

Peterson, Sonja

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Monitoring, accounting and enforcement in emissions trading regimes

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**OECD GLOBAL FORUM ON SUSTAINABLE DEVELOPMENT: EMISSIONS TRADING
CONCERTED ACTION ON TRADEABLE EMISSIONS PERMITS (CATEP) COUNTRY FORUM**

**MONITORING, ACCOUNTING AND ENFORCEMENT IN EMISSIONS TRADING REGIMES
(DOCUMENT 5)**

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This paper was prepared by Sonja Peterson (Kiel Institute for World Economics – IfW) for the OECD Global Forum on Sustainable Development: Emissions Trading and Concerted Action on Tradable Emissions Permits (CATEP) Country Forum held on 17-18 March 2003 at OECD Headquarters in Paris. The ideas expressed in the paper are those of the author and do not necessarily represent views of the OECD or its Member countries.

Contact person: Mr. Stephen Bygrave, ENV/GSP [Tel: (33-1) 45 24 14 86; Email: stephen.bygrave@oecd.org]

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This is the third of 3 synthesis papers presented by the Concerted Action on Tradable Emissions Permits (CATEP), a research network funded by DG Research of the European Commission, and co-ordinated by the Department of Environmental Studies, University College, Dublin. The papers highlight key issues identified in CATEP research to date and cover selected themes presented and discussed at CATEP workshops hosted respectively by Fondazione Eni Enrico Mattei in Venice (2001), University College, London in London (2002), the World Economics Institute in Kiel (2002), and FIELD, UNEP and CEC in Budapest (2003). The purpose of this paper is to synthesise papers and presentations on the theme: “Monitoring, Accounting and Enforcement in Emissions Trading Regimes.”

Acknowledgement

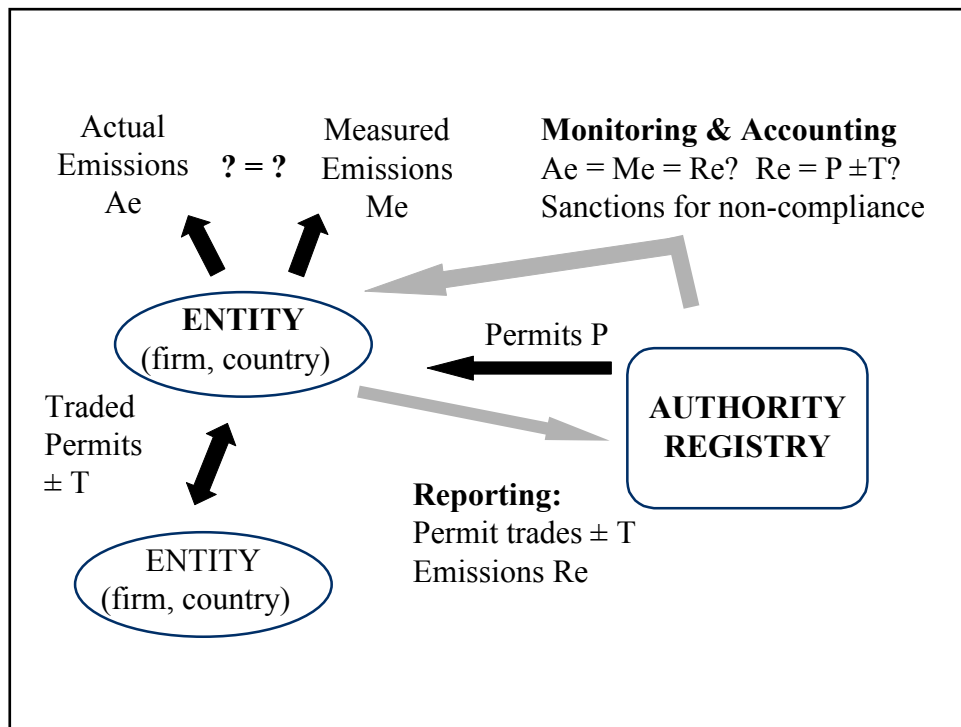
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1. INTRODUCTION

1. In the past few years permit trading has become a popular policy instrument to achieve emissions reductions or other environmental goals at minimal cost. There are already a number of existing regimes on firm as well as on national level in which permits for SO₂, NO_x and CO₂ emissions but also fishing quotas or water rights are traded. In addition European CO₂ emissions trading is expected to start in 2005 and international emissions trading is also planned for the Annex B countries of the Kyoto Protocol. Experience has shown though that permit trading can only be an efficient instrument if emissions¹ and permit trades are monitored and accounted appropriately and if compliance is enforced by those running the programs. Or, as Tietenberg (2001) puts it: “regardless of how well any tradable permit system is designed, non-compliance can prevent attainment of its economic, social and environmental objectives”.
2. The compliance in a permit system depends on the technical ability to detect violations and the legal ability to deal with the violations (Boemare and Quirion 2001). Figure 1 shows the relevant emission and permit flows that are part of any emissions trading regime and the information that is needed to assure compliance.
3. As the basis for an emissions trading regime are the actual emissions of the participants (which can be individual firms or countries, but also operational parts of firms) there have to be techniques, devices, instruments and methods available and in place to measure or at least estimate these emissions appropriately. The difficulty in obtaining a reasonable accurate and continuous measure or estimate of the emissions of each entity at reasonable cost is one reason why only some GHG have been traded so far and why at the moment the international trading schemes are limited to CO₂ emissions. The measured (or estimated) emissions have to then be reported to the regulating authority. Detailed technological and process requirements in guidelines for inventories aim to minimise the inaccuracies in these first two steps that can be summarised as monitoring the emissions.
4. Compared for example to emission taxes, the regulators of emissions trading regimes face a more complex problem as they do not only have to focus on emissions but also on the behaviour of the participants in terms of their participation in the emission permit markets (Stranlund et al. 2002). The participants of the trading regime receive their permits from the regulating authority and can then trade them with other participants. In order to be able to detect non-compliance, it is essential to keep track of the permits. This can be achieved by a registry to which all trades have to be reported. The authority then has to make sure that every participant’s emissions do not exceed the level allowed by the number of permits the participant holds. Keeping track of emissions and emission allowances for the purpose of assessing compliance is summarised under the term accounting (Anderson 2003). Finally, the authority must be able to enforce compliance and thus to penalise or sanction participants for misreporting or emitting in excess of their permit holding.

¹ This paper will focus on emissions trading. In what follows the special characteristics and needs of other tradable permit regimes such as water rights and fishing quotas are not considered.

