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Implementing Greenhouse Gas Trading in Europe: Lessons from Economic Theory and International Experiences

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Summary

The European Commission (2001a) has recently presented a directive proposal to the Parliament and the Council in order to implement a tradable permits scheme. However, as stressed by the positive political economy, due to the influence of various interest groups, very few environmental policies are implemented in their textbook forms. A close look at implemented emission trading schemes, stressing their discrepancies with textbook requests, is thus useful to increase the chances of forthcoming emission trading schemes to go through the political process without being watered down. We thus review ten emission trading systems, that are either implemented or at an advanced stage of the policy process. We draw attention to major points to be aware of when designing an emission trading system: participants, spatial coverage, permits allocation, temporal flexibility, trading organisation, monitoring, enforcement, compliance, and the harmonisation vs. subsidiarity issue. The aim is to evaluate how far experiences in emission trading move away from theory and why. We then provide some lessons and recommendations on how to implement a greenhouse gas emission trading program in Europe. A review of the theoretical and applied literature, and some interviews, lead us to the assessment of the European system.

Keywords: Emissions trading, climate change policy, policy-making and implementation

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1. INTRODUCTION

The Bonn political agreement and the Marrakech accords, reached respectively in July and November 2001, paved the way for the ratification and entry into force of the Kyoto Protocol. Compliance with the first commitment period of the Protocol (2008-2012) will require a quick implementation of emission reduction measures, given the inertia of most emission sources. In the European Union, according to the *European Climate Change Programme* (European Commission, 2001c), there is a gap in the range of -6.6% and -8% between the effects of existing policies and measures and the Kyoto target. Given the failure of the European Council to agree on a European-wide tax scheme so far, the implementation of tradable permits is likely to be part of any cost-efficient combination of policies and measures able to reach the Kyoto target.

However, the failure of the European Commission tax proposals in the 1990s, in spite of their widespread support from environmental economists, recalls that even smart environmental policy proposals may perish during the policy process. More generally, as stressed by the positive political economy (Kehoane et al., 1998) due to the influence of various interest groups, very few environmental policies are implemented in their textbook forms.

A close look at implemented emission trading schemes, stressing their discrepancies with textbook requests, is thus useful to increase the chances of forthcoming emission trading schemes to go through the political process without being utterly watered down. It may also point to potential problems addressed by some existing programmes, but neglected by standard theory. Such a multilateral analysis has been lacking so far, although Schwarze and Zapfel (2000) provide a bilateral comparison of two US programs: the Reclaim and the Acid Rain programs.

We thus review ten emission trading systems, that are either implemented or at an advanced stage of the policy process[1]. We thus leave out proposals that are not clearly enough defined yet. Furthermore, we only look at 'cap and trade' schemes and not at 'baseline and credit' ones[2]. Indeed, in recent years, virtually all implemented systems have been of the former type,

[1] Information has been obtained from grey literature, academic sources and interviews, for the ongoing *Interact* project, funded by the European Commission (DG RTD), which we thank for its financial support. Philippe Quirion also thanks the Institut français de l'énergie for its funding.

[2] Earlier experiences in credit trading in the United States are reviewed in Stavins (2000).

because baseline and credit systems have proved to be less secure environmentally and to create higher transactions costs (Unctad, 1998; Farrell, 2001 and references therein). At last, we do not focus only on greenhouse gases, since some lessons can be drawn from experience with other pollutants.

Although the idea of tradable permits is quite simple, their implementation involves several steps that may make one system essentially different from another. We thus point out major items to be aware of when designing an emission trading system. Section 2 deals with the participants and spatial coverage. Sections 3 and 4 are about, respectively, permit allocation and temporal flexibility. Sections 5 presents trading organisation and monitoring aspects, and section 6 discuss enforcement and compliance. Lastly, section 7 draws some lessons on the harmonization vs. subsidiarity issue from the US OTC NO_X programme, the only example of integration between the federal and State levels.

In the conclusion, we provide some recommendations on the implementation of a tradable permits system for greenhouse gases in Europe.

Two tables at the end of the paper provide a list of the ten systems studied and gather the core information on them, as well as on the EU trading directive proposal.

2. PARTICIPANTS AND SPATIAL COVERAGE

2.1 Theoretical requirements

Standard theory suggests that, providing administrative and monitoring costs are not disproportionate, as many emitters as possible should be covered by the permit scheme, for two reasons.

First, a large number of participants is required to benefit from significant abatement cost differences among firms.

