduced in 1995 by the Commonwealth Government. The aim of the program is to encourage firms to enter into voluntary cooperative agreements with government to reduce their GHG emissions. Whilst the program largely involves promoting the adoption by firms of no regrets options aimed at improving energy efficiency, recently the Greenhouse Challenge Office began investigating opportunities for firms to invest in carbon sequestration activities to offset their emissions. If a domestic emission trading scheme were introduced it would be desirable to see such investigation continued with the aim of incorporating sequestration into the trading scheme.

There is a wide range of possible emission reduction options for splitting any required overall emission abatement between permit periods — these can be broadly grouped into three options which vary in terms of emission reduction stringency over time. One option is to have more stringent reductions in emissions in the initial periods, becoming relatively less stringent in subsequent periods until the target abatement level is reached. A second option is to spread the total emission abatement burden evenly over the number of permit periods. A third option is to phase in emission reductions gradually over the overall abatement period, such that the emission reductions become relatively more stringent in each successive permit period. The basis for choosing between different emission reduction options will depend on the relative costs and perceived environmental benefits associated with different options.

There are a number of issues relating to a domestic GHG emission trading scheme that require further work and analysis. Some of these issues, such as the need to develop more reliable methods of measuring and monitoring GHG emissions, would require ongoing work. Other important issues, that would need to be resolved before the implementation of an emission trading scheme, include the permit period and the schedule of emission reductions over several periods, the initial participants and the method of allocating permits initially.

1 INTRODUCTION

As signatories to the United Nations Framework Convention on Climate Change (FCCC), Australia and other industrialised countries have agreed to implement measures aimed at reducing emissions of greenhouse gases (GHGs) into the atmosphere. The initial goal adopted was to return emissions to 1990 levels by the year 2000.

Recent negotiations have revolved around GHG emission reduction policies and objectives for the period beyond 2000. In the lead up to the third Conference of Parties to the United Nations FCCC, held in Kyoto in December 1997, several different proposals for reduction targets have been suggested. The European Union has proposed that industrialised countries reduce emissions by 15 per cent below 1990 levels by 2010. The United States' proposal is to stabilise emissions at 1990 levels by between 2008–2012. Discussions on post 2000 emission reduction objectives and policies will be the focus of the Kyoto Conference and any subsequent negotiations (ABARE 1997).

Australia's current greenhouse response strategy is based mainly on 'no regrets' action (see CoA 1992, 1995 and ICESD 1997 for details). No regrets measures have been defined as those that have net benefits (or at least no net costs) in addition to reducing GHG emissions (CoA 1992). The measures most commonly proposed as no regrets options include those that are aimed at improving efficiency in energy production, distribution and use, with particular attention paid to the residential, industrial and commercial sectors.

While it is perhaps debatable whether these measures really meet the criterion of 'no net cost', the Intergovernmental Committee on Ecologically Sustainable Development (ICESD 1997) has indicated that current actions based on these no regrets measures will be insufficient for Australia to meet the abatement target implied in the FCCC, or any strengthened commitments. To satisfy GHG emission abatement commitments, additional instruments will be necessary.

1.1 Role of economic instruments

Cost-effectiveness of international GHG abatement is a basic principle of the United Nations FCCC. This principle is particularly important in the Australian context. Australia relies heavily on the use of fossil fuels in the generation of energy and has a large energy-intensive export industry. (An overview of the current pattern and distribution of GHG emissions, both overseas and within

Australia, is provided in Appendix A — understanding this pattern is important as it influences the nature of the GHG abatement effort.) A cost-effective policy instrument is desirable for emission abatement because it minimises the loss of welfare to society and enhances the acceptability of the policy to industries, governments and communities.

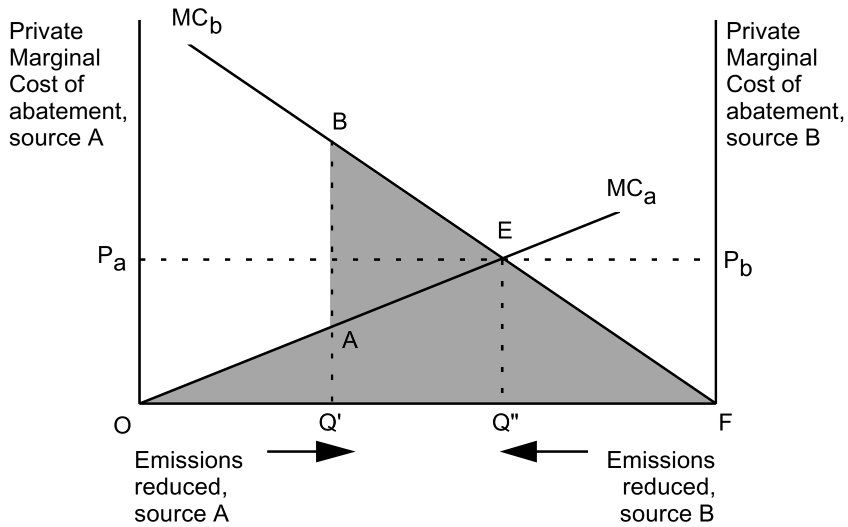
Two groups of policy tools that can be used in meeting Australia's GHG emission commitments are 'command-and-control' measures (which involve regulating or directly controlling emissions by specifying either the permissible emission levels that each source must meet or the necessary production process or equipment to be used), and 'market-based' instruments (which affect the cost of production and/or output prices) (IC 1997a). Market-based instruments include environmental taxes (which can be imposed either on the polluting feedstock or on the rate of emission), subsidies (which are conferred to encourage the development or adoption of cleaner production processes or technologies), and tradable emission permits (IC 1991).

Market-based instruments are generally more cost-effective than command-and-control measures because the burden of reducing emissions is shared across those polluters who are able to reduce emissions at the least cost — for tradable permits this is illustrated in box 1.1. Market-based measures also provide polluters with an incentive to develop new methods of meeting their obligations over time. For this reason alone they are generally regarded as preferable to command-and-control measures.

An international tradable permit, or emission trading, scheme has been promoted by some countries, such as the United States, as a mechanism to reduce the international cost of reducing GHG emissions (ICESD 1997; DFAT 1997). In the context of international negotiations, the Commonwealth Minister for the Environment has indicated that 'Australia supports emission trading in principle, recognising its possible contributions to improving the cost-effectiveness of emission reduction' (Hill 1997, p.6). A recent publication by DFAT (1997) refers to Organisation for Economic Cooperation and Development estimates which indicate that international emission trading would lower the cost of emission abatement to Australia by 50 per cent compared with having to meet an abatement target in the absence of an international trading scheme.

Box 1.1 Cost-effectiveness of economic instruments

Consider a hypothetical example in which coal-fired electricity plants A and B are the main sources of GHG emissions. The distance OF is the required reduction in emissions. The emission reductions of plants A and B are measured from point O and point F, respectively. The lines MC_a and MC_b represent plant A's and plant B's *marginal costs of abatement,* respectively — these represent the extra cost incurred from increasing the plant's compliance to abate GHG emissions. In the absence of any requirements to abate, A and B would operate at O and F, respectively.



Consider an example in which A and B were required, as a result of regulation, to reduce their emissions by an equal proportion, and that (given the different structures of the firms) this proportion required them to reduce emissions by OQ' and FQ' respectively. In the absence of fixed costs (required to continue production), the areas under each curve represent the total cost of abatement. The cost to A from the reduction will be the amount shown by the area OHQ'. The cost to B will be the amount shown by the area FGQ'. The cost to both A and B is the sum of the two areas, OHGF.

Consider an alternative example in which the government issued tradable permits such that the distance OF represented the amount of emissions required to be reduced. The firms would trade permits until the marginal costs of abatement for each are equalised, which would occur at point E. The low cost plant (A) reduces emissions by amount OQ" (Q'Q" more than it did under command-and-control) and the high cost plant (B) reduces emissions by amount FQ". The total costs to society would amount to the area OEF. The amount HGE is the cost-saving from adopting a tradable permit scheme rather than using a command-and-control approach.

Environmental taxes and tradable permits are conceptually equivalent and yield the same cost-effective results. In the above example, a reduction in emissions by an amount OF implies that the price for permits is equal to P_a ($=P_b$). Under a regime of environmental taxes, a universal tax rate set at P_a for each unit of emission would induce plants A and B to reduce their emissions by OQ" and FQ", respectively.

Emission trading could also be implemented at a domestic level as a tool for Australia to meet its GHG abatement commitments. An operational domestic emission trading scheme could, in a practical sense, make the interface with an international scheme easier, in the event that an international scheme is established.