Figure 1: Monitoring, accounting and enforcement in tradable permit regimes



5. Monitoring, accounting and enforcement have been addressed in quite a number of presentations, papers and discussions in the past four CATEP workshops. Besides drawing conclusions from the experiences with existing trading regimes, different aspects of compliance have been analysed in more detail and finally there has been a special focus on standardised accounting systems. This paper tries to summarise the diverse findings to get a comprehensive picture of what is needed to assure high compliance in emissions trading regimes and identify any specific problems. The paper proceeds as follows. The next section focuses on real trading regimes that are all local or at most national. It describes the monitoring, accounting and enforcement systems in existing and planned trading regimes to get an idea of what such systems include and to draw conclusions from experience. One focus is on enforcement mechanisms, as different from monitoring and accounting, which are basically a question of regulation and technology, penalties and compliance are a question of choices by participants and can be analysed with analytic tools. Section 3 deals with specific monitoring, accounting and enforcement problems in international emissions trading. It describes the development of internationally standardised systems and discusses the commitment period reserve as one instrument to avoid overselling of permits in international emission trading under the Kyoto Protocol. Section 5 provides a summary and conclusion.

2. EXPERIENCE FROM LOCAL AND NATIONAL TRADING REGIMES

6. The elements of a (general) monitoring, accounting and enforcement system have already been outlined in the introduction. Meanwhile quite a number of local and national trading regimes do exist or are close to implementation so that lessons for future regimes can be derived. These regimes include the pioneer permit trading regimes in the USA (Acid rain program, Ozone Transport Commission (OTC), NO_x budget program, RECLAIM), the CO₂ trading in Denmark and the UK but also trading of CO₂ and CH₄ between operational parts of BP and Shell. CO₂ trading is also planned in Norway, the Czech Republic and Switzerland. The Netherlands are close to implementing NO_x trading and Chile plans a program to trade suspended particulates in the Santiago area. At the international level European emissions trading is expected to commence in 2005 and Kyoto trading is likely to start in this decade as well. Further countries such as Canada, France, Poland and Japan are currently considering their own programs for emissions trading. To get a more detailed idea of the elements of a monitoring, accounting and enforcement system, this section describes three programs in more detail and also summarises the methods used in other systems and various issues that have been raised. Tables 1 and 2 in the Appendix summarise the relevant information for all the trading regimes. Finally, section 2.4 focuses on penalties, that, more than monitoring and accounting, can be approached using analytical tools.

2.1 The SO₂ and RECLAIM programs in the US

7. Two early examples of emissions trading regimes which are also the most prominent are the Sulphur Dioxide Allowance Trading Program (SO₂) and the Regional Clean Air Incentives Market (RECLAIM), both located in the USA². These systems have been analysed with respect to their monitoring, accounting and enforcement strategies by Stranlund et al. (2002).
8. The SO₂ trading program is part of the U.S. Acid Rain program implemented under the 1990 Clean Air Act Amendments and was designed to reduce annual SO₂ emissions from fossil-fuelled electric utility units by ca. 10 million tonnes, almost 50% of the 1980 emissions level. In the first phase that started in 1995, the program covered 445 units – this was extended to about 2100 units fired by coal, oil and gas in the second phase that started in 2000. The units receive emissions allowances that authorise the owner to emit one tonne of SO₂ during a given year. The allowances are fully tradable and bankable. Borrowing is not allowed. To achieve overall emissions reductions, the total amount of allocated permits is limited. During the second phase, permits are allocated for 8.95 million tonnes SO₂ per year.
9. The RECLAIM program aims to achieve federal ambient standards for ozone and particulate matter in the Los Angeles airshed. It was designed to reduce Nitrogen Oxides (NO_x) and Sulphur Oxides (SO_x) from stationary sources of a certain size. The program started in 1993 and by the end of the 1999 compliance year covered 254 facilities. The program is expected to achieve reductions of 71% in NO_x and 60% in SO₂ emissions in 2003 relative to 1994 levels. RECLAIM facilities are allocated trading credits for each year until 2010 that allow the release of one pound of NO_x or SO₂. Banking and borrowing is not allowed. Again, the overall amount of allocated credits is restricted. Even though RECLAIM is an emissions trading program, it also includes emission fees that are based on each facility's total emissions and were used to help finance the program.

² Further information on the programs can be found on the internet at www.epa.gov/airmarkets/arp resp. www.aqmd.gov.

10. The monitoring, accounting and enforcement systems in both programs are essentially quite similar. Emissions monitoring relies heavily on self-reporting by the facilities themselves. To avoid mistakes and to minimise the opportunities for misreporting, both programs impose rather stringent technological and process requirements on all facilities. The facilities in the SO₂ program are required to install so-called continuous emissions monitoring systems (CEMS) or an equivalent device that provides a nearly continuous and very accurate account of the facility's SO₂ emissions. The 15 minute data and the data for 1-hour averages are collected and entered into the quarterly reports that are submitted to the Environmental Protection Agency (EPA) electronically. The whole process of generating emissions reports and submitting them to the EPA is fully automated, thus minimising the opportunities for misreporting. The reports are the main basis for audits and are reviewed by the EPA. In addition, there may be also in-site inspections. RECLAIM facilities also need to install specific monitoring and reporting equipment that differs among types of sources. Major sources have to install CEMS. In smaller facilities cheaper, less accurate systems are admitted. The estimated emissions have to be reported with additional equipment and specific software. Evaluations of the reported data at the end of each compliance year focus on ensuring the accuracy of the data and look for incidences of non-compliance. The audits include in site visits and each report is audited every year.
11. In both trading regimes there are also systems in place to track the issuance, holding, deduction and transfer of allowances.
12. If non-compliance is detected in the SO₂ program, a penalty of \$2,000 per tonne excess emissions in 1990 indexed with inflation (so that for example the penalty was \$2,581 per tC in 1998) is automatically imposed on the non-compliant facility. This penalty is much higher than the allowance price, which varied between \$65 and \$220 per tonne SO₂. In addition, the facility must offset the excess emissions from its allowance allocation in some future year. If an audit reveals non-compliance in a RECLAIM facility, the facility is firstly provided an opportunity to review the audit and to present additional data. If it is still found to be non-compliant the facility's allocation for the subsequent year is automatically reduced by the total amount of excess emissions. In addition, the RECLAIM authorities can set a penalty of up to \$500 for every 1000 pounds of excess emissions for every day it persists. This implies that roughly for one tonne of excess emissions per day the penalty could be up to \$1,100 which would mean a penalty of roughly \$400,000 for one tonne excess emissions that persists for the whole year. If the annual average price of credits reaches \$8,000 per tonne the penalty of \$500 can be applied to every 500 pounds (thus effectively doubling the penalty). The penalty is not automatic as in the SO₂ program but depends on the facts of the particular case. Permit prices in the RECLAIM program (which are also relevant for compliance - see section 2.4) are high and increasing. Average prices for a tonne NO_x were below \$250 in the first four years and rose to \$451 during 1998 and to \$1,827 during 1999. In 2000, the prices increased dramatically and reached \$45,000 per tonne of NO_x. Average prices of one tonne SO₂ were under \$150 during the first four years and rose to about \$300 in 1998, \$780 in 1999 and \$2,400 in 2000. The average price for 2003 NO_x credits traded in 2000 was \$13,800 while it was \$3,000 for SO₂, thus prices can be expected to remain high. Effective prices for emissions were even higher due to the additional emission fees. These relatively strict enforcement strategies have been quite successful - one reason while they have been analysed in more detail. The compliance in the SO₂ program is apparently 100%. In the RECLAIM program compliance rates have ranged between 85% and 95%.