Second, it lowers the risk of market power on the permit market. Market power involves the ability of participants to manipulate prices strategically either as a monopolistic seller or a monopsonistic buyer (Hahn, 1984). This behaviour has two detrimental effects. First, it reduces the volume of transactions, lessening the cost-effectiveness of the system. Second, as

shown by Misiolek and Elder (1989), the combination of market power on the permit market and on the good market may allow some firms to dry up the permit market in order to prevent the entry of new firms or to push existing ones out of the market. For this to happen, participants in the permit scheme have to operate on the same good market.

For CO_2 emissions from fossil fuel burning, two levels of control are available: upstream (at the level of the producers and importers of fossil fuels) and downstream (at the level of the fossil fuel consumer, i.e. the CO_2 emitter). Most academics have favoured the former approach, the sole which allows to control diffuse sources (households and transportation).

In reality, these requirements are altered for pragmatic or political economy reasons.

2.2 How far experiences in emission trading move away from theory and why

Spatial coverage

Spatial coverage is often reduced because of the threat of hot spots (NO_X Budget program, Reclaim) or because upwind States or regions are reluctant to cut their emissions if they cause damages in downwind States or regions (NO_X Budget program; cf. Farrell, 2001).

Emission trading may increase the threat of hot spots in two main ways. First, trades may create unacceptably high local concentrations near sources that have acquired permits as an alternative to further control. Second, permits may allow the long range transport of emissions to increase, thereby increasing deposition problems (Tietenberg, 1999b). This concern depends of the environmental problem. It may be important concerning ozone or acid rains. It is much less when addressing climate change where the GHG accumulation in the atmosphere determines the global warming potential. Note, however, that reducing CO_2 emissions from fossil fuels usually leads to a reduction in local pollutants; hence localisation of emissions does matter, although indirectly.

Sectoral coverage

In most cases, the regulators have chosen not to include as many emitters as possible, at least in a first phase. Sectoral coverage has sometimes been reduced to one sector at the beginning of the system in order to reach the simplest and clearest system possible (Denmark).

For this reason, with the exception of the Norwegian project, a downstream approach has been preferred over an upstream one (U.K., Denmark, BP, Shell).

Acid Rain and NO_X OTC Budget programs are implemented in two phases whereas the others are not. In the Acid Rain program, large sources with relatively high SO_2 emissions are regulated first in Phase I which lasts from 1995 to 2000. Phase II starts in 2000 and includes most other significant sources. Because the electric utility industry is highly interconnected, sources in Phase I can easily shift their load (and emissions) to unaffected sources which would not be covered until Phase II. This load shifting capability has made implementing a phased approach difficult (Environmental Law Institute, 1997).

Experiences show that although the pollutants covered among the emission trading schemes are different, electricity generating units are the most often affected sources (Acid Rain, NO_X OTC program, Denmark). Notable exceptions are the U.K. scheme and the Reclaim one for SO_2. This is due to social reasons in the UK: the government did not want the electricity bill of low-budget households to raise.

Phase-in

To alleviate the difficulty to implement a large system at once, a phased approach can expand coverage so as to get the most comprehensive system as possible but:

- a phased coverage of sources within an industry may create a perverse incentive to shift production to non regulated sources (e.g. smaller units). This problem could be addressed by an output based allocation, but with possible other perverse side effects (cf. 2.1 below and Fischer, 2001).

- a phased coverage of industries does not raise such concern. It may be possible to consider phased inclusion of transportation, utility or industrial sectors, as there is limited possibility between these sectors to shift the production from one regulated sector to an unregulated one.

Opt-in

Some programs include provisions for firms to voluntarily participate (opt-in) either as a permanent part of the program, receiving an annual allocation of allowances, or on a project-by-project, "baseline and credit" basis. The Acid Rain program allows two provisions for permanent opt-in. The first type of opt-in was temporary, and allowed utility sources that would normally not be covered until Phase II (starting in 2000) to participate in Phase I (1995-2000). In addition, the program provides for non-utility industries with SO_2 emissions to opt into the regulatory system. This opt-in program allows these important sources of emissions to participate in the program, which otherwise would not cover them. The EPA

(Environmental Protection Agency) has promulgated opt-in rules for industrial combustion sources, which emit 14% of all SO_2.

Any opt-in source has to have a definable baseline and accurate emissions monitoring to guarantee that any further reductions they make contribute to the environmental goals. The opt-in source must demonstrate its baseline emissions and an adequate monitoring plan (Environmental Law Institute, 1997).