In the context of GHG emission abatement, the potential for an emission trading scheme to include GHGs other than carbon dioxide (CO_2) and sectors other than energy gives rise to the potential for the marginal cost of emission abatement to be lowered (relative to a scheme that covers only CO_2), and therefore the total cost of pollution abatement reduced. Some of the additional sectors a tradable permit scheme could include are agriculture, land use change and forestry, where emissions can not only be released but can also be absorbed through, for example, tree planting and improved land management practices. This process of absorbing emissions is called 'sequestration' and can reduce a country's net emissions of GHGs.

There are several examples of tradable permit schemes that have been implemented both in Australia (see box 1.2) and overseas. The scheme that has perhaps received the most attention, and has been the most successful, is the United States' sulphur dioxide emission trading scheme. This scheme is described in Appendix B. In Australia, under existing environmental guidelines in the New South Wales electricity sector, electricity retailers are required to pursue emission reduction benchmarks as part of their licence conditions for operating in New South Wales. The use of a voluntary emission trading scheme has been suggested recently in this context (Committee of Inquiry into Sale of the NSW Electricity Assets 1997).

Given this background, this paper brings together several recent analyses of emission trading schemes and attempts to provide a basic framework for setting up a practical domestic GHG emission trading system for Australia.

1.2 Structure of the report

A number of issues that would need to be addressed when considering a domestic emission trading scheme are described in chapter 2. These issues include: how to distribute the initial stock of permits; the appropriate and necessary institutional and legislative arrangements; and how to incorporate carbon sequestration. In addition, some design options for an emission trading scheme in Australia are provided.

Box 1.2 Examples of tradable permit schemes in practice

Several different tradable permit schemes currently operate in Australia. The Salinity and Drainage Strategy, managed by the Murray-Darling Basin Commission, includes a salt credits trading scheme to reduce the level of salinity in the Murray-Darling river system. This scheme operates between the irrigation districts of New South Wales, Victoria and South Australia.

The Hunter River Salinity Trading Scheme is another example of a tradable salt discharge scheme, operating along the Hunter River in New South Wales. This scheme involves 11 coal mines and two large power stations who amongst them are licensed to discharge a total predetermined level of salt into the river or its tributaries. Within the total level of discharge, each firm is allocated discharge ‘credits’ which they are free to trade with other credit holders.

Also in New South Wales there is in place a quasi-tradable permit scheme to reduce phosphorous levels in the Hawkesbury-Nepean river system. The main source of phosphorous is sewage effluent for which the Sydney Water Corporation is responsible. The New South Wales Environment Protection Authority (EPA) developed the South Creek Bubble Licence Scheme involving three Sydney Water sewerage plants. Under this scheme, the New South Wales EPA sets an aggregate load limit of phosphorous levels for the bubble as a whole and allows the Sydney Water Corporation to determine the load allocation between the plants. This implies that the plants are able to ‘trade’ phosphorous discharges between themselves to meet the overall required reductions in emission levels at least cost.

Source: IC (1997b)

Finally, in chapter 3, the issues involved with the implementation of an emission trading scheme, once a scheme has been designed, are discussed. These issues include: the role of existing policies in an emission trading scheme; different possible reduction scenarios to achieve a given level of emission abatement (and the implications of these scenarios); and the interface of a domestic emission trading scheme with an international trading scheme.

2 DEFINING THE ISSUES IN EMISSION TRADING AND SOME DESIGN OPTIONS

An emission trading scheme for greenhouse gases (GHGs) would involve a market in the exchange of emission permits. To ensure that such a scheme operates as efficiently as possible, care must be taken in its design and implementation. Property rights associated with tradable permits would need to be clearly defined, secure and enforceable. The success of an emission trading scheme also depends on whether the market for permits is competitive. The nature of the GHGs and the industries involved will have an influence on whether a competitive market in permit rights will develop. However, policy makers may also be able to influence competitiveness through the way in which rights are specified and the initial assignment of permits (Rose 1997). This chapter discusses the main issues likely to be encountered when establishing an emission trading scheme and highlights some design options for Australia. Some of the material in this chapter has been drawn from Mullins and Baron (1997), Fisher et al. (1995) and EPA Victoria (1995).

2.1 Defining the product

The first step in implementing an emission 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 GHGs covered under the scheme.

Duration of permits

In an emission 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. 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 emission 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).

A potential problem with introducing large changes to the emission cap is that existing permit holders will be affected, whether the cap is increased or decreased, and they might resist changes in the stock of permits. Permit holders may argue against reductions in the total stock of permits on the basis that permits comprise a necessary input to their production process and are therefore regarded as valuable private property. This perception of permits may make it difficult for the total emission load to be reduced without adequate compensation or appropriate lead times. Alternatively, raising the emission limit and allocating additional permits would reduce the value of permits already issued and is also likely to be met with resistance. Experience with markets in government issued licences, such as taxicab licences, indicates that current licence holders can be a powerful lobby against changing the total number of licences (EPA Victoria 1995; UNCTAD 1996).

The potential for problems to arise with introducing changes to the emission cap largely depend on the perception of permits as a secure asset. One solution is for the central authority to signal the intended adjustment path when the emission cap is initially decided, and to schedule changes to the emission cap well in advance. Institutional arrangements for such changes should be built into the design of an emission trading scheme. Changes to the emission cap need to be infrequent to minimise uncertainty (Mullins and Baron 1997).

Furthermore, 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 sulphur dioxide (US SO_2) emission 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 emission 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 emission trading scheme. From an economic perspective, the total cost to all the participants in an emission 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.

As the relationship between the consumption of fossil fuels and CO_2 emissions is generally understood, if an emission trading scheme were to cover only CO_2 emissions, permits could be based on quantities of fossil fuel consumed and their related carbon contents rather than emissions (Fisher et al. 1995; Mullins and Baron 1997).

An alternative could be to establish separate trading regimes for individual GHGs whose emissions can not be measured as accurately as those of CO_2. As the markets in GHG permits develop, and estimation techniques and monitoring improve, it may become more feasible to develop markets for more GHGs. However, the markets for some gases may not have enough participants to ensure a competitive market, and hence the range of cost-effective mitigation options available to participants would be reduced (Mullins and Baron 1997).

2.2 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 emission trading scheme is also a key determinant in whether the number of traders in the market will be large enough to ensure competition (IC 1997a). The issue of market power is discussed later in this chapter.

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 emission 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 emission trading scheme.

Given that energy related CO_2 emissions are the easiest of all GHG emissions to measure and monitor (see box 2.1), 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 — these large emitters are identified in Appendix A. 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.

2.3 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.

Box 2.1 Potential participants in a domestic greenhouse gas emission trading scheme

As noted in Appendix A, energy related GHG emissions (that is, emissions from fuel combustion) comprise the greatest proportion of total Australian GHG emissions of any source, accounting for about 60 per cent of total measured emissions. Emissions from fuel combustion can be split into those from stationary sources and those from transport, with stationary sources contributing the greater part. Emissions from stationary sources of fuel combustion can be measured and monitored relatively easily, cheaply and reliably. This is due to the fact that the main emitters are relatively large entities and can be easily identified (such as electricity generators), and the fact that by far the most significant type of emission from stationary energy sources is CO_2 for which there exist methods of reliably measuring emissions (NGGIC 1996a).

Emissions from transport may be less easy to include in an emission trading scheme. This is mainly because emissions from transport come from a large number of small, individual emitters, and a permit scheme directly including every emitter in the transport sector would be administratively complex and thus costly. However, emissions from this source could be covered indirectly by, for example, issuing permits upstream to fuel retailers or refiners (NGGIC 1996a).

Emissions from non-energy sectors on the whole may be more difficult and/or costly to measure and monitor than those from energy sectors. This is because the sources of emissions within non-energy sectors often include large numbers of relatively small emitters, such as farms and small businesses. Furthermore, means and methods of measuring and monitoring emissions of the various GHGs from these sources generally have not yet been fully developed. However, there are some sources of non-energy sector GHG emissions which may be more easily included than others. For example, the existence of companies that already collect methane (CH_4) emissions from landfill (to generate process heat and electricity, for example) suggests opportunities for measuring and monitoring at least some waste related CH_4 emissions.

Non-emitters should also be able to participate in an emission trading scheme. Any person or entity could buy, sell and hold permits, as long as they abide by the rules of trading. Sequestration activities should also be included in an emission trading scheme for Australia.

With a perfectly competitive domestic emission 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).

However, the presumption that to whom the initial assignment of permit shares is made is of importance only from a distributional point of view, and has no efficiency effects, is unlikely to hold in practice. Some conditions which will affect the efficiency of the initial allocation of permits include:

- imperfect competition in permit trading — for example, to whom permits are assigned will influence the efficiency of the outcome if there is a likelihood that some participants will have market power;
- transaction costs; and
- imperfect information — that is, where participants have differing information on, for example, methods of reducing emissions or the market for permits (Fisher et al. 1995; Rose 1997).