2.2 The planned Dutch NO_x trading regime

13. Against the background that national and EU NO_x emissions targets seem to be out of reach with traditional types of regulation and that command and control measures are not fit for complex situations, the Netherlands are currently planning a national trading scheme for NO_x (Dekkers 2003). The program will cover the ca. 250 industrial facilities with installed total thermal capacity above 20

MWth that were responsible for 90 kt NO_x in 2000. The system will be a cap and trade system with a relative cap that declines from 65g NO_x per GJ fossil fuel use to 50g in 2010. This so-called performance standard rate is calculated by dividing the fixed NO_x target for 2010 by the projected 2010 fossil fuel use. The cap will be revised in 2006 to guarantee that the 2010 target is reached. Emission allowances are allocated to the facilities based on past performance. Banking and borrowing is restricted to 5% of one year's allowances. Bilateral and multilateral trade is allowed provided each transfer is accepted and registered at the bureau of registration that is part of the emissions authority.

14. Monitoring of the emissions is the responsibility of the companies. Based on "General Requirements for NO_x Monitoring" set by the emissions authority, the companies have to draft their own monitoring protocol that specifies for all installations all monitoring and reporting requirements. Again, the basis will be CEMS. The protocols are examined and approved by the emissions authority. The companies then have to monitor their emissions in line with the requirements in the approved monitoring protocol, and have to submit annual reports that are independently verified by the emissions authority for correctness. Fines for non-compliance have not been set at this stage.

2.3 Lessons learned from local and national trading regimes

15. The monitoring, accounting and enforcement mechanisms of the three trading regimes just described can be regarded as typical. Boemare and Quirion (2001) reviewed ten emissions trading regimes (including the three regimes just described) that either have been implemented or are at an advanced stage of implementation. They conclude that both reporting and registration of trades are key compliance mechanisms. Reporting should cover both emissions and emissions trading activities. Compared to the 15 min emissions reporting of the SO₂ and RECLAIM trading, most national trading regimes require monthly emissions reporting. Even though the experience shows that bilateral trade without prior government approval favours trading and lowers transactions cost, mandatory registration is needed to account for the permit trading activities and to assess compliance. All reviewed systems include a registry, mostly established by the organisation that has the institutional governance and is responsible for recording the company's allowances. Boemare and Quirion (2001) also see a registry as a useful management tool because it creates an open public process for allowance recording which enhances compliance.
16. Tietenberg (2001) notes that integrated computer systems for reporting and permit trading are also a key to a smoothly implemented permit trading program. Such systems were also used in the three permit trading regimes described in the last section and are apparently also present in most other permit trading systems, especially as technology is progressing. For example, an internet-based monitoring system to submit CO₂ and energy data is being constructed for the CO₂ trading system being developed in Switzerland (Burkhardt 2003). This suggests that it would be indeed possible to make the information available on-line to the public, as advocated by Tietenberg (2001) for the reasons of increasing compliance, the possibilities for public pressure and even legal action from non-governmental environmental agencies and/or citizens.
17. Penalties are not only found in the SO₂ and RECLAIM programs but also in the trading systems in Denmark, Chile and the U.K. In the Danish case, the penalty is \$6 per tonne CO₂. In the other cases Boemare and Quirion (2001) could not determine the penalty. The NO_x OTC budget program deducts allowances of three times the excess emissions in case of non-compliance from the subsequent year. In the BP trading scheme there is no penalty, and in the Shell system there is a fine equal to three times the average fourth quarter price for each permit short fall. In the EU trading scheme there will be a fine of 50 Euro/t CO₂ in the first period until 2008 and 100 Euro/t CO₂ afterwards plus restoration of excess tonnes in the following year.

18. There are also a number of other design elements of permit trading regimes that have been discussed in the CATEP papers and presentations and that also have an impact on monitoring, accounting and enforcement and thus on compliance. The most important are liability rules, upstream versus downstream regimes, absolute versus relative emission caps and linking of different trading regimes.

Liability rules

19. One question in permit trading regimes is who is liable. Seller liability means that if the emissions of the seller of permits exceed the reduced quantity of permits it possesses, the authority has to apply sanctions. Thus, regimes with seller liability rely on the effectiveness of the enforcement regime to ensure that participants meet their targets (Haïtes and Mullins 2001). In the case of buyer liability the buyer would have to assess the 'quality' of the permits he buys. If they are not covered by emissions reductions of the seller, they are returned to the seller to help bring him into compliance. Buyer liability makes sense if there are, for example in international Kyoto trading, sound reasons to distrust the capability or willingness of some national authorities to enforce their national schemes properly (Boom and Nentjes 2002). On the other hand, buyer liability would complicate the system and impede permit trades as potential buyers have to undertake efforts to assess whether offered permits will be covered by genuine emissions reductions or not which increases transaction costs. With an effective enforcement system in place, seller liability can be recommended and is indeed observed in most existing permit trading regimes³.