Indeed, sources have an interest in opting in if they can cheaply reduce emissions and derive economics benefits from selling their excess allowances. This raises the risk that firm opt in only if they can benefit from an over-estimated baseline – "hot air" in the climate negotiations lingo. There is thus an obvious trade-off between administrative and monitoring costs, on the one hand, and environmental integrity on the other hand. This difficulty seems to be overcome in schemes which treat firms that opt-in as a permanent part of the program, like Acid Rain, but is more problematic when opt-in is on a project-by-project, "baseline and credit" basis.

2.3 Lessons for the European GHG trading scheme

The European Commission proposal provides a wide spatial and sectoral coverage, even if, for political reasons, process emissions for the chemical industry are not covered. These emissions, as well as other gases than CO_2, are likely to be phased in later. A significantly wider coverage could have been provided only by an upstream system, which has been excluded by the Commission at the beginning of the process. The reason was again political: an upstream scheme would have too much looked like a tax.

The coverage could have been narrowed a lot by the opt-out provision that was present in previous drafts of the proposal. It allowed a State to exclude some sectors from the system, provided that they were regulated by another instrument, such as a voluntary agreement. Such a provision, which is still pushed for by industry, may harm a lot the efficiency of the system.

Perhaps for the sake of symmetry, the opt-in provision has also been dropped in the final proposal. However, if properly framed, opt-in on a permanent basis can expand coverage without necessarily endangering environmental integrity. It is in any case environmentally safer than opt-in on a project-by-project basis that the Commission intends to introduce via another directive (European Commission, 2001b).

3. PERMITS ALLOCATION

3.1 Theoretical requirements

From an economic point of view, three methods of allocating permits have to be distinguished: auction, criteria exogenous for firms receiving the permits, and output-based allocation.

- when allowances are auctioned, the permits are allocated to the highest bidders. Various allocation methods exist (see Klemperer, 1999, for a general survey or Cramton and Kerr, 1998, for auctioning applied to tradable permits).

- the most common exogenous criterion is a share of historical emissions, i.e. grandfathering. With pure grandfathering, new entrants have to buy their permits from existing sources and a firm continues to receive permits even if its plants shut down.

- with an "output-based" or "performance standard" allocation, firms receive an amount of permits proportional to their production (x permits per kWh for power plants, y permits per ton of aluminium…). Of course, since no sole indicator of production exists, the total amount of permits has first to be divided between sectors, except when a single sector is covered. Such an allocation method is equivalent to "specific" or "relative" permits, i.e. expressed in relative terms (e.g. one ton of CO_2 per kWh).

General equilibrium modelling has shown that the most cost-efficient way to allocate permits is to auction them and to use the revenue to cut pre-existing distortionary taxes (e.g. Goulder et al., 1999; Fullerton and Metcalf, 2001). Indeed grandfathered and auctioned permits, like any instrument that allows firms to reach part of their target by reducing their production, raise product prices above the marginal cost of production, generating a scarcity rent. With grandfathering, this rent is captured by regulated firms, which is socially inefficient when public funds are raised through distortionary taxes. Auctioning socialises this scarcity rent and allows to use it to cut pre-existing taxes or to produce public goods. According to the "strong double-dividend" hypothesis (Goulder, 1995), such policy would even increase welfare and employment. Although this hypothesis is controversial, the superiority of auctioning over grandfathering (the "weak double dividend") is not.

Furthermore, grandfathering reduces the incentive for regulated firms to develop environmental innovations, as compared to auctioning (Milliman and Prince, 1989). This is because environmental innovations reduce the value of the permits, thus the wealth of permits-holders.

Third, grandfathering may create a bias against new firms entering product market since existing firms get their permits free while new firms must buy them (Howe, 1994). Such a problem may arise if the capital market is imperfect and/or if existing firms benefit from market power on the permits markets. In both cases, these firms may be able to use their permits to drive their potential competitors out of the market.

At last, before the beginning of the system, grandfathering can increase pollution if sources are aware that larger current emissions will result in larger future permit allocations. This problem can be circumvented by basing the initial allocation, not on actual emissions, but on past emissions, or on the command and control authorised emissions, as it has been done in the earlier stages of permit systems in the United States (Tietenberg, 1999a).