Governments may have a role in facilitating the dissemination of information and other aspects of the development and operation of permit markets to reduce market power and transaction costs (Rose 1997).

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 emission 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 emission 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 emission 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 — see box 2.2 for a discussion of different bases for issuing 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’.

Box 2.2 Different bases for issuing permits free of charge

There is a number of different bases on which the initial allocation of permits potentially could be differentiated between participants. Permits could be distributed on the basis of differences in the marginal costs of emission abatement between different participants. If such information could actually be obtained, the outcome, in terms of the number of permits held by each participant, would be similar to that which would result from auctioning permits and to that which would eventuate after trading if permits were initially allocated on some other basis.

Some may argue that permits should be allocated in a way which rewards emitters who have voluntarily undertaken action to reduce their emissions prior to the introduction of an emission trading scheme. It is likely that in some instances, voluntary action will have been taken on the basis of it being 'no regrets' action (that is, action which does not result in a net cost for the firm). In these cases there is no economic rationale for rewarding such firms, as their decision to reduce emissions will, by definition, have conferred on them a net benefit. If there are firms who have voluntarily reduced emissions through means which are beyond no regrets measures at a net cost to them, there may be a case for rewarding such firms — but identifying them and determining appropriate compensation would be very difficult.

Grandfathering permits, by allocating permits on the basis of past fossil fuel use (or fossil fuels embedded in output, depending on where in the chain of production and consumption permits are allocated), is another option. Issuing permits free of charge on a grandfathering basis does not discriminate between efficient and inefficient users of fossil fuels, though subsequent trading would tend to ensure that permits are used by those for whom abatement is most costly (BIE 1992; Fisher et al. 1995).

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

2.4 Administering the scheme

There is a need for a designated central authority to administer an emission 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 sulphur 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 emission 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 emission 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 might be applied on borrowings from future periods (DFAT 1997).

2.5 Market issues

A number of market issues need to be considered when designing an emission 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.

Market power

Mullins and Baron (1997) have argued that market power could arise in the form of a few large buyers of GHG permits, a few large sellers of permits or a few participants that dominate the permit market through the size of their GHG permit holdings. Using a conceptual model, Hahn (1984) has explained how a single firm with market power (holding the largest share of permits) might exercise its influence in a market for transferable property rights.

According to Hahn (1984), just because a firm may have a large share of total permits this does not necessarily mean it can influence the outcome in the permit market. For example, if the firm with market power receives an allocation of permits just equal to the amount it would choose to use, the marginal cost of abatement for all firms will be equal to the equilibrium price of permits, leading to an efficient market outcome. On the other hand, if the firm with market power does not receive an amount of permits equal to the amount it chooses to use, then its marginal cost of abatement will either exceed, or be less than, the permit price resulting in an inefficient market outcome. In other words, if a firm has market power in the permit market, its effect on permit price varies with its excess demand for, or supply of, permits.

The potential for market power can be influenced by the way the emission trading scheme is designed and by the participants that are allowed to trade GHG permits. A market with a large number of diverse participants in which permits can be easily traded will be less susceptible to market power by individual participants. This is an important reason to allow GHG permits to be bought and sold by any individual or entity.

2.6 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.

The net amount of carbon absorbed by carbon sinks can be increased, all other things held equal, by:

- reducing land clearing;
- increasing the amount of vegetation, such as planting more trees and woody scrub; and
- improving land management techniques to reduce the amount of carbon released from soils.

As well as providing a store for carbon, these actions can in some cases result in other benefits, such as increased biodiversity, reduced levels of soil erosion and salinity and improved land productivity for agricultural purposes. However, there will also be opportunity costs associated with alternative uses of resources, such as land, forgone.

Incorporating sequestering activities into an emission trading scheme would increase the flexibility, and may reduce the cost to participants, of the scheme by providing an additional avenue through which emission permits could be obtained and the opportunity to reduce the marginal cost of emission abatement. Permits obtained through sequestration could be used by the holder to offset their own emissions or sold on the permit market for financial gain.

A possible concern with including sequestration in an emission trading scheme is the increased administrative costs that may be associated. These costs would need to be weighed against the benefits of including sequestration.

At an international level, the importance of the role of carbon sequestration in reducing GHG emissions has been recognised. There are currently a number of examples of sequestration programs. One such example is administered by the United States Initiative on Joint Implementation (USIJI), established with the aim of reducing GHG emissions through international partnerships. In 1995 the USIJI, together with its clients, developed a pilot sequestration project in Rio Bravo in Belize, Central America, to explore and demonstrate the use of carbon sinks as a credible and accountable GHG emission reduction strategy (USIJI 1996).

The Commonwealth Government's Greenhouse Challenge initiative encourages firms to reduce their emissions voluntarily through a number of means, including planting trees to sequester CO_2. Currently over 100 firms have either signed cooperative agreements with the Commonwealth Government to reduce GHG emissions or given a formal commitment to develop an agreement. Some of these firms have identified tree planting as a method by which they plan to reduce their emissions.

Key issues in incorporating sequestration

There are several key issues that would need to be addressed in incorporating sequestration in an emission 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 and the United Nations Framework Convention on Climate Change 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 emission 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 1997a).

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 emission trading scheme.

It is likely that improved and more cost effective measuring techniques will develop with the establishment of an emission 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 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.

3 ISSUES FOR IMPLEMENTATION

In the event that Australia were to adopt an emission trading scheme for greenhouse gases (GHGs), in addition to issues relating to the design of an emission trading scheme, there are issues associated with the implementation of such a scheme which would need to be addressed. Some of these implementation issues include the role of existing initiatives to reduce GHG emissions, the schedule of emission reductions to be undertaken to meet a particular abatement target and the interface of a trading scheme with an international emission trading scheme. These issues are the subject of this concluding chapter.

3.1 Role of existing initiatives

There currently exist a number of Commonwealth and State Government initiatives that would complement an emission trading scheme if such a scheme was to be established in Australia. In 1995 the Commonwealth Government, in association with industry, announced the introduction of the Greenhouse Challenge program, to be administered by the Greenhouse Challenge Office (GCO). The aim of the program was to encourage firms to enter into voluntary cooperative agreements with government to reduce their GHG emissions. The program largely involves promoting the adoption by firms of 'no regrets' options aimed at improving energy efficiency. However, the GCO recently began investigating opportunities for firms to invest in carbon sequestration activities to offset their emissions. To this end it is currently establishing a framework to address issues relating to measuring, and accounting for, carbon sequestration.

Whilst some participants in the Greenhouse Challenge initiative have already begun tree planting activities, carbon sequestration is still at the early stages of its development as a fully accountable offset for emissions. In the event of the introduction of a domestic emission trading scheme it would be desirable to see such development continued with the aim of incorporating carbon sequestration into the trading scheme. The Industry Commission, in its inquiry into ecologically sustainable land management, has also recently highlighted the need to continue work to develop appropriate methods of measuring carbon sequestration and establish a system of carbon credits for sequestering activities (IC 1997c).

Currently in New South Wales there is a proposal relating to the introduction of a voluntary GHG emission trading scheme to cover the State's electricity retailers (see Committee of Inquiry into Sale of the NSW Electricity Assets 1997). The objective of the scheme would be to facilitate the achievement by electricity retailers of GHG emission reduction benchmarks, which are required as part of their licence conditions. The Committee of Inquiry into Sale of the NSW Electricity Assets (1997) suggested that a voluntary emission trading scheme would be the most cost-effective method for achieving the objective of emission reductions. If the Committee's suggestions are accepted, and New South Wales electricity retailers commence emission trading, such a program could easily become part of a national emission trading scheme in the event that a national scheme is established.

It is important to recognise the merit in having a national emission trading scheme compared with a trading scheme operating at a state level. Previously, the Industry Commission has estimated (using 1988 as a base year) that if each State independently tried to reduce GHG emissions by 20 per cent, the national costs of emission reduction would be higher than if Australia as a whole reduced emissions by 20 per cent — this is because the marginal cost of emission abatement would be reduced, and those states for whom it is relatively cheap to reduce emissions will do so ahead of those for whom it is more costly. Further, the Commission's analysis suggested that the economic costs of reducing emissions would be lower if a system of tradable permits existed instead of a regional or activity-specific reduction target (IC 1991).

3.2 Possible emission reduction scenarios

In the event that Australia is required, for example through an international agreement, to reduce GHG emissions to a target level by a given date, a schedule of achieving these reductions will need to be determined. There is a wide ranging number of options for splitting the required overall emission abatement between permit periods, however these can be broadly grouped into three different options which vary in terms of emission reduction stringency over time.

One option is to have more stringent reductions in emissions in the initial periods, becoming relatively less stringent in subsequent periods until the target abatement level is reached. Therefore, the burden on participants is relatively high in the initial periods and relatively low in later periods. A second option is to spread the total emission abatement burden evenly over the number of permit periods. A third option is to phase in emission reductions gradually over the overall abatement period, such that the emission reductions become relatively more stringent in each successive permit period.