Upstream versus downstream regimes

20. In a downstream regime all emission sources are required to hold emission permits. In the case of CO₂ trading it is also possible to install an upstream regime where the suppliers of fossil fuels have the obligation to cover the carbon content of their fuel sales with permits. Both systems have a number of advantages and disadvantages that have been discussed in length (Boom and Nentjes 2002; Haïtes and Mullins 2001; Baron and Bygrave 2002). Concerning monitoring, accounting and enforcement most effects stem from the fact that far less and much bigger firms would participate in trading in an upstream regime than in a downstream regime. Thus, upstream regimes are easier to manage and monitor while downstream systems are associated with high administrative costs and expensive monitoring of the emissions at every source (Boom and Nentjes 2002; Baron and Bygrave 2002). Although an upstream regime is preferable with respect to monitoring, accounting and enforcement and although it is also recommended by a large part of the literature, downstream regimes clearly dominate in practice. The reason is probably that upstream systems are not politically feasible. First, since there are almost no options for suppliers of fossil fuels to reduce the carbon content of the fuel, the carbon cap in an upstream regime is actually a fuel cap. And second, the distribution of the permits is also problematical. As fossil fuel suppliers can transfer the main part of the additional costs to end-users suppliers would capture large rents under grandfathering, which is not politically acceptable. If permits are auctioned though, this will meet resistance from the affected sectors: the suppliers as well as the end-users (Boom and Nentjes 2002).

Absolute versus relative emissions caps

21. Monitoring and accounting also differs between regimes with absolute caps and regimes with relative caps. While an absolute cap fixes the total emissions during a specified period, a relative cap fixes a target for an emissions rate per unit of output or activity such as GDP or energy consumption (as for example in the planned Dutch NO_x trading regime). This metric has to be monitored in addition to emissions. Also, relative caps create problems of measuring and tracking emissions reductions across

³ Haïtes and Mullins (2001) mention some regimes with buyer liability.

companies with different outputs or, within a company that changes its product mix or has varying degrees of vertical integration. Problems are also created through different production processes. All this implies additional administrative and monitoring requirements (Baron and Bygrave 2002). The UK permit trading regime features absolute and relative caps at the same time. This creates the problem that permit sales from the participants in the rate-based regime to participants in the absolute regime can cause overall emissions to increase. To avoid this, a so-called gateway has to restrict the net inflow from the rate-based regime to the absolute regime (Haïtes and Mullins 2001). This requires additional monitoring and surveying. The same is true whenever an absolute and a rate-based regime are linked. Overall, from a monitoring, accounting and enforcement perspective, absolute caps are thus clearly preferable.

Linking of different trading regimes

22. Problems not only occur when linking an absolute and a rate-based permit trading regime, but also when linking trading regimes that have different monitoring, accounting and enforcement systems. If, for example, one regime does not include adequate monitoring of emissions, a source could sell unqualified allowances resulting from inaccurate GHG monitoring to others, undermining the environmental integrity of the regime (Mullins and Haïtes 2001). Another problem that is often mentioned is, that if penalties are not comparable across linked systems, non-compliance is likely to be exported to the system with the lowest penalty level. But as Baron and Bygrave (2002) note there are also other factors such as certainty of penalties, other sanctions (e.g. loss of access to market) and registries that might not allow over-selling, so that such a problem may be less evident. Pressure toward harmonisation might stem from competitive disadvantages for firms in trading regimes with higher penalties. In addition, systems with high penalties may not be willing to link to those with low penalties. As both systems gain from linking though this can also be an incentive for penalties that are acceptable to all and for stringent compliance controls. Altogether, standardised monitoring, accounting and enforcement system simplify linking of different permit trading regimes. The standardisation of at least accounting rules is the subject of section 3 below. The CATEP workshops have also shown that wherever new trading schemes are developed monitoring and accounting of emissions and tracking permits as well as the institutional requirements (registries etc.) are acknowledged as important issues that have to be solved (Blachowicz 2002, Burkhardt 2003, Jilkova et al. 2002). The features of the existing and planned different trading regimes are summarised in Table 1 in Annex A at the end of this paper.

2.4 Penalties revisited

23. While monitoring and accounting are to a large degree a question of regulation and technology, penalties and compliance are a question of choosing incentives for the participants in a trading scheme. These incentives have been analysed in more detail.

24. A successful enforcement program requires a carefully constructed set of sanctions for non-compliance (Tietenberg 2001). In other words, effective penalties for non-compliance, particularly for holding insufficient allowances or having inadequate monitoring systems, are an essential component of the trading system (Palmer and Davies 2002). To enforce compliance, the regulating authority must in particular be able to enforce sanctions if they find that emissions are greater than allowance holdings. As we have seen in the last section, there are basically two possibilities for sanctions, that can also be combined:

- i. a financial penalty per tonne of excess emissions;

- ii. a deduction of allowances from the next year's allowance holdings (or allocation) to make up the difference. These reductions can also be greater than the excess emissions as in the US NO_x OTC trading program.
25. Furthermore, there is the possibility to exclude participants that are non-compliant from the permit market (Tietenberg 2001). This is for example the case in the planned Kyoto trading regime.
26. Stranlund et al. (2002) focussed on the question of the optimal level of a penalty. They set up a simple model for compliance in which each firm will be audited with a certain possibility. The audit is assumed to be sufficient to discover a violation if one exists. There is then a per unit fine levied for emissions violators and a per unit fine for under-reported emissions. Transactions cost and banking are ignored. Firms will choose how much they will emit, how much they will report and how many permits to hold in order to minimise their expected costs. These expected costs are the sum of emissions controls cost, receipts or expenditures from permit trades and expected penalties from reporting and emissions violations. To guarantee that participants hold enough permits for their emissions, it is necessary that the expected penalty for emitting one tonne too much is above the permit price. Otherwise, it would be cheaper to buy a permit. To achieve complete compliance, (i.e. no excess emissions and accurate reporting), the expected overall penalties must be higher than the permit price. Thus, the model stresses the importance of the prevailing permit price that (in a reasonable competitive trading environment) summarises each facility's marginal benefit of non-compliance. Stranlund et al. (2002) extract a number of guiding principles from their study that also analyses the reasons for more or less compliance in the SO₂ and RECLAIM trading programs:
- There is no reason for an enforcement authority to differentiate the sanctions between heterogeneous facilities. As the prevailing permit price completely summarises each facility's marginal benefits of non-compliance, details about a facility's operations, like production and emissions-control technologies, are not important components of their compliance incentives.
 - As permit prices are so important, unit penalties should be tied directly to prevailing permit prices.
 - The penalties should be substantially higher than prevailing permit prices.
27. One reason for the high compliance in the SO₂ trading program is apparently that the fine for non-compliance is 10 times the costs of allowances. Another way to achieve the latter two objectives is, as mentioned above, to deduct more than the excess emissions from the permit holding in some future year.
28. A number of other elements of the compliance system also improve the effectiveness of the SO₂ trading program. One element is the certainty of the penalty and the size of the penalty. Other than for example in the RECLAIM program where the authority can decide on a case-by-case basis whether to apply a penalty at all (and also the size), it is recommended that fixed penalties are applied automatically in cases of non-compliance (Stranlund et al. 2002, Palmer and Davies 2002). Uncertainties for firms about the consequences of non-compliance would weaken the deterrence value of the enforcement strategy. If the regulator can use its discretion to determine the size or decide if the penalty is applied at all, penalties can become subject to manipulation. Especially when penalties are high, authorities may be reluctant to impose them and participants are aware of this reluctance. Unrealistic high penalties are also likely to consume excessive enforcement resources as those served with penalties seek redress through the appeal process (Tietenberg 2001). Stranlund et al. (2002) conclude that the certainty of penalties in the SO₂ program is one reason why compliance was almost 100%, while the uncertainty of penalties weakened the system in RECLAIM. In addition, Boemare and Quirion (2001) have set up a guideline that the smaller the probability of control is, the higher the

non-compliance penalty should be (and inversely) which is in line with the model of Stranlund, et al. (2002).

29. One final thing to consider is, that even though theoretically arbitrarily high levels of penalties could guarantee full compliance even at low monitoring probabilities, there are sound theoretical and ethical reasons why very high penalties are not very practical (Stranlund et al. 2002)⁴. One reason is that penalties are limited by the assets of a firm. If the penalty is too high, it can lead to unintended bankruptcies. Further, if participation in a trading regime is optional or can not be enforced, high penalties increase the rates of non-participation.

3. MONITORING, ACCOUNTING AND ENFORCEMENT IN INTERNATIONAL EMISSION TRADING REGIMES

30. So far, the analysis has focussed on local or at least national trading schemes in which firms are the main participants. Meanwhile it is very likely that international emissions trading will take place in the near future: in the European trading scheme and probably also more or less world-wide under the framework of the Kyoto Protocol. The size of the market and also the role of national governments as additional actors in international trading imply new challenges for compliance mechanisms. One challenge is to develop internationally standardised monitoring and accounting systems. Another challenge is to avoid overselling in this special framework, for example using the Commitment Period Reserve.

3.1 International standardisation of monitoring and accounting systems

31. So far, each trading regime has basically developed its own monitoring, accounting and enforcement system. The need for standardised monitoring and accounting systems has grown with emissions trading under the EU Directive and especially the planned trading under the Kyoto Protocol. One source of standardisation is the Kyoto Protocol itself. The framework that is given in the Protocol can be seen as a basis for developing monitoring and accounting systems for domestic and regional emissions trading that also provide the flexibility for linkages. Though it is mainly aimed for the parties to the Protocol, thus nations, the common reporting framework can be developed to account at the level of installation as well (Anderson 2003).
32. The Kyoto Protocol's accounting system⁵ builds on the provisions for monitoring, reporting and review established under the United Nations Framework Convention on Climate Change (UNFCCC). To be eligible to participate in Kyoto emissions trading, the parties need to fulfil a number of requirements. The first requirement (Article 5.1) is a national system for the estimation of their emissions and removals of greenhouse gases. The UNFCCC reporting guidelines provide a common reporting format and e.g. list sources and sink categories, facilitate comparability and consistency and assure completeness. Every party has to submit an annual report, including a national inventory (Article 7.1) that has to be in line with these guidelines and consistent with previous recommendations. The reports will be subject to in-depth reviews under Article 8 and, when the

⁴ See Macauley (1998) for a discussion of the limits to setting arbitrarily high penalties.

⁵ This summary builds on Anderson (2002) and (2003).

monitoring methodologies are not followed or when the inventory data is found to be incomplete or inaccurate, adjusted to the methodologies accepted by the International Panel on Climate Change (IPCC) (Article 5.2). Annex 1 parties have to submit supplementary information as part of their National Communication under the UNFCCC.

33. Parties that wish to take advantage of the flexibility mechanisms of the Kyoto Protocol such as emissions trading are obliged to establish national registries under Article 7.4. These registries will act like banks recording the issuance, transfer and cancellation of Kyoto units. Basically, these registries are standardised electronic databases with separate accounts for legal entities, retirements and cancellations that keep track of the units around the registry network. In addition, there will be an independent transaction log, which will record each transaction and check the eligibility of each actor in the transaction and for transaction “discrepancies”. There will also be daily reconciliation checks for account inconsistencies. On the other hand, it is not yet clear which transfers could or should actually be stopped, who will be entitled to do so, and what will be the legal consequences for companies if a transaction is stopped. The technical standards for the transaction log are also still being elaborated but they should be ready for the next Conference of the Parties (COP9) in December 2003. A compliance regime with penalties for non-compliance is also being negotiated (Haite and Missfeldt 2002). Some agreements have already been reached at the COP7 in Bonn setting three principal consequences for the case that a Party is out of compliance (IEA 2001):
 1. Tonnes in excess of permits must be restored at a rate of 1.3 to 1 (a country must make up its shortfall plus 30 percent in the next target period);
 2. Until full restitution is made, a country is ineligible to sell credits; and
 3. A country must develop a compliance action plan (CAP).
34. Installations and firms are the entities who are actually trading in existing permit regimes, and who will primarily be trading in the EU regime and in Kyoto trading. A standardisation of monitoring and accounting systems for firms would have a number of advantages. First, it would enhance the environmental integrity by promoting consistency, transparency and credibility in greenhouse gas monitoring. Second, there are direct advantages of a standardisation for firms participating in trading. Standardisation would enable the creation of credible, comparable GHG units that increase investor confidence and facilitate trading. It would also enable entities to identify and manage GHG-related liabilities and assets and thus lead to better risk management and market certainty (Cherp 2003).
35. One prominent initiative to develop a standardised system is the Greenhouse Gas Initiative (Cherp 2003). It is a partnership of government and non-governmental and inter-governmental organisations working together to share knowledge and experience on greenhouse gas accounting issues. The initiative operates under the umbrella of the World Resource Institute and the World Business Council for Sustainable Development and aims to develop and promote international GHG accounting standards for business through an inclusive and transparent multi-stakeholder process. It has two modules: corporate inventories and GHG projects. A corporate standard was published in 2001 and tested by over 30 firms in nine countries. A second revised edition is scheduled for mid-2003. The project standard aims to identify project reduction opportunities and project typologies, to ensure eligibility, to identify GHG impacts, to quantify GHG reductions and to ensure adequate monitoring and verification. At the moment, the standard is undergoing revisions and reviews. The goal is to release it for COP9 in December 2003.
36. Another attempt is undertaken by the International Organisation for Standardisation (ISO). The ISO was established in 1946 to develop voluntary international standards. Its members are 143 national

standards bodies from around the world. After the ISO followed the international climate change negotiations for three years, a special working group on climate change was formed in 2002. This group is now developing guidelines for measuring, reporting and verifying entity- and project level GHG emissions that are hoped to become "best practice" for industry and to be incorporated into climate change laws in many countries (ECOLOGIA 2003; Cherp 2003).