Output-based allocation does not suffer from the first shortcoming: it does not create scarcity rents since it provides no incentive to raise the price-cost margin. Nor does it suffer from the third weakness: new entrants receive the same number of permits as existing firms. However, the allocation of permits acts as a subsidy to production. Therefore, it prevents to mobilise inter-sectoral substitutions in the overall reduction in emissions. For instance, an output-based CO_2 permits scheme would provide an incentive to reduce the CO_2 emissions per ton of concrete produced, but not to substitute wood for concrete in buildings. Furthermore, the definition of "output" raises complex problems as soon as several sectors are covered (Fischer, 2001).

The main economic advantage of an output-based allocation over the two others is that it reduces drastically the incentive to relocate polluting activities in "pollution havens". Indeed, if a polluting firm closes, it receives no permits anymore. On the contrary, with pure grandfathering, a firm can close its plants in the regulated country, build a new plant abroad and still benefit from grandfathered permits. Edwards and Hutton (2001) general equilibrium simulations indicate that such output-based CO_2 permits scheme could allow much of the potential "double dividend" to be realised, though an auction system would still be preferable. On the other hand, Burtraw et al. (2001) partial equilibrium simulations of the electricity

generation sector in the US suggest that the output-based allocation of CO_2 permits would imply roughly the same cost than grandfathering, and about twice that of auctioning.

3.2 How far experiences in emission trading move away from theory and why

Most experiences in emission trading have used grandfathering (Reclaim, Chile, U.K., BP, Shell), sometimes with special provisions for new entrants: auctioning (Acid rain) or free distribution according to criteria still to be defined (Denmark). Exceptions are the OTC NO_X budget program that let firms decide between grandfathering and an output-based allocation, the Dutch NO_X (output-based allocation) and the Norwegian scheme which favours selling the allowances. Implementation of the latter system is not decided yet.

The choice of grandfathering in most systems is a direct consequence of the political influence of regulated firms in the policy process (Kehoane et al., 1998). Indeed, a lesson from positive political economy is that firms which risk an important loss are more likely to incur the costs of lobbying than households or firms which could benefit from a reduction in pre-existing taxes – even if they outnumber the former. However, one cannot rule out the possibility of mobilising potential winners from a "double-dividend" strategy, that allowed ecological tax reforms in Scandinavian countries. Another strategy is to distribute revenues from auctioning to all citizens as a basic income (Kopp et al., 1999) in order to increase public support for emissions limitation.

Furthermore, even if a part of the permits has to be allocated for free, it must be stressed that not all the permits have to be grandfathered to compensate existing firms: several studies show that the grandfathering of all permits is likely to overcompensate the regulated industry. Bovenberg and Goulder (2000) as well as the US Congressional budget office (2000) have demonstrated that the complete grandfathering of CO_2 upstream permits in the US would let fossil fuel firms better off, and not worse off. Indeed, the gain from the scarcity rent would be much greater than the profit loss due to the decline in production. According to Burtraw et al. (2001), the same is true for downstream CO_2 permits in the US electricity generation sector.

A politically interesting feature of the output-based allocation is that it can be based on existing performance standard, like in the Dutch system. Furthermore, an output-based allocation is more acceptable to regulated firms than auctioning since it is revenue-neutral.

Last but not least, in its statement on the Danish system, the European Commission has ruled out pure grandfathering because of the bias against new entrants: Denmark has to provide the latter with permits in the same conditions than existing firms, which forms the basis of an output-based allocation.

3.3 Lessons for the European GHG trading scheme

The directive proposal prevents the member States from selling the permits in the first period (2005-2007), while the allocation method for the next periods is to be decided later on. This is arguably the aspect of the proposal which is most open to criticism. Although an harmonisation towards auctioning would make sense in order to prevent a race to the bottom, a generalisation of free allocation does not, even taking into account political realities: some of the sectors covered are likely to see their profits rise if all permits are grandfathered.

Whether a member State can (or has to) choose pure grandfathering, pure output-based allocation or a combination of both remains unclear. If the Commission wants to be consistent with the aim of "levelling the playing field", it should give more attention to this question. An output-based allocation basically combines a payment for emissions with a rebate for production. Thus, auctioning permits in the sheltered sector and allocating them according to production in exposed sectors, as the Dutch special commission on CO_2 trade (Vogtländer) recommends, makes much sense if one is afraid of "carbon leakage" towards unregulated areas. Pure grandfathering, on the other hand, can (over)compensate firm owners, but, if capital is perfectly mobile, does not protect competitiveness.