The basis for choosing between different emission reduction options will depend on the relative costs and perceived environmental benefits associated with the different options. It is important to recognise that different individuals and governments place different valuations on the environment, and that these valuations change with income. The opportunity costs of different emission reduction options have two dimensions, namely the physical effects of the different options and the valuation of these effects. The perception of these opportunity costs could vary between different countries and within countries over time, and will be influenced by the time path over which emission abatement is planned and the rate of time preference (or the discount rate).

3.3 Interface with an international trading scheme

IPCC (1996) states that an international tradable permit scheme would be the most cost effective method of attaining an agreed level of global emission reduction with certainty (subject to enforcement). A number of studies (for example BIE 1992, ABARE and DFAT 1995, Mullins and Baron 1997, DFAT 1997 and IC 1997a) have examined the issues involved in developing an international trading scheme for GHG emissions to meet any future international commitment to reduce emissions.

In the event of the establishment of an international emission trading scheme for GHGs, DFAT (1997) outlines several options for how trading might be conducted, all of which could see a domestic trading scheme coexist with or merge into an international scheme. One option would be for trading to be restricted to national governments, in which case the Australian Government would be able to purchase or sell additional permits from or to other national governments. In this case, a domestic permit trading scheme in Australia could coexist with an international scheme, with the domestic emission cap set by the number of international permits the Australian Government holds.

A second option would be to allow international trading at either a company or individual level. National governments would be able to allocate permits domestically from within the internationally agreed national target or permit level to facilitate a domestic emission trading market but with links to an international market. With time, it is possible that this approach would lead to a market in emission permits similar to existing commodity markets operating on major international exchanges with a freely quoted market price and high volume sales levels (DFAT 1997).

A third option, favoured by the United States, would be to allow national governments to trade alongside private participants (DFAT 1997).

It is important to recognise that to reduce GHG emissions effectively and efficiently any international emission trading scheme must include all nations. This includes less developed countries, such as China and India, who will contribute significantly to world emission levels as they develop their economies early in the next century (BIE 1996).

In principle, the same type of issues as those discussed in the previous chapter for a domestic emission trading scheme would need to be resolved when establishing an international trading scheme. One of the major issues would be deciding on the initial allocation of permits to each country. There would also be a number of institutional arrangements which would need to be negotiated that may have the potential to affect market confidence and the costs of transactions (see DFAT 1997).

Currently, in recognition of the global nature of GHG emissions, countries can enter into agreements with others to reduce emissions through pilot programs for Activities Implemented Jointly (AIJ), which is overseen by the Framework Convention on Climate Change. AIJ is based on the concept of joint implementation (JI), whereby countries with high costs of GHG emission abatement can undertake abatement activities in other countries with lower marginal abatement costs to meet reduction targets. Proponents of JI argue that such an approach to emission abatement will lower the adjustment costs for the investing country and provide the developing country with new environmentally friendly technology and investment.

The pilot stage of the AIJ program is to continue until the year 2000, during which time participants are able to trial JI projects and any problems associated with the program or individual projects can be identified and overcome. Under the program, developed countries may enter into agreements with each other or with developing countries on a voluntary basis. However, during the pilot phase countries are not able, through their sequestration activities in other countries, to earn emission credits to offset emissions in their own country (DFAT 1997).

Several developed nations, including the United States, the Netherlands and Nordic countries, have invested in JI projects through the AIJ program (BIE 1996). Australian industry is well placed, both geographically and technologically, to pursue future JI opportunities in the Asia–Pacific region (BIE 1996).

Tietenberg and Victor (1994) and ABARE and DFAT (1995) have suggested a phased approach to introducing an international GHG emission trading scheme. In Phase I, developed countries could continue to pursue emission stabilisation goals while experimenting with joint implementation projects in developing countries, which would allow developed countries to achieve part of their emission abatement commitments in lower cost countries. In Phase II an emission trading scheme among developed countries could begin. The process of using jointly implemented projects, to allow developed countries to achieve part of their emission abatement commitments in lower cost countries, could also be formalised. For each emission abatement project in the developing countries, a certified number of tradable permits could be created, equivalent to the amount of emission abatement achieved, to be held initially by the project investor. Such permits could be treated as equivalent to the permits issued to developed countries in the emission trading scheme and could be traded freely. The emission trading scheme could become fully global in Phase III by expanding to include all other countries.

The above phased approach reflects a more gradual and a step-wise approach toward implementing a global emission trading scheme compared to immediately adopting a widespread scheme. It is in this context that the feasibility of a domestic emission trading scheme needs to be explored.

3.4 Areas for further work

There are a number of issues relating to a domestic GHG emission trading scheme that require further work and analysis. Some of these issues would require ongoing work, even after the introduction of an emission trading scheme. Other issues would need to be resolved before the implementation of an emission 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. As mentioned in chapter 2, it would be desirable to have a comprehensive emission 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 emission 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.

APPENDIX A CURRENT PATTERN OF GREENHOUSE GAS EMISSIONS

To assist in the formulation of an emissions trading scheme, this appendix presents information on the size and distribution of different greenhouse gas emissions in Australia and compares Australia's position with that of other countries.

A.1 Australia's emissions in perspective

Greenhouse gases (GHGs) are released into the atmosphere as a result of natural processes, such as vegetation decay, fires and volcanoes, and as a result of other anthropogenic (human) activity. Some natural processes and some human activities result in the capture of GHGs from the atmosphere. The information presented in this appendix, and this paper, focuses on emissions resulting from human activity.

The main GHGs are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and perfluorocarbons (PFCs). These gases vary in their contribution to the enhanced greenhouse effect. The global warming potential (GWP) of a gas indicates the relative impact of a gas on the atmosphere and is measured in terms of CO_2 equivalence. The GWP of a gas is determined by its atmospheric lifetime and its relative efficiency in absorbing infrared radiation. Typical GWPs of some common GHGs are shown in table A.1.

Table A.1 Global warming potential of common greenhouse gases

Type of GHG	*Chemical formula*	*100 year GWP (CO_2 equivalent)*
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
Perfluoromethane	CF_4	6500
Perfluoroethane	C_2F_6	9200

Source: NGGIC (1997b)

In 1995, total Australian GHG emissions were estimated at 402 million tonnes of CO_2 equivalent. This estimate includes total emissions net of any removals by greenhouse sinks, but excludes the contribution of the Forest and Grassland Conversion (F&GC) sector for which the estimates are subject to large uncertainties. Methodological changes in the 1995 GHG inventory implies that care should be taken in comparing 1995 estimates with those for previous years (NGGIC 1997b).

Absolute and per capita CO_2 emissions for Australia and 19 other of the world's top emitting countries are reported in table A.2 for 1994. The data include CO_2 emissions from the combustion of fossil fuels, cement production and gas flaring. The difference between the figure for Australia given in table A.2 and that from the National Greenhouse Gas Inventory Committee (NGGIC) referred to above reflects the much broader measure of GHG emissions covered by the NGGIC. The NGGIC figure includes emissions of other GHGs and emissions from other non-energy sources.

In 1994 Australia contributed a small proportion (approximately 1.2 per cent as measured in table A.2) to estimated global CO_2 emissions. It is also shown, in table A.2, that Australia is not a large emitter relative to the other countries featured, ranking 15th amongst the top 20 countries. In absolute terms, Australia's emissions are considerably less than those of countries such as the United States, China, Russia and Japan. However, Australian emissions are amongst the highest when measured relative to population: it can be seen from table A.2 that in 1994 Australian CO_2 emissions per person were second only to the comparable figure for the United States.

The most significant reasons why Australian per person GHG emissions are so high are:

- Australia's relatively more intensive use of coal;
- Australia's greater reliance on fossil fuels for energy; and
- Australia's export of energy intensive products.

Coal combustion produces higher rates of CO_2 emissions per unit of energy than either oil or natural gas. Coal has been estimated to emit about 25 kilograms of carbon per gigajoule (kg C/GJ) of energy, oil produces about 20 kg C/GJ and natural gas produces about 15 kg C/GJ (IPCC 1996). As a result a country may influence its level of emissions through its choice of fuels. Marland and Boden (1997) compares CO_2 emissions from the combustion of fossil fuels, cement manufacture and gas flaring for selected countries. Marland and Boden find that the proportion of Australian emissions from the combustion of solid fossil fuels (mainly coal), at nearly 60 per cent, is substantially higher than many other countries (including large emitters such as the United States, Germany, Japan and Canada) and well above the global average. Australia's more intensive use of solid fuels is resulting in higher emissions for a given level of energy consumption than if liquid and gaseous fuels featured more prominently in the fuel mix.

Table A.2 Energy and related [a] carbon dioxide emissions of the top 20 carbon dioxide emitting nations, 1994

Country	*CO_2 emissions (Mt)*	*Rank*	*Emissions per person ($t\ CO_2$)*	*Rank*
Australia	278.3	15	15.58	2
Canada	446.3	8	15.33	3
China	3037.6	2	2.57	18
France	323.4	13	5.61	15
Germany	806.7	6	9.90	7
India	867.0	5	0.95	20
Indonesia	245.5	19	1.25	19
Iran	255.1	17	3.89	16
Italy	392.1	10	6.86	14
Japan	1112.0	4	8.91	9
Kazakhstan	244.0	20	14.34	4
Mexico	248.2	18	3.89	16
North Korea	260.6	16	11.11	5
Poland	338.9	11	8.84	10
Russia	1616.9	3	10.96	6
South Africa	313.5	14	7.74	12
South Korea	336.8	12	7.55	13
Ukraine	409.4	9	7.96	11
United Kingdom	549.1	7	9.39	8
United States	5086.6	1	19.51	1
World	**22733.3**		**4.03**	

a Includes emissions from the combustion of fossil fuels, cement production and gas flaring.
Source: Marland and Boden (1997)

Australia's greater overall reliance on fossil fuels for energy is also likely to lead to higher per person GHG emissions. The burning of fossil fuels generates more GHG emissions than alternative energy forms such as nuclear and hydro-electric power. Australian electricity generation is amongst the most fossil fuel intensive in Organisation for Economic Cooperation and Development (OECD) countries (OECD/IEA 1995). In 1993 over 90 per cent of Australia's electricity was generated using fossil fuels, with the majority of this (nearly 80 per cent of the total) coming from the burning of coal (OECD/IEA 1995). This compares with nearly 58 per cent from fossil fuels and just under 40 per cent from coal for the OECD overall. Australian reliance on fossil fuels for electricity is significantly higher than for the United States (nearly 70 per cent), Japan (around 60 per cent), New Zealand (24 per cent) and Canada (20 per cent) (OECD/IEA 1995).

As well, fossil fuel intensive products represent a significant proportion of Australia's exports. This has the effect of increasing Australia's per capita emissions relative to countries whose exports are less fossil fuel intensive.

The contribution of various activities to total national GHG emissions is illustrated in table A.3. The National Greenhouse Gas Inventory provides estimates of GHG emissions from sources, and removals from sinks, that result from human activities. Emissions and removals that result from natural processes are beyond the scope of the inventory. According to the inventory, in 1995 the majority (over 60 per cent) of Australia's GHG emissions came from energy related sources. Stationary energy sources such as electricity and heat production, iron and steel production and cement production, contributed over 45 per cent of total emissions. The transport sector contributed over 14 per cent of emissions. A further 5 per cent came from fugitive emissions which mainly occur through leaks in the production, transmission, processing, storage and distribution of fuels.

Agriculture was the most significant source of non-energy GHG emissions in 1995, accounting for over 17 per cent of total emissions in that year. Land use change and forestry (LUC&F) contributed over 11 per cent of emissions. Of the remainder, waste accounted for over three per cent and industrial processes nearly two per cent of net GHG emissions.

The contribution of various GHGs to total Australian emissions is also shown in table A.3. Emissions of CO_2 accounted for nearly three quarters (71.6 per cent) of total emissions in 1995. Emissions of CH_4 contributed over one fifth (22.7 per cent) of total GHG emissions, whilst N_2O emissions accounted for just over five per cent. Emissions of PFCs represented less than 1 per cent of total net GHG emissions.

On the basis of information in table A.3, it is clear that the sources of Australian GHG emissions are diverse. The main GHG is CO_2, and it is emitted and removed through a number of different activities. Emissions of CH_4 and N_2O are also significant particularly from agriculture, fugitive emissions and waste.

Table A.3 Contribution of various activities to Australia's greenhouse gas emissions, by type, 1995

Emitting activity	*CO_2 equivalent[a] emissions (Mt)*				*Contribution of activity*
	CO_2	*CH_4*	*N_2O*	*PFCs*	*to total emissions (%)*
Fuel combustion					
Stationary	220.28	1.84	0.87	–	45.78
Transport	65.19	0.54	3.04	–	14.12
Fugitive (Leakage etc)	4.23	21.36	0.03	–	5.26
Industrial Processes	7.02	0.08	0.43	1.43	1.84
Solvent	–	na	na	–	–
Agriculture	–	66.07	21.30	–	17.94
LUC&F	51.87	4.28	0.87	–	11.71
Waste	0.02	16.34	na	–	3.36
Total	**348.59**	**110.51**	**26.51**	**1.43**	**100.00**
Contribution of each gas to total emissions (per cent)	71.57	22.69	5.44	0.29	

a CO_2 equivalence estimated on the basis of GWP of 21 for CH_4 and 310 N_2O, 6500 for CF_4 and 9200 for C_2F_6. Does not include NO_X, CO and NMVOC emissions for which GWP information was not available. The figures for LUC&F and Total are net figures for CO_2. Solvent and other product use produced 0.17 Mt of NMVOC emissions in 1995.
– Exactly zero.
na Data not available.
Source: NGGIC (1997b)

A.2 Greenhouse gas emissions from non-energy sources

GHG emissions from non-energy sources represent approximately one third (34.85 per cent) of Australia's anthropogenic GHG emissions (table A.3). This section presents some greater detail on emissions from agriculture, LUC&F, waste and non-energy industrial processes.

Agriculture

It can be seen from table A.3 that in 1995 agriculture contributed nearly 18 per cent of net CO_2 equivalent emissions in 1995. The most significant GHG is CH_4, accounting for around three quarters of CO_2 equivalent emissions from the agricultural sector. The agricultural sector is also the largest emitter of N_2O, representing over 80 per cent of Australian N_2O emissions.

Land use change and forestry

Data reported in table A.3 show that in 1995 LUC&F accounted for approximately one eighth (11.7 per cent) of total CO_2 equivalent emissions. However there is much uncertainty associated with the LUC&F data and it is generally regarded as less reliable than data on other sectors.

The Intergovernmental Panel on Climate Change specifies four sectors within the LUC&F category. These sectors are: Abandonment of Managed Lands; Changes in Forest and Other Woody Biomass; Other; and F&GC.

The first sector, Abandonment of Managed Lands, is not significant in Australia. The next two sectors are net sinks for carbon, on a stock and flow basis. In the Changes in Forest and Other Woody Biomass sector the carbon released from harvested timber was less than that removed through biomass growth. In the Other sector pasture improvement, minimum tillage and other agricultural practices produced net carbon removals (NGGIC 1996a).

For Australia, F&GC refers to the clearing of native vegetation for agriculture, and it is typically estimated as a net source of GHG emissions. In the 1990 GHG inventory, emissions from land clearing were estimated to lie between 39 megatonnes (Mt) CO_2 and 352 Mt CO_2, with a best estimate of 156 Mt (NGGIC 1996a). The large uncertainty surrounding the F&GC emissions arises from the lack of data on the carbon content of the vegetation cleared and the soils involved (NGGIC 1996a).

Estimates for 1995 show the LUC&F sector to be a net emitter of GHGs, the emissions resulting from F&GC are greater than those removed in the other two sub-sectors (NGGIC 1997b).

LUC&F also emits relatively small amounts of other gases. However, the lack of conversion data means that the oxides of nitrogen (NO_X), carbon monoxide (CO) and non-methane volatile organic compound (NMVOC) emissions are not reflected in the total reported in table A.3. Bearing in mind the limitations of this measure, CO_2 dominates emissions from the LUC&F sector.

Waste

The disposal of solid waste through decomposition and incineration releases GHG emissions. Similarly, the disposal of liquid wastes through waste water may also release GHGs. The NGGIC estimates GHG emissions from landfill, waste water and waste incineration for Australia.

The primary GHG which is released through disposal of waste is CH_4. In 1995 the CH_4 emissions from waste were estimated as being equivalent to 16.3 Mt of

CO_2 (see table A.3). This does not represent a large proportion of Australian CO_2 equivalent emissions (just over 3 per cent) but accounts for nearly 15 per cent of Australian CH_4 emissions.

As noted earlier, CH_4 has a GWP of 21 times that of CO_2 over a 100 year period. Collecting and burning CH_4, thereby converting it to CO_2, reduces the GWP of the gas, and in turn reduces the impact of CH_4 emissions on the atmosphere. An alternative and preferable option involves capturing the CH_4 and using it to generate heat and electricity. In some instances, these procedures may be applied to CH_4 emissions resulting from the disposal of waste.

Non-energy industrial processes

Non-energy industrial processes are not a major contributor of GHGs. In 1995 they accounted for under 2 per cent of Australian CO_2 equivalent emissions.

The largest contribution to total industrial process GHG emissions came from the non-ferrous metal processing industries (NGGIC 1997b), and are in addition to the emissions generated in the production of the vast quantities of electricity required for the smelting process. These non-energy related emissions are largely due to the smelting of alumina to aluminium, which produces a number of GHGs, including PFCs which have the highest GWPs of all GHGs. In 1995 industrial processes generated nearly all of the PFC emissions in Australia (NGGIC 1997b).

Cement production is the most significant source of CO_2 emissions from non-energy industrial processes (NGGIC 1997b). In 1995 the manufacture of portland cement clinker accounted for over 45 per cent of industrial process CO_2 emissions and over 35 per cent of industrial process CO_2 equivalent emissions. Chemical reactions at very high temperatures (around 1500 degrees Celsius) convert calcium carbonate into calcium oxide. This process releases approximately 0.5 tonnes of CO_2 for every tonne of cement produced (NGGIC 1996b). In addition, large quantities of fossil fuels are burnt in order to achieve the high temperatures required for the chemical conversion in cement production. Cement production is a significant contributor to total CO_2 emissions when both the non-energy industrial process and energy related emissions are considered (Pearce 1997).

A.3 Energy and related greenhouse gas emissions

Nearly two thirds (65.16 per cent) of Australian anthropogenic GHG emissions come from energy related sources (see table A.3). Because of their overall significance, sources of energy related emissions are potentially important participants in an emissions trading scheme. Therefore, it is useful to identify these sources of GHG emissions, the magnitude of their emissions and the types of fuels that are producing those emissions.

Energy consumption data allow identification of the end-users of energy. However, the GHG emissions associated with the use of energy are often not produced at the point of energy consumption but earlier in the energy cycle. An understanding of the energy cycle is helpful in tracing emissions to their source and thereby useful in implementing an emission trading scheme.

Energy supply

The energy supply and consumption cycle can be categorised into three stages. 'Supply' is the first stage and consists of the energy in its 'raw' input form. The bulk of the Australian energy supply is sourced domestically although there are some imports, particularly of crude oil and petroleum products (Bush et al 1997). Australia exports large volumes of its energy supply, including all uranium mined. Stocks of energy sources are also held which may be either built up or run down depending on the volume of exports relative to supply. The domestic availability of the different energy supplies is given by indigenous supplies and imports, net of exports and stock changes (Bush et al 1997).

Some of the energy can be harnessed in its initial form. In other cases the energy supplies need to be transformed into a more consumable form. This process represents the 'conversion' stage, the second phase of the process.

Conversion of energy

In this phase raw materials are processed to convert their 'stored' energy into a consumable form. In this phase some types of energy sources are used and others are produced in the different conversion processes. For example, in the electricity generation process coal, gas, petroleum products and renewable energy sources are consumed, and electricity is produced.

The conversion process results in net energy losses and consequently the final domestic energy availability is less after the conversion phase (Bush et al 1997).

End-use energy consumption

The final phase is the consumption of electricity by end-users. The breakdown of energy use by sector and fuel is shown in table A.4. The two largest energy consuming sectors, transport (38.1 per cent) and manufacturing (31.0 per cent), account for two thirds of Australian end-use energy consumption. In comparison, agriculture, which accounts for 2.1 per cent of total energy consumption, and construction (1.5 per cent) are relatively small energy consumers.

Table A.4 Australian energy end-use, 1995-96

	Fuel consumption (PJ)							
	Coal products	*Gas*	*Elect-ricity*	*Crude oil and ORF*	*Petrol. products*	*Renew-ables*	*Total*	*Share[a] (per cent)*
Final domestic availability	*186.0*	*608.0*	*549.6*	*0.7*	*1520.7*	*203.5*	*3068.4*	
Agriculture	..	..	9.5	..	55.9	..	65.4	2.1
Mining	10.9	124.8	43.6	0.7	51.8	..	231.8	7.6
Manufacturing	167.8	329.7	213.1	..	122.4	117.3	950.3	31.0
Construction	..	0.3	0.1	..	46.1	..	46.5	1.5
Transport	3.8	1.6	7.7	..	1157.1	..	1170.1	38.1
Commercial	3.3	45.8	122.5	..	12.8	0.7	185.1	6.0
Residential	0.3	105.8	153.3	..	15.5	85.5	360.4	11.7
Other	..	..	..	..	59.0	..	59.0	1.9
Total energy end-use	**186.0**	**608.0**	**549.6**	**0.7**	**1520.7**	**203.5**	**3068.4**	**100.0**

a Share of total energy consumption.

- Exactly zero.

Notes: **Coal** includes black coal, brown coal, coke, coal by-products and briquettes; **Renewables** includes wood, bagasse, hydro-electricity and solar; **Gas** includes natural gas and town gas; **Mining** includes iron and steel, chemical and other industry; **Transport** includes road, rail, air and water transport; **Other** includes lubricants, greases, bitumen and solvents; **ORF** is other refined feedstocks.

Source: Bush et al (1997)

The type of fuel consumed also varies significantly across sectors. Petroleum products and electricity are used widely across all sectors, however only the mining sector reports directly using crude oil and other refined feedstocks. The manufacturing sector is a large user of most energy sources, while the agricultural sector uses petroleum products relatively intensively.

This information on energy end-use by industry together with information on these sectors' emission contributions will assist in identifying potential market participants in an emission trading scheme.

Energy-related emissions

Energy-related emissions (resulting from the combustion of fossil fuels) are the most significant contributor to Australia's total greenhouse emissions. The contribution of the various components to the emissions related to fuel combustion is shown in table A.5.

The most significant GHG is CO_2, which accounts for over 71 per cent of Australian emissions. The energy and transformation sector is by far the most significant source of emissions and is responsible for 54.9 per cent of total fuel combustion emissions of CO_2 (see table A.5). Within this sector electricity and heat production emits 49.4 per cent of Australian CO_2 emissions. However, electricity produced is used widely throughout the economy (see table A.4).

The transport sector is the largest end-user of energy in the Australian economy (see table A.4). Perhaps not surprisingly, the transport sector is also a significant emitter of CO_2 (see table A.5), accounting for 22.8 per cent of CO_2 emissions from fuel combustion. Road transportation, which accounts for 19.9 per cent, is the main source of emissions within the transport sector. The industry sector is the third largest emitter of CO_2, accounting for 16.8 per cent of CO_2 emissions from fuel combustion. This reflects the large energy use of the manufacturing sector reported in the table A.4.

Table A.5 Estimated emissions related to fuel combustion, 1995

	CO_2 emissions		*Total CO_2 equivalent emissions* [a]	
	Quantity (Mt)	*Share (per cent)*	*Quantity (Mt)*	*Share (per cent)*
Energy and transformation	*156.8*	*54.9*	*157.4*	*53.9*
Electricity and heat production	141.1	49.4	141.6	48.5
Petroleum refining	6.8	2.4	6.9	2.4
Solid fuel transformation	8.9	3.1	8.9	3.1
Industry	*47.8*	*16.8*	*48.0*	*16.4*
Iron & steel	11.1	3.9	11.2	3.8
Non-ferrous metals	13.7	4.8	13.7	4.7
Chemicals	5.1	1.8	5.1	1.8
Pulp, paper and print	2.0	0.7	2.0	0.7
Food processing, beverages etc	3.2	1.1	3.2	1.1
Other	17.7	6.2	17.8	6.1
Transport	*65.2*	*22.8*	*68.8*	*23.6*
Civil aviation	4.4	1.6	4.5	1.5
Road transportation	56.9	19.9	60.3	20.7
Railways	1.5	0.5	1.5	0.5
Navigation	2.0	0.7	2.0	0.7
Other transportation	0.4	0.1	0.4	0.1
Small combustion	*13.6*	*4.8*	*13.7*	*4.7*
Commercial/institutional	3.4	1.2	3.4	1.2
Residential	6.5	2.3	6.5	2.2
Agriculture, forestry, fishing	3.8	1.3	3.8	1.3
Other	*2.0*	*0.7*	*2.0*	*0.7*
Stationary (Solvent combustion)	0.7	0.2	0.7	0.2
Mobile (Military)	1.3	0.4	1.3	0.4
Biomass burned for energy [b]	*18.4*	*6.5*	*20.4*	*7.0*
All fuel combustion activities	**285.5**	**100.0**	**291.7**	**100.0**

a Estimated on basis of GWP of 21 for CH_4 and 310 N_2O. Does not include NO_X, CO and NMVOC emissions for which GWP information was not available.

b CO_2 emissions from biomass not included in the inventory.

Source: NGGIC (1997b)

APPENDIX B SULPHUR DIOXIDE EMISSION TRADING IN THE UNITED STATES

This appendix discusses the United States' sulphur dioxide (US SO_2) emission reduction scheme. The first part of the appendix briefly describes the scheme and the second part presents some lessons to be learnt from the operation of the scheme. Much of the information contained in this appendix was retrieved from the US Environmental Protection Agency's (EPA) website on the internet.

B.1 Description of the scheme

The US SO_2 emission reduction program operates through Title IV of the Clean Air Act and is administered by the US EPA. The primary goal is to reduce annual SO_2 emissions by 10 million tons below 1980 levels over the life of the program. The Act also calls for a 2 million ton reduction in oxides of nitrogen (NO_X) emissions by 2000. The SO_2 and NO_X programs together constitute the EPA's Acid Rain Program.

In brief, the scheme involves distributing permits to SO_2 emitters which allow them to emit a certain amount of SO_2. Permits may be bought, sold or banked. Emitters wishing to emit more than the level of their permits must purchase permits from other permit holders or else reduce their emissions. At the end of each year, each emitter must hold an amount of permits at least equal to its annual emissions of SO_2.

Participants

The SO_2 program involves tightening restrictions in two phases. Phase I began in 1995 and includes 263 units at 110 mostly coal burning electric utility plants. These are generally relatively large, high emitting plants. An additional 182 units have joined as substitution or compensating units, making 445 affected units. Phase II begins in 2000 and tightens restriction on Phase 1 plants and sets restrictions on smaller, cleaner plants fired by coal, oil and gas. Phase II will cover about 2000 units. The primary participants are officials designated and authorised to represent the owners and operators of electric utility plants that emit SO_2. These officials are called authorised account representatives (AARs).

In addition to these compulsory participants, any party may purchase permits from the market and participate in permit trading, for example brokers, investors and public interest groups.

Allocating permits

Affected utility units were initially allocated permits by a grandfathering method based on historical fuel consumption and a specific emission rate. Allocations to individual units were differentiated according to 29 different allocation rules. For example, additional allocations went to utilities that were expected to have increasing capacity utilisation, in states experiencing fast population growth, for utilities using lignite, for utilities installing scrubbers to remove emissions and for coal mines in high-sulphur coal producing states (DFAT 1997).

One permit entitles the holder to emit one ton of SO_2 during or after a specified year. New entrants who begin operation after 1996 are not allocated permits. These entrants must purchase permits from the market or auctions to cover their SO_2 emissions.

Reserves

In addition to receiving an annual allocation of permits, there are three reserves held by the EPA to which a unit may apply to obtain extra permits. One reserve makes available extra permits to those units installing qualifying technology which must be able to remove at least 90 per cent of a unit's SO_2 emissions. Another reserve is for units achieving SO_2 emission reductions through customer oriented conservation measures or renewable energy generation. A third reserve of permits is held for auctions sponsored yearly by the EPA.

The second mentioned reserve consists of 30 000 permits set aside to stimulate energy efficiency and renewable energy generation by making them available to units who implement demand side energy conservation programs to curtail emissions or install renewable energy generation facilities. There are specific rules for what qualifies as being eligible for bonus permits and who can apply. The rate of issuance to those successful in applying for these permits is one permit per 500 megawatt hours of energy saved. Applications for permits from this reserve can be made on or after 1 July for measures employed in the previous year. Units may apply each year, or wait and apply for several years worth of savings at once.

Annual reconciliation

To cover emissions for the previous year, units must finalise permit transactions and submit them to the EPA by 30 January to be recorded in unit accounts. Permits may not be used for compliance prior to the calendar year for which they are allocated — that is, there is no provision for borrowing permits from future periods.

If a unit's emissions are less than the number of permits it holds, the remaining permits are carried forward, or banked, into the following year's subaccount. If a unit's emissions are greater than the number of permits, the unit must pay a fine and surrender permits for the following year equivalent to the excess of emissions. The fine for excess emissions is equal to a 1990 penalty of $US2000 per excess ton adjusted each year for inflation. For example, in 1995 the penalty rate was $US2391.65 per excess ton. The fine is usually equivalent to about 20–30 times the market price of permits (DFAT 1997). A unit may choose to have permits deducted immediately or at a later date. If permits are to be deducted at a later date, the unit must submit to the EPA an Excess Emissions Offset Plan, outlining how and when the unit will provide the necessary permits for compliance. This Plan must undergo public review and comment before approval.

The EPA considers whether a unit has been 'underutilised'. Utilisation is calculated as a three year rolling average of heat input used. The EPA will consider demand side efficiency improvements when determining underutilisation, and will not deduct permits for that portion of emission reduction. A unit may actually receive extra permits if it applies to the reserve set aside for rewarding demand side efficiency improvements (see earlier discussion on reserves).

The EPA also considers whether a unit is subject to special provisions, such as State laws limiting emissions on a system-wide basis. Regardless of the number of permits held by a source, it may not emit at levels that would violate Federal or State limits set under Title 1 of the Clean Air Act, to protect public health.

Once permits are deducted they are transferred into a permanent EPA retirement account. After reconciliation is complete, and changes in permits have been put through the tracking system, the EPA will mail to each AAR a report.

Recording, monitoring and reporting

The EPA maintains a permit tracking system to record all permit balances and trades. Each party has an 'account' with the EPA. Any interested party wishing to purchase permits may open an account by submitting an application to the EPA. The tracking system has Unit Accounts, for all utilities governed by the Acid Rain Program, and General Accounts, for any other trader (non-emitters, who are not subject to annual reconciliation and permit deductions). General Accounts may be used for a variety of purposes, such as by:

- utilities to pool permits;
- brokers to hold permits they buy or sell;
- investors to hold permits; and
- public interest groups who purchase permits.

The tracking system tracks the issuance of all permits, holdings of permits in accounts and reserves, deductions of permits for compliance purposes and transfers of permits between accounts. Parties must notify the EPA of transfers so they may be recorded, although they do not have to do so after every single transaction.

Each permit within the tracking system is identified by a 12 digit serial number. The first four digits identify the first year in which the permit can be used and the remaining eight digits are a unique identifier. For example, a permit with the serial number 1995-04875234 may be used for compliance in any year from 1995 onwards.

Tracking system information is available on the internet, but the tracking system does not record prices or other terms associated with permit trades. This information is collected and reported by the private sector through established exchanges or other trade information brokers.

Continuous emissions monitoring (CEM) systems are the main systems used for monitoring emissions from a unit. All CEM systems must be in continuous operation and be able to sample, analyse and record data at least every 15 minutes, which are then reduced to one hour averages.

Units must submit hourly emission data on a quarterly basis to the EPA. The EPA verifies the quality, consistency and completeness of the data, adherence to the Electronic Data Report format and appropriate usage of missing data procedures. The data are recorded in the emissions tracking system, which is a repository of emission data for the electric utility industry. The rules that apply for calculating missing data represent a conservative approach which provides the incentive for utility operators to keep their CEM system down-time to a minimum.

Performance tests are required for CEM systems, and they must be certified by the EPA before they can be used in the Acid Rain Program. This involves running a number of tests and submitting the results to the EPA or appropriate

State agency. Notification of approval or disapproval is then given within 120 days.

All correspondence by utilities, units or parties with the EPA must be conducted by an AAR. When transferring permits, the AAR submits a transfer form to the EPA which must be signed by the AARs from both transferor and transferee. If the EPA makes an error in recording permits, the AAR may file a claim of error requesting the EPA to correct the mistake. Further avenues of appeal include the Environmental Appeals Board and then the federal courts.

Units are required to develop compliance plans. Units may choose their own compliance strategy, such as repowering units, using cleaner burning fuel, reassigning some energy production capacity from dirtier to cleaner units, and adopting energy conservation or efficiency measures. Some of these options afford the unit special treatment, such as compliance extension or extra permits. Most options (like fuel switching) do not need prior approval, so a source can respond quickly to market conditions.

Auctions

The EPA holds an annual auction of permits from its Special Permit Reserve. The number of permits in this reserve is 2.8 per cent of total annual permits allocated to all units. The reasons for holding auctions are to send the market a price signal for permits, furnish utilities with additional revenue for purchasing the required amount of permits and provide new units with a public source of permits beyond those initially allocated to existing units.

Private permit holders also may offer permits for sale at auctions, provided the permits are dated for the year in which they are offered, for any previous year or for seven years in the future.

Auctions are conducted by the Chicago Board of Trade (CBOT) for the EPA. CBOT was chosen by the EPA due to its demonstrated ability in handling and processing financial instruments and using transactional information systems, and because the EPA believes a significant benefit is created for the permit market by having an auctioneer who is active in facilitating the permit market.

CBOT is delegated, not contracted, by the EPA to administer the auctions — the authority to delegate the administration of the auctions is set out in the Clean Air Act. Therefore, CBOT is not compensated by the EPA for its services, nor is it allowed to charge fees. It is also not allowed to bid for permits in auctions nor transfer permits in the tracking system.

Auctions are held on the last Monday of March each year. There are two parts to an auction — a spot permit auction, for current year permits, and an advance auction, for permits up to seven years ahead. Bidders send sealed offers containing information on the number and type (spot or future) of permits desired and the purchase price to CBOT no later than three business days prior to auction, and must include a certified cheque or letter of credit for the total bid cost.

Permits from the EPA's Special Permit Reserve are sold first, ahead of private offers, on the basis of the price bid for permits, starting with the highest bid and continuing until all permits are sold or all bids exhausted. Offered permits are sold in ascending order, starting with the lowest minimum price requirements, and are sold until the supply is depleted, the bids are used up or the minimum price for the next set of offered permits exceeds the purchase price of the next bid.

EPA returns the proceeds and unsold permits from the Special Permit Reserve on a pro rata basis to those units from which the EPA originally withheld permits to create the reserve. With private offers, the proceeds and unsold permits are returned to the owners who offered them for sale.

Opt-in Program

The Opt-in Program expands the EPA's Acid Rain Program to include additional SO_2 emitting sources, which are not required to participate. These additional sources can enter the program voluntarily, receive permits, reduce emissions and sell excess permits to electric utilities (required to be in the Program) where reducing emissions is relatively more expensive. This will enable the overall emission reduction to be achieved at relatively low cost.

A source wanting to opt-in must submit an application and a monitoring plan to the EPA or a State permitting authority. This is then made available for public comment, and eventually the source is rejected or accepted. If a source is accepted it must install and certify emission monitors.

Opt-in sources must comply with the same or similar provisions as compulsory participants. The number of permits an Opt-in source receives is based on the product of its 'baseline' (average heat input for all fuel consumed between 1985–1987) and the lesser of three emission rates: actual 1985 rate; 1985 allowable rate; and allowable rate at the time of applying to the Opt-in Program. If a source began operating after 1985, the alternative baseline is the average heat input consumed during the first three consecutive calendar years.

B.2 Lessons from the scheme

There are several lessons to be learnt from the US SO_2 scheme about designing and implementing effective and efficient tradable permits systems. The design of a tradable permits system is critical because it determines whether effective and efficient implementation is possible. The goals of the program and responsibilities of all parties involved should be clearly stated and there should be clear and enforceable penalties for non-compliance or for any party delaying participation in the system where it is required. From the beginning of the program the emissions of all potentially affected sources should be accounted for and a maximum allowable emission cap should be established (and sustained). Accurate measurement of emissions is the key to environmental accountability, market credibility and operational flexibility. Overall, the design should be simple (McLean 1996).

In implementing the system, government should stay focused on achieving the goals of the program, resolving issues promptly and improving operational efficiency. Government should refrain from trying to participate in, control or fine tune the market, particularly since many changes, such as industry restructuring, may occur outside the regulator's purview. All those involved in implementing the program — government and industry — should maintain a vigorous dialogue with the goal of continuous improvement in both the environmental effectiveness and the operational efficiency of the program (McLean 1996).

REFERENCES

ABARE (Australian Bureau of Agricultural and Resource Economics) 1997, *The Economic Impact of International Climate Change Policy*, Research Report 97.4, ABARE, Canberra.

ABARE and DFAT (Department of Foreign Affairs and Trade) 1995, *Global Climate Change: Economic Dimensions of a Cooperative International Policy Response Beyond 2000*, ABARE, Canberra.

BIE (Bureau of Industry Economics) 1992, *Environmental Regulation: The Economics of Tradeable Permits — A Survey of Theory and Practice*, Research Report 42, AGPS, Canberra.

—— 1996, *Prospects for Australian Industry Involvement in Greenhouse Gas Abatement Overseas: The Scope for 'Activities Implemented Jointly' in the Asia Pacific Region*, Report 96/13, AGPS, Canberra.

Bush, S., Harris, J. and Trieu, L. 1997, *Energy: Australian Energy Consumption and Production Historical Trends and Projections to 2009-10*, ABARE Research Report 97.2, Commonwealth of Australia.

CoA (Commonwealth of Australia) 1992, *National Greenhouse Response Strategy*, AGPS, Canberra.

—— 1995, *Greenhouse 21C: A Plan of Action for a Sustainable Future*, AGPS, Canberra.

Committee of Inquiry into Sale of the NSW Electricity Assets 1997, *Report*, (R. Hogg, Chairman), State of New South Wales.

DFAT (Department of Foreign Affairs and Trade) 1997, *Australia and Climate Change Negotiations: An Issues Paper*, Commonwealth of Australia, Canberra.

EPA (Environment Protection Authority) Victoria 1995, *Tradeable Permit Systems*, Discussion Paper, Publication 447, February.

Fisher, B., Barrett, S., Bohm, P., Kuroda, M., Mubazi, J., Shah, A. and Stavins, R. 1995, 'An economic assessment of policy instruments for combatting climate change' in *Climate Change 1995 — Economic and Social Dimensions of Climate Change* (eds J. Bruce, H. Lee and E. Haites), Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, New York.

Hahn, R. 1984, 'Market Power and Transferable Property Rights', *The Quarterly Journal of Economics*, vol. XCIX, no. 4, November.

Hill, Senator the Hon. Robert 1997, *Australia's International Policy on Climate Change*, address to The American Chamber of Commerce in Australia, ANA Hotel Sydney, 9 July.

IC (Industry Commission) 1991, *Costs and Benefits of Reducing Greenhouse Gas Emissions*, Report 15, AGPS, Canberra.

—— 1997a, *Industry Commission Submission to the ICESD on the National Greenhouse Strategy*, AGPS, April.

—— 1997b, *Role of Economic Instruments in Managing the Environment*, Staff Research Paper, Industry Commission, Melbourne, July.

—— 1997c, *A Full Repairing Lease: Inquiry into Ecologically Sustainable Land Management*, Draft report, September.

ICESD (Intergovernmental Committee on Ecologically Sustainable Development) 1997, *Future Directions for Australia's National Greenhouse Strategy*, Discussion Paper, Department of the Environment, Sports and the Territories, Canberra.

IPCC (Intergovernmental Panel on Climate Change) 1996, *Technologies, Policies and Measures for Mitigating Climate Change*, Technical Paper I.

Marland, G. and Boden, T. 1997, 'Global, Regional and National Emissions', in *Online Trends: A Compendium of Data on Global Change*, CDIAC (Carbon Dioxide Information Analysis Centre), Oak Ridge National Laboratory, http://cdiac.esd.ornl.gov/trends/emis/meth_reg.htm, accessed 26 August 1997.

McAfee, R. and McMillan, J. 1987, 'Auctions and Bidding', *Journal of Economic Literature*, vol. 25, pp.699–738.

McLean, B. 1996, *Evolution of Marketable Permits: The US Experience With Sulfur Dioxide Allowance Trading*, United States Environmental Protection Agency, Washington DC.

Mullins, F. and Baron, R. 1997, 'International GHG Emission Trading', *Policies and Measures for Common Action*, Annex 1 Expert Working Group on the FCCC, Working Paper 9, March.

NGGIC (National Greenhouse Gas Inventory Committee) 1996a, *National Greenhouse Gas Inventory 1988 to 1994: Summary and Analysis of Trends*, Commonwealth of Australia, AGPS, Canberra.

—— 1996b, *Workbook for Industrial Processes and Solvents and Other Product Use*, Workbook 7.1, Revision 1, Commonwealth of Australia, AGPS, Canberra.

—— 1997a, *Land Use Change and Forestry: Workbook for Carbon Dioxide from the Biosphere*, Workbook 4.2, Revision 2, Commonwealth of Australia, Environment Australia, Canberra.

—— 1997b, *National Greenhouse Gas Inventory 1995*, Commonwealth of Australia, Environment Australia, Canberra.

OECD/IEA (Organisation for Economic Cooperation and Development / International Energy Agency) 1995, *Energy Balances of OECD Countries 1992-1993*, OECD Publications, France.

Pearce, F. 1997, 'The concrete jungle overheats', *New Scientist*, 19 July, p.14.

Rose, R. 1997, 'Tradable quotas for efficient natural resource management', in *Outlook 97*, ABARE, Canberra, pp.107–115.

Tietenberg, T. and Victor, D. 1994, 'Possible Administrative Structures and Procedures for Implementing a Tradeable Entitlement Approach to Controlling Global Warming' in *Combating Global Warming: Possible Rules, Regulations and Administrative Arrangements for a Global Market in CO2 Emission Entitlements*, United Nations Conference on Trade and Development, United Nations, New York.

UNCTAD (United Nations Conference on Trade and Development) 1996, *A Pilot Greenhouse Gas Trading System: The Legal Issues*, United Nations, Geneva.

USIJI (United States Initiative on Joint Implementation) 1996, *International Partnerships Report*, vol. 2, no. 3, June.