37. There are at least 10 to 15 different governmental, international and voluntary initiatives that develop standardised systems and all these initiatives work more or less parallel to each other without much interaction. At the moment, a single international standard can not be expected to be forthcoming (Cherp 2003). In addition, there are still many open questions of how to integrate monitoring, accounting and trading at company level (as in the national trading regimes and also the upcoming EU emissions trading) with the Kyoto trading requirements. How, for example, should the site level monitoring systems be linked to national inventory data to ensure the consistency of entity level monitoring with national inventory methodologies? And what should be the relationship between entity level allowances and permit accounting with the national registries? Thus, to ensure accurate national and entity level monitoring, accounting and enforcement, further harmonisation is an important future task.

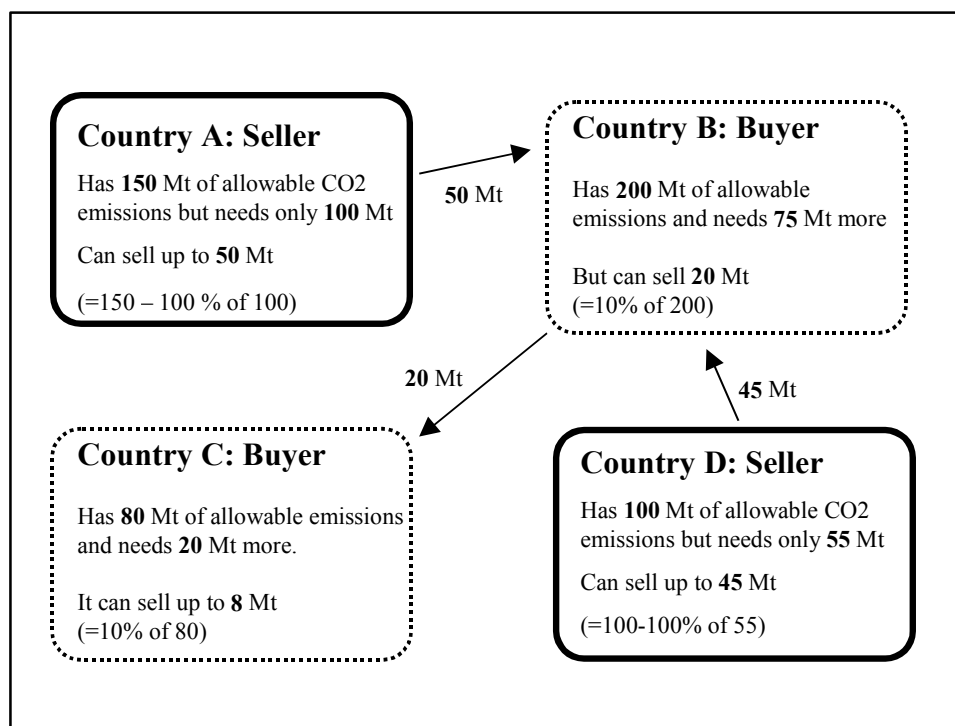
3.2 Compliance in international trading regimes: The commitment period reserve

38. Enforcing compliance in international emissions trading is more difficult than in local and national trading regimes where one single authority is able to impose sanctions on non-compliant participants. Responsibility for compliance at international level will reside with the participating sovereign nations. Haites and Missfeldt (2002) cite Chayes and Chayes (1998) who note that under existing international agreements, sanctioning authority is rarely granted by treaty, rarely used when granted, and likely to be ineffective when used. In emissions trading regimes where emissions and permits have to be accounted for, the potential for non-compliance becomes even greater than under commitments without trading (Haites and Missfeldt 2002). Even though a penalty system for Kyoto trading is being negotiated and has been partly agreed, a party that finds a penalty to be too high could simply withdraw from the Protocol and avoid the penalties.
39. Concern that the enforcement regime under the Kyoto Protocol may be too weak has led to a number of so-called "liability" proposals which seek to reduce overselling of permits by limiting permit sales in different ways. Haites and Missfeldt (2001a) evaluate fourteen different liability proposals using a highly aggregated model with a single Annex B buyer, a single Annex B seller and a single Non-Annex B seller. They find that indeed several of the liability proposals are able to avoid non-compliance at negligible cost in terms of excess emissions or extra compliance costs. The only proposal that was able to meet all their evaluation criteria though is a permanent reserve. After further considerations Haites and Missfeldt (2001b) proposed what is now called the Commitment Period Reserve as the best mechanism to avoid abuse of international permit trading.
40. The Commitment Period Reserve proposal requires each Annex B Party to set aside part of their 2008-2012 allowable emissions in a reserve. The reserve is the lower of (a) X% of five times the Party's most recently reviewed emissions inventory⁶ and (b) Y% of the Party's initial assigned amount. At COP6 X was agreed to be 100% and Y to be 90% for all Annex B countries. For potential sellers of emission permits, X is typically the lower quantity (they have more assigned units than emissions) while Y is lower for net buyers of permits. Figure 2 illustrates one example where the numbers are combined for the 5 year commitment period and where it is assumed that "what is needed" is also the

⁶ Note that the commitment period from 2008 – 2012 covers 5 years so that five times the latest inventory is an estimate for the overall emissions in the commitment period.

inventory. Countries A and D are net sellers of permits. Their reserve has to be $X = 100\%$ of their inventories. Thus, they are allowed to sell their assigned units minus this reserve ($150 \text{ Mt} - 100 \text{ Mt} = 50 \text{ Mt}$ resp. $100 \text{ Mt} - 55 \text{ Mt} = 45 \text{ Mt}$). Countries B and C are net buyers. Their reserve has to be $Y = 90\%$ of their assigned units. Thus, they are allowed 10% of 200 resp. 80 Mt . One possible scheme of trades is sketched in the figure, where country A sells 50 Mt to country B, country B sells 20 Mt to country C and country D sells 45 Mt to country B. Thus, country B, even though a net buyer, is also selling some permits.