4. TEMPORAL FLEXIBILITY

4.1 Theoretical requirements

Standard theory suggests that as long as there is no risk of "temporal hot spots", a fully cost-effective tradable permit system must have full temporal flexibility, implying that allowances can be both borrowed and banked (Tietenberg, 1999b). Providing temporal flexibility to sources is important not only because of the effect of discounting, but also because of the importance of timing investments.

In general banking encourages firms to make early investments by allowing them to either use or sell allowances not needed for compliance during the current year. Banking of allowances provides sources with significant additional flexibility in compliance investment and decision-making.

The key concern with banking involves the potential for creating "temporal hot spots". Complete freedom on temporal offers the possibility for emissions to be concentrated in time. Since clustered emissions can cause more danger than dispersed emissions, regulators have chosen to put restrictions on the temporal use of permits despite the cost-effectiveness penalty that extracts (Tietenberg, 1999b).

Another concern lies in the fact that the accumulation of a large bank of allowances could make rapid implementation of future emissions reductions more difficult.

Borrowing gives flexibility by allowing firms to delay investments until such time as they may be optimal from the firm's perspective. However, it raises two concerns. First, borrowing, especially if unlimited, triggers the possibility to delay emissions reduction indefinitely. Second, when pending the adoption of future commitments, a source may have an incentive to rely heavily on borrowing to artificially raise its future compliance cost curve and obtain softer future targets.

4.2 How far experiences move away from theory and why

Allowance reference period

The allowance reference period can be daily, seasonal or annual. It is related to chemical and health consideration: when environmental effects are caused by long term accumulation in the atmosphere like for SO_2 and for CO_2, the reference period is annual. For ozone or particulates, the reference period is daily (Chile) or seasonal (five months in the OTC NO_X Budget program).

Banking

Most of the emission trading programs allow banking, the Netherlands, Reclaim and Chile being exceptions. Sometimes it is restricted because of health considerations (in the NO_X OTC Budget program, banking may worsen daily ozone levels). There has been heavy use of banking in the US Acid Rain Program, which has led to early reductions and substantially

lowered overall costs of compliance. Banking is especially significant for industries in which major capital expenditures must be made, as it allows individual sources flexibility in the timing of such major investments.

The argument against banking by which banked allowances could be used over a short term period to increase emissions with detrimental effect on environment, may be significant for SO_2 but is not for greenhouse gases.

Another concern by which the accumulation of a large bank of allowances could threaten futures GHG reductions can be addressed by giving allowances a long, but limited, life or by limiting the overall possible amount of banked allowances. It would prevent the possibility that a large allowance bank may build up and affect the government's ability to increase or decrease allowance allocating according to future international negotiated limits. The Environmental Law Institute (1997) report proposes a long life such as 20 years to allow sources to capture all the benefits of banking, while allowing the government increased flexibility; in addition, the size of any future reduction could also be adjusted to reflect the size of the allowance bank.

Borrowing

Borrowing is not explicitly allowed in any emission trading experiences because of ensuing difficulties in resolving environmental problems. However, the OTC NO_X program allows de facto borrowing as a compliance provision (cf. 5.2 below).

4.3 Lessons for the European GHG trading scheme

Because the European directive proposal intends to comply with the Kyoto Protocol, it is useful to recall the temporal flexibility provision of the Protocol and subsequent texts. The Protocol allows banking (except, since the Marrakech accords, for sinks credits), which may encourage early reductions beyond the Kyoto target. For the reasons mentioned above, borrowing, as a flexibility mechanism, has not been allowed by the Protocol. However, according to the Bonn political agreement, the main provision for non-compliance is the deduction of 1.3 times the excess emissions from a Party's first commitment period assigned amount, to be applied to the assigned amount of the second commitment period. This is economically borrowing with a 30% interest rate, but is politically very different since a Party in such a situation will be declared in non-compliance, and other consequences will apply

(submission and review of a compliance action plan, suspension of eligibility to transfer allowances via emission trading or joint implementation).

The directive proposal allows for the banking of allowances but not for the borrowing. Both provisions seem sound, the former because there is no risk of "temporal hot spot" in the context of climate change, the latter for all the reasons mentioned above. The resulting loss of cost-effectiveness in eliminating borrowing is a reasonable price to pay for easing enforcement and compliance.

5. TRADING ORGANISATION

All programs allow direct bilateral trade, except BP and Shell's in which transactions have to be made through a central broker, and Chile in which an administrative approval is required.

All implemented emission trading systems include the registration of transfers (Acid Rain, NO_X OTC Budget Program, Reclaim). A registry set up by the organism who has the institutional governance records the companies' allowances accounts (except in the Danish case).

The international experiences speak for simplicity: bilateral trade without prior government approval favours trading and lowers transaction costs. But, mandatory registration is needed to assess country compliance with the Kyoto commitment.

A registry is a useful management tool because it creates an open, public process for allowance recordation which helps ensure compliance with the law. Coupled with the penalty provisions a registry works well for compliance purposes (Environmental Law Institute, 1997).

The EU directive proposal sticks to usual practices by allowing bilateral transactions without government approval but with mandatory registration.

6. MONITORING, ENFORCEMENT AND COMPLIANCE

6.1 Theoretical requirements

Regardless of how well any tradable permits system is designed, non compliance can prevent the attainment of its economic, social and environmental objectives (Tietenberg, 2000).

The enforcement of permit system depends on the technical ability to detect violations and the legal ability to deal with the violations once detected, thus to deter them.

Direct continuous monitoring of emissions can be a means to avoid such a problem but Tietenberg (1980) argues it is not essential to the success of the program. Others techniques are available for estimating the emissions flow, such as, for CO_2, calculation using activity data, emission factors and oxidation factors. Second requirement is the legal authority to deal with non compliance including effective sanctions. A guideline can be set up: the smaller the probability of control is, the higher the non compliance penalty should be (and inversely).

The last point is the liability rule, i.e., does a permits remain valid when its issuer turns out to be in non-compliance? The answer is yes in a seller liability regime and no in a buyer liability one, but numerous other rules exist[3]. Pure seller liability should be avoided if the compliance regime is weak, since it can spur over-selling. If the compliance regime is strong, pure seller liability minimises transaction costs.

6.2 How far experiences move away from theory and why

Monitoring

One of the reasons why the Acid Rain program has been successful is the high integrity of the allowance currency, due to the requirement that utilities install continuous emissions monitoring devices to accurately measure actual emissions (Environmental Law Institute, 1997).

Several programs require continuous emissions monitoring by sources (Acid Rain, NO_X OTC Budget Program, Reclaim) (Unctad, 1998).

Reporting is a key compliance mechanism and covers both emissions monitoring results and emission trading activity. On a national level, many countries require monthly reporting of

[3] Haites and Missfledt (2000) analyse these rules in the context of the Kyoto Protocol.

emission data. Continuous emissions monitoring technology allows reporting as often as every 15 minutes. US domestic trading systems require reporting of emission trading activity to a government registry which is open to the public and may be available on the world wide web (Unctad, 1998).

Enforcement and penalties

Acid Rain, Reclaim, Denmark, Chile, U.K. set penalties for non-compliance (respectively \$2000/ton SO_2, \$500 per day and \$6 per ton CO_2 for the first three) whereas NO_X OTC budget program deducts allowances in case of non compliance from the subsequent year, which is basically borrowing with a 300% interest rate. The level of penalties in past trading appears to be positively correlated with compliance levels (100% for the Acid rain program) (Unctad, 1998). In BP, there is no penalty whereas in Shell there is a fine equal to three times the average fourth quarter price for each permit short fall.

Liability

All the systems we have studied feature seller liability.

6.3 Lessons for the European GHG trading scheme

High quality monitoring is essential to assure effectiveness of both compliance and trading systems. The Commission decision to start with the sole CO_2 reflects the importance given to monitoring. However, even for industrial CO_2 emissions, calculation using activity data, emission factor and oxidation factor is not without problems. The accuracy of current national inventories based on this method falls far short of what is needed for a trading scheme, so further guidance has to be provided at the EU level.

Compliance penalties seem to be set at a sufficiently high level: 50 €/t CO_2 in the first period, 100 afterwards, plus restoration of excess tons in the following year.

7. HARMONISATION VERSUS SUBSIDIARITY

In the Green paper on emission trading issued by the European Commission (2000), most open questions were related to the "harmonisation vs. subsidiarity" issue: what should be set

at the European level and what should be left for member States to decide? Three features were of particular concern: the sectoral coverage, the allowances allocation procedure and the compliance regime.

7.1 Theoretical requirements

A basic theoretical requirement is to try to equalise costs and benefits in each country. Since the benefit from cutting emissions is the same in whatever country the reduction takes place, and because tradable permits allow to equalise marginal abatement costs despite national circumstances[4], on the three features mentioned above, theory calls for a high degree of harmonisation.

7.2 The experience of the US OTC NO_X program

The OTC program in the United States gives the only example of integration between federal and State levels. The program is under U.S. Environmental Protection Agