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Foreword

Emissions trading - specifically the trading of greenhouse gas emissions - is likely to be a very cost-effective way of reducing pollution and a big movement from conventional cap and control measures to market instruments. The concept of emissions trading began a few decades ago with SO_2 and NOx trading in the United States and will be applied by the EU for CO_2 trading in 2005. The rationale behind emissions trading is to ensure that the emission reductions take place where the cost of the reduction is lowest thus lowering the overall costs of combating environmental pollution. The concept is relatively simple, however, the implementation is difficult, particularly at the international level, and remains at a trial stage.

In this study, the current status of Greenhouse Gas Emissions Trading Systems is analyzed and policy recommendations for the future direction are presented. This study aims at taking a step towards more comprehensive and in-depth analysis in the coming years.

The study focuses on a review of emissions trading systems under the Climate Change Convention and Kyoto Protocol, including the history of negotiation up to COP 9 and linkage of emissions trading systems with other mechanisms and issues. The global trends in GHG emissions trading are examined and the current status, future plans and policy implications are presented for key emissions trading initiatives in European Union, United Kingdom, Denmark, the United States, Canada, Japan, Korea and other countries.

The Korea Environment Institute conducted the study, jointly with the Institute for Global Environmental Strategies and the UNEP RISOE Centre on Energy, Climate and Sustainable Development. Yong Gun Kim, Poul Erik Morthorst, Steve Sorrell, Erik Haites, Tae Yong Jung, Myung Kyoon Lee and Jong Soo Lim are the authors of the study. We would like to thank the authors for their efforts and great work. We also thank Jeong Moon Choi and Sun Young Kim for editing the manuscript.

We hope that this study will serve as a meaningful first step for further research collaboration among three institutions in the coming years and help to widen the knowledge and understanding of all who are committed to global action against the destabilizing effect of climate change.

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Abstract

The Kyoto Protocol, if it enters into force, would establish emission limitation commitments for the developed countries and a full international emissions trading system for greenhouse gases. This has forced each nation to give the emissions trading consideration and prepare its domestic climate policies. Domestic greenhouse gas (GHG) emissions trading systems (ETS) are already being in operation in UK and Denmark, and European Union has decided to introduce compulsory domestic GHG emissions trading from year 2005. Other non-European developed countries such as Japan and Canada are actively considering the introduction of domestic ETS. In the United States, even though it is still refusing to ratify the Protocol, many states are implementing or considering programs that would limit GHG emissions and a growing number of major companies are undertaking significant efforts to address climate change including participating in emissions trading. The United States Congress tries to establish the compulsory reduction target and a nation-wide ETS combined with its traditional climate policy.

This study analyzed the results of recent international climate change negotiations related to the credit transaction of Clean Development Mechanism and Joint Implementation, and the international GHG ETS which was stated in the Kyoto Protocol. This study also provides an overview of the UK emissions trading scheme, describing its main elements and limitations and difficulties associated with the scheme. The major elements of the EU Emissions Trading Scheme, which begins in 2005, are also reviewed focusing on the areas which have generated particular controversy and difficulty. Also, the recent trend in Denmark is summarized especially in relation to the energy reform and the green certificate markets. The current progresses in introducing GHG ETS are overviewed for United States, Japan and Canada. These non-European

countries are considering the linkage with the EU emissions trading market and it is assessed that the expansion to the integrated international ET market is highly likely.

Korea, as a developing country under UNFCCC and Kyoto Protocol does not have the obligation to reduce its GHG emissions. However, it is likely that the country could be obligated to take more responsibilities, depending upon the future negotiations. Thus, it needs to prepare its domestic climate change policies for the future expansion of international ET market. In this study we tried to analyze the basic principles for the design of domestic GHG ETS and detailed design method under these special circumstances. And it appears that it is necessary to promote a voluntary and incentive based ET market prior to the introduction of compulsory ETS.

The international effort to introduce ETS is expected to expand and intensify, thus the trend analysis and researches on international cooperation program should be continuously pursued. This study is the start of those research activities and it is believed that international cooperative researches of various experts of each nation are indispensable in this regard.

요 약 문(Abstract in Korean)

선진국에 대한 양적 감축의무 부과와 국제 배출권 거래제도의 도입을 핵심 내용으로 하는 교토의정서의 채택은 국제 온실가스 배출권 거래시장의 출범을 예고하고 있으며, 각국 정부는 이에 대응하기 위한 국내정책기반을 강화하고 있다. 덴마크와 영국 등 일부 선진국은 이미 국가 차원의 온실가스 배출권 거래제도를 시행하고 있으며, 유럽연합은 2005 년부터 역내 모든 국가가 참여하는 강제적인 온실가스 배출권 거래제도의 도입을 결정한 바 있다. 일본, 캐나다 등 비유럽 선진국에서도 온실가스 배출권 거래제의 도입을 적극 추진중이며, 교토의정서 참여를 거부하고 있는 미국에서도 주정부와 민간기업의 자율적인 배출권 거래제 도입이 확산되고 있으며 특히 미국 의회는 강제적인 감축목표 설정과 전국적인 배출권 거래제도의 도입을 전통적인 대기관리정책과 연계하여 추진하고 있다.

본 연구는 교토의정서에 명시되어 있는 국제 온실가스 배출권 거래제도와 함께 상호 호환거래가 가능한 청정개발체제 및 공동이행 사업의 크레딧 거래와 관련하여 최근까지의 협상결과를 분석하였다. 그리고 전국적인 온실가스 배출권 거래제도를 시행하고 있는 영국의 사례의 특징과 시사점을 분석하였으며, 2005 년부터 시행예정인 유럽연합의 역내 배출권 거래제도에 대해서도 지금까지의 진행경과와 향후 전망을 분석하였다. 또한 온실가스 배출권 거래제도와 밀접하게 연계되어 진행되고 있는 신재생에너지 발전크레딧 제도의 사례로서 덴마크의 최근 관련 동향을 정리하였다. 뿐만 아니라 미국, 일본, 캐나다의 온실가스 배출권 거래제도 도입 추진동향을 분석하고 향후 전망과 시사점을 도출하였다. 이들 비유럽 국가들은 유럽의 역내 온실가스 배출권

시장과의 연계를 모색하고 있으며, 향후 통합된 국제 배출권 시장으로 발전할 가능성이 높은 것으로 평가된다.

우리나라는 기후변화협약 및 교토의정서상으로 아직 개도국 지위를 인정받고 있음에 따라 정량적인 감축의무를 부담하고 있지 않다. 하지만 선발 개도국으로서 향후 추가적인 온실가스 감축의무 협상시 의무부담국가에 포함될 가능성이 있고, 국제적인 배출권 시장의 확대 과정에서 국내 대응역량의 확충이 필요한 상황이다. 본 연구에서는 이와 같은 특수한 여건하에서 국내적인 온실가스 배출권 시장의 설계에 대한 기본원칙과 세부 설계방안에 대한 분석을 시도하였다. 강제적인 배출권 거래제도의 도입 이전단계에서 자발적인 인센티브에 기초한 배출권 시장의 조성이 필요할 것으로 판단된다.

배출권 거래제도의 도입을 위한 국제적인 노력은 보다 활성화될 것으로 예상되며, 이에 대한 동향분석과 국제적인 협력방안에 대한 연구 또한 지속적으로 확대되어야 할 것이다.

본 연구는 이러한 연구의 시발점으로 평가되며, 앞으로도 각국의 전문가가 참여하는 국제협력연구가 적극 추진되어야 할 것이라 판단된다.

1. Kyoto Mechanisms

Erik F. Haites[*]

The Kyoto Protocol to the United Nations Framework Convention on Climate Change, if it enters into force, would establish emission limitation commitments for 2008~2012 for the developed countries (Annex B Parties) that ratify the Protocol.[1] Each Annex B Party would issue assigned amount units (AAUs) equal to its emissions limitation commitment and issue Removal Units (RMUs) for internationally approved increases in designated carbon sinks. In addition to domestic emission reductions and sink enhancements, an Annex B Party can meet its commitment through emission reductions or increases in carbon sinks in other countries. Such actions lead to the creation and transfer of other units (ERUs, CERs, tCERs or lCERs). To comply with its emission limitation commitment an Annex B Party must hold Kyoto units (AAUs, ERUs, CERs, tCER,s lCERs or RMUs) equal to its actual emissions during the 2008~2012 period.

The Protocol includes three mechanisms through which an Annex B Party can encourage emission reductions or increases in carbon sinks in other countries. All three mechanisms can be used by Annex B governments to help meet their national commitments. All of the mechanisms also allow the participation of private entities under the supervision of the relevant government. Entities covered by domestic emissions trading programs in Annex B countries are likely to be allowed to use Kyoto units for compliance and so may wish to use the mechanisms.

The three mechanisms are:

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[1] The emission limitation commitments of 38 countries (plus the European Community), expressed as a fraction of each country's base year (usually 1990) emissions, are listed in Annex B to the Protocol. Hence, a country with an emission limitation commitment that ratifies the Protocol is called an Annex B Party. Developing countries would not have emission limitation commitments. A developing country that ratifies the Protocol is called a non-Annex B Party.

- Article 6: Joint Implementation (JI): A project to mitigate climate change -- reduce emissions or enhance specified sinks of greenhouse gases -- in an Annex B Party can earn emission reduction units (ERUs) that can be used by another Annex B Party to help meet its emission limitation commitment. This reduces the net emissions of the host country and allows higher emissions in the country that acquires the ERUs.

  Joint Implementation projects and the associated emission reductions or increases in carbon sinks can be approved in one of two ways. An international process, similar to that for the Clean Development Mechanism (discussed below), will be established by a JI Supervisory Committee. And Annex B Parties that meet specified criteria may establish a domestic process. A project in a country with a domestic process could choose either the domestic or international approval process.[2] Joint Implementation projects can begin to earn ERUs only in 2008, so the international process is not yet operational.

  Several governments and funds have entered into contracts to purchase ERUs. Those contracts typically require the host government to indicate that it will approve the project as a JI project. These countries, then, have criteria for JI projects, but most of them have not yet established a formal review and approval process.

  To issue an ERU the host government, an Annex B Party, converts an AAU by adding relevant codes. Converting an AAU reduces the country's allowable emissions. If the reductions achieved by the JI project are less than the ERUs issued (AAUs converted), compliance with the country's emission limitation commitment becomes more difficult. Thus the host Party has an incentive to ensure that JI projects achieve the emission reductions or sink increases claimed.

[2] Buyers may believe that the international process is better known and so may prefer projects approved under that process. A project developer might choose the international process to reduce the risk that ERUs could not be issued if the host government loses its eligibility to implement a domestic process during the life of the project. Since all projects require the approval of the host government, it could require projects to use the domestic process.

- Article 12: Clean Development Mechanism (CDM): A project to mitigate climate change in a non-Annex B Party can generate certified emission reductions (CERs, tCERs or lCERs) that can be used by an Annex B Party to help meet its emission limitation commitment. To ensure that the projects achieve the emission reductions or increases in carbon stocks claimed, they must use methodologies approved by the CDM Executive Board and have the claims certified by an accredited expert.

  An emission reduction project reduces the net emissions of the host country and allows higher emissions in the country that acquires the resulting CERs. Afforestation or reforestation of lands that were vacant on January 1, 1990 is also allowed. Since the carbon stored by the trees and soil can be released again by disease, fire, harvesting or other events, special provisions are included to address the non-permanence of these projects. The non-permanence provisions result in the issuance of units, tCERs or lCERs, with limited lifetimes.

- Article 17: International Emissions Trading (IET): One Annex B Party can transfer some of its allowable emissions, assigned amount units (AAUs), or acquired ERUs, CERs and Removal Units (RMUs), to another Annex B Party. This increases the allowable emissions in the recipient country and reduces those of the seller country.

  Many Annex B Parties are establishing domestic greenhouse gas emissions trading programs for designated industrial sources. These programs establish limits on the aggregate greenhouse gas emissions by the designated sources. Allowances equal to the aggregate emissions are distributed. The allowances are usually distributed free to the trading program participants, but some allowances may also be auctioned. Each participant must measure its actual emissions and submit allowances equal to its actual emissions to the regulatory authority. Participants can buy or sell allowances to ensure that they have enough to cover their actual emissions.

Participants generally are also allowed to use Kyoto units for compliance purposes. The European Commission has proposed that participants in the trading programs under the EU Emission Allowance Trading Scheme be permitted to exchange CERs and ERUs for EU allowances, which they can then use for domestic compliance. The EU allowances can be freely traded across all countries (at least the 25 EU Member States) participating in the scheme. From 2008 on that means international trades of EU allowances must be matched by transfers of AAUs so that the compliance strategies adopted by participating establishments do not adversely affect national compliance efforts.

The mechanism of interest to developing countries is the Clean Development Mechanism. Although the Kyoto Protocol has not yet entered into force, activity under the Clean Development Mechanism is underway. Detailed rules for emission reduction projects under the CDM were agreed in November 2001 as part of the Marrakech Accords. Members of the Executive Board, which administers the CDM, were elected at that time. Rules for afforestation and reforestation projects under the CDM were adopted in December 2003.

An emission reduction project under the CDM must:

- use an approved methodology to define the baseline emissions -- the emissions that would have occurred in the absence of the project -- from which reductions are calculated;
- use an approved monitoring methodology to monitor actual emissions and collect other information needed to calculate the emission reductions achieved; and
- be reviewed by an accredited "operational entity" which confirms that the proposed baseline and monitoring methodologies are appropriate and that other eligibility requirements are met.

As of October 31, 2003 34 proposed baseline and monitoring methodologies had been submitted to the Executive Board. Of these, 6 methodologies had been approved and 19 were still under review. As of the same date 19 organizations had submitted an application to be accredited as an operational entity. It is expected that the first operational entities could be accredited and the first projects be registered during the first quarter of 2004.

The Executive Board has prepared simplified baseline and monitoring methodologies for 13 categories of small-scale CDM projects. Small-scale CDM projects are:

- Renewable energy project activities with a maximum output capacity equivalent of up to 15 megawatts (or an appropriate equivalent);
- Energy efficiency improvement project activities which reduce energy consumption, on the supply and/or demand side, by up to the equivalent of 15 gigawatt/hours per year;
- Other project activities that both reduce anthropogenic emissions by sources and directly emit less than 15 kilotonnes of carbon dioxide equivalent annually.

As of October 31, 2003 no small-scale projects had been submitted to the Executive Board.

Private and/or public entities may implement CDM projects. The host government must approve the project. The Annex B Party using the CERs toward its commitment must also approve the project. Official development assistance (ODA) may not be used to help finance CDM projects. Projects may choose a single crediting period of ten years or a renewable crediting period of seven years with up to two renewals for a total of 21 years.[3] The baseline must be revised as appropriate for each renewal. Some

[3] The crediting period is the period during which a CDM project can earn CERs for the emission reductions or sink increases achieved.

of the CERs earned go to the Executive Board for administrative expenses and to contribute to an adaptation assistance fund.

The rules for afforestation and reforestation projects under the CDM are identical to those for emission reduction projects with a few exceptions. The projects must be implemented on land that was not forested on 1 January 1990. The projects may choose a single crediting period of 30 years or a renewable crediting period of 20 years with up to two renewals for a total of 60 years. The project proponents must choose one of the two options to address non-permanence leading to the issuance of tCERs or lCERs. Both of these units expire at specified times and then must be replaced. An Annex B Party may only use tCERs and lCERs equal to 5% of its base year (usually 1990) emissions for compliance during the first commitment period.

Small-scale afforestation and reforestation projects under the CDM are those that are expected to result in net removals by sinks of less than 8 kilotonnes of CO_2 per year and are developed or implemented by low-income communities and individuals as determined by the host Party. If a small-scale afforestation or reforestation project results in net removals greater than 8 kilotonnes of CO_2 per year, the excess removals will not be eligible for the issuance of tCERs or lCERs. Simplified rules for small-scale afforestation and reforestation projects are to be developed for adoption in December 2004.

Eligible CDM projects can generate CERs, tCERs, or lCERs from January 1, 2000. For this reason, initiatives to develop projects for registration as CDM projects have been underway for several years despite the fact that the formal registration process is not yet fully operational. These initiatives, most of which cover both CDM and JI projects, include:

- The Prototype Carbon Fund (PCF), which was launched by the World Bank in January 2000 to develop CDM and JI projects on behalf of the investors. Canada, Finland, Japan, Netherlands, Norway and Sweden as well as a number of firms have subscribed to the PCF.

- The CERUPT tender launched by the government of the Netherlands in December 2001 to acquire CERs. The tender led to the selection of 18 projects with a total reduction of 16.551 $MtCO_2e$ in March 2003. The Netherlands is also buying ERUs and CERs through several other arrangements.

- Programs to purchase emission reductions from CDM and/or JI projects announced by the governments of Austria, Belgium, Denmark, Finland, Germany, Italy, Japan, Norway, Sweden and Switzerland.

- An Asian Development Bank fund to help finance CDM projects in Asia. Several other funds to invest in CDM and/or JI projects have been proposed by international agencies, national governments and private sector organisations and are at various stages of implementation.

Most CDM projects are expected to be implemented by an entity in the host country, which contracts the sale of CERs, tCERs, or lCERs to one or more buyers such as the PCF, an Annex B government, or an entity in an Annex B country. The sales contract may involve an initial payment, but most of the money is paid when the CERs, tCERs, or lCERs are delivered. A sales contract with a creditworthy buyer can help secure financing for a project.

The CERs, tCERs, or lCERs generated by a CDM project can be used by an Annex B Party to help meet its emission limitation commitment for 2008-2012. An Annex B Party can also implement domestic emission reductions and sink enhancements and acquire other Kyoto units to help meet its emission limitation commitment. Thus, the demand for CERs, tCERs, or lCERs depends upon the emission reductions Annex B Parties need to meet their commitments as well as competition from all of the other options for meeting these commitments.

The demand for CERs, tCERs and lCERs could be significantly affected by several developments:

- The American decision not to ratify the Kyoto Protocol significantly reduces the demand for CERs, tCERs and lCERs because the United States was projected to be a large net buyer of Kyoto units.[4]

- Assuming the Russian Federation ratifies the Kyoto Protocol, it is projected to have a surplus of AAUs that is large relative to the projected demand for Kyoto units. If it sells most of its surplus AAUs, it would drive down the price and the demand for CERs. Model results suggest that Russia could increase its total revenue by restricting sales of its surplus AAUs to raise the market price. This would increase the price and the demand for CERs, tCERs and lCERs.

- The European Union will require that each member state implement an emission allowance trading program for CO_2 emissions by specified industrial sources beginning in 2005. It proposes to allow CERs and ERUs, but not AAUs, to be exchanged for EU allowances which participants can then use for compliance beginning in 2008. At the same time the scope for potential JI projects in member states will be reduced. These proposals, then, increase the potential market for CERs. The proposal does not yet cover tCERs and lCERs because the rules governing afforestation and reforestation projects had not been agreed when it was released.

- Virtually all of the announced government initiatives to purchase Kyoto units are limited to CERs and/or ERUs, excluding AAUs and RMUs. These initiatives, therefore, improve the market for CERs.

[4] Since Australia plans to meet its commitment without ratifying the Protocol, it will not be a buyer or seller of Kyoto units. To the extent that Australia was projected to be a buyer of Kyoto units, its withdrawal reduces the demand.

2. The EU Emissions Trading Scheme

Steve Sorrell[*]

The EU Emissions Trading Scheme (EU ETS) is of fundamental importance to both European and global efforts to tackle climate change. Beginning in 2005, this scheme will place a cap on some 45% of EU carbon dioxide (CO_2) emissions and introduce Europe-wide trading of EU carbon allowances ('EUAs'). Over time, the scheme is expected to cover an increasingly large proportion of Annex 1 emissions under the Kyoto Protocol, as a consequence of both the enlargement of the EU and the inclusion of more sectors and greenhouse gases within the scheme. The European Commission is relying heavily on the EU ETS to deliver the EU's obligations under the Kyoto Protocol while the same time minimising the cost to EU industry. The scheme appears likely to go ahead even in the absence of Russian ratification and is expected to set the framework for European climate policy for the foreseeable future. With an extremely ambitious timetable for implementation, the scheme is promoting furious activity within each Member State as government, industry and regulators try to get to grips with both the mechanics of emissions trading and its major economic implications.

This section provides a brief overview of the major elements of the EU scheme, focusing on those areas which have generated particular controversy and difficulty. These issues are emphasised as they are likely to be common to attempts to introduce GHG emissions trading schemes elsewhere in the world.

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I. History and Context

It is ironic that the EU is adopting a leadership role in greenhouse gas (GHG) emissions trading, as historically European countries have been rather sceptical towards this instrument. For example, the EU led the attempts to impose restrictions ('concrete ceilings') of the use of the Kyoto mechanisms. But several factors have combined to change the EU's position (Christiansen and Wettestad, 2003). First, both the EU and individual Member States have experienced considerable difficulty in introducing carbon/energy taxes and emissions trading (with free allocation of allowances) provides an attractive means to break this policy deadlock. Second, there has been an enormous amount of learning since 1997, facilitated by the active involvement of economists and experts from the United States, together with increasing support from the business community. Third, the EU saw a clear need to strengthen climate policy, given a projected 1% increase in GHG emissions by 2010, compared to the Kyoto target of an 8% reduction in emissions. Finally, the EU wanted to avoid a bottom-up evolution of emissions trading schemes at the Member State level, since the resulting patchwork of schemes could fragment the market, increase transaction costs and reduce the scope for cost saving (Christiansen and Wettestad, 2003). For example, the schemes developed by the UK and Denmark are almost entirely incompatible. This created the need for common rules at the EU level to ensure a level playing field.

The process began with the publication of a 'Green Paper' on GHG emissions trading in 2000 (European Commission, 2000), together with the establishment of the European Climate Change Programme (ECCP) to bring together all the relevant stakeholders to collaborate in policy development. Drawing upon consultancy work by the Foundation for International Environmental Law & Development and the US Centre for Clean Air Policy, the ECCP engaged in a wide-ranging debate on the design choices for an EU scheme, focusing in particular upon competitiveness and internal market issues and the extent to which the different elements of the proposed scheme needed to be either harmonised at the EU level or left to the discretion of individual

Member States. The ECCP reported their recommendations in July 2001, and on the 23rd October 2001, the European Commission issued a proposal for an EU-wide trading scheme (European Commission, 2001). Following an extensive process of negotiation, the European Parliament endorsed an amended version of the Directive on 2nd July 2003, which was then adopted by the Council of Ministers on 22nd July 2003 (European Commission, 2003a). Implementation decisions must now have been made within an extremely tight timeframe in order to meet the scheduled start date of 1 January 2005, and delays are still possible.

II. The core elements of the EU scheme

The design of the EU ETS represents a pragmatic compromise between economic efficiency and political acceptability. The final text accommodates the concerns of key Member States such as Germany and has won the broad support of both industry lobbyists and environmental groups.

The EU ETS is a 'cap and trade' scheme, along the lines of the US Acid Rain Program. The estimated 12,000+ participants in the scheme include electricity generators, oil refineries and energy intensive manufacturing installations in sectors such as iron and steel, paper and minerals. Each participant will be allocated a number of allowances each year on the basis of a range of criteria, including the technological potential to reduce emissions. On the 30th of April each year, each participant will be required to surrender a quantity of allowances equal to its emissions in the preceding calendar year. Participants with high abatement costs will be able to cover their emissions by purchasing additional allowances, while those with low abatement costs will be able to reduce emissions and sell their surplus allowances for a profit. Estimates made on behalf of the Commission suggest that the scheme will reduce total abatement costs by some 24%, leading to cost savings of some €2.1billion/year by 2010 (Capros and Mantzos, 2000). The main features of the scheme are summarised in Table 2-1.

Table 2-1. The main elements of the EU emissions trading scheme (EU ETS)

Compliance periods	Phase 1: 2005~2007 Phase 2: 2008~2012 (i.e. the first Kyoto Protocol commitment period).
Type of target	Absolute targets
Allocation of allowances	Phase 1: A minimum of 95% of allowances to be allocated free of charge Phase 2: A minimum of 90% of allowances to be allocated free of charge National allocation plans are subject to approval by the Commission and must be based on objective and transparent criteria, including those set out in Annex III of the Directive
Sectors included	All combustion plant >20MW thermal input, including electricity generators Oil refineries, coke ovens, ferrous metals, cement (>500 tonnes/day), paper and pulp, brick, glass and ceramics (> 20 tonnes/day). Based upon the coverage of the IPPC Directive, but some IPPC sectors are excluded (e.g. food and drink, waste incineration, chemicals) Sites below IPPC size thresholds in eligible sectors may also be included
Size of market foreseen	>12000 installations >=45% of all EU carbon dioxide emissions
Basis	Phase 1: only direct CO_2 emissions Phase 2: other gases may be included, provided adequate monitoring and reporting systems are available and provided there is no damage to environmental integrity or distortion to competition
Links with JI/CDM	Proposed 'Linking' Directive allows credits from JI and CDM projects to be recognised from 2008. If the number of credits equals 6% of the total number of allowances allocated during Phase 2, the Commission will consider whether a cap on credit imports should be introduced.
Links with other countries schemes	Agreements with third parties listed in Annex B of the Kyoto Protocol may provide for the mutual recognition of allowances between the EU ETS and other schemes
Monitoring, Reporting and Verification	Common monitoring, verification and reporting obligations to be elaborated. Verification through third-party or government authority.
Allowance tracking	Linked/harmonised national registries with independent transaction log.
Sanctions	Phase 1: 40 €/tCO_2 penalty + restoration of excess allowances in the subsequent year Phase 2: 100 €/tCO_2 penalty + restoration of excess allowances in the subsequent year
Banking	Banking across years within Phase 1 and Phase 2 Member States can determine the rules for banking from Phase 1 to Phase 2.

Phase 1 of the EU ETS is due to commence in January 2005 and covers the three year period 2005~2007. Phase 2 of the scheme coincides with the first Kyoto

commitment period and is likely to involve a larger number of participants from a wider range of sectors. The Directive was the subject of controversy throughout its lengthy negotiation and the Commission found it necessary to compromise in several areas in order to secure political agreement. Three particularly contentious issues were:

- the scope of the scheme, including the use of opt-out provision;
- the mechanisms for allowance allocation; and
- the interfaces with other trading schemes and with the Kyoto mechanisms.

These are briefly discussed below.

III. The scope of the scheme and the opt-out provisions

The coverage of the EU ETS is based on that of the existing Integrated Pollution Prevention & Control (IPPC) Directive, but a large number of IPPC sectors and sub-sectors are excluded. These include chemicals, food and drink, non-ferrous metals and waste incineration. The IPPC Directive includes a minimum size threshold for eligible installations within each sector, and installations which lie below this size threshold are not obliged to join the scheme. IPPC was chosen on the basis of administrative convenience, since it provided an existing mechanism for monitoring and reporting emissions which could be readily adapted for the EU ETS. However, not all the installations regulated by IPPC are major sources of GHG emissions and many large sources of emissions lie outside the scope of IPPC.

A number of Member States considered that the sectoral coverage of the EU ETS was inadequate, but proposals for expanding the coverage met with strong opposition, particularly from Germany who wanted to ensure that the chemicals sector remained outside the scheme. The Commission justified this exclusion on the basis of the high administrative costs entailed in including such a large number of installations within the scheme, but the real reason is likely to have been political.

The Directive allows installations in eligible sectors which lie below the relevant size threshold to 'opt-in' to the scheme in 2005. In practice, it seems unlikely that many installations will use this provision, owing to the market uncertainty and high transaction costs involved. In Phase 2 of the scheme, individual Member States have the option of extending the coverage to include additional sectors and installations, provided this poses no threat to environmental integrity and does not introduce distortions to competition. In practice, a more likely route to extending the scheme during Phase 2 will be *harmonised* extensions, proposed by the Commission and applying to all Member States. This will require an amendment to the Directive, together with suitable guidelines for monitoring and reporting.

During Phase 1, the EU ETS only regulates CO_2 emissions. The UK was one of several Member States who argued for the scheme to be extended to other GHGs during Phase 1, but the Commission opposed this on the grounds that the monitoring protocols were inadequate. However, other GHGs may be included in the scheme during Phase 2 on identical terms to the opt-in provisions discussed above. Extension of the scheme to all six GHGs during Phase 2 appears very likely.

One practical difficulty with the scheme is the inclusion of combustion plant with a thermal input of >20MW, since this is lower than the 50MW size threshold used in IPPC. Combustion plant capacity is calculated by aggregating the thermal input of *all* the plant at an installation, regardless of their level of utilisation or the physical distance between them. The net result of this rule is that a large number of previously unregulated installations are now covered by the scheme, including very small installations such as universities, retail centres and hospitals. These are difficult to identify and their operators know little about the implications of emissions trading and frequently lack the relevant baseline data. Furthermore, while the chemicals and food and drink sectors are nominally excluded from the scheme, many individual installations within these sectors are now included as a result of the size of their combustion plant. This is one reason why the Commission's estimate of the number of

sites covered by the scheme has increased, from ~5000 when the Directive was proposed to over 12000 now.

A second practical difficulty is the definition of a ‘combustion plant’. While boilers, engines and turbines clearly fall within this definition, there are differences between the Commission and individual Member States over the inclusion of other plants such as furnaces, crackers, dryers, heaters, kilns and ovens (ENDS, 2003a). If a wide definition of combustion plant is included, the scope of the scheme could be extended yet further.

A related problem is the complex boundary issues faced by individual sites. Typically, some portions of a site are included within the EU ETS installation and some are not. Since there are equally complex boundary issues associated with the coverage of existing national regulations such as negotiated agreements, the overlaps between them are likely to lead to complex disputes over ‘double regulation’ and ‘differential treatment’. For example, Sorrell (2002, p. 31~67) has shown how these differences may lead to individual sites in the UK facing up to eighteen possible combinations of four different regulations. This all leads to substantial administrative costs for Member State governments and could well trigger significant changes in national regulations (Sorrell, 2002).

The Commission wanted participation in the EU ETS to be mandatory, but this was opposed by the UK and Germany who wanted to protect their existing negotiated agreements with energy intensive industry. The final Directive allows individual installations to opt-out of the scheme during Phase 1, but participation is mandatory during Phase 2. Opt-outs will only be permitted if installations can demonstrate ‘equivalence’ in terms of the emission reductions required under existing regulations, the associated monitoring, reporting and verification requirements and the penalties for non-compliance.

The opt-out provisions have facilitated political consensus but they also have reduced the environmental effectiveness of the EU ETS, reduced the market size in Phase 1, created additional administrative costs, and (arguably) distorted competition. Equivalence of effort will be very difficult to demonstrate owing to differences in the

scope of EU ETS compared to existing regulations (i.e. the sectors, installations and emission sources which are covered), the nature of the targets (including the choice between relative and absolute targets), the provisions for modifying and updating those targets, and the marginal abatement costs under each regulation. The choice to opt-out will depend upon expectations regarding abatement and transaction costs under the EU ETS compared to those under existing regulations, together with the expectations regarding the future evolution of each scheme. While the Commission may refuse applications to opt-out of the EU ETS, a combination of information asymmetry and severe time constraints could bias the Commission towards leniency. In practice, however, only the UK has indicated its intention to employ the opt-out provisions and even here opt-outs are only feasible for a subset of eligible installations. Crucially, the UK electricity generators are unable to opt-out and hence must join the scheme in 2005.

IV. Allowance allocation

The allocation of allowances is the most politically contentious issue within any emissions trading scheme and the EU ETS is no exception. The European Parliament supported allowance auctioning during the negotiation process, but this was vigorously opposed by industry lobbies and several Member State governments. While economic studies invariably suggest that auctioning combined with revenue recycling can deliver net benefits to a national economy (Parry, 1997), most governments have protected the interests of the participating sectors.

The Directive requires a minimum of 95% of allowances to be freely allocated during Phase 1, and a minimum of 90% during Phase 2. These ceilings are restrictive and will reduce the economic efficiency of the scheme. Furthermore, it is likely that individual Member States will refrain from using the auctioning provisions if other Member States are issuing all their allowances free. Hence, the ultimate use of

auctioning is likely to be much less than is permitted by the Directive - and could be zero.

National allocation plans (NAPs) must be drawn up by the individual Member States and are subject to approval by the Commission. These plans will determine both the total number of allowances to be distributed within each Member State, and the distribution of these allowances between individual installations. Hence, the aggregate cap for the EU ETS will be determined in a bottom-up fashion by summing the allocations of each Member State. The individual allocation plans must be consistent with a number of criteria, including:

- the Member State burden sharing target and progress towards that target;
- the proportion of overall emissions accounted for by EU ETS participants;
- national energy policies and the national climate change programme;
- the potential, including the technological potential, to reduce emissions;
- other EU legislation, including increases in emissions resulting from new legislation; and
- the internal market and state aid rules;

In addition, the plan ‘may accommodate’ early action to reduce emissions and must include information on how clean technology and competition from sources outside the EU will be taken into account.

These criteria involve a mixture of top-down and bottom-up requirements that will be very difficult to interpret. Since the criteria are potentially contradictory, it will be difficult for a single set of allocation rules to meet all of the criteria simultaneously. For example, a rule that was consistent with national progress towards meeting the burden sharing targets could give relatively lenient allocations to UK installations, since the UK is on course to meet its target. But these allocations may not be consistent with the

technological potential of each installation to reduce its emissions. Similarly, a comparable rule would give more stringent targets to Spanish installations, since Spain looks likely to exceed its burden sharing target. But the resulting differential treatment of installations within the same product market could violate EU internal market and state aid rules.

The Commission has suggested that the approval process for the NAPs will be fairly lenient (ENDS, 2003b). But even if a NAP is approved by the Commission, it is still possible for individual companies or Member States to challenge particular provisions in court, with the result that the early stages of the scheme could easily become bogged down in multiple legal challenges. Ultimately, these difficulties could be overcome through harmonised allocation rules, but this was not considered politically achievable for the Phase 1 of the scheme. However, the Commission is required to review implementation of the Directive by 2005 and to consider whether further harmonisation of the allocation rules is required.

Member States are required to submit their allocation plans to the Commission by the 31st March 2004, having previously allowed a three-month period for public consultation. Each plan must specify the total number of allowances to allocate, the allocation to each of the participating sectors, and the allocation to individual installations within each sector. The NAPs are being prepared under intense political pressure to tight time schedule, and with inadequate baseline data. They are likely to pose a major challenge to Member States, and several may be unable to meet the March deadline.

The decision on the total allocation must take into account the emission reductions required to meet the burden sharing targets, the extent to which the Member State intends to use the Kyoto mechanisms, how existing policies are expected to perform and the forecast emission trends for non EU ETS sectors such as transport. This requires assumptions about energy prices, GDP and other factors and analysis with an economy-wide energy model. Excessively lenient allocations to the participating sectors could pose difficulties in meeting the burden sharing target since most non EU

ETS sectors are expected to increase emissions by 2010. However, excessively stringent allocations could lead to the participants becoming net buyers of EUAs during Phase 1. Since EUA transfers prior to 2008 will not be associated with Assigned Amount Unit (AAU) transfers, there is a risk that Member States which host net buyers will make insufficient modifications to their national emission path during Phase 1, leaving them poorly placed for subsequent compliance with the Kyoto Protocol.

The sharing of the total allocation between sectors and individual installations opens up a range of complex issues (Harrison and Radov, 2002; Harrison et al, 2003). While a very wide range of options are possible, the final decisions are likely to be severely constrained by the available data. For example, while allocating according to benchmark performance levels may be attractive, this is not a viable option if the appropriate benchmarks are not available. Similarly, allocating on the basis of historic emissions is only feasible if the emissions data is available, and typically, such data is only available for the most recent years.

Several Member States are planning to divide the total allowance cap between individual sectors and then allocate these sector totals between individual installations. This allows sector-level considerations to be incorporated, such as the anticipated increase in emissions from the oil refining sector, but sector level data will not precisely match the emissions from those installations that are covered by the EU ETS. The allocation rules for individual installations may differ between sectors. For example, allowances could be allocated to electricity generators on the basis of electricity output, while allowances could be allocated to paper companies on the basis of historic emissions.

The chosen rule must select between:

- historic data or forecast emission trends - perhaps including the anticipated impact of other energy and climate policies;
- historic emissions, or alternative metrics such as product output, fuel consumption, plant capacity or some combination of these;

- data from the most recent year or from a number of years; and
- data averaged over a number of years, or the maximum value of some variable during that period.

Two particularly important issues are the treatment of new entrants and plant closures. For new entrants, the choice is between purchasing allowances or setting aside a pool of allowances to be freely allocated to new entrants. The first option may create barriers to entry, while the second option reduces the number of allowances available to incumbents. It also raises difficult issues regarding the appropriate size of the pool and discriminates against the expansion of production from existing installations. With plant closures, any confiscation of the allowances will create perverse incentives for installations to remain open as well as creating difficulties in defining what is meant by plant closure.

Several Member States are intending to use the allocation plan to reward early action and/or encourage certain types of technology, such as CHP. But the definition of 'early action' is contested and could simply be seen as creating 'hot air' through rewarding actions that have already been taken. Similarly, the obstacles to technologies such as CHP may be better addressed through other market reforms, rather than through distorting and complicating the allocation plan.

In sum, the development of acceptable allocation plans poses a formidable challenge to Member States and difficulties with this process may yet delay the start of the scheme.

V. Interfaces and linking

The third area which has created difficulties is the horizontal links between the EU ETS and other national emissions trading schemes, together with the vertical links

between the EU ETS and the Kyoto mechanisms. In respect of the first, the Directive allows agreements to be concluded with third parties to allow for the mutual recognition of allowances between the EU ETS and third party trading schemes. The third party must have ratified the Kyoto Protocol, which at present would exclude trading with the US. However, the development of links with trading schemes in Canada and Japan looks increasingly likely.

The links to the Kyoto mechanisms are the subject of a proposed second Directive (European Commission, 2003b). This amends the EU ETS to allow the import of Emission Reduction Units (ERUs) from Joint Implementation projects and Certified Emission Reductions (CERs) from Clean Development Mechanism (CDM) projects. At present, there are no plans to allow the direct import of AAUs, although the relationship between the EU ETS and International Emissions Trading (IET) will be addressed in the review of the EU ETS promised for 2006.

The main provisions of the proposed 'linking' Directive are as follows:

- From 2008 onwards CERs and ERUs can be converted into EUAs on a one-to-one basis and used for compliance. However, project credits from whatever source cannot be used for compliance during Phase 1.
- Credits obtained from nuclear energy projects are excluded, while credits from large hydro schemes and other projects with negative environmental and social impacts are discouraged, but not specifically outlawed.
- Credits obtained from land use, land use change and forestry (LULUCF) projects are also excluded since they do not achieve permanent emission reductions, do not promote technology transfer and could result in significant negative impacts on biodiversity. However, this issue will be revisited in the light of agreement on the modalities for forestry projects under the CDM.
- Double counting is avoided by ensuring that no ERUs are issued for reductions that directly or indirectly affect emissions that will be covered by the EU ETS.

This mainly applies to JI projects in Eastern Europe, but JI projects which are approved before 31 December 2004 will be excluded from the trading scheme.

Much of the debate over the linking Directive centres on possible restrictions on the number of ERUs and CERs that can be imported. The rationale for such restrictions goes back to the supplementarity provisions of the Kyoto Protocol. While unrestricted access to JI/CDM credits will lower the cost of compliance with the EU ETS, it will also reduce the incentives for developing and adopting low carbon technologies (Grubb, 1997). By effectively locking the EU into a high emissions path, this could make it more expensive to make substantial emission reductions in the future. In addition, the import of credits means that the environmental co-benefits of reduced fossil fuel use (e.g. lower NOx emissions) will no longer be obtained within the EU (European Commission, 2003b).

The Directive does allow for restrictions on credit imports, but these are fairly limited. It proposes that a review will take place once the number of credits converted for use in the EU ETS reaches 6% of the total quantity of allowance allocated for the period 2008-12. This corresponds to around 2% of the EU base year emissions and around one quarter of the total emission reductions required from a business as usual baseline. If the 6% ceiling is reached, the Commission may decide to impose a maximum limit of, for example, 8% of the total quantity of allowances allocated. In practice, the supply of credits is likely to be hindered by low prices, high transaction costs and inadequate institutional capacity, which makes it unlikely that such a ceiling will be required. If, however, the ceiling is approached, the uncertainty regarding potential import restrictions may create instabilities in EAU prices.

While the exclusion of nuclear projects is consistent with the Marrakesh Accords, the exclusion and discouragement of other types of projects goes beyond the international rules. In practice, this is likely to contribute to an increasing differentiation in credit prices from different types of project within the international

carbon market. For example, credits from sink and hydro projects may be expected to trade at a lower price than credits from renewable energy projects (Grubb, 2003).

Despite these restrictions, the impact of the linking Directive on the EU ETS market is expected to be considerable. Modelling work by the Commission suggests a 20% reduction in compliance costs, with EAU prices falling from €26/tCO_2 to around €14/tCO_2 (European Commission, 2003b). However, in the absence of an agreed cap and with limited knowledge of the global JI/CDM potential, any such estimates are highly uncertain.

VI. Other issues

The following issues have also attracted attention during the negotiation process and are likely to remain important as the Directive is implemented.

- *Compliance:* The penalty for non-compliance with the EU ETS during Phase 1 is set at €40/tCO_2 and combined with an obligation to surrender an amount of allowances equal to the excess emissions in the following calendar year. In Phase 2, the penalty increases to €100/tCO_2. These penalties create an effective ceiling on allowance prices and marginal abatement costs, which for Phase 1 is relatively low. The compliance provisions have been weakened from earlier proposals, which for Phase 1 were €50/tCO_2 or twice the market price, whichever was higher. However, the penalty for Phase 1 remains above most forecasts of EUA prices.

- *Pooling:* Germany secured the inclusion of an additional provision which allows installations to form an emissions Pool. Here, a single authority (e.g. a sector association) takes on all the responsibility for issuing, trading and surrendering allowances for all members of the Pool. This provision, which was designed to protect the German negotiated agreements, provides for ‘joint and several’

liability for installations within a sector and creates incentives for free riding: i.e. installations that make efforts to reduce emissions may be subsidising competitors that do not. Pooling will require a very coherent sector to be successful and has not attracted much interest from other Member States.

- *Banking:* the Directive allows unrestricted banking of allowances within each Phase, while banking from Phase 1 to Phase 2 is at the discretion of individual Member States. Banked allowances will allow higher emissions during the commitment period, but since these emissions will not be backed by AAUs the compliance of a Member State which is a net buyer of banked allowances could be threatened. Furthermore, the compliance of the EU as a whole may be threatened if there is extensive use of banked allowances. In response to this, some countries are proposing to ban banking while others may require that installations can bank allowances for emission reductions they have achieved themselves but cannot 'buy to bank'. This is one area which would benefit from harmonisation, since differences in banking rules between Member States can easily be circumvented by transferring/selling a surplus to installations in other Member States with more lenient banking rules, and then buying it back subsequently.

- *Impacts on competitiveness:* The impact of the scheme on industrial competitiveness is a controversial topic which is difficult to assess. The impact will depend in part upon the ability of a sector to pass costs onto customers, which in turn will depend upon the extent to which the sector is exposed to international competition - or more specifically, to competition from countries which are not subject to comparable constraints on carbon emissions. In this respect, industrial sectors such as chemicals and non-ferrous metals have a much greater degree of exposure than the electricity industry.

- *Impacts upon electricity prices:* The electricity industry plays a central role in the EU ETS as it accounts for around two-thirds of the emissions covered by cap.

Hence, the potential impact of the scheme upon electricity prices is attracting increasing attention. In theory, wholesale electricity prices should be proportional to the marginal cost of generation which should include the *opportunity* costs of allowance holdings. This means that the price increases faced by electricity consumers should be identical, regardless of whether the allowances are freely allocated or sold in an auction. With free allocation, the economic rent is captured by the participating firms, thereby increasing their market value, while the government receives no revenue with which to compensate electricity consumers for the resulting price rises. An additional point is that the increase in wholesale electricity prices should be proportional to the carbon intensity of the *marginal* plant on the generating system. Since in many countries this is coal-fired, the price impacts could be substantial. Indeed, some analysts have forecast that wholesale electricity prices will increase by as much as 40% (ENDS, 2003c).

VII. Summary

The EU ETS is a bold experiment whose success is critical for the future of EU climate policy and for the development of GHG emissions trading throughout the world. The scheme represents a pragmatic compromise between economic efficiency and political acceptability and it has many commendable features which should enhance its viability over the long-term. The main difficulties result from the speed in which the scheme is being introduced and the tensions within the EU over the appropriate level for political decision-making.

The Commission remains committed to a start date of 2005, although this gives Member States very little time to get all the elements in place. Typically, the lack of institutional capacity at the government level is mirrored by a lack of knowledge and awareness within the affected industries. All Member States face difficulties in obtaining adequate data on baseline emissions, which makes the development of

acceptable allocation plans highly problematic. These problems could be reduced by delaying the start of the scheme by one year, but this would be politically embarrassing for the EU as well as delaying action to reduce emissions.

Conflicts over the appropriate locus of decision-making has led to several decisions being devolved to the Member State level which may have been better addressed at the EU level. This applies in particular to the allocation criteria, the banking rules and the definitions of eligible installations. In remains to be seen whether more informal co-operation over the next few months will achieve greater harmonisation in these areas. The provisions for review in the Directive give the opportunity for revising these rules in time for Phase 2, which suggests that the difficulties created in these areas may reduce over time. But disputes over allocation are likely to remain a central difficulty until greater use of auctioning can be achieved.

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3. The UK emissions trading scheme

Steve Sorrell[*]

The position of the UK emissions trading scheme (UKETS) within UK climate policy is paradoxical. On the one hand, the UK was the first country in the EU to launch a fully developed greenhouse gas (GHG) trading scheme. This built upon three years of consultation during which UK companies and government departments familiarised themselves with the intricacies of trading scheme design, worked constructively together to develop specific proposals, and played an influential role in the European Climate Change Program. On the other hand, the UK ETS is entirely voluntary and occupies a subsidiary role within the overall UK climate program. The constraints created by the existing policy mix have led to a complex and unusual design which is unlikely to be followed by other countries and which appears largely incompatible with the proposed EU Emission Trading Scheme (EU ETS) (Sorrell, 2003a). These incompatibilities may mean that the scheme has a much shorter lifetime than that originally envisaged. In effect, the UK's early start in emissions trading may ultimately be judged a false start (Sorrell, 2003b).

This section provides an overview of the UK emissions trading scheme (UK ETS), describing in turn its three main elements:

- the cap and trade sector (the direct participants);
- the baseline and credit sector (the CCA participants); and
- the proposed project sector.

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The section emphasises the limitations of a voluntary trading scheme and highlights the difficulties associated with establishing emission baselines particularly for non CO_2 GHGs.

I. History and context

The UK ETS has its origins in a 1998 government task force on economic instruments and the business use of energy (Marshall, 1998). This recommended an energy tax in preference to an emissions trading scheme but suggested that a 'pilot' trading scheme should be established to facilitate learning.

Following these recommendations, the UK government introduced the Climate Change Levy (CCL), in April 2001. The CCL is a revenue neutral downstream energy tax, levied at different rates on coal, gas and electricity use by the industrial, commercial and public sector. Household energy use, oil use, CHP fuel and renewable electricity are all exempt. The government chose a downstream tax, combined with indirect treatment of electricity[5] to avoid energy price increases for low income households, and chose an energy tax rather than a carbon tax to protect what remains of the UK coal industry. These decisions have influenced the entire shape of the UK climate program.

To protect energy intensive industry, the government negotiated a series of Climate Change Agreements (CCAs) with energy intensive 'facilities' to cover the period 2001 to 2013. These give exemption from 80% of the CCL, provided facilities take on binding targets for either energy use or CO_2 emissions. The penalty for non-compliance is a return to paying the full CCL for the following two years. CCAs have been negotiated with 44 industrial sectors representing around 5500 industrial companies.

Once these instruments were announced, the scope for a parallel emissions trading scheme appeared very limited. However, there remained strong interest in a pilot

[5] A direct treatment entails taxing the fuel input into electricity generation, while an indirect treatment entails taxing electricity at the point of consumption.

scheme from business, government and the financial sector and this led to the formation of the UK Emissions Trading Group (UKETG) in June 1999. The UK ETS was largely designed by the UKETG, which published its first proposals in October 1999 and its full proposals in March 2000 (UKETG, 2000). These fed into government proposals for a trading scheme which were published as a consultation document in November 2000 and as a framework document in May 2001 (DEFRA, 2001). The scheme was finally launched in August 2001.

Since the UK scheme involve direct subsidies to industry, the UK government had to seek the approval of the European Commission under 'state aid' rules. This was achieved in November 2001. The Commission 'welcomed the positive initiative of the UK Government', but warned of possible divergences between the UK scheme and the recently proposed EU ETS. This could lead to market distortions in the future, in which case the Commission would propose modifications to align the UK scheme with the EU's.

II. Elements of the UK ETS

The UK ETS began operation in January 2002 and will run for five years (DEFRA, 2001). There are three types of participant in the scheme: direct participants, who take on absolute targets for GHG emissions; CCA facilities, who are also allowed to engage in trading; and individual emission reduction projects, which may generate saleable GHG credits. While the direct participant and CCA components are up and running, the project component has been stalled and now appears unlikely to go ahead.

The basic structure of the scheme is illustrated in Figure 3-1. The direct participant sector consists of a small number of firms who have taken on absolute targets for GHG emissions in exchange for direct subsidies from the government. The CCA sector consists of facilities which are signatories to a CCA but also allowed to engage in trading. These in turn can be split into two groups: the small number that have absolute

targets for energy use or GHG emissions, and the much larger number that have relative targets (e.g. GWh/output). The trading rules differ between these two groups, in that trading with the 'CCA absolute sector' is unrestricted, while trading with the 'CCA relative sector' is constrained by the provisions of the 'Gateway'. Table 3-1 illustrates the relative size of the direct participant and CCA sectors, while Table 3-2 summarises the key components of these two parts of the scheme.

Figure 3-1. Structure of the UK emissions trading scheme

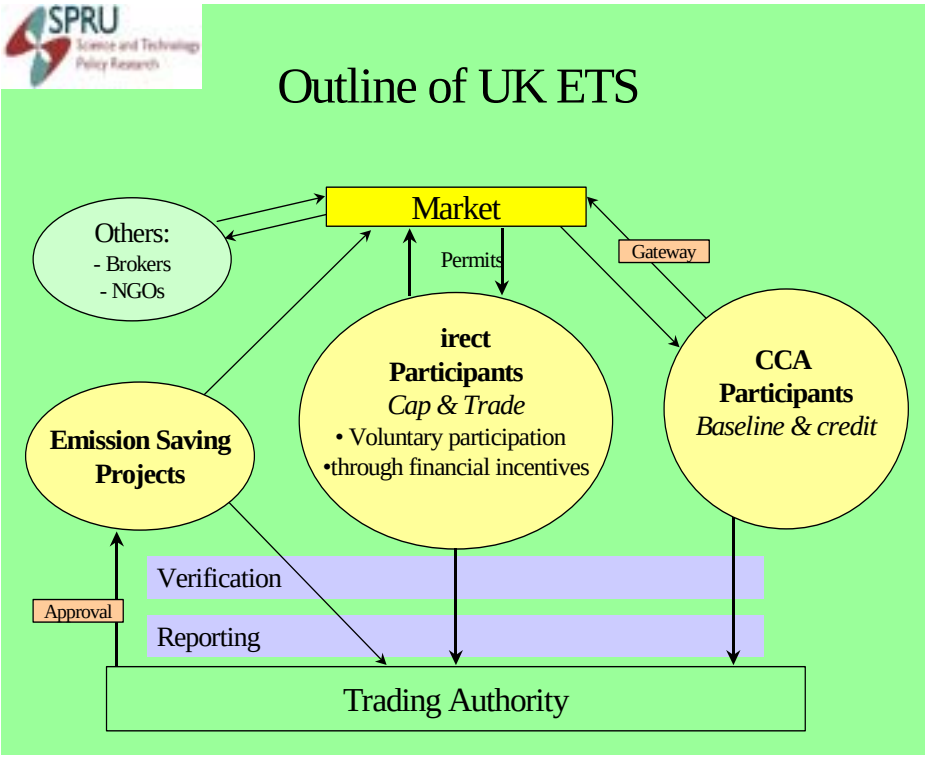

Figure 3-2. Trading routes in the UK emissions trading scheme

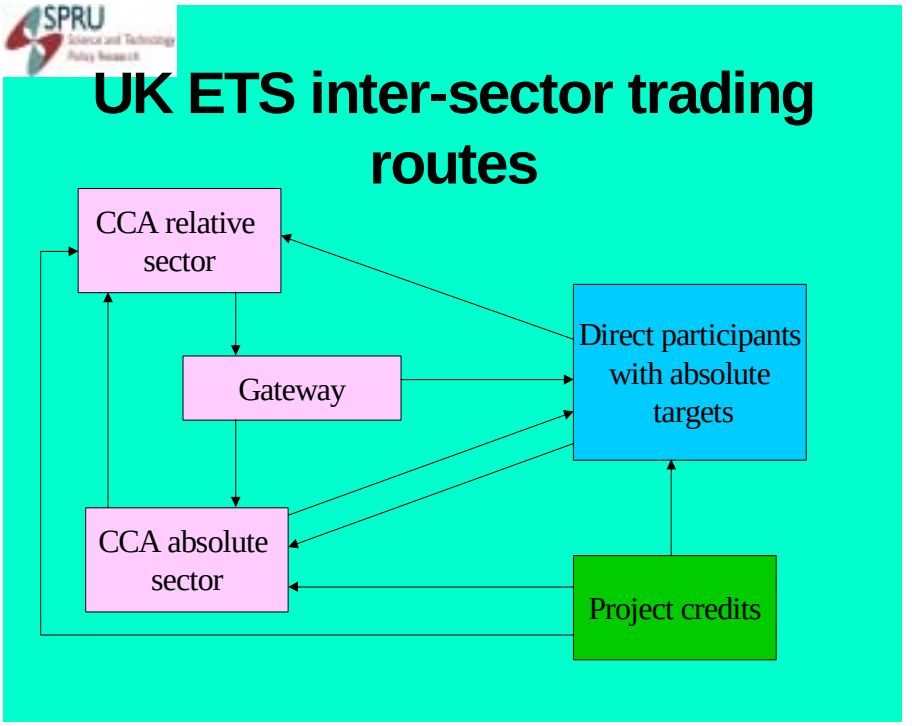

Table 3-1. Comparison of direct participant and CCA sectors of the UK ETS

	CCAs	DPs
Number of firms	5500	34
Number of sites	12,000	1000
Emissions covered ($MtCO_2e$)	100	30
Emission reductions in final year from base year ($MtCO_2e$)	9.2	4.0
Average emission reduction per year($MtCO_2e$)	0.9	0.8

Source: (Kroger, 2003)

Table 3-2. Key elements of the direct participant and CCA components of the UK ETS

	Direct participants	Climate Change Agreements (CCAs)
Compliance periods	Annual targets decreasing each year from 2003 to 2007	Targets defined at two yearly intervals up to 2010.

Type of target	Absolute GHG emissions.	Firms allowed to choose either relative or absolute targets for either energy use or CO_2 emissions. In practice, most have chosen relative energy targets.
Allocation of allowances	Distributed via an 'incentive auction', in which participants bid for government subsidies	Baseline and credit trading arrangements from existing CCA targets. Allowances can be used to meet targets and can be generated when facilities exceed their targets.
Sectors included	Voluntary participation. Open to organisations in the public, commercial and industrial sectors.	All sectors regulated under IPPC, but with no size threshold. Some energy intensive installations in non-IPPC sectors are also eligible.
Number of participants	34 organisations and ~1000 individual sites	~5500 firms and 12,000 individual sites
Basis	Participants adopt targets for combustion and process emissions of all six Kyoto gases. These include indirect emissions from electricity consumption, estimated using a fixed conversion factor for the carbon content of purchased electricity.	Firms adopt targets for energy use or CO_2 emissions. Latter applies to combustion sources (not process) and includes indirect emissions from electricity consumption.
Links with JI/CDM	Interfaces to JI, CDM and IET proposed, but not possible until after 2008 and subject to approval by UK government	Interfaces to JI, CDM and IET proposed, but not possible until after 2008 and subject to approval by UK government
Links with other countries schemes	Interfaces to third party trading schemes proposed but subject to approval by UK government	Interfaces to third party trading schemes proposed but subject to approval by UK government
Monitoring, Reporting and Verification	Monitoring and reporting in accordance with IPPC, WBCSD and other standards, with verification by an independent third party accredited by the UK Accreditation Service	Monitoring and reporting in accordance with IPPC, WBCSD and other standards, with verification by an independent third party accredited by the UK Accreditation Service
Allowance tracking	Registry maintained by the UK government, intended to evolve into international registry for IET	Registry maintained by the UK government, intended to evolve into international registry for IET

Sanctions	£30/tCO_2e fine for excess emissions	Payment of Climate Change Levy at full rate (about £4.6/tCO_2 to £9.4/tCO_2, depending on fuel) for the subsequent two years
Banking	Banking allowed up to 2007. Government reserves right to restrict banking into the commitment period	Banking allowed up to 2007. Government reserves right to restrict banking into the commitment period

Source: DEFRA (2001).

III. The direct participant sector

The focus of the UK ETS is a cap and trade scheme for organisations that take on absolute emissions targets. The most important point to note is that this is a *voluntary* scheme in which a financial incentive is provided by government to encourage organisations to take on a cap. This means that the scope of the cap and trade scheme is not defined at the outset, but is established by industry's response to the financial incentive. A second point to note is that the scheme applies to all six GHGs and that the majority of emission reductions achieved through the scheme are for non-CO_2 gases. A third point is that the coverage of CO_2 emissions includes both direct emissions from the site and *indirect* emissions associated with the consumption of electricity at the site. The latter are calculated by means of a fixed emission factor for the carbon content of imported electricity. This approach was taken to ensure consistency with the CCL and CCAs and has the important consequence that the electricity generators are excluded from the UKETS because of the risk of double counting emission reductions. Given both the contribution of electricity generation to overall CO_2 emissions and the prominence of electricity generators in other trading schemes, this is a rather unfortunate outcome.[6]

The primary objective of the direct participant scheme is to deliver emission reductions which are additional to business as usual. However, the government also

has additional objectives such as promoting learning among a range of actors (e.g. participants, verifiers, consultants, brokers) and establishing the City of London as a centre for emissions trading. These secondary objectives become more important if - as appears to be the case - the additionality of the emission reductions are called into question.

To initiate the scheme, the government held an 'incentive auction' in March 2002. Companies were invited to bid emission reductions against a defined baseline in exchange for subsidy payments totalling £215 million over five years (i.e. £30 million per year). A wide range of organisations in the industrial, commercial and public sectors were eligible to participate in the auction, but not emission sources that were already subject to a CCA. Thirty four companies were successful in this auction and committed to reduce emissions by a total of 4.03MtCO_2e by 2007. This figure was much greater than anticipated, and represents about 6% of the total reductions required in the UK Climate Change Programme. Two of the successful companies subsequently withdrew from the scheme, leaving 32 remaining with total targets in 2006 of 3.96 MtCO_2e.

The 'descending clock' auction began with the announcement of a starting price of £100/tCO_2.[7] Participants then bid the quantities of emission reduction they were prepared to make at this price. The government then multiplied the price by the total quantity bid and found that it exceeded the total budget available. The price was then reduced and the bidding process repeated until the total quantity of emission reductions multiplied by the final price was equal to £215 million. The final price corresponded to a subsidy of £17.79 per tonne of CO_2e emission reduction over the lifetime of the scheme.[8]

The total emission reduction bid by each participant was divided into five increments, so that each participant's allocation decreases by one-fifth of its total reduction target

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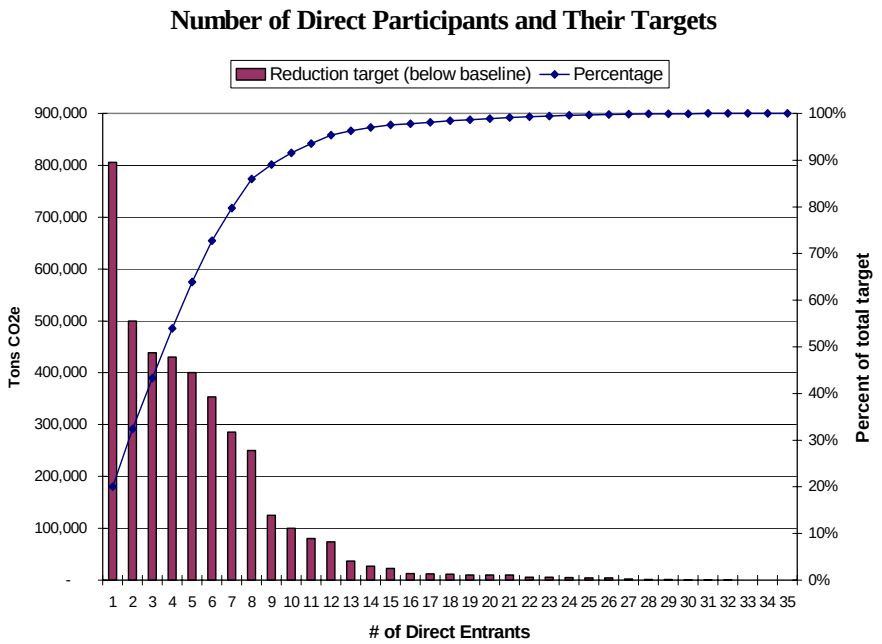
[6] For example, the Danish CO_2 trading scheme is confined *solely* to the electricity generators.
[7] Equivalent to the government's estimate of the 'social cost of carbon'.
[8] In practice, this number may effectively be lower since the incentive monies are subject to corporation tax.

each year.[9] The baseline for each target was typically the average annual emissions for the three-year period preceding the start of the scheme. The initial period of trading began in April 2002, with annual compliance deadlines until March 2007. The penalty for non-compliance is a fine of £30/CO_2e, which creates a ceiling on the allowance price. Any surplus emission allowances can be banked until 2007, while the government allows participants to bank into the first Kyoto commitment period 'up to a maximum limit of the emission reductions below their target which they have achieved themselves'. In other words, it is not possible to 'buy to bank'. The government originally intended to hold further incentive auctions and to extend the duration of the scheme beyond 2007, but the introduction of the EU ETS appears to have scuppered these plans. In the absence of any link between the UK ETS and the EU ETS, the value of any banked UK ETS allowances beyond 2007 may be very limited (Sorrell, 2003a).

The companies participating in the auction ranged from large chemical plants to small universities and museums. A number of the participants were large multinationals, such as BP, British Airways, and Shell, but these only bid a small proportion of their total emissions and facilities. Figure nn indicates that the largest nine bidders were responsible for over 90% of the total reductions. The emission reductions were dominated by Ineos Fluor (0.8MCO_2e) and DuPont (0.5MCO_2e) who both bid in non CO_2 gases (HFCs and N_2O respectively). It is the extremely high global warming potential of these gases which accounts for the large volumes of CO_2e (e.g. one tonne of HFC23 is equivalent to 11700 tonnes of CO_2).

[9] For example, if a company's baseline was 1000 tons, and its reduction target was 100 tons, the target in the first year would be 980 tons, the second year 960 tons, and so on. The final year target would be 900 tons.

Figure 3-3. Number of direct participants and their targets



Source: Irving (2002)

A major difficulty with a voluntary scheme is that it attracts companies which anticipate reducing emissions, but not those which anticipate increasing emissions. Survey results suggest that this is exactly what happened in the incentive auction, with 81% of participants reporting that their emissions were falling and only 6% reporting that their emissions were rising (Kroger, 2003). This has led to criticism that the UK government has rewarded companies for emission reductions that they were planning to make anyway as well as creating a one-sided allowance market that is dominated by sellers (ENDS, 2002a). However, the second problem is partially mitigated by the existence of potential buyers within the CCA sector (described below).

The bidding strategies in the auction were insensitive to price and rarely based upon estimates of marginal abatement costs (Kroger, 2003). The criticism that the auction price was significantly higher than actual abatement costs for most participants appears

to be borne out by early experience with the allowance market. Prices peaked at £12.50/tCO_2e in September-October 2002, before dropping sharply to around £5.00/tCO_2e and then declining further. Since the first compliance deadlines (February 2003 for CCA participants and March for direct participants), there has been very little market activity and prices have fallen to less than £2.50/tCO_2e. By the end of 2002, 23 of the 32 direct participants had reduced their emissions by as much or more than their targets. Altogether, the total emission reductions were 4.64MtCO_2e compared to the first-year target of 0.79MtCO_2e - an excess of 3.85MtCO_2e or 487%.

Despite the low prices, the government has been encouraged by the volume of allowance trading. Overall, 7.2MtCO_2e of allowances were transferred during the first year of the scheme, representing 24% of the total allocation of 30.2MtCO_2e (DEFRA, 2003). More than 80% of these transfers took place during the three-month period preceding the compliance deadlines, and many appear to have been intra company-transfers rather than proper trades. Some 0.5MtCO_2e of allowances were purchased by the CCA sector, while 8.2MtCO_2e were retired by the direct participants for compliance with their first-year targets.

The early stages of the direct participant scheme have been plagued by disputes over the 'additionality' of the emission reductions achieved. This has been the focus of a series of exchanges between the government and a prominent environmental journal (The ENDS Report), and is currently the subject of independent investigation by the National Audit Office (NAO). The greatest problems lie in the treatment of non-CO_2 GHG emissions at the three large chemicals plants (Ineos Fluor, DuPont, Rhodia), since these are already subject to environmental regulations under the Integrated Pollution Prevention & Control (IPPC) Directive. For regulated sources, the government required that the emissions baseline should be based upon the emissions limit rather than historic emissions, so that only emission reductions that were additional to regulatory requirements would be subsidised. For the Ineos Fluor site, the government set the baseline at the site limit for annual VOC emissions which had been established by the Environment Agency. But this neglected the fact that the HFC-23

emissions regulated by the UK ETS were only one component of the overall site VOC emissions. In addition, the VOC limit included significant 'headroom', which meant it was unlikely to be reached during normal operation (ENDS 2002b). The net result was that the emissions baseline of 148 tonnes of HFC-23 was substantially above the actual emissions in 2000 of around 45 tonnes. This gave Ineos Fluor a surplus of around 100 tonnes, which translates into a massive 1.2MtCO_2e. This is 50% above the company's final (2006) target of 0.8MtCO_2e and creates the possibility that ~3.6MtCO_2e of emission allowances could be banked from this one site during the course of the scheme (i.e. almost as much as the total emission reductions required by 2006). However, Ineos Fluor argues that emissions in 2000 were unusually low due to plant shutdown and that the UK ETS targets go beyond regulatory requirements. Hopefully the NAO investigation will allow more definitive conclusions to be drawn on this issue.

The dispute over Ineos Fluor is mirrored at several of the other direct participant sites (KOKO). For example, DuPont's emissions of N_2O in 2002 were only 43% of its baseline, creating an allowance surplus of 1.3MtCO_2e. This is worth £3.5 million at £2.50/tCO_2e, which is on top of the £26.7 million DuPont received in incentive payments. Similarly, British Sugar is expecting to achieve compliance by closing several sites and shifting production to other, more efficient sites - a move which had already been announced prior to the start of the UK ETS. Hence, while adverse selection may be anticipated within a voluntary scheme, the problem appears to have been compounded by the difficulties in establishing baselines at several of the most important sites, coupled with the 'amplifier' effect of high global warming potentials for non-CO_2 gases. The resulting disputes have undermined the credibility of the UK ETS and may have tarred the image of emissions trading more broadly.

IV. The CCA sector

In contrast to the direct participant sector, which was designed as a cap and trade scheme from the outset, the CCA sector represents an existing set of negotiated agreements to which baseline and credit trading arrangements have been added. But while the trading rules have added both flexibility to the CCAs and a demand side to the allowance market, they have also introduced further complexity into an already crowded policy mix.

The Climate Change Agreements (CCAs) are negotiated agreements between energy intensive 'facilities' and the government and cover the period 2001 to 2013. CCAs give facilities exemption from 80% of the CCL, provided they take on binding targets for energy use or CO_2 emissions. The targets are defined for two-yearly intervals up to 2010 and may be either absolute (e.g. MWh or tCO_2e) or relative (e.g. MWh/output or tCO_2e/output). The targets cover CO_2 emissions only, and cover both direct emissions and indirect emissions from electricity consumption. The penalty for non-compliance is a return to paying the full CCL for the following two years. Eligible facilities are those located in sectors which are regulated under IPPC and include many facilities which lie below the IPPC size threshold. However, oil refineries and electricity generators are excluded from the scheme. CCAs have been negotiated with 44 industrial sectors representing around 5500 companies and 12,000 individual facilities. The government initially estimated that these would reduce CO_2 emissions by 9.2 $MtCO_2$/year by 2010, corresponding to ~12% of baseline emissions (DETR, 2000).

The CCAs vary widely in their choice of base year, the improvement required over a business as usual baseline, the assumptions used about production levels and product mix, and the provisions for 'risk management'.[10] In all cases, the targets are based upon a percentage of the 'cost effective' energy efficiency potential, identified through modelling work by AEA Technology (ETSU 2001). Several commentators have argued

[10] Some sectors are allowed to adjust their targets if there are changes in product mix or output level, while others have adopted a 'tolerance band' around their target.

that the targets are weak, as a consequence of information asymmetry, limited sectoral and technology disaggregation in the AEA database, the choice of simple paybacks rather than discounted cash flow for investment appraisal, the very short paybacks used (2 to 4 years) and the fact that only a percentage of cost effective improvements are required (Waller, 2001). In response, industry has emphasised the importance of hidden costs, such as management time and constraints on capital availability (ETSU, 2001).

The UK ETS introduces additional trading arrangements for the CCAs which allow facilities to generate 'allowances' if they perform better than their target, and to use allowances for compliance if they perform worse than their target.[11] Allowances can only be generated for overcompliance during the one year 'milestone period' leading up to the biennial milestone deadline. Overcompliance in the year preceding the milestone period does not count and cannot be sold or banked. The banking or sale of allowances is only possible ex-post, once compliance with the milestone targets has been verified by third party. However, non-verified overcompliance can be 'ring fenced' by a facility, and if this is subsequently verified it may also be banked or sold. Allowances can be traded with other CCA facilities and also with the direct participants in the UK ETS.

The inclusion of CCA trading arrangements is to the benefit of CCA facilities but has complicated the design of the UK ETS. Relative targets create problems as increases in output can lead to increases in emissions – although this is constrained in the short term by production capacity. To prevent any violation of the emissions cap for direct participants, a 'Gateway' had to be established to prevent the net sale of allowances from the CCA sector to the direct participant sector. The Gateway operates in real time and participants are able to check its status on the Registry web site. In practice the Gateway has remained open since the start of the scheme since there has been little demand for allowances from outside the CCA sector.

[11] The trading arrangements for the CCA participants are of the baseline & credit form, so the trading commodity should strictly be termed a *credit*. However, since the CCA sector is linked to the direct participant sector, the same commodity is used in both. Hence, the commodity is termed an *allowance* and is identical to that used in the direct participant scheme.

Trading offers CCA facilities a highly cost effective route to avoiding non-compliance penalties, since the cost of purchasing allowances to cover marginal exceedances of the CCA target is much less than the cost of CCL payments on all fuel and electricity use over a two-year period. Furthermore, if the price of allowances is very low, the incentive for meeting the CCA targets through improving energy efficiency is undermined since low-cost compliance is available through the purchase of allowances. Hence, there is a risk that the trading arrangements will substitute the purchase of 'hot air' allowances for real action to reduce emissions. A related point is that trading creates an incentive for overcomplying facilities to sell allowances outside their sector, rather than subsidise their competitors by contributing to overall sector compliance. As a consequence, the incentive for individual facilities to free ride is much diminished. Overall the trading arrangements have both increased the incentive for individual facilities to comply with their targets, and provided a cheap mechanism with which to do so.

The CCA sector was anticipated to provide the 'engine of demand' in the UK ETS to compensate for the dominance of allowance sellers within the direct participant sector. But while the bulk of allowance demand has indeed come from the CCA facilities, the relative weakness of the CCA targets (at least for the first milestone year) has led to demand being less than expected. The government estimates that emissions from the CCA facilities in 2002 were 15.8 $MtCO_2$ less than the baseline, or 13.5$MtCO_2$ less than an adjusted base year of 2000 (ENDS, 2003).[12] This is more than three times the cumulative target for the first milestone and more than the total savings expected by 2010. Around 60% of this reduction has come from plant closures within the steel industry and the government has taken steps to ensure that this surplus cannot be sold. However, the remaining sectors also overcomplied by some 3$MtCO_2$, with at least two-thirds of companies exceeding their targets (ENDS, 2003). A total of 743 participants bought 0.5 million allowances and use them against their targets, while 123 participants verified overcompliance totalling 1.3 million allowances. However, the latter does not

[12] Different sectors have different baseline periods.

include the 4MtCO_2 of overcompliance which has been ring fenced, of which the steel industry counts for 1.7MtCO_2. The net result is that an allowance surplus is building up in the CCA sector of comparable magnitude to that in the direct participant sector. This may be reduced as the milestone targets are tightened in subsequent years, but at present the UK ETS market is characterised by chronic oversupply. This in turn leads to limited market activity and very low allowance prices.

V. The project sector

The third component of the UK ETS was intended to be a scheme for emission reduction projects, analogous to JI and the CDM but for projects within the UK. This was intended to incentivise investment in areas outside the scope of the direct participant and CCA sectors, including in particular the built environment, CHP, methane recovery and transport.

The government commissioned consultation work on the project scheme in 2002 (Begg et al, 2002) and intended to launch a 'limited pilot phase' for projects in 2003. However, this work ran into difficulties. First, the proposals for estimating emissions baselines and demonstrating additionality proved to be highly complex and threatened to introduce prohibitively high transaction costs. Second, the conflicts with existing policy instruments proved problematic and appeared to rule out investment in the household sector, despite the clear need for projects in this area. Third, the low carbon price provided little incentive for project activity since it made little difference to the economics of the majority of projects.

But the most important factor was the impending introduction of the EU ETS. While this including proposals for a 'linking Directive' to link the EU ETS to JI and CDM, it was far from clear that this would also allow linking to the UK project scheme. Even if linking were possible, there was a risk that the EU scheme could exclude certain project categories that were included in the UK ETS or impose rules on additionality

and baselines that were inconsistent with the UK rules. Given these risks, the government decided that the project scheme should be delayed until the EU rules were clear.

The EU ETS has now been finalised and the proposals for a 'linking directive' have been published (European Commission, 2003). But these do not include any provisions for linking to a domestic project scheme such as the UK ETS. Furthermore, the trading of allowances between the wider UK ETS and the EU ETS is expected to be prohibited, partly as a consequence of double counting problems. As a result, the project scheme appears to have been quietly dropped and there seems no prospect of resurrecting the proposals in the foreseeable future.

VI. Summary

What overall assessment can be made of the UK scheme? On the positive side, the scheme can be seen as a useful experiment which has led to substantial learning within the UK. The UK Emissions Trading Group has brought together individuals from a wide range of businesses and encouraged detailed engagement with the design and implementation of a viable trading scheme. There is now a substantial core of emissions trading expertise in the UK and several profitable businesses have been established in the areas of allowance trading, monitoring and verification of emissions and consultancy on carbon abatement opportunities. The government has developed substantial knowledge and expertise in this area and an allowance Registry has been established which can be modified for subsequent use in the EU ETS and IET. The experience has helped the UK position itself for the introduction of the EU ETS and has placed the UK ahead of other Member States in getting to grips with the details of trading schemes.

On the negative side, the voluntary nature of the UK scheme has led to the adverse selection of organisations which expected their emissions to reduce. The predictable

result is a one-sided allowance market with a dominance of sellers. This problem has been compounded by the errors in establishing emission baselines for a number of the key participants. The high global warming potential of non-CO_2 gases has amplified the significance of these errors, with the result that a large volume of 'hot air' has been introduced into the scheme. This has damaged the credibility of the scheme and potentially of emissions trading more broadly.

The linking of the scheme to the existing CCAs has improved the scope for cost saving, at the expense of introducing greater complexity. While the CCAs has fulfilled a valuable role in providing a 'demand side' to the allowance market, this has been undermined by the relatively weak targets and the resulting overcompliance within the CCA sector. The net result is that the current UK ETS market is awash with surplus allowances.

The excessive complexity of the UK scheme has been frequently remarked upon, but this was largely a consequence of the scheme needing to fit alongside existing instruments such as the CCL and the CCAs. One important consequence was the indirect treatment of electricity, and it is this more than anything else which has led to the incompatibility between the UK ETS and the EU ETS. The latter will eclipse and replace the UK scheme over the long-term, but in the interim the UK faces some complex transition issues which have yet to be resolved. Contrary to initial expectations, the UK allowance market will largely cease to exist beyond 2007 and the value of any banked allowances may be very small. The UK scheme may be viewed in the future sting experiment, whose complexities and idiosyncrasies prohibited it providing a viable framework for emissions trading over the longer term.

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4. Danish Green Certificate Scheme

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The energy market will be affected by several factors including the stable supply of energy sources, technological breakthrough of new and renewable energies, the country's energy and environmental policies, etc. Among these factors is the UN Framework Convention on Climate Change and its Kyoto Protocol. Even before its entry into force, the Kyoto Protocol requires a dramatic change in our perception on energy consumption and the global eco-system.

One of key components in the energy market is the electricity market. The electricity market in Europe is changing rapidly. A number of countries have already liberalized or are in the transition phase of liberalizing their electricity industry. Electricity trade markets are also emerging to facilitate the trade of electricity and now exist in several countries such as England, Norway, Sweden, Finland and to a certain extent Denmark.

In parallel with this market development, a number of countries have committed themselves to considerable reductions of their emissions of greenhouse gases (GHG) in relation to the Kyoto protocol. The European Union has agreed to reduce GHGs by 8% in the years 2008~2012 compared with its emission level in 1990. However, the agreed burden sharing within the EU member countries implies that some countries such as Denmark and Germany have to reduce their GHG emissions by 21% for the same period. In order to meet these targets, the development of renewable energy sources is expected to play a crucial role.

In its recent White Paper on a strategy for the development of renewable energy, the European Commission has set a goal of covering 12% of the European Union's gross inland energy consumption by the year 2010 by renewable sources, that is mainly biomass, hydro power, wind energy and solar energy. Next to biomass, wind energy is

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foreseen to be the main contributor to achieving this goal. The installed capacity of wind power in EU countries is proposed to grow to 40 GW by the year 2010 – by the end of 1997, approx. 4.5 GW was installed in the EU (European Commission, 1997).

Integrating renewable energy resources into a liberalized market model might confront obstacles. At present, most renewable energy technologies are not commercially viable compared to conventional power generation technologies. Therefore, a pure competition of renewable energies in a free market would mean the deterrence of the installation of new generation capacity by renewable energies.

One way of promoting renewable energy technologies is to develop a separate market for electricity generated by renewable energies. This approach will give time to renewable energies to become competitive against conventional electricity generation technologies, facilitate the integration of renewable energy technologies into the liberalized competitive market and at the same time make it possible for renewable energy technologies partly to be economically compensated for the environmental benefits that they can generate.

I. The Danish Energy Reform

In Denmark, a comprehensive restructuring of the legal framework for the electricity and the energy industry was completed in 1999. As an agreement between the Danish government and the Danish Parliament, the electricity reform elaborates the framework for how the power supply industry and renewable energy producers can operate within the context of a liberalized electricity market (The Danish Ministry of Environment Energy, 1999).

According to a plan, all electricity consumers can freely choose their own power suppliers with a full liberalization of the Danish electricity market from the end of 2002. The consumers with an annual electricity consumption of more than 1 GWh can enter the market at the end of year 2000.

In relation to the development of renewable energy technologies the most important issues are the following:

- A full liberalization of the Danish electricity market and its connection to the Nordic power exchange, NordPool. Following a transition phase all electricity generated by renewable energy technologies will be supplied to the market.
- Development of a separate green market for electricity generated by renewable energy technologies.
- The introduction of tradable CO2 permits for the electricity industry. From the year 2000, a CO2 emission quota of power plants is set and this emission quota is gradually reduced until 2003. If the emissions is over the quotas, the power companies have to pay 40 DKK/ton CO2 (approx. $5-6/ ton CO2) in the period 2000 to 2003.

The impacts from these three issues will to a certain extent be interrelated. The introduction of tradable CO2 permits for the power industry will have an impact on electricity prices determined at the power exchange market. In years with a considerable export of electricity generated by conventional power plants, the marginal spot price will tend to be higher, whilst in years with no export of conventionally generated electricity, prices will not be affected[13].

The owners of renewable energy power plants will expect the electricity price to be the sum of the price of electricity at the spot market and the price of green certificate. This total sum of spot market price and the price of green certificate is determined by the quota of green electricity set by the government. Thus if the spot market price is low, this will increase the expected price of green certificates. If the price (including the price of green certificates) is above the long-term expectations, the generation

[13] In Denmark, a large share of electricity is generated by conventional power plants of which the cost is higher than hydropower imported from Norway and Sweden. Hence, when Denmark exports power generated by conventional power plants, the spot price is normally higher than otherwise.

capacity by renewable energy technologies will increase faster than expected and thus it tends to force the spot market price to go downward.

II. The Green Certificate Market

The main objective of introducing a separate green electricity market in Denmark is to secure the development of renewable energy technologies while at the same time releasing the Government from the heavy burden of subsidizing renewable energy technologies. Presently in Denmark, wind power is purchased through long-term agreements on (almost) fixed feed-in tariffs, and these feed-in tariffs are fixed at fairly high levels. Approximately half of the tariff is a government subsidy (Morthorst, 1999). In the green certificate model the providers of renewable production subsidy shifts from the government to electricity consumers.

The main characteristics of the Danish proposal for a green certificate market are the following:

- All electricity consumers in Denmark are obliged to buy a certain share (20%) of electricity generated by renewable energy technologies. A major part of this transaction will be carried out by the electricity distribution companies, which will buy the green electricity on behalf of the final end-users. Large companies (or other consumers) trading directly with power suppliers will also have to cover 20% of their consumption with green electricity.
- All renewable energy technologies, including wind power, biomass and biogas plants, photovoltaics, geothermal and small hydro plants, will be certified for producing green electricity.

A green certificate will be issued per unit of electricity produced (per MWh) and be sold to distribution companies or other electricity consumers with the obligation to cover a certain share of their electricity consumption with renewable energy

technologies. The Danish Energy Agency will determine this share for a number of years in advance. According to the Danish Energy Reform agreement, 20% of total electricity consumption has to be covered by renewable energy technologies by the end of 2005. The supply of green certificate will be determined by electricity generation from the above mentioned renewable energy technologies. At present approximately 17% of total electricity consumption in Denmark is covered by wind power.

The green certificate market will function solely as a financial market. The only relation to the physical electricity market will be given by the upper limit of green certificates, which cannot exceed the amount of electricity produced by the renewable energy technologies. On an annual basis the demand for green certificates is given by the obliged demand covering the quota of domestic electricity consumption as required by the Energy Agency.

The supply of green certificates can come from two sources. One is the existing power generation by renewable energies. The other is power generation by renewable energies that will be developed in the coming years promoted by green certificates. Thus an important task for the Energy Agency will be to set the quota in such a way that an appropriate development of new renewable electricity generation capacity will take place. If the quota is too low, the realized price of green certificates might be too low to secure the development of new capacity. On the other hand, if the quota is too high, there might not be enough supply of green certificates and electricity consumers would have to pay a penalty for not fulfilling the quota.

A number of issues might influence the functioning of the green certificate market:

- There will be a considerable time lag in the development of new renewable capacity. For some renewable energy technologies the construction will take at least 3~4 years, and even for wind turbines it might take 2~3 years including the planning procedure.

- For wind power the changing wind conditions might have a significant influence on price determination of green certificates. The maximum variability of wind

generated electricity from year to year is approx. +/- 20%, introducing a considerable uncertainty in the supply of green certificates.

- The long-term determination of demand quotas will be of utmost importance for determining prices of green certificates and thus for the development of new renewable capacity.

These issues may be important to address in organizing the green certificate market. Unless measures are taken to stabilize the green certificate market, it might turn out to be a market with highly fluctuating prices, especially when a large share of green certificates is generated by wind power.

The launch date for the Danish green certificate scheme was January 1 2003. But it is now unclear when it will start. If everything goes as planned, the market for green certificates will open in 2005. However, a delay seems to be unavoidable from the current progress. The Danish obligation system to support renewable energy was criticized by the Danish Wind Turbine Owner's Association, the Confederation of Danish Industries, Danish Agriculture's energy committee, the Danish Wind Industry Association and the Organization for Renewable Energy at a public meeting in September 2001 which led to the scheme being put on hold. The level of obligation had yet to be decided when the scheme was shelved although the Danish Energy Agency in its report in September 2001 says the obligation would be decided at the beginning of each year and preliminary numbers published for 5 ~ 10 years ahead[14].

Box 4-1.

In Denmark, an emissions trading system for electricity generators was established by the Danish *CO2 Quota Act*, which was passed by the Danish Parliament in 1999[15]. The Act entered into force in July 2000, and became operational after formal approval by the EC in April 2001. The system sets limits on total CO2 emissions from power production for the years 2001 to 2003, allocates emissions allowances to eight individual power companies and allows emissions trading and banking.

[14] http://www.platts.com/features/greencertificates/europe.shtml

[15] This description is based on Sigurd Lauge Pedersen, "The Danish CO2 Emissions Trading System," *RECEIL*, vol. 9, no. 3, 2000, pp. 223 - 231.

The emissions cap is set at 22 MtCO2 for 2001 declining by 1 MtCO2 each year to 20 MtCO2 for 2003[16]. The cap covers emissions by about 500 electricity producers, most of which are very small combined heat and power plants[17]. The small plants are not part of the emissions trading program[18]. The emissions trading program is limited to eight big firms.

Allowances are allocated free to the eight firms based on the 1994-98 base period. Allowances are allocated first to combined heat and power plants (about 50% of total electricity generation) with the balance being allocated to the remaining plants[19]. The allocation is adjusted annually taking into account trading during the previous year. The first allocation was carried out on 15 December 2000 for 2001. Two firms, Elsam and Energi E2, received 93% of the allowances allocated[20].

The penalty for failing to hold sufficient allowances is relatively low - DKK 40 (about US$5 – 6) per metric ton of CO2. A "saving limit" is also established annually for each of the eight producers in the trading program. The saving limit is a little less than the firm's allowance allocation. If actual emissions are above the saving limit banking is not allowed. If actual emissions are less than the saving rate, the difference can be banked for future use[21].

Although caps have only been set through 2003, banking for use after 2003 is possible if the program is extended. The *CO2 Quota Act* empowers the Minister for Environment and Energy to issue guidelines on the participation of Danish electricity producers in the use of the Kyoto Mechanisms (IET, JI, CDM). However, under the Act the guidelines can only be issued when international rules for the mechanisms exist, which is not yet the case. So far, power producers have not lobbied for such guidelines.

To date no trades have taken place, although Natsource reports a mid-market bid/offer price of US$3.78 per metric ton of CO2 for 2001 to 2003[22].

Source: Haites, Erik and Fiona Mullins, 2001

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[16] For comparison, the average of annual emissions over the period 1994 ~ 1998 was 30.3 Mt of CO_2. Total Danish emissions are around 60 Mt of CO_2, so the system covers about 33% of national emissions.

[17] A small plant has annual emissions of less than 100,000 tonnes of CO_2.

[18] The small plants do not receive an allocation of allowances and are not required to pay a penalty in case of non-compliance.

[19] Although the allocations are calculated by plant, the allowances are given to firms.

[20] To work well, an emissions trading program should establish a competitive market for the allowances. A program with only 8 participants, 2 of which account for 93% of the allowances, will not be a competitive market. Since the firms are all in the same industry, selling allowances could be interpreted as providing market share to a competitor. Trading activity, therefore, is likely to be minimal in the absence of links to other trading programs. With a link to another program, the overall market might be competitive and so could yield the anticipated economic benefits.

[21] If A is the firm's allocation, E is actual emissions for the same year and S is saving limit for the year, A > S and banking is limited to S - E when S > E.

[22] *Utility Environment Report*, August 24, 2001 p. 6 reporting on a study of greenhouse gas trades conducted by Natsource LLC for the World Bank Prototype Carbon Fund.

The next table compares the Danish, UK and EU emissions trading schemes. The Danish scheme is mandatory and targets only carbon dioxide and electricity generation industry while the UK scheme is voluntary and targets all six GHGs and industrial sector excluding electricity sector. The Danish scheme is also unique with its banking limit in the first two years while the other two have unlimited banking.

Table 4-1. Comparison of Danish, UK and EU Emissions Trading Schemes

	Denmark	UK	European Union
Mandatory vs. voluntary	Mandatory	Voluntary with financial incentive payments or climate change levy discounts	Mandatory
Compliance periods	2001 ~ 2003	Direct participants: 2002 ~ 2006; Agreement participants: 2002 ~ 2010	2005 ~ 2007, 2008 ~2012
Gases	CO_2	Firms choose coverage: all six GHGs or CO_2 only	Initially only CO_2
Sectors	Electricity generation only	Industrial sectors; electricity sector excluded	Industrial and energy sector; chemical sector excluded
Allocation approach	Grandfathering	Direct participants: grandfathering; Agreement participants: free allocations for excess reductions beyond target after compliance is demonstrated	2005 ~2007: grandfathering: 2008 ~2012: to be determined
Absolute vs. relative target	Absolute	Direct participants: absolute; Agreement participants: relative or absolute	Absolute (allows for conversion of relative to absolute)
Domestic project credits	None	Projects in UK are allowable except in domestic sector; sequestration not eligible although it may come under review	None initially, inclusion to be determined in Commission report by June 30, 2006
International project credits	None initially, will issue guidelines on JI and CDM inclusion when international rules are finalized	None initially, will consider CDM inclusion to a certain percentage when CDM rules are finalized	None initially, inclusion to be determined in Commission report by June 30, 2006
Banking	Participants may bank difference between emissions and saving limit. Savings limit: 90 % of 2001 allocation, 95% of 2002 allocation, 100% of 2003 allocation	Unlimited within compliance period	Unlimited banking in 2005 ~2007 and 2008 ~2012; countries may allow banking of 2005 ~2007 allowances into 2008 ~2012 period

Financial penalty	40 Danish kroner/ton CO_2 initially (US$ 5~6)	Direct participants: noncompliance means ineligible for annual financial incentive payment; Agreement participants: not eligible for climate change levy discount for year of noncompliance	2005 ~2007: 50/ton or 2 times of average allowance price; 2008 ~2012: 100/ton or 2 times of average allowance price
Environmental penalty	None	Direct participants: for each ton of overage, 1.1 to 2 allowances deducted from next year; Agreement participants: None	For each ton of overage, one allowance deducted from next period
Financial incentives	None	$309 million over 5 years for direct participants; climate change levy 80% discount for agreement participants	None envisioned; incentives at national level could be considered impressible "State Aid"
Safety valve (price cap)	None, but low penalty acts as allowance price ceiling	None	None (but considered in September 2001 proposal)

Source: Rosenzweig, Richard, et. al., 2003

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5. Domestic Greenhouse Gas Emissions Trading Program in Japan

Tae Yong Jung[*]

Japan as one of Annex I countries has a quantified target, which is to reduce GHG emissions of 6% below the 1990's level during the first budget period. Japan has interest in utilizing the Kyoto Mechanism and sink options to meet this target, as well as possible domestic policy and measures. One of domestic policy and measures that is closely examined now is the domestic GHG emissions trading (DET) program. Ministry of Environment (MoE) and Ministry of Economy, Trade and Industry (METI) have prepared for this program. According to the plan of Japanese Government, the first step (2002 ~ 2004) of implementing DET is to have voluntary pilot programs. At the second step (2005 ~ 2007), the full scale DEP will be implemented, considering the results of the first step and the performance of other DET markets abroad. The association of industries (Keidanren) has its strong preference on 'Voluntary Action Program', which was made by industries with series of specific actions of reducing GHG emissions, setting up voluntary targets of either intensity or absolute level.

I. Guideline of GHG Emissions Calculation

MoE, Japan recognizes the basic infrastructure to launch DET is to set up a guideline of calculating accurate GHG emissions by the participants of this program. MoE clearly states that the objective of the guideline is the emitters calculate GHG emissions by their activities accurately and trace out the trend of their GHG emissions, comparing to the GHG emissions of others. The emitters should follow the five principles:

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- *Relevance*: To define the appropriate boundary that reflects the emitters' decision on GHG emissions
- *Completeness*: To explain clearly the activities and organizations that are to engage in GHG emissions calculation
- *Consistency*: To make it possible to have a reliable comparison of GHG emissions for a certain period of time
- *Transparency*: To explain possible issues related to GHG emissions calculation based on facts
- *Accuracy*: To obtain the accurate GHG emissions, which can be used as intended

The GHGs are six gases that are defined in the Kyoto Protocol: CO_2, CH_4, N_2O, HFC, PFC and SF_6. The organization to calculate GHG emissions is basically corporation unit. However, the group of companies can include all the emissions from the whole subsidiary companies that belong to a group. The GHG emissions from domestic activities only are included. The subsidiary companies means that the group holds more than 50% right of decision. The boundary of activities for calculating GHG emissions is to include the direct emissions from such as fossil fuel combustion, production processes and vehicles in addition to the indirect emissions from electricity and heat.

The calculation method follows the 5 steps:

- Period: One year from April to next March, which is the fiscal year of Japan
- Activity: the boundary of activities and type of activities to calculate GHG emissions should be listed up. (direct emissions, indirect emissions,..)
- Organization: the boundary of organizations and type of organizations to calculate GHG emissions should be listed up. (office, factory, branches,…)

- Quantity of Activity: it means that the activities or types of activities should be quantified to calculate GHG emissions by emissions factors. (energy consumption, mileage of vehicles, amount of waste,…)

- Conversion to CO_2: GHG emissions should be converted into CO_2 equivalence by Global Warming Index (GWI)

When the emitter is to announce its GHG emissions, the following information should be included; period, organization and activity for calculation, GHG emissions, relevant management indexes (number of employment, sales, production, number of stores and branches,..) intensity (per production, per monetary amount) and other relevant information.

The verification process is as follows:

- Objective: To examine closely the details of data and process of GHG emissions calculation. The emitter is to set up the objective of verification, the usage of GHG emissions calculation.

- Inspector: In case that the emitter uses its internal information, the internal inspector might verify it. However, to make it public, it is necessary to have external verification.

- Range: It covers the whole process of calculation method, including the accuracy of data and calculation.

- Desk Review: The inspector reviews the documents to understand the calculation method and the situation, collecting information for the next step of risk analysis.

- Risk Analysis: The possible areas that affect the calculation should be carefully examined with priority.
    - relatively large source of GHG emissions
    - calculation with uncertainty

- possibility of miss-input of internal data

- Calculation Process: Data collection and input method, GHG emissions calculating method and proper derivation of the calculation results should be verified.

- Report: An inspector makes a verification report that contains the errors, risk, recommendation and comment for the revision.

II. Summary of Domestic Emissions Trading Program of Mie Prefecture

MoE and Mie Prefecture jointly launch a pilot project to figure out the potentials of DET markets and possible problems of introducing DET with actual participation of 24 companies in Mie Prefecture, understanding the situations of companies, simulating GHG emissions of those 24 companies under 5 alternative schemes of DET markets. The objective of this pilot project is to develop a new pattern of policy and measures, which is to collaborate central and local governments with industries, reflecting the request from the industries and the local government. This project follows the guideline established by MoE.

- *Company*: who has business and plant in Mie Prefecture (24 companies)

Table 5-1. Size Distribution of Participants

Below 10 th. T-CO_2 /Year	10 th. T-CO_2 ~ 100 th. T-CO_2	Above 100 th. T-CO_2	Total
6	14	4	24

- *GHG*: Based on the visit-survey, it is found that to figure out other GHGs than CO_2 is difficult in some companies. Hence in this project, only CO_2 emissions are considered.

- *Period*: 2005 ~ 2012, which is from the starting year of the 2nd step of DET to the ending year of the 1st budget period of the Kyoto Protocol. For simulation, the sub-period is divided as follows.

Table 5-2. Definition of Sub-period

Year	2005 ~2007	2008	2009	2010	2011	2012
Term	I	II	III	IV	V	VI

- Base Year: 2001

- Target: Amount of total emissions and intensity, if necessary, can be the base for the target setting. In case of intensity target, there is a possibility of increasing emissions. Furthermore, in case of intensity approach, it is necessary to revise the baseline, if there is a big change of production scale.

- Target Value: The logic for 7.9% reduction is that the reduction target of industrial sector is 7.0%, adding 0.9%, which was the increase of emissions in 2000, compared with those of 1990. The logic for 14.0% is that 6.0%, which is the target of Japan according to the Kyoto Protocol plus 8.0% increase of the total emissions of Japan in 2000, compared with those of 1990. The logic for 19.9% is that industrial sector in Mie Prefecture should reduce 19.9% of total emissions to meet the Japanese national target of 6% reduction.

Table 5-3. Alternative Forms of Targets

Alternative 1, 4	Base Year (2001) –7.9%
Alternative 2, 3 (Amount)	Base Year (2001) –14.0%
Alternative 3 (Intensity)	Keidanren's Voluntary Action Program
Alternative 5	Base Year (2001) –19.9%

- *Past Effort to Reduce GHG emissions*: It is very difficult to consider the past effort of reducing GHG emissions with a specific method. For example, in the following table, the hypothetical two firms A and B were same in 1987 in terms

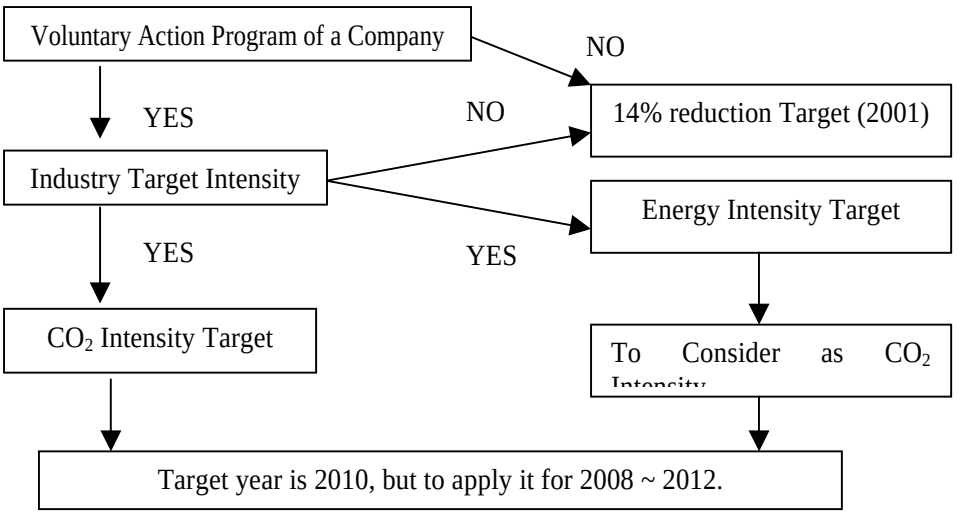
of production and intensity. However, firm A improved its intensity by 50% in year 2001, while firm B remains unchanged. In case of 14% of reduction (Alternative 2), firm A has 36% of credits, since this firm has already reached below the level of the target. However, firm B should achieve 14% reduction target from 2001.

Table 5-4. The Relationship among Intensity and Actual Emissions and Tradable Permit

		1987	2001	Actual Emissions (A)	To Reflect Mitigation Effort (B)	Tradable Permit (B) × (-14%)	Effect
Firm A	**Intensity**	**100**	**50**	10,000 (50 × 200)	20,000 (100 × 200)	17,200 (20000 × -14%)	36% Credits
	Production	100	200				
Firm B	**Intensity**	**100**	**100**	20,000 (100 × 200)	20,000 (No Change)	17,200 (20000 × -14%)	14% Reduction is required
	Production	100	200				

- *Keidanren's Voluntary Action Program (1997)*: Alternative 3 follows the Voluntary Action Program of Keidanren, which set up the voluntary target of absolute amount or intensity. The following flow shows the application of Alternative 3.

Figure 5-1. Flowchart of Target-setting Procedure



- *Banking*: The target period is from 2008 to 2012, but before 2008 (Term I) and targets by steps are set.

Table 5-5. Target Values of Alternative Baseline Methods

	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Term I Target	-7.0%	-7.0%	-3.95%	-10.0%
Final Target	-14.0%	-14.0%	-7.9%	-19.9%

- *Penalty*: If the final target is not met, 100,000 Yen/t-CO_2 is considered.

After the simulation, the following items are evaluated for 5 alternatives to develop DET programs.

- *Effectiveness*: The degree of achieving the final target
- *Economy*: The degree of cost to achieve the final target
- *Verification*: The degree of confidence
- *Fairness*: The degree of sharing similar cost burdens among participants

The following table shows the evaluation of each alternative by 24 participating companies.

Table 5-6. Evaluation of Alternatives

Item	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Verification	○	△	×	○	△
Fairness	△	○	△	△	△
Easiness	○	△	×	×	○

Note. ○: Not harmful, △: some factors to be harmful, ×: Harmful

After this pilot project, MoE and Mie Prefecture draw the following 8 items from the consensus of participants, which will be very useful for the development of actual DET in Japan.

- To set up the base year, it is quite necessary to consider the past effort of reducing GHG emissions. For example, the base year emissions can be the average emissions of several years.
- The inevitable GHG emissions to preserve environment should be considered. For example, to control and manage chemicals and wastes, the extra facilities are necessary and the GHG emissions from such facilities should be considered separately.
- To set up the target value should be very much careful. The demand and supply balance of the market for DET and social cost of introducing this new policy should be considered.
- To set up a specific boundary of a company, it is necessary to have some rooms for the overall social cost of reducing GHG emissions.
- It is quite necessary to encourage the internal incentives of companies to reduce GHG emissions. For example, the technology improvement by companies should be motivated.
- The method of calculating GHG emissions and verification and rules should be determined as soon as possible.

- Forest sink options should be considered to offset the GHG emissions.
- The power generation from Refuse Derived Fuel (RDF) should be considered, which is the plan of Mie Prefecture. In general, the usage of renewable energy should be combined into DET market by sharing the cost of such options.

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6. A design of Greenhouse Gas Emissions Trading for Korea

Yong Gun Kim[*]

I. Background

Emissions trading has emerged as an essential policy instrument in the area of climate change mitigation after the adoption of the Kyoto Protocol in 1997. Denmark and UK are running their own national trading systems and the European Union decided to launch a regional trading system from 2005. Most of the other developed countries, who have quantitative emission reduction obligations under the Kyoto Protocol, are also endeavouring to introduce emissions trading system in near future.

Korea is not listed in Annex B of the Kyoto Protocol and so does not have any quantitative emissions reduction target. Many actors in Korea, however, have great interest in design and implementation of national emissions trading system. Government has made efforts to design emissions trading system for a pilot phase experiment. Industry representatives have been discussing potential emissions trading system and have experimented some simulation game. Research institutions have been analyzing the effects of various potential trading mechanisms.

This chapter explores appropriate forms of emissions trading systems for managing greenhouse gas emissions in case of Korea.

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II. Emission Profile of Korea

Total greenhouse gas emission in Korea is 148.0 million ton of carbon equivalent in 2001. The trend of total greenhouse gas emissions between 1990 and 2001 indicates an annual increase of 5.2% with per capita emissions rising by 4.3% per year since 1990, recording 3.13 tons of carbon in 2001. However, greenhouse gas intensity indicated the increase seen during the early 1990s began to fall after 1996. In the energy sector, which consists of fuel combustion and fugitive emissions, greenhouse gas emissions increased 5.6% per year from 67.6 MtC in 1990 to 123.5 MtC in 2001. After 1990, emissions from industrial processes recorded a sharp increase of 10.2% per year.

Table 6-1. Major indicators of Greenhouse Gas Emissions

Classification	1990	1995	1998	1999	2000	2001	1990~2001 Average Annual Growth Rate(%)
Total GHG Emissions (1,000tC)	84,738	123,445	123,974	135,542	144,259	148,038	5.2
Per Capita GHG Emissions (tC per Capita)	1.98	2.74	2.68	2.91	3.07	3.13	4.3
GHG/GDP (tC per Million Won, '95)	0.322	0.327	0.314	0.310	0.301	0.300	-0.6

Source: Republic of Korea (2003)

The growing trend of greenhouse gas emissions will continue if the current shift of Korea's industrial structure continue and considerable efforts to reduce emissions are not implemented. Projections indicate that Korea's greenhouse gas emissions will rise by 70% above 2000 levels by 2020. However, the carbon dioxide intensity during the forecast period is expected to gradually decrease due to improvements in demand-side energy efficiency and shifts to cleaner fuels. Carbon dioxide, the main gas among energy related greenhouse gases, will see an increase of 2.9% annually from 2000 to 2020 and account for 96.8% of all greenhouse gas emissions in 2020 from the 93.5% in

2000. This implies that carbon dioxide is the most important greenhouse gas for the government to be controlled to cope with climate change.

III. Basic Approach: Incentive Auction

There are two basic approaches in designing emissions trading: cap-and-trade and baseline-and-credit. The cap-and-trade approach is based on predetermined level of total emission quantity and allocates the total emissions between participants and allows transfers and acquisitions. The baseline-and-credit approach is based on standard emission baselines for individual emission sources and allows each source to get and transfer verified emissions reduction credits if it reduces its emission below its baseline emission.

The major advantage of cap-and-trade approach is that it guarantees to achieve an environmental objective, expressed in terms of total amount of emission, with minimum cost if there is no transaction cost and market is perfectly competitive. The cap-and-trade approach, however, could impose severe constraint to the economy under uncertainty and total compliance cost could be very high if economic growth is unexpectedly high and vice versa. The baseline-and-credit approach could be utilized to avoid a rigid constraint to the economy by way of allocation of emissions based on flexible baselines. Moreover, under the lack of strict environmental objective in the form of total emission quantity, the baseline-and-credit could be preferred to accommodate voluntary incentive scheme at least as a first-phase introduction of emission control policy instrument.

In case of Korea, which is one of the developing countries that have no international obligation in the form of emissions reduction quantity, voluntary incentive mechanism, possibly based on baseline-and-credit trading, would be preferred to mandatory cap-and-trading approach not only from political but also from economic point of view.

Incentive auction mechanism, where individual emission sources voluntarily bid their own emission reduction targets to get compensation from the government through

allocation of incentive money, could be considered as a promising policy instrument to facilitate early action to reduce greenhouse gas emissions in advance of any mandatory regulation that are not expected to be started in near future.

The incentive auction is well known as having been applied in UK emissions trading in 2002. The UK government has made available up to £ 215 million as an incentive money that is allocated to voluntary bidders according to their reduction targets. The reduction is measured based on historical emission level. The amount of money each bidder gets is equal to its reduction target multiplied by equilibrium price that is determined by dynamic descending clock auction.

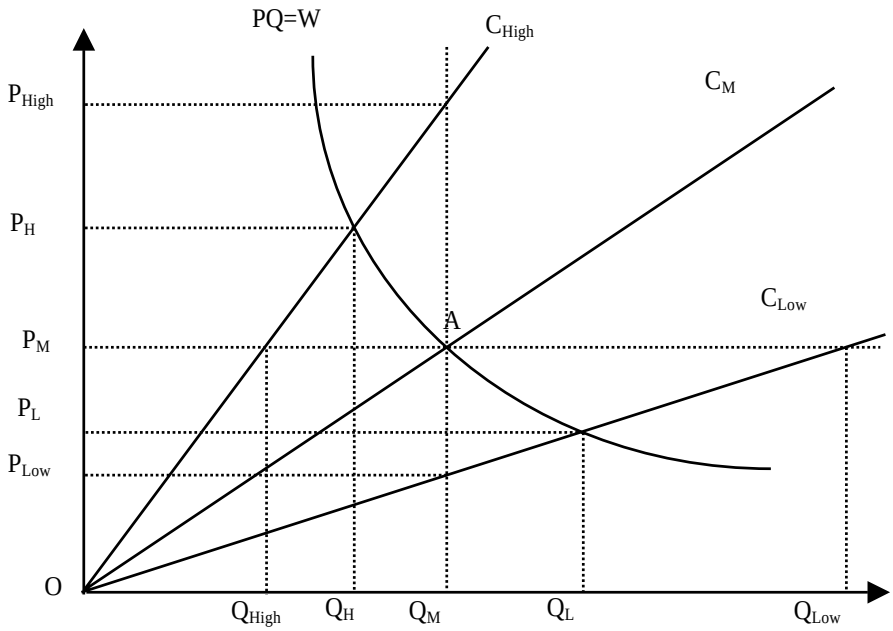
The incentive auction has several compelling advantages. First, it provides emission sources voluntary participation incentives. Second, the magnitude of total reduction cost can be effectively capped by the amount of incentive money. These properties are very useful for any policy instrument to induce early action to reduce emissions in developing countries.

The effective cap on reduction cost seems to be quite important particularly in the face of asymmetric information or uncertainty. We can attain valuable insight through comparison with other policy instruments such as emission taxes and simple cap-and-trade system in particular. Figure 6-1 illustrates equilibrium outcomes under asymmetric information on emission reduction costs for three policy instruments: emission taxes, cap-and-trade and incentive auction.

Let's assume that a regulator evaluates (aggregate) marginal reduction cost of emission sources as C_M. In case of emission taxes, the regulator may set the tax rate at P_M and if its conjecture on marginal reduction cost is right, the resulting equilibrium quantity of emission will be Q_M. If the true marginal reduction cost turn out to be higher (C_{High}) or lower (C_{Low}) than expected, the equilibrium outcome (emission reduction quantity) will be Q_{High} or Q_{Low}. Such a wide difference would incur great uncertainty of reduction cost, as well as reduction amount, on emission sources and so generate huge risk to the industry. In case of cap-and-trade policy, on the contrary, the regulator will allocate Q_M of emission allowances among emission sources based on its

expectation of C_M for marginal reduction cost. If the true marginal reduction cost turn out to be higher (C_{High}) or lower (C_{Low}) than expected, the equilibrium outcome (price of emission allowances) will be Q_{High} or Q_{Low}. This will also result in a great uncertainty of reduction cost, together with market price of emissions, on emission sources.

Figure 6-1. Comparison of Equilibrium Outcomes among Emission Tax, Cap-and-Trade and Incentive Auction under Asymmetric Information on Emission Reduction Costs



Under the incentive auction, the regulator, with the expectation of C_M on marginal reduction cost, will allocate incentive money of $P_M \times Q_M$ among emission sources through auction mechanism and equilibrium price and reduction quantity are expected to be P_M and Q_M. In case of higher- or lower-than-expected marginal costs, i.e., C_{High} or C_{Low}, the equilibrium price and reduction quantity will be P_H and Q_H or P_L and Q_L. The variance of equilibrium outcomes is quite smaller than in the case of emission taxes or cap-and-trade system. In the simple case of linear marginal cost, the total reduction cost

(measured by integration of marginal cost function up to equilibrium reduction quantity) does not change at all. Such a stability of reduction cost seems to be a quite useful property particularly when the regulator tries to induce maximum reduction efforts up to a certain amount of cost burden.

Maximizing reductions under a budget constraint could be seen as a plausible policy objective of the regulator in the climate change context particularly for developing countries. Developing country governments do not have substantial emission constraint and global climate change does not seem to be a major concern for domestic environmental policy. Developing country government may want to facilitate early action of private industry for some reasons like capacity building and preparing for the future international regulation by way of learning by doing. In this case, the government does not want to incur high uncertainty or great cost burden on the industry, particularly under uncertainty and asymmetric information.

Under the incentive auction, successful bidders can achieve much greater incentive payments compared to their reduction costs. Assuming competitive behaviors of bidders, participant are paid P_M*Q_M in the above illustration while their total reduction cost is only one half of it. Strategic bidding by participants or strong convexity of reduction cost function makes the net profit of successful bidders even greater.[23] Conservative bidding, partially due to lack of experience, could also contribute to the benefit of participants, as is the case of UK.[24]

IV. Design Variables and Suggestion

There are many design variables to be decided to implement emissions trading, including target or commitment period, greenhouse gas and emission source coverage,

[23] Refer to KEI(2001) for rigorous analysis of incentive auction in a game-theoretic formulation.

[24] In the incentive auction in the UK, too little participants bid too small amounts of reductions and so achieved too high rent from the auction through a very high compensation rates. This resulted in a sharp decrease of allowance price even with the increase of market demand facilitated by climate change agreements.

eligibility to trade, banking and borrowing provision, liability rules, non-compliance penalty, monitoring and verification methodology, reporting protocol, legal framework. The amount of incentive money and auction procedure are also to be determined in order to apply incentive auction as an allocation mechanism.

Commitment period

There is a trade-offs between a longer or a shorter commitment period. While a longer commitment period provides higher inter-temporal flexibility for companies, it could result in higher non-compliance after the end of the period.

Table 6-2. Uncertainties due to Emission Factors and Activity Data

1	2	3	4	5
Gas	**Source category**	**Emission factor** U_E	**Activity data** U_A	**Overall uncertainty** U_T
CO_2	Energy	7%	7%	10%
CO_2	Industrial Processes	7%	7%	10%
CO_2	Land Use Change and Forestry	33%	50%	60%
CH_4	Biomass Burning	50%	50%	100%
CH_4	Oil and Nat. Gas Activities	55%	20%	60%
CH_4	Coal Mining and Handling Activities	55%	20%	60%
CH_4	Rice Cultivation	3/4	1/4	1
CH_4	Waste	2/3	1/3	1
CH_4	Animals	25%	10%	25%
CH_4	Animal waste	20%	10%	20%
N_2O	Industrial Processes	35%	35%	50%
N_2O	Agricultural Soils			2 orders of magnitude
N_2O	Biomass Burning			100%

Note: Individual uncertainties that appear to be greater than ± 60% are not shown. Instead judgement as to the relative importance of emission factor and activity data uncertainties are shown as fractions which sum to one.

Source: IPCC(1996)

A shorter length of commitment period provides a possibility to check compliance status more often but it could harm the efficiency of decision-making on longer-term

investment and inter-temporal resource allocation. In domestic policy context, the length of commitment period could be set at a level shorter than five years, which is the length of commitment period under the Kyoto Protocol, in order to enforce a more rigorous compliance mechanism for companies, the life of which could be much shorter than governments. The inter-temporal flexibility could be improved by way of banking or borrowing. Commitment periods could be designed to overlap each other to avoid instability of allowance market at end of each period.

Gas coverage

Uncertainty inherent in monitoring and verification seems to be quite low in the case of carbon dioxide from energy combustion and industrial processes, compared to the other greenhouse gases such as methane, nitrous oxide. Table 6-2 illustrates uncertainties of emission inventories for various gases and source categories. Overall uncertainty of carbon dioxide emission from energy and industrial processes is around 10%, which is far lower than methane (20~100%), nitrous oxide (50 ~100%) or carbon dioxide from land use change and forestry (above 60%). It is reasonable to start with carbon dioxide from energy and industrial processes and extend gas coverage to include other gases designated in the Kyoto Protocol.

Eligibility

In case of incentive auction, the eligibility of getting incentive from the government does not need to be limited to a certain kind of companies. The eligibility to participate in incentive auction must be open to all emission sources from the equity perspective. In practice, however, minimum size threshold could be applied as an eligibility criterion to reduce administrative and transaction costs. Lack of emission inventory or reliable baseline methodology should also be a criterion to exclude applicants from participation.

Incentive money

How much to spend on compensating participants through incentive auction may be determined by the government in view of the priority and political importance of emission reduction policy. A part of incentive money could be raised through emission tax or entry fee on participants. Levying entry fee has some economic rationale in the case of incentive auction where successful bidders achieve much higher compensation compared to their costs of emission reductions required.

Incentive auction

The descending clock auction designed by DEFRA(2001) could be applied to a very broad range of situations. Under the descending clock auction, the auctioneer announces a price per tCO_2e and asks each bidder to submit a bid (in terms of a quantity of emission reduction) in response to the stated price by a specified deadline. After each bidder submits a bid, the auctioneer announces the total quantity of reductions that was bidden by all bidders in response to the stated price. If the price multiplied by the total quantity bid is less than or equal to the total incentive money, the auction will end at that point. If the price multiplied by the total quantity bid is greater than the total incentive money, the auction will move to the next round. The auctioneer will begin by announcing a lower price per tCO_2e and continue as set out above until the total quantity of emission reductions bid multiplied by the price announced for that round is less than or equal to the total incentive money.

Banking and borrowing

Local or seasonal hotspot problem is almost negligible in the climate change issue, which is of very long-term nature and has pollutants mixing almost perfectly in the atmosphere. Therefore, free trading between different sources and periods is preferred to ensure efficient resource allocation. Unlimited banking and borrowing need to be

allowed in this respect. Unlimited borrowing, however, could cause endless delay of emission reductions. Therefore, borrowing is generally strictly limited or not allowed. Banking also could cause a problem if some allowances are banked from pre-Kyoto period to the Kyoto period during which developed countries should comply with international reduction commitments. For developing countries, free banking might be more useful and could improve the liquidity and efficiency of allowance market.

Liability rules

Seller liability rule, where the buyer does not have any liability on non-compliance resulting from a trade of allowance, is commonly applied to domestic emissions trading. Under the seller liability, however, the risk of overselling could be high and some kinds of count-measures are necessary. One of solutions to the over-selling is the commitment period reserve (CPR) such as the one under the Marrakech Accords. According to the Marrakech Accords, each country cannot sell above 90% of initial allowance or 100% of emission inventory of the previous year (UNFCCC, 2002). CPR of this kind may help reduce the possibility of intentional over-selling.

Baseline

Under the incentive auction, a baseline emission for each facility plays a role of free initial allocation since any additional reductions are in effect bought (or compensated) by the government. Under a generous baseline methodology, emission source may have a lot of hot air to sell and take over-compensation or windfall profit through a big amount of incentive payment. In this case, the environmental effectiveness (the level of emission reduction achieved) of incentive auction might be quite small, even with a huge amount of incentive money distributed. Such an adverse effect becomes more serious under a voluntary participation mechanism since any facility who does participate is most likely to be the one who has too much generous baseline and so has a lot of extra allowances without any additional efforts. This problem, often called

'adverse selection' in the economics literature, is one of the most difficult problems to resolve. A rigorous and strong baseline methodology should be developed to mitigate the adverse selection, though not able to eliminate completely.

It is also an important issue whether to allow sales of extra emission allowances generated by curtailment of production activity or even shut-down of facility. If we permit such extra allowances to be sold without any regulation, a firm may try to move production activities from a participating facility to a non-participant facility or even shut down the participating facility possibly with rebuilding a new facility. Like the adverse selection explained above, this is more serious in the case of voluntary scheme. Potential solution to this problem includes non-tradable quotas or intensity targets indexed on production activities.[25] In case of substantially high uncertainties in business-as-usual emission forecasts, it may be useful to apply dual intensity targets in which there are two kinds of targets, i. e., a compliance target and a selling target.[26]

Legal framework

The incentive auction and greenhouse gas emission allowance trading can be introduced with the amendment of Air Quality Conservation Act of Korea. Alternatively, a new legislation could be made to deal with climate change issue in a more comprehensive manner so as to include establishment and implementation of national climate change policy. Contractual relationship between the government and private industry could be utilized at the starting point in case of no legal infrastructure ready to apply in time.

[25] Refer to Hagem (2003) for an in-depth analysis on non-tradable quotas and intensity targets as preventive measures to unintentional firm closure.
[26] Refer to Kim and Baumert (2002) for detailed description of dual intensity targets and implementation issues pertaining to emissions trading.

Non-compliance penalty

The basic principle is that a non-compliance penalty should be strong enough to deter non-compliance or to provide incentive to comply. Two most common forms of penalties in emissions trading are monetary penalty and deduction of allowances in the next period. Many of US emission trading schemes apply both of the two penalties but the Marrakech Accords agreed in the seventh conference of the Parties to UN Framework Convention on Climate Change employs only the latter one. For domestic policy implementation, monetary penalty needs to be applied to increase efficiency of enforcement. The level of monetary penalty, per each unit of emissions above allowance submitted, should be higher than the expected price of allowance to ensure the market to function well to minimize cost while keeping emissions below predetermined targets.[27] From the economic point of view, the equilibrium price stemming from the incentive auction can be considered to be the expected market price of allowances. Any financial penalty rate higher than auction clearing price could be applied to deter non-compliance. Reimbursement of penalty could be designed to facilitate returns to compliance in the following periods. For example, we can set the penalty rate at two times the auction price and reimburse 90% of the penalty if the non-compliant reduces more than its obligation in the next period.

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[27] Under cap-and-trade system where the allowance price can be increased to a very high level, financial penalty per unit of over-emission can be utilized as a price cap in order to prevent unbearable cost burden to emission sources. In case of incentive auction, however, the probability of allowance prices much higher than auction clearing price is not so high.

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7. Emissions Trading in the United States and Canada

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I. American Experience with Emissions Trading

This section describes the major American emissions trading programs for air pollutants other than greenhouse gases. The descriptions are updated from Haites, 2002.[28]

Electric Utility SO_2 Allowance Trading

The 1990 Clean Air Act Amendments created a cap and trade program for sulphur dioxide (SO_2) emissions by electric utilities. The objective of the program is to cap utility SO_2 emissions at 8.95 million tons per year after 2010, a 10 million ton reduction from the 1980 level.[29]

The program began in 1995. It was implemented in two phases, with each phase designed to achieve a roughly 5 million ton reduction. Phase II, from 2000 on, applies to all electric utility generating units with an output capacity of 25 MW or greater and that use fossil fuels with a sulphur content greater than 0.05 per cent. There are over 3,200 participants.

Allowances are distributed free to participants. In Phase II the allowance allocation is of 1.2 pounds per million BTU multiplied by the average energy input (million BTU)

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[28] See Ellerman, Joskow and Harrison, 2003 for additional material on these and other programs.

[29] Approximately 1.5 million tons of the reduction is expected to come from industrial sources through existing programs and 8.5 million tons is expected to come from electric utility sources, which account for about 70% of total SO_2 emissions.

for the years 1985 through 1987 or, if lower, the actual emissions rate multiplied by the average energy input for the same period. The basic allocation rules are supplemented by a number of special provisions.[30]

Sources built after 1995 receive no allowances and must purchase allowances to cover their total emissions from existing sources. Sources operating in 1990 continue to receive allowances even if they cease to operate.

The vast majority of units are required to install continuous emissions monitors and to report their hourly emissions data to the EPA each quarter. The penalty for non-compliance is $2,000 (1990 dollars) plus a loss of one allowance from the next year's allocation per excess tonne. Allowances can be banked for future use. Federal, state and regional regulations limiting SO_2 emissions by participants to protect human health and the local environment take precedence. In other words, if federal or state regulations limit actual emissions the unit cannot use allowances to exceed that limit.

Data on the operation of the program are presented in Table 1. Actual emissions were well below the allowance allocation during each year of Phase I, leading to the accumulation of a large bank that is being drawn down during Phase II.[31] Full compliance was achieved from 1995 through 1999, but in 2000 a few sources failed to comply, with total excess emissions of 54 tons.

Sources are individual generating units and a single company may own many generating units. The trading volume reported in the table is for transactions between unrelated participants. Since 1997 the volume of such trades has generally exceeded the annual allocation, because trades may involve allowances for future years and an allowance may be sold several times during a year. The prices of allowances have

[30] The allocation rules include six special allowance reserves and 29 different formulae to allocate allowances in Phase II. Some of the formulae are designed primarily to achieve environmental objectives while others provide differential treatment for various categories of units. If the allocations based on the formulae do not exactly meet the overall emission limit, the allocations are scaled down proportionally to ensure that the allowances issued equal the emissions cap.

[31] Since Phase I focused on large, high-emitting units and included incentives for early action, over compliance and banking during the initial years of the program was not surprising although the extent of the over compliance was not anticipated. In effect many of the expected sellers were regulated in Phase I but most of the likely buyers were not regulated until Phase II, so sellers built up their inventories for their own future use or for future sales.

been lower than projected when the legislation was being debated due to the adoption of low cost compliance options made possible by emissions trading.[32]

Table 7-1. SO_2 Allowance Trading Programme

Year	Number of Participants	Allowances Allocated (million)	Actual Emissions by Participants (million tons)	Actual Emissions by All Sources[a] (million tons)	Allowances Banked[b] (million)	Allowances Traded[c] (million)	Price Range (dollars per ton)[d]
1995	431	8.74	5.30	11.87	3.44	1.92	$108-$138
1996	445	8.30	5.44	12.51	6.30	4.41	$68-$95
1997	423	7.15	5.48	12.98	7.96	7.9	$87-$114
1998	408	6.95	5.29	13.13	9.63	9.5	$98-$198
1999	398	6.99	4.95	12.45	11.62	6.2	$153-$214
2000	2,262	9.97	11.20	11.20	10.38	12.7	$126-$155
2001	2,792	9.55	10.63	10.63	9.30	12.6	$150-$214
2002	3,208	9.54	10.20	10.20	9.30	11.6	$130-$173

Notes: a Emissions by sources participating in the program in 2000.
b Allowances banked at the end of the year
c Allowances traded between unrelated parties. The allowances traded may be for the current or ny future year. Allowances may be traded several times during a year.
d Price range is determined from monthly prices quoted by Utility Environment Report, Natsource and the clearing price for the annual auction.

Sources: Annual compliance reports for 1995 through 2002

Ozone Transport Commission NOx Budget Program

Ground-level ozone is formed in the atmosphere by complex chemical reactions involving nitrogen oxides (NOx), volatile organic compounds (VOCs) and sunlight. To help limit ozone formation, the Ozone Transport Commission (OTC), composed of 12 north-eastern states and the District of Columbia, has implemented a regional NOx Budget Program to reduce summertime NOx emissions.[33]

[32] A switch to low-sulphur coal has been the most common compliance option and scrubber costs have fallen while their performance has improved.
[33] See Ozone Transport Commission, 2003 for a report on the implementation of the program.

In May 1995, large combustion sources were required to implement reasonably available control technologies (RACT). The emissions trading program began on May 1, 1999 with a cap of 219,000 tons for the May–September ozone season.[34] A second phase of the trading program was scheduled to begin on May 1, 2003 with a seasonal cap of 143,000 tons. But it was replaced by the NOx SIP Call Trading Program with a seasonal cap of 141,000 tons. The NOx SIP Call Program will be expanded to 21 eastern states, including all of the OTC states except New Hampshire, and the District of Columbia in 2004.

The cap was divided among the states under a negotiated agreement and each state then allocates allowance to the participants. Each allowance permits a source to emit one ton of NOx during the control period (May through September of a given year) for which it is allocated, or any later control period. Allowances may be bought, sold, or banked. Participants remain subject to other federal, state and local regulations governing NOx emissions.

In general, the program applies to large industrial boilers with a maximum rated heat input capacity of 250 mmBTU/hour or more, and to all electricity generating facilities with a rated output of 15 MW or more. States have the option of subjecting additional source categories to the program.

Data on the performance of the program are summarized in Table 7-2. Only ten of the thirteen jurisdictions in the OTC participate in the trading program. The number of sources in the program has risen each year mainly due to the participation of additional jurisdictions. Emissions have been less than the allowances allocated each year, so the size of the bank has increased annually. The cost of compliance has been significantly lower than anticipated, leading to a sharp decline in allowance prices during the early part of the program.

A unique feature of this program is a limitation on the use of banked allowances called ‘progressive flow control’. This allows unlimited banking of allowances, but discourages the ‘excessive’ use of banked allowances. A two-for-one discount rate is

[34] NOx emissions during the balance of the year are not capped, but many sources are subject to emission

applied to the use of some banked allowances when the total number of banked allowances exceeds 10% of the allowable NOx emissions. Current year (i.e. 2003 allowances for 2003 reconciliation) are used first for compliance purposes. Then, and only when needed, banked allowances can be used. For each source, the first X% of the banked allowances cover emissions at face value (1 ton per allowance), where X depends upon the size of the bank. Any additional banked allowances used are discounted by 50% (two allowances per ton of emissions).

Table 7-2. Ozone Transport Commission NOx Budget Program

Year	Number of States	Number of Entities	Allowances Allocated (thousand)	Actual Emissions (000 tons)	Allowances Traded[b] (thousand)	Allowances Banked[a] (thousand)	Flow Control Ratio[c]	Price Range (dollars per ton)[d]
1999	8	912	218.7	174.8	53	48.6	0.50	$717-$6,375
2000	9	937	195.4	174.5	70	60.6	0.36	$371-$912
2001	10[e]	970	207.8	183.3	111	78.7	0.36	$540-$1,712
2002	10[e]	1,143	217.2	193.4	90	94.2	0.27	

Notes: a Allowances banked at the end of the year
b Allowances traded between unrelated entities.
c See text for discussion of flow control.
d Price range is determined from monthly prices quoted by Utility Environment Report.
E Includes the District of Columbia.

Source: Annual compliance reports for 1999 through 2002 and Ozone Transport Commission, 2003.

Participants must install continuous emissions monitors, and face a penalty of three allowances for each ton of excess emissions. There has been a minor amount of non-compliance each year, ranging between one and five participants with total excess emissions of less than 60 tons per year.

RECLAIM

The Regional Clean Air Incentives Market (RECLAIM) was established by the South Coast Air Quality Management District (SCAQMD) for NOx and SOx emissions by large point sources (emissions of more than 4 tons per year) beginning January 1,

rate limits under other regulations that limit NOx emissions outside the ozone season.

1994. The NOx program has 330 participants which account for approximately 65% of the NOx emissions from permitted stationary sources in the SCAQMD and the SOx program has 36 participants which account for roughly 85% of the SOx emissions from permitted stationary sources.[35] But the RECLAIM program covers only 17% of total NOx and 31% of total SOx emissions in the SCAQMD.

Each facility receives a free allocation of RECLAIM Trading Credits (RTCs) annually. The allocation is calculated from a starting allocation for 1994, a mid-point allocation for 2000, and an ending allocation for 2003.[36] Each allocation is calculated by multiplying the *historic use* or throughput of each piece of NOx and SOx equipment at the facility by the appropriate emission factor based on the adopted and proposed rules. The *historic use* is based on the peak year for each facility between 1989 and 1992. Allocations for intermediate years are straight line interpolations between the 1994, 2000 and 2003 allocations.[37] New sources must purchase sufficient RTCs from existing sources to cover their emissions. Existing participants can continue to receive allowances if they cease to operate.

All participants are randomly assigned to one of two compliance cycles: January 1~December 31 or July 1 ~June 30. Trading can involve facilities in either compliance cycle, but the RTCs are only valid for the compliance year for which they are issued and cannot be banked.[38] Each participant must hold sufficient RTCs at the end of the year to cover its actual emissions. Facilities that do not hold sufficient RTCs are subject to enforcement actions -- the excess emissions are deducted from the next year's allocation, monetary penalties of up to $500 per violation per day may be imposed, and other penalties may be applied. Several participants have been found to be out of

[35] All of the SOx participants are also NOx participants, so the total number of participants is 300 as of June 20 2002.

[36] The starting allocation was based on rules adopted as of December 31, 1993. The 2000 allocation reflects 100% implementation of 1991 Air Quality Management Plan proposed Tier I control measures. And the 2003 allocation reflects 100% implementation of proposed Tier I and Tier II control measures.

[37] Each facility has its own emission reduction rate determined by its allocations for 1994, 2000 and 2003 with linear interpolation for the intervening years. Allocations remain constant after 2003. The weighted average emission reduction rates are 8.3% per year for NOx and 6.8% per year for SOx from 1994 through 2003.

compliance each year the program has been in operation, although the excess emissions have been small.

Estimated actual and allowable emissions for RECLAIM facilities are shown in Table 3. Actual emissions were well below allowed levels from 1994 through 1998 suggesting that the allocations during the first few years may have been above the "business-as-usual" emissions. During 2000, electricity generators operated at significantly higher than their historical levels due to California's energy crisis. Although they purchased all available RTCs, driving up prices significantly, their emissions exceeded their allowance holdings.[39] The price increases caused by the electricity crisis triggered a review that led to temporary isolation of power producing facilities from the program, a requirement that power producers install emission controls, and a number of other changes in May 2001.

Table 7-3. Actual and Allowable Emissions of NOx and SOx by RECLAIM Participants

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
NOx (thousands of tons/year)										
Allowable[a]		40.1	36.0	32.0	27.9	24.7	21.0	17.2	15.8	14.2
Actual[a]	25.0	25.3	25.7	24.8	21.8	21.0	20.8	20.5	15.7	
Traded[b]		2.21	11.68	5.60	9.18	26.00	8.92	8.34	8.60	5.53
Average Price ($/ton)[b]		$679	$710	$786	$1,024	$1,373	$2,557	$21,308	$34,151	$5,562
SOx (thousands of tons/year)										
Allowable[a]		10.4	9.6	8.9	8.2	7.6	6.9	6.2	5.6	4.9
Actual[a]	7.2	7.2	8.1	6.5	6.5	6.8	6.4	6.0	5.0	
Traded[b]		--	3.05	5.17	5.08	1.78	1.55	2.09	5.53	2.29
Average Price ($/ton)[b]			$524	$1,063	$2,305	$618	$840	$2,108	$4,033	$7,915

38 The staggered compliance cycle eliminates the price uncertainty that could occur if all participants had the same compliance deadline with no banking.

[39] Table 7-3 shows the overall program exceedance by comparing Compliance Year 2000 emissions to the allocations for the same compliance year. The staggered compliance years allow RTCs from 1999 and 2000 to be used during Compliance Year 2000. Since some 1999 RTCs were used for emissions during 2000, the total amount of emissions in excess of allocations held by individual facilities was 1,089 tons rather than 3,294 tons as suggested by Table 7- 3.

Notes: a Figures relate to the compliance year -- the 18 months beginning on January 1 of the year shown.
b Data relate to the calendar year. RTCs traded may be for the current year or any future year. The quantities are for trades with a price; excluding transfers to brokers, etc.

Source: SCAQMD, 2003.

Table7-3 shows the quantity of RTCs traded with price. RTCs used for compliance or remaining unsold in the facility's account are subject to an emission allocation fee of roughly $374 per ton. Surplus RTCs can be transferred without price to brokers to avoid the fee. The volume of NOx trades with price has been rising relative to the annual allocation and is now approaching 50%. The quantity of NOx RTCs traded in 1996 was inflated by changes in ownership of electricity generators. The volume of SOx traded with price relative to the allocation, has been lower than for NOx in most years.

Lead in Gasoline

Effective November 1982, the Environmental Protection Agency (EPA) regulated the lead content of leaded gasoline to a maximum of 1.1 grams per gallon. A “baseline and credit” trading program was introduced to ease the burden of the standards on small refiners. Each refiner and importer was required to keep its actual lead use during each quarter below the regulatory limit plus net purchases of lead use rights.

There was no overall cap on lead used in gasoline. Total lead use was limited by the quantity of leaded gasoline produced and imported multiplied by the maximum lead content. Lead rights were allocated free based on each participant's production or imports of leaded gasoline during the quarter. Banking of lead use rights was not allowed, but leaded gasoline could be stored for sale in future periods.

Faced with new evidence of health damage from lead, the EPA set a maximum lead content for leaded gasoline of 0.5 grams per gallon effective July 1, 1985 and a minimum of 0.1 grams per gallon after January 1, 1986.[40] To facilitate this sharp

[40] The EPA determined that 0.1 grams of lead per gallon was the minimum needed to avoid wear to engine valve seats in vehicles using leaded gasoline. Continuing a trading program would likely have led to production of some gasoline with lead content below 0.1 grams per gallon.

reduction in the lead content, the EPA introduced banking into the trading system. Participants were allowed to bank lead use rights during calendar year 1985 and to withdraw them until the end of 1987, when the trading program concluded.

One of the reasons EPA set up the allocation rule this way was to encourage new entrants and so transfer some of the value of the lead use rights from producers to consumers. The number of participants grew from 265 in 1983 to 849 in 1985 and then fell to 547 in 1987. Only about 200 of these participants were refineries that produced leaded gasoline from crude oil. The balance were firms that added ethanol to leaded gasoline thus "manufacturing" leaded gasoline equal to the amount of ethanol added.[41] Entry of such firms on this scale was possible only because every firm that manufactured gasoline during a given quarter received lead use rights equal to its leaded gasoline production. Anderson *et al.*(1990) conclude that competition from these new manufacturers led to lower gasoline prices for consumers and lower profits for gasoline refiners.

II. Greenhouse Gas Emissions Trading Programs and Proposals in the United States

Although President Bush has indicated that he does not plan to submit the Kyoto Protocol to the Senate for ratification, several initiatives for greenhouse gas emissions trading are being implemented or considered in the United States. Oregon and Washington require new energy facilities to offset part of their greenhouse gas emissions. Massachusetts and New Hampshire require a few existing fossil-fired generating stations to reduce their CO_2 emissions. Several bills in the Congress to reduce emissions by electricity generators include limits on their CO_2 emissions. And

[41] If the leaded gasoline was already at the maximum concentration, adding the ethanol would reduce the concentration below the allowed level and so generate credits equal to the volume of ethanol times the maximum concentration.

bill to implement a comprehensive trading program to limit greenhouse gas emissions was recently defeated in the Senate. These initiatives are briefly described below.

State Initiatives

Many states are implementing or considering programs that would limit greenhouse gas emissions.[42] A few of those initiatives allow the purchase of offsets as a compliance option. This enables regulated sources to buy offsets from non-regulated sources, rather than to buy surplus allowances from other regulated sources.

Oregon The Oregon Energy Facility Siting Council sets CO_2 emissions standards for new energy facilities -- base-load gas plants, non-base load power plants, and non-generating energy facilities. The standard for base-load plants is 17% below the most efficient base-load natural gas plant in the United States. Emissions beyond the standard must be offset. The emissions standards do not apply to existing energy facilities, nor to existing or new non-energy facilities.

An applicant can meet the CO_2 standard by:

- using cogeneration to reduce fossil fuel emissions for steam production;
- implementing CO_2 offset projects directly or through a third party; or,
- providing $0.85 per ton of CO_2[43] plus contracting and selection funds to the Oregon Climate Trust so that it can purchase CO_2 offsets.

All projects approved since the standard came into effect have relied exclusively on the option of providing offset funds to the Climate Trust.

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[42] See Rabe (2002) and Schmidt, et al. (2002) for summaries of state initiatives.

[43] The Council increased the offset fund rate from $0.57 to $0.85 per short ton CO_2 ($1.03 per metric tonne of CO_2) on September 14, 2001. No further increases are allowed until September 2003 and then the increase is limited to a maximum of 50%.

The statute requires that offsets must come from future actions and prohibits the use of CO_2 credits for reductions or sequestration awarded in another regulatory setting. Thus, purchased credits or allowances can not be used to achieve compliance. CO_2 offsets required to meet the standard can not be sold; the Council or the Climate Trust hold them in trust for the citizens of Oregon. The cost of the offsets purchased by the Climate Trust has been over $1.50 per ton, so the emissions offset are substantially less than reductions required by the regulations.[44]

For the past few years the Washington state Energy Facility Site Evaluation Council has included CO_2 mitigation requirements in all siting approvals. In October 2003 the Council proposed a draft CO_2 Mitigation Rule to formalize this practice. The requirement would apply after July 1, 2004 to all large electricity generating facilities under the jurisdiction of the Council; new facilities with a capacity of at least 350 MW and expanding facilities that will have a capacity of at least 350 MW or will increase their CO_2 emissions by at least 18,500 metric tonnes per year.

The draft Rule would require a new fossil-fired generation plant to offset 20% of the CO_2 calculated to be emitted during 30 years by operating at full capacity at a rate of $0.87 per tonne.[45] The operator of the plant may meet the requirement through payment to a third party approved by the Council or direct conduct investment in CO_2 mitigation project(s). Offset projects may include energy efficiency measures, clean and efficient transportation measures, renewable energy resources, and sequestration programs. Offset projects located within the county or immediate surrounding counties of the energy facility, and second within the State of Washington, are preferred.

Massachusetts A regulation to reduce NOx, SO_2, CO_2, and mercury (Hg) emissions from the state's six oldest and dirtiest power plants went into effect in June 2001. These coal- and oil-fired plants produce about 40% of the electricity generated in the state but are the source of more than 90% of total greenhouse gases from

[44] Facilities pay $0.85 per ton CO_2 for the reductions they are required to achieve. If the cost of offsets is $1.50 per ton, only 57% (.85/1.50) of that reduction is actually achieved.

[45] The cost per tonne is in 2003 dollars and is indexed to inflation. The offset requirement and the cost per tonne can be revised every two years.

Massachusetts electricity generating facilities. They were built prior to 1970 and have repeatedly been exempted from new air pollution standards thus making it economically attractive to keep them in operation.

The plants will be required to reduce their CO_2 emissions below 1,800 lbs per MWh, resulting in an estimated 10% reduction from the average of 1997 to 1999 levels. The CO_2 standard goes into effect one year after the facility is required to be in compliance for the other emissions. Plants that convert to natural gas have a compliance deadline of October 2008. Plants that implement other compliance options, such as pollution control equipment, have to comply in 2006. The CO_2 standard can be met at the plant or through the purchase of credits from state-certified "off-site reduction" measures such as carbon sequestration or renewable energy generation.

New Hampshire The Clean Power Act of 2002 mandates lower NOx, SO_2, CO_2, and Hg emissions by the three fossil fired power plants in the state. Two of the plants use coal and the third uses oil and natural gas. All three plants are owned by Public Service of New Hampshire, a division of Northeast Utilities which also operates plants covered by the Massachusetts regulation. The plants must stabilize their CO_2 emissions at 1990 levels, approximately 3% below their 1999 emissions, by December 31, 2006. To comply with the CO_2 cap, affected sources may use CO_2 allowances from federal or regional trading and banking programs, or other programs acceptable to the Department of Environmental Services.

New England States The New England Governors and Eastern Canadian Premiers adopted a Climate Change Action Plan in 2001 with a short-term goal of reducing regional GHG emissions to 1990 levels by 2010 and to 10% below 1990 levels by 2020.[46] The Action Plan calls for the states and provinces to cooperate in reducing GHG emissions by cutting emissions from power plants and increasing the use of renewable energy sources, energy efficiency, and conservation.

[46] The states and provinces are Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, Newfoundland, New Brunswick, Nova Scotia, Prince Edward Island, and Quebec.

They also agreed to investigate the feasibility of emissions trading to help achieve the targets. Canada's subsequent ratification of the Kyoto Protocol and plan to implement a national emissions trading program complicate the implementation of an international emissions trading program for this region. However, several of the New England states are continuing to discuss implementation of a regional greenhouse gas emissions trading program but no specific proposals have yet been released.

Federal Proposals

The Pew Center on Global Climate Change indicates that 45 bills, resolutions and amendments that address climate change and greenhouse gas emissions had been introduced in the 108th Congress (2003-2004) by August 2003.[47] They include proposed legislation on greenhouse gas emission reductions, greenhouse gas emissions reporting, international climate change negotiations, energy policy, appropriations, emissions by power plants, transportation emissions, hydrogen, clean coal technology, carbon sequestration and climate science.

Emissions by Power Plants

Three bills would require electricity generators to reduce their NOx, SO_2, CO_2 and Hg emissions:

- The Clean Power Act of 2003, sponsored by Senator Jeffords, would require power plants to reduce their CO_2 emissions to 1990 levels by 2009.
- The Clean Air Planning Act of 2003, sponsored by Senator Carper, would require power plants to reduce their CO_2 emissions to 2006 levels by 2009 and to 2001 levels by 2013.

[47] See http://www.pewclimate.org/what_s_being_done/in_the_congress/108th.cfm

- The Clean Smokestacks Act of 2003, sponsored by Representative Waxman, would require power plants to reduce their CO_2 emissions to 1990 levels by 2009.

The NOx, SO_2 and Hg reductions proposed by the bills differ as well. All of these bills would establish emissions trading for the four pollutants.

A Clean Skies Act of 2003 has been introduced in both the Senate and the House of Representatives at the request of the President. It proposes reductions of the NOx, SO_2 and Hg, but not the CO_2, emissions of power plants with emissions trading. It would also exempt new power plants from the existing requirement that they report their CO_2 emissions.

Analyses indicate that efforts to reduce NOx, SO_2, Hg, and CO_2 emissions are linked.[48] Emissions control equipment added to reduce NOx and SO_2 also leads to lower Hg emissions, but may increase CO_2 emissions. Reducing CO_2 emissions typically leads to lower coal use, so it also lowers NOx, SO_2, and Hg emissions. Thus some utilities that believe limits on their CO_2 emissions are likely at some point during the next decade favour including them in any legislation to reduce power plant emissions to provide greater certainty for the evaluation of emission reduction actions for all of the pollutants.

Climate Stewardship Act

The Climate Stewardship Act would require the Environmental Protection Agency to promulgate regulations to limit the greenhouse gas emissions by the electricity generation, transportation, industrial, and commercial sectors.[49] These sectors accounted for approximately 85% of total U.S. emissions in 2000. The bill would cap the 2010 emissions of the covered sectors at the 2000 level. The Commerce Department would biennially re-evaluate the emissions cap to determine whether it was consistent with the United Nation's Framework Convention on Climate Change

[48] See EIA 2001.

objective of stabilizing GHG emissions at a level that will prevent dangerous anthropogenic interference with the climate system.

An entity would be subject to the requirements of the bill if it:

- owned at least one facility that annually emitted more than 10,000 metric tonnes of GHGs measured in tonnes of carbon dioxide equivalents ($MtCO_2e$);
- produced or imported petroleum products that, when combusted, would emit more than 10,000 $MtCO_2e$; or
- produced or imported HFC, PFC and SF_6 that, when used, would emit more than 10,000 $MtCO_2e$.

There would be no emission limits for the agricultural and residential sectors.

The bill would establish an emissions trading program for the covered entities. The Secretary of Commerce would determine the quantity of allowances to be given to each participant and the quantity to be auctioned. Each covered entity would be required to submit to the EPA an allowance for each $MtCO_2e$ directly emitted. Each petroleum refiner or importer and each producer or importer of HFC, PFC, and SF_6 would be required to submit an allowance for each unit of product sold that, when used, would emit one $MtCO_2e$. Proceeds from the auction would be used to reduce energy costs to consumers and assist disproportionately affected workers.

In addition to the allowances issued to it, a covered entity could purchase auctioned allowances or buy allowances from other covered entities, if necessary. A covered entity also would be allowed to satisfy up to 15% of its total allowance requirements by submitting:[50]

- tradeable allowances from another nation's market in GHGs;

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[49] See McCain and Lieberman, 2003.

[50] A covered entity that agreed to emit no more than its 1990 levels by 2010 would be allowed meet up to 20% of its requirement through international credits, sequestration, and registered reductions, but not borrowed credits.

- a net increase in sequestration registered with the National Greenhouse Gas Database established by the bill;
- a GHG emission reduction by a non-covered entity registered with the Database; and
- allowances borrowed against future reductions, if eligible.[51]

Covered entities would be required to report their GHG emissions and non-covered entities would be allowed to register GHG emission reductions and sequestration to a National Greenhouse Gas Database. A covered entity that did not have sufficient allowances to cover its actual emissions would be fined three times the market value of an allowance for each tonne of excess emissions.

The Climate Stewardship Act was defeated by a vote of 55 to 43 on October 30, 2003. However, given the relatively narrow margin of defeat, a revised version of the bill could be re-introduced in the future or portions of the bill could be introduced as amendments to other legislation.

III. Canada's Proposed Domestic Greenhouse Gas Emissions Trading Program[52]

Canada estimates that its annual greenhouse gas emissions during 2008-2012 will be 240 megatonnes of CO_2 equivalent (Mt CO_2e) higher than its average emission

[51] An entity planning to make capital investments or deploy technologies within the next 5 years would be allowed to borrow against the expected GHG emission reductions to meet current year requirements. The loan would include a 10% interest rate.

[52] Canada had two pilot emissions trading programs. The Pilot Emission Reduction Trading (PERT) program in Ontario focused initially on ground-level ozone precursors but expanded to include greenhouse gases. It operated from 1996 through 2000. The Greenhouse Gas Emission Reduction Trading (GERT) pilot program involved six provinces and the federal government and operated from June 1998 through December 2001. It dealt only with greenhouse gases. For descriptions of these programs see Haites and Hussain, 2000.

limitation commitment under the Kyoto Protocol. The Climate Change Plan for Canada (Plan) sets out a three-step approach for achieving Canada's Kyoto Protocol commitment. Initiatives announced prior to the Plan are projected to reduce emissions by 80 Mt CO_2e per year. The Plan outlines actions designed to lower emissions or enhance sinks by a further 100 Mt CO_2e annually. Finally, the Plan identifies a number of current and potential actions that should enable Canada to address the remaining 60 Mt CO_2e reduction.

One of the initiatives outlined in the Plan is a domestic emissions trading (DET) program for large final emitters (LFEs). The DET is expected to cover all firms in sectors that have average annual GHG emissions per facility of 8 kt CO_2e or more and average annual emissions of 20kg CO_2e or more per $1,000 of output. These sectors include thermal electricity, oil and gas, mining and manufacturing. The estimated 500 to 700 firms in this group are forecast to account for about half of Canada's total greenhouse gas emissions in 2010. Consideration is being given to excluding firms whose annual emissions are less than a minimum threshold.

The LFE companies will be subject to a "backstop and covenant" system. The "backstop" will take the form of legislation and regulations that will define default emission intensity targets, emission measurement methodologies, emission reporting requirements, provisions for emissions trading (including the use of domestic offset credits and Kyoto Protocol units), penalties for non-compliance, and conditions for the negotiation of a voluntary covenant between a firm and the government regarding its GHG reduction commitments. A covenant could modify backstop emission intensity target or other requirements to respond to competitiveness concerns or to address early action.

The target of the "backstop and covenant" system is to reduce the projected "business as usual" emissions of large industrial emitters by 55 Mt CO_2e per year. Reducing the projected 2010 "business as usual" emission intensities by 15% is estimated to be sufficient to achieve this target. In addition to the 55 Mt CO_2e per year reduction through the backstop and covenant system, previously announced measures

are expected to reduce the emissions of LFE companies by 25 Mt CO_2e per year and complementary actions in the Plan to promote innovation and technology are projected to reduce the LFE emissions by a further 11 Mt CO_2e per year.

A key feature of the proposed program is that targets will be expressed as emission intensities and compliance will be assessed relative to the target emissions intensities. An emission intensity target covering all greenhouse gases will be set for each process (product) produced by each of the industries covered. The emission intensity targets could remain constant or decline over the 2008~2012 period. The emission intensity targets are expected to be set out in a schedule adopted by regulation. Conceptually, the schedule would have the following structure.

Table 7-4. Hypothetical Backstop Intensity Targets

Industry/Process	2008	2009	2010	2011	2012
Thermal Electricity Generation					
Process A (t CO_2e/MWh)	0.900	0.880	0.860	0.840	0.820
Process B (t CO_2e/MWh)	0.300	0.300	0.300	0.300	0.300
Manufacturing Industry 1					
Process 1-A (t CO_2e/unit)	20	20	20	18	18
Process 1-B (t CO_2e/unit)	0.010	0.010	0.010	0.010	0.010
Process 1-C (t CO_2e/unit)	1.55	1.50	1.45	1.40	1.35
Manufacturing Industry 2 (etc.)					

Covenants might modify the emission intensity targets for some (or all) processes in a particular industry or for an individual firm.[53] An industry able to demonstrate that compliance with the proposed targets would impose costs that would significantly weaken its competitive position relative to foreign firms could negotiate less stringent targets as part of a covenant.[54] An individual firm that implemented early action to

[53] The Draft Covenant is based on the UK Climate Change Agreements, the Quebec/Aluminum Association Agreement; and the Canadian Chemical Producers Association Agreement with Canada, Ontario and Alberta.

[54] The Allocation Paper sets out principles that will be used to guide the government in assessing competitiveness concerns, including. Competitiveness is a sector-wide concern. Competitiveness is best reflected in a rate of return on equity that is significantly lower than the average for Canadian industry. Competitive stress requires low rates of return on equity for a relatively long period, not short-term economic conditions. The burden of proving competitive

reduce its greenhouse gas emissions could negotiate a covenant with less stringent targets if it was able to demonstrate that its early action placed it at a disadvantage under the backstop targets.[55]

Covenants are intended to: be voluntary but legally binding; provide the flexibility required to respond to sectoral and/or company-level circumstances; be negotiated by industry associations (as a framework agreement) but entered into by specific companies (through a specific facility or entity agreement); include emission intensity based targets; include public reporting requirements subject to limited confidentiality; stipulate emission measurement methodologies and best industry practices; mandate annual reporting, verification and auditing requirements; and potentially modify regulatory requirements if required to respond to competitive concerns and early action.

At the end of each year every participant will receive a free allocation of allowances equal to its actual output for each process (product) multiplied by the corresponding emission intensity target as established by the backstop regulation or covenant. The allocation will cover all establishments operated by the firm that are covered by the firm. It is assumed that the allocation of allowances will be rounded to the nearest metric tonne. Thus the allocation to a firm would involve a calculation such as the following:

Table 7-5. Allocation of Allowances to Firm Q for 2010

	Actual Output during 2010 by Firm Q at its Three Production Establishments			**Intensity Target 2010 (tCO_2e/unit)**	**Allowance Allocation for 2010 (000 tCO2e)**
	Site 1 (units)	Site 2 (units)	Site 3 (units)		
Process 1-A	1,139		5,378	20	130

distress lies with the industry sector. Antiquated capital stock is not evidence of competitive distress.

[55] The Allocation Paper contemplates providing limited "credit" to entities that implemented early emission reduction actions and would be disadvantaged as a result of those actions. To demonstrate that it had implemented early action, a firm would need to provide evidence that the early action was real and financially additional; its emission intensity is among the best in the world; its current emission intensity relative to 1990 has improved more than a yet to be defined amount; and there is a marked change in its emission intensity trend.

Process 1-B	250,666	867,234	0.010	11
Process 1-C	5,295	29,748	1.45	51
Total				192

Since actual output can not be known until after the end of the year, the final allocation can not be made until that time. To provide liquidity for the trading program, a procedure for early distribution of some of the allowances is being studied. For example, allowances might be distributed based on 80% of the previous year's output.

Table 7-6. Compliance by Firm R in 2010

	Actual Emission Intensity (tCO_2e/t)	Actual Output, 2010 (tonnes)	Allowance Allocation (kt CO_2e)	Actual Emissions (kt CO_2e)	
1	0.71	100,000	71	71	Precise compliance by the firm, actual emissions as projected.
2	0.71	125,575	89	89	Precise compliance, the government is responsible for the extra 18 kt CO_2e of actual emissions.
3	0.71	81,396	58	58	Precise compliance, the government benefits because actual emissions are 13 kt CO_2e lower than projected.
4	0.80	100,000	71	80	Firm must buy 9 kt CO_2e allowances to comply, no impact on government.
5	0.80	81,396	58	65	Firm must buy 7 kt CO_2e of allowances to comply, actual emissions will be 13 kt lower than projected.
6	0.65	100,000	71	65	Firm has 6 kt CO_2e of surplus allowances, no impact on government.
7	0.65	125,575	89	82	Firm has 7 kt CO_2e of surplus allowances, government responsible for extra 18 kt CO_2 e of extra emissions.

Note: Emission intensity target is 0.71 tCO_2e/tonne and projected output is 100,000 tonnes for projected total emissions of 71 kt CO_2e in 2010.

Each year every firm participating in the DET would: (i) receive free emission allowances equal to its emission intensity target multiplied by its actual production; and

(ii) be required to surrender eligible emission commodities equal to its actual emissions. Eligible emission commodities include: allowances issued to LFE participants, domestic offset credits, and Kyoto Protocol units. Companies that do not comply with their covenant obligations will be provided with notice and opportunity to correct the default. If the default is not remedied, the company will be subject to penalties specified by the backstop legislation.

To illustrate the compliance process assume that Firm R produces only one product, that the emission intensity target for this product in 2010 is 0.71 tCO_2e/tonne of product, and that the projected output for 2010 was 100,000 tonnes of product. The firm is responsible for meeting the emission intensity target, but the government bears the risk that output by LFE firms will be higher than projected, leading to a reduction from "business as usual" emissions of less than 55 Mt CO_2e per year. The following cases illustrate the compliance possibilities:

If the actual emission intensity is higher than the target, the firm must purchase allowances to achieve compliance, regardless of its actual output. Conversely, if the actual emission intensity is lower than the target, the firm will have surplus allowances regardless of its actual output. Regardless of the firm's actual emission intensity, the government will face an emission reduction obligation if the firm's actual output is higher than the projected output. Lower than projected output by the firm reduces the emission reduction burden of the government, regardless of the firm's actual emission intensity.

The emission intensity targets are being established through negotiations between the government and the associations for the affected industries. These negotiations are confidential. It is believed that the negotiations define the major processes (products) and emission intensity targets for an industry. Firms that have unique processes (products) are then addressed in a manner consistent with the industry agreement.

The government promised the Canadian Association of Petroleum Producers ("CAPP") a price cap of CDN$15/t CO_2e (estimated to be about US$10/t CO_2e) for

domestic permits in 2010. No details as to how this cap will be implemented have yet been provided.

Emissions sources not covered by the backstop and covenant system would be allowed to create emission reduction or carbon sequestration "offset credits" that could be used for compliance by participants in the backstop and covenant system. An Offsets Discussion Paper, released to facilitate national consultations, sets out policy options and issues related to the design, administration, and specific application of the offsets system to the forestry, agriculture and landfill gas ("LFG") sectors.

The specific design proposals would allow a domestic offset credit to be created from emission reductions that: (i) are reflected in Canada's national inventory; (ii) result from projects commenced after a date to be defined; (iii) occur during the first Kyoto commitment period; (iv) are real, measurable, verifiable, surplus to regulatory requirements and other government climate change measures, and unique; and (v) are the subject of secure and transparent ownership rights.

The government intends to codify the offset credit creation process in a regulatory framework, a guidance document and a series of quantification protocols. The proposed process involves: (i) ex ante validation of emission reduction/removal projects through submission, review and registration of a Project Document; (ii) ex post verification of the GHG reductions and removals; and (iii) final approval of the reductions/removals and the issuance of offset credits.

Ultimately, the offset system is intended to include a number of "quantification protocols" to facilitate the creation of offset credits in at least the forestry, agriculture, and landfill gas sectors. Other projects may also be eligible to create offset credits if they conform with baseline, boundary, leakage, and permanence rules that are in the early stages of consideration by the federal government. All offset projects would be expected to contribute to reducing Canada's national GHG inventory.[56]

[56] Such a contribution may be implemented through baseline adjustments or mandatory retirement of a percentage of the resulting credits.

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8. Greenhouse Gas Emissions Trading Initiatives and Activities in Other Countries

Yong Gun Kim[*]

Unless otherwise mentioned, all of the summaries for other countries in this section are directly quoted from "Summary of Countries' Emissions Trading Activities" reported in the third annual workshop on Greenhouse Gas emission trading, co-organized by International Energy Agency (IEA), International Emissions Trading Association (IETA), Electric Power Research Institute (EPRI) and IDDRI, held on 23rd September 2003.

Australia

Australia is an Annex B nation with a Kyoto Protocol commitment of +8%. Greenhouse gas emissions in the 1990 baseline year were 493Mt CO_2e (incorporating the current best estimate of land clearing emissions), rising to 520Mt CO_2e in 1998, an overall increase of 5.4%.[57]

The Federal Government has predicted that Australia will be within reach of greenhouse gas emission targets by the end of the decade, but it is still refusing to ratify the Kyoto Protocol. Figures released in September 2003 showed greenhouse gas emissions for 2001 were at 1990 levels, and slightly below 2000 levels. According to the 2001 National Greenhouse Gas Inventory, the greatest reduction came in the area of

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[57] See http://www.co2e.com/CarbonBriefing/carbonbriefingview.asp?categoryid=195

land clearing, with emissions dropping by 70 per cent from 1990. However, emissions in the transport, energy, agriculture and waste sectors continued to climb.[58]

The Australian government has indicated that it favors the use of market based mechanisms (emissions trading) to assist Australia in meeting its greenhouse gas emission targets.[57] And emissions trading options have been well analyzed in Australia. However, it is unclear if and when a trading system will be implemented. The decision to put a trading system in place will be tied to a decision on ratification of the Protocol, a debate that is currently ongoing. If the Australian Parliament decides to ratify the Protocol a domestic emissions trading regime could be implemented within two years of that decision.[59]

Chile

Chile is part of the UNFCCC since 1995 and ratified the Kyoto Protocol on August 28th, 2002. As a non-Annex I country, it does not have the obligation to reduce its GHG emissions, which account for less than 0.05% of the global emissions.

The Emissions Trading System (ETS) Bill of Law was presented to Parliament in July 2003 and it is expected to enter into force by 2005. It is a framework law that enables the environmental authority to apply ETS to different sources and pollutants. As a framework law, it considers all the different ET designs, i.e. cap and trade, credit base and offset. It includes the linkage to Kyoto, as well.

For Santiago, in a first stage, ETS will be applied to large stationary sources (mainly, manufacturing), public transportation and industrial processes and will cover PM_{10} and NOx (maybe SOx and CO_2). It's going to be a cap and trade design and new sources will have to offset their emissions.

[58] See http://www.ieta.org/Library_Links/IETAEnvNews/Sept19_Australia.htm
[59] See http://www.nrtee-trnee.ca/EmissionsTrading/en/overview_countries_Australia.htm

Finland

Under the EU burden sharing arrangement, GHG emissions of Finland is adjusted to 0% from 1990 levels.

The National Climate Strategy (NCS), which was finished during spring 2001, is being updated to include EU emission trading Directive and should be ready by the end of year 2004.

Ministry of Trade and Industry (MTI) is in charge of preparing the National Allocation Plan (NAP), the national legislation implementing the directive. MTI is also coordinating the updating of the NCS. The work has been done with cooperation with other related ministries – Environment, Transport, Agriculture & Forestry, Finance and Foreign Affairs.

The timetable of Emission Trading Directive-starting January 1, 2005- is turning to be hard to meet. Several studies have been done and are under work. The large share of the hydropower in the common Nordic power market and the fluctuation of the hydropower production and it's replacing mainly with coal condensing power does not make the preparation of the ETS easy.

France

France is one of the Annex B nations in Europe, with a Kyoto Protocol commitment of -8%, adjusted to 0% under the European Union "burden sharing" arrangement. Greenhouse gas emissions for the 1990 baseline year were 546Mt CO_2eq rising to 550Mt CO_2eq in 1996, an increase of less than 1%, (excluding HFCs, PFCs and sulphur hexafluoride emissions). France intends to participate in the proposed European Union emission trading system that is scheduled to commence in 2005.[60]

[60] See http://www.co2e.com/CarbonBriefing/carbonbriefingview.asp?categoryid=198

Hungary

Under Kyoto Protocol Hungary undertook an individual emission reduction target of 6% compared to the average emission of 1985~87, corresponding to its special circumstances and capabilities. Compliance with this target is being ensured by way of domestic polices and measures, such as on-going national energy efficiency schemes, different sectoral programs and other measures. Based on these domestic efforts Hungary appears capable of fulfilling its Kyoto commitment by 2012.

Regarding the implementation of the EU ETS, Hungary expressed its concerns about the community-wide scheme and asked the Commission for further consultation on the issue. For the time being, the first database of the installations covered by the directive has been already compiled and is currently under consultation with the relevant representatives of the affected industries.

Italy

Under the EU burden sharing agreement, Italy has been allocated a greenhouse gas target of –6.5% from 1990 GHG emission levels.

The Emissions Trading development process in Italy is well under way. At the moment Italy does not foresee developing its own national emissions trading program. Such decision was based on the consideration that truly global markets maximize cost-effectiveness and minimize abatement costs. In such respect national emission trading systems through market fragmentation often yield to higher transaction costs and reduce the scope for cost minimization. In light of such considerations, emissions trading in Italy is being developed within two frameworks: the EU Emission Trading Directive and the Kyoto Protocol Emission trading rules.

Within the Kyoto Protocol Emission trading framework, Italy has been closely following and contributing to UNFCC negotiations. At the same time it has performed in depth analysis through desktop studies and simulations of the role of its governments and legal entities within the global carbon trading market. On the project mechanisms

side the Italian government has established a number of memorandum of understanding with countries in Eastern Europe, Asia and Africa.

Within the framework of the EU Emission trading directive, Italy has been actively contributing to the community debate and negotiations leading to the finalization of the EU emission trading system and its links with the UNFCC project mechanisms. At the national level, under the lead of the Environmental Ministry, Italy has undertaken the process of implementing the Directive at the institutional and operational levels. From the regulatory point of view, no delays are foreseen in terms of compliance with the deadlines set by the Directive.

From the technical point of view, development of the national allocation plan has started. The National Climate Action Plan finalized in late December 2002 in consultation with the main stakeholders already sets important references for sector specific emission levels, an important advanced starting point for negotiating the activity level emission caps required by the national allocation plan. In such respect a first phase of identification and evaluation of different policy scenarios will be followed by stakeholder consultation activities. Given the current status of the development process, it is not possible to release figures regarding the number of quotas at overall, activity and plant levels.

Latvia

Latvia is obligated to implement EU Directive establishing a scheme for GHG emission allowance trading within the European Community till May 2004.

Some research has been done on emissions trading that will serve as an input to the legislation and National Allocation Plan, such as: ET Directive overview and existing legislation analyses; identification of operators and installations covered by ET Directive. The Ministry of Environment has started to transpose the ET Directive. It is decided to implement the basic requirements of the Directive through Law “On Pollution”, Law “On Natural Resource Tax” and Latvian Administrative Violations

Code. Preparation of Cabinet of Ministers Regulations regarding to monitoring, reporting, verification, GHG registry etc. is foreseen till May 2004. A private company ("Ekodoma") is chosen to elaborate the first draft of National Allocation Plan, which will be developed in the end of year 2003.

The Netherlands

Under the EU burden sharing agreement, the Netherlands has been allocated a greenhouse gas target of -6% from 1990 GHG emission levels.

All aspects of implementation of EU directive are carried out in close cooperation with industry. Implementation includes a change of national environment law, the design of monitoring and verification protocols and the establishment of a National Emission Authority. Even though the time schedule for implementation is very tight, no delays are foreseen.

Drafting of the allocation plan is currently being processed. Data are almost available on an appropriately detailed level. Approximately 300 companies will participate, of which 250 companies signed voluntary agreements. Emissions of these companies are approximately 100 Mton, which is about 45% of Dutch total CO_2 emissions.

The Dutch allocation plan must comply with the EU directive itself; the CO_2 targets for industry and energy sector, which have recently been calculated and are now sent to Parliament; and-if possible-the current practice of benchmarking, which ask for an allocation based on energy efficiency standards.

Different allocation methods will be applied to different sources. Process emissions will be allocated allowances, based on historic emissions, corrected for sector production growth. For combustion emissions, however, another correction factor will be applied, based on international energy efficiency benchmarking. Finally, co-generation plants opt for yet another allocation method.

New Zealand

Under the Kyoto Protocol, New Zealand has agreed to stabilize its GHG emissions to 1990 levels by 2008 ~2012. National estimates indicate that greenhouse gas reductions in the order of 20%, compared to a business-as-usual scenario, will be required to achieve this target.[61]

While the New Zealand government has announced that a domestic emissions trading program is its preferred policy measure for meeting its Kyoto commitments, the potential design of such a system has not yet been determined.[61]

Norway

Norway has a commitment under the Kyoto Protocol to limit the increase in its GHG emissions to 1% above 1990 levels for the first commitment period between 2008 and 2012. National estimates indicate that greenhouse gas reductions of the order of 17%, compared to a business-as-usual scenario, will be required to achieve the Kyoto target.[62]

The government of Norway has been exploring the potential design of an emissions trading system since 1998. In August 2001, the Government released a white paper on climate policy, which included recommendations on a domestic emissions trading system, which would replace the current carbon dioxide tax law. The proposed emissions trading scheme is pending parliamentary approval. Foundations of the trading scheme are being developed and would be functioning as early as 2005.[62]

Russia

Russia is an Annex B nation that has a Kyoto Protocol commitment of 0%. Greenhouse gas emissions for the 1990 baseline year were 3,040Mt CO_2eq.[63]

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[61] See http://www.nrtee-trnee.ca/EmissionsTrading/en/overview_countries_New-Zealand.htm
[62] See http://www.nrtee-trnee.ca/EmissionsTrading/en/overview_countries_Norway.htm
[63] See http://www.co2e.com/CarbonBriefing/carbonbriefingview.asp?categoryid=199

A number of emissions trading scenarios are under consideration in Russia. These scenarios range from the situation where the transfer of the emission reduction unit must be undertaken in conjunction with a project that falls under the Joint Implementation regime to the situation where international organizations are appointed as "brokers" for the sale of assigned amount units.[63]

Russia is in the process of developing elements required to enable international trading, including the design of an emission inventory system at each source, development of emission control and monitoring systems and design of environmental audits.[63]

However, Andrei Illarionov, Vladimir Putin's chief advisor on economic issues mentioned on December 2, 2003 that it will not ratify the UN Kyoto Protocol in its present form because it would hamper the country's economic growth. Russia needs to ratify Kyoto for it to come into force. The treaty, which aims to cut emissions of gases responsible for global warming, requires approval from countries responsible for 55 percent of emissions. This leaves Russia with the casting vote since top polluter the United States has pulled out.[64]

Many observers, however, think Russia will eventually ratify the protocol enticed by the potential to earn billions of dollars in emission credits, because its slumping economy has done its own part in reducing Russia's greenhouse gas emissions.[65]

Sweden

Under the EU burden sharing agreement, Sweden has been allocated a greenhouse gas target of 4% above 1990 GHG emission levels by 2012.

In May 2003, a Swedish parliamentary commission presented a proposal to the government for how the recently adopted EU emissions trading directive could be implemented in Sweden during the pre-commitment period 2005~2007. According to

[64] See http://www.co2e.com/news/story.asp?storyid=1391
[65] See http://www.enn.com/news/2003-12-12/s_11260.asp

the proposal, some 300 installations would be covered, that equals roughly 30% of the total Swedish CO_2 emissions.

The FlexMex2-Commission's assessment is that the installations covered by the directive would need 24 million ton of CO_2 allowances per year. Allocation should be based both on historical and projected emissions depending on the type of emission. At present, the Swedish Ministry of Industry, Employment and Communication is preparing a bill that will establish the principles to be used for the Swedish national allocation plan. The bill is going to be based on the proposal of the commission and the views that various stakeholders, such as industry, authorities and NGOs, have had on the proposal. In a second step, probably spring in 2004, a proposal for the national legislation implementing the emissions trading scheme will be put forward to the parliament.

Switzerland

The envisaged domestic emissions trading is a voluntary scheme based on the federal CO_2 law, which stipulates legally binding reduction targets for energy related CO_2 emissions. In addition to an overall reduction target of minus 10 percent by 2008~12 compared to 1990, emissions from combustibles are to be lowered by minus 15 percent and from motor fuels by minus 8 percent. Also, an incentive tax on fossil fuels is to be introduced, the rates of which depend on the target gaps in each sector but must not exceed 210 Swiss francs per tonne of CO_2.

Emission trading is primarily designed for companies signing a legally binding commitment to reduce their energy related CO_2 emissions. In return, these companies will be exempted from a possible tax on fossil fuels. To seek tax exemption by taking on emission caps is of vital interest to energy intensive industries, such as cement, paper & pulp, glass, ceramic, aluminium etc.

Allowances are allocated free of charge according to negotiated absolute CO_2 reduction targets for 2008~12, which are derived in a bottom-up approach. For small

and medium-sized companies, a simplified top-down approach is applied and absolute reduction targets are drawn from an industry benchmark.

Negotiations with big emitters (>250,000 t CO_2 p.a.) are carried out directly with government offices. All others submit their application through the privately run Energy Agency for the Economy. Reduction offers are subject to a formal audit procedure attended by government representatives and industry experts and consisting of desk reviews and random visits. To date, targets have been agreed, among others, with cement, ceramics, pulp & paper, limekilns, sugar mills, and cheese producers. Audits with around thirty more industries are scheduled for 2003/04.

As of 2008, emission allowances equalling the emitted amount of CO_2 are to be cancelled annually. Allowances not needed for compliance can be sold or carried over to future commitment periods. To cover excess emissions, allowances have to be acquired on the domestic or international market.

Detailed regulations on the exchange of domestic emission allowances and the use of the flexible mechanisms are currently elaborated.

9. Conclusion and Future Research Area

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Greenhouse gas emissions trading has been poised at the center of international and domestic climate change mitigation policy. After the Marrakech Accords agreed at the Seventh Conference of the Parties to UNFCCC in 2001, international emissions trading activities has surged. The volume of transaction is estimated to be over 70 million tonnes of carbon dioxide equivalent emissions. Increasing number of countries have been involved in designing and implementing domestic emissions trading schemes. United Kingdom and Denmark are already running their national trading systems.

Table 9-1. Forecast for 2003 Global Carbon Market, as of September 2003 ($MtCO_2e$)

Market	Target	Range	Market Share
UK ETS	0.2	0.1 ~ 0.3	0.27
Denmark	0	0.0 ~ 0.1	0.00
NSW, Australia	1.7	1.4 ~ 2.0	2.33
USA	0.3	0.1 ~ 0.5	0.41
Canada	1.1	0.1 ~ 0.5	1.50
EU ETS	1.0	0.8 ~ 1.2	1.37
AAUs	0.1	0.1 ~ 0.3	0.14
Erupt (JI)	8.6	0 ~ 50	11.76
Cerupt (CDM)	16.5	7 ~ 10	22.57
Prototype Carbon Fund	19.6	16 ~ 17	26.81
Other CDM	15	14 ~ 24	20.52
Other JI	2.5	10 ~ 20	3.42
Other	6.5	1.5 ~ 3.5	8.89
Sum	73.1	50 ~ 138	100.0

Source: Point Carbon

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In spite of disembarkation of the United States and Australia from Kyoto Protocol, and even with the uncertainty related to Russian ratification, international and domestic efforts to develop greenhouse gas emissions trading schemes are expected to grow steadily in the coming years. EU-wide emission trading initiative is right at the core of these efforts. EU-wide emission trading system will more or less determine the future global standard for emissions trading regime.

Although the emissions trading provides a cost effective solution to domestic and international greenhouse gas emission reductions, actual worldwide implementation of emission trading system is expected to face numerous problems. As we witnessed from the UK and Danish experiments, the performance of emissions trading system may not work as expected due to some unforeseen complications and drawback of detailed architecture. Application in the future to circumstances with broader scope as well as different environmental conditions may require greater efforts to deal with potential problems so as to make it workable. A wide range of research activities is indispensable in this regard. Some of important areas for further researches would include the following.

Firstly, we need more researches on the design of emissions trading system where developing countries without binding emission reduction and limitation targets play a part in it. As argued so often by numerous policy analysts, cap-and-trade system is more efficient than baseline-and-credit system in a wide range of issues. Cap-and-trade system could minimize administrative burden for verification and helps us avoid complications coming from adverse selection. Therefore, it would be best if all the market players have cap-and-trade policy. As of now, no known incentive system for all non Annex-1 countries to adopt cap-and-trade policy has been found. Much less to impose mandatory GHG emission reduction and limitation target on them. Since it is clearly better to have some voluntary cooperative action from non Annex-1 countries than having nothing at all, we need to come up with an emission trading system where CER from CDM projects can be traded in a unified market with credibility and assurance. Simply put, it amounts to narrowing the gap between simple cap-and-trade system and baseline-and-credit system. Advancement in this area would surely pave

the road for non Annex-1 countries to using more efficient policy instruments, and thus eventually yielding real environmental impact.

Secondly, methods to efficiently link different national or regional trading systems should be explored. It is obviously crucial if we ever hope to have a full-fledged global trading regime. Key design variables requiring minimal consistency include severity of penalty in case of failing to meet the regulations and requirements, banking and borrowing provision, allocation rules and coverage of sources. The EU initiative to introduce new emissions trading system deserves attention in this regard. The final national emission allocation plans of individual member countries, due next March, may be a naturally emerging research subjects.

Tackling all these research topics requires efforts of more than just a few experts. Long-term review and wide collaboration amongst analysts are prerequisite for such an effort to succeed. This report is only the first step toward that direction. A great deal more of in-depth studies with consensus-building process with wider participation of experts and practitioners are to be followed.