Figure 2: Illustration of the commitment Period Reserve Rule, Following IEA (2001)



41. One problem of the commitment period reserve that limits sales is that it might reduce the ease with which a permit can be bought or sold, in other words, the liquidity of the permit market. Haites and Missfeldt (2002) analyse this issue in detail. They find that sufficient liquidity should be available in the international market regardless of the specification of X and Y . However, in the domestic permit markets their analysis suggests that only a value of X close to 90% and a value of Y between 95 and 98% will maximise the effectiveness of the Commitment Period Reserve in limiting possible non-compliance due to overselling while minimising the number of Annex B countries subjected to restricted sales of surplus quota or low international liquidity for domestic emissions trading programs (Haites and Missfeldt 2002). The actual higher value for X can in some circumstances restrict sales of quota surplus to a country's compliance needs. The lower value of Y allows higher level of potential non-compliance.

4. CONCLUSIONS

42. For an emissions trading regime to operate efficiently and to meet environmental targets, a strong monitoring, accounting and enforcement system is a key pre-requisite. The system has to be able to record emissions and emission permits and to detect and sanction non-compliance in the sense of misreporting or emitting more than the permits allow. In addition, it should be accurate, transparent, comprehensive and efficient.
43. Monitoring of emissions is the first module of such a comprehensive system. The attainable accuracy depends mainly on available technical methods that are already highly developed for some greenhouse gases on a facility level (e.g. SO₂ and NO_x) and less accurate for example for the estimation of national CO₂ emissions.
44. Regular reporting is the next key compliance mechanism and covers both emissions monitoring results and emissions trading activities. For the latter, a registry that tracks permit holding, reduction and transfers is indispensable. Today, automated monitoring and reporting systems that submit the data electronically are state of the art. The existing local and national systems require at least quarterly reporting, whereas in the international systems we will see annual reporting.
45. The enforcement of compliance does not only depend on the technical ability to detect non-compliance but also on the legal ability to deal with it. If violations are detected there is optimally an automatic, fixed penalty per tonne of excess emissions that should be: (1) the higher the smaller the possibility of control or detection; (2) well in excess of the expected permit price; and, (3) not extensively high so that it reduces the participation in the trading regime or leads to bankruptcy. In addition, all existing penalty systems deduct at least the excess emissions from the allowances of the next compliance period, also to ensure environmental integrity. One way to ensure that the penalty is always higher than the permit price it to deduct more than the shortfall of permits from the permit holding in some future year.
46. The upcoming schemes for international emissions trading impose new challenges for monitoring, accounting and enforcement. As opposed to national systems, there is no single authority that can enforce compliance - instead the participants are countries that are sovereign nations. The first challenge is to establish standardised monitoring and accounting systems at a business level as well as at a country level. Such standardisation would have a number of advantages. It would increase transparency and credibility of greenhouse gas measurement, reporting and verification and also enhance the certainty for investors as well as facilitate emissions trading. Different initiatives are presently developing different standards for emissions accounting at firm and project level in anticipation of CDM and JI projects under the Kyoto Protocol. Two main initiatives are the Green House Gas Protocol Initiative and the ISO standard. The Kyoto Protocol itself also sets a framework for a standardised system providing flexibility for linkages.
47. The Commitment Period Reserve agreed at COP6 restricts permits sales to avoid overselling in international emissions trading. Even though it is regarded as a good mechanism to assure compliance, it has the potential of imposing inadequate liquidity constraints leading to a non-efficient permit market.
48. Future tasks include improving the techniques for monitoring emissions and developing standardised methods that can be applied to any new system. Even though the Kyoto framework is a step in the right direction, significant uncertainties on inventories, especially for non-energy related emissions still raise concern about the ability of the Parties to appropriately monitor emissions (Baron and

Bygrave 2002). Boemare and Quirion (2001) conclude that even for industrial CO₂ emissions, calculation using activity data, emission factor and oxidation factor are not without problems and the accuracy of current national inventories based on this method falls short of what is needed for a trading scheme. Furthermore, it is not yet clear how to link monitoring and accounting on entity level with national inventory methodologies and national registries that are part of Kyoto trading.

49. Another open question is the cost of the required monitoring and accounting systems. In the SO₂ and RECLAIM programs there is for example some evidence that the very costly CEMS would not have been necessary to ensure compliance. There are not yet any cost benefit estimates of certain monitoring and accounting techniques.
50. Further, research has mainly focused on the issue of non-compliance in the sense of not holding enough permits to cover all emissions and has more or less neglected non-compliance in monitoring and reporting. This is especially problematic, as the main problem at the moment is getting accurate information on emissions as this is required in order to assess whether a participant holds enough permits. Finally, the dynamics of compliance and the enforcement problems associated with implementing emissions trading in a wider variety of environmental policy problems are still under-exposed.

REFERENCES

- Anderson, Molly (2002). "Verification of the Kyoto Protocol filling in the detail". VERTIC briefing paper 2.
- Anderson, Molly. (2003). "Kyoto Protocol accounting and domestic and regional trading regimes". Presentation at the 4th CATEP Workshop on Emissions Trading and Project-Base Mechanisms: Synergies between emerging Regimes, Central European University, Budapest, 7-8 February, 2003.
- Baron, Richard and Stephen Bygrave (2002). "Towards International Emissions Trading: Design Implication for Linkages". Paper presented at the 3rd CATEP Workshop on Global Trading, Kiel Institute for World Economics, 30 September - 1 October 2002.
- Blachowicz, Andrzej (2002). "Poland and Emissions Trading in 2002: Lost Decade and Awaiting Challenges". Presentation at the 3rd CATEP Workshop on Global Trading, Kiel Institute for World Economics, 30 September - 1 October 2002.
- Boemare, Catherine and Philippe Quirion (2001). "Implementing Greenhouse Gas Trading in Europe: Lessons from Economic Theory and International Experiences". Paper presented at the 1st CATEP Workshop on Linking Industry, Local/Regional, National and International Emissions Trading Schemes, Fondazione Eni Enrico Mattei, Venedig, 3-4 December 2001.
- Boom, Jan-Tjeerd and Andreis Nentjes (2002). "Alternative Design Options for Emissions Trading: A Survey and Assessment of the Literature". Paper presented at the 2nd CATEP Workshop on the Design and Integration of National Tradable Permit Schemes for Environmental Protection, University College London, 25-26 March 2002.

- Burkhardt, Andrea (2003). "Switzerland and the proposed EU Trading Regime". Presentation at the 4th CATEP Workshop on Emissions Trading and Project-Base Mechanisms: Synergies between emerging Regimes, Central European University, Budapest, 7-8 February 2003.
- Chayes, Abram and Antonia Chayes (1998). *"The New Sovereignty: Compliance with International Regulatory Agreements"*. Cambridge, Massachusetts: Harvard University Press.
- Cherp, Aleg (2003). "International Standardization of GHG Accounting". Presentation at the 4th CATEP Workshop on Emissions Trading and Project-Base Mechanisms: Synergies between emerging Regimes, Central European University, Budapest, 7-8 February 2003.
- Dekkers, Chris (2003). A Central Role for Emissions Trading as an Instrument for Regulating Industrial Emissions in The Netherlands". Presentation at the 4th CATEP Workshop on Emissions Trading and Project-Base Mechanisms: Synergies between emerging Regimes, Central European University, Budapest, 7-8 February 2003.
- ECOLOGIA (17.02.2003). "An ISO Greenhouse Gas Standard". www.ecologia.org/ems/ghg/standard.html.
- Haites, Erik and Fanny Missfeldt (2001a). "Limiting Overselling in International Emissions Trading Regimes I: Cost and Environmental Impacts of Alternative Proposals". Workingpaper 10, UNEP Collaborating Centre on Energy and the Environment.
- Haites, Erik and Fanny Missfeldt (2001b). "Limiting Overselling in International Emissions Trading Regimes II": Analysis of a Commitment Period Reserve at National and Global Levels". Workingpaper 11, UNEP Collaborating Centre on Energy and the Environment.
- Haites, Erik and Fanny Missfeldt (2002). "Liquidity Implications of a Commitment Period Reserve at National and Global Levels". Paper presented at the 3rd CATEP Workshop on Global Trading, Kiel Institute for World Economics, 30 September - 1 October 2002.
- Haites, Erik and Fiona Mullins (2001). "Linking Domestic and Industry Greenhouse Gas Emission Trading Systems". Paper prepared for EPRI, International Energy Agency (IEA) and International Emissions Trading Association.
- IEA (2001). "Climate Change and the Bonn Agreement. Questions and Answers from the IEA" www.iea.org/envissu/quesbonn.pdf.
- Jilkova, Jirina, Thomas Chmelik, and Eva Snajdrova (2002). "Domestic Emissions Trading System in the Czech Republic: Options for an Implementation Framework". Paper presented at the 3rd CATEP Workshop on Global Trading, Kiel Institute for World Economics, 30 September – 1 October 2002.
- Macauley, Molly and Timothy Brennan (1998). "Enforcing Environmental Regulation: Implications of Remote Sensing Technology". RFF Discussion Paper 98-33, Resources for the Future (RFF), Washington D.C.
- Mullins, Fiona and Erik Haites (2001). "Links between Emissions Trading Programs. Presentation at the 1st CATEP Workshop on Linking Industry, Local/Regional, National and International Emissions Trading Schemes, Fondazione Eni Enrico Mattei, Venedig, 3-4 December 2001.
- Palmer, Ronan and Neil Davies (2002). "Proposals for a NO_x and SO₂ Trading Scheme in the United Kingdom". Paper presented at the 2nd CATEP Workshop on the Design and Integration of National

Tradable Permit Schemes for Environmental Protection, University College London, 25-26 March 2002.

Stranlund, John K., Carlos A. Chavez, and Barry C. Field (2002). "Enforcing Emissions Trading Programs: Theory, Practice, and Performance". Paper presented at the *2nd* CATEP Workshop on the Design and Integration of National Tradable Permit Schemes for Environmental Protection, University College London, 25-26 March 2002.

Tietenberg, Tom (2001). "The Tradable Permits Approach to Protecting the Commons: What Have We Learned?". Paper presented at the *1st* CATEP Workshop on Linking Industry, Local/ Regional, National and International Emissions Trading Schemes, Fondazione Eni Enrico Mattei, Venedig, 3-4 December 2001.

Table 1: Design feature of existing emissions trading regimes

	Substance	Special features	Sanctions	Liability	Reference period	Bilateral trade	Registry
1. US Acid rain program	SO ₂		penalty \$2000 per ton of excess SO ₂	seller	annual budgeting	yes	yes
2. US OTC NO _x budget program	NO _x		allowance deducted from the subsequent year at the rate 3:1	seller	Seasonal (May to September)	yes	yes
3. RECLAIM (USA)	NO _x / SO ₂	additional emission fees	penalty up to \$500 per 1000 or 500 pound excess emissions per day (not automatic)	seller	annual	yes	yes
4. Denmark	CO ₂	downstream	\$6 per ton of excess CO ₂	seller	annual	yes	yes
5. UK Emissions trading Scheme	CO ₂ equiv.	downstream absolute and relative targets	negotiated agreement source loose 80% tax reduction, absolute cap participants must repay incentive with penalty	seller	annual allowances	yes	yes
6. BP	CO ₂ equiv (CH ₄ , CO ₂).	downstream	no	seller	annual allowances	through central broker	yes
7. Shell (STEPS)	CO ₂ equiv (CH ₄ , CO ₂).	downstream	fine of three times average fourth quarter trade for each permit shortfall	seller	3 years	through central broker	yes

Sources: Boemare and Quirion (2001), Haites and Mullins (2001), Stranlund et al. (2001).

Table 2: Design feature of planned emissions trading regimes

	Substance	Special features	Sanctions	Liability	Reference period	Bilateral trade	Registry
8. Dutch NO _x trading	NO _x	relative targets	to be worked out	seller	annual	with approval	yes
9. Norway	CO ₂ equiv.		to be worked out	?	2008 - 2012	yes	yes
10. Santiago Area, Chile	CO ₂		penalty fee	seller	daily permits	with approval	yes
11. Czech Republic	CO ₂		?	?	?	yes	yes
12. Switzerland	CO ₂	downstream	Tax on all emission since introduction of tax of max \$150/t CO ₂ (depends on projected gap to overall target)	group liab. of pool of firms	annual	yes	yes
13. EU directive	CO ₂	downstream	€50 (1 st period) resp. €100 per ton CO ₂ + restoration	seller	2005 – 2007 then 2008 - 2012	through central broker	yes
14. Kyoto trading	CO ₂	reserve rule	Ineligibility to sell permits until restoration at rate of 1.3:1 Compliance action plan to be negotiated	seller	2008 - 2012	through national registries	yes
Further regimes planned in France, Canada, Poland, Japan							

Sources: Boemare and Quirion (2001), Burkhardt (2003), Jilkova et al. (2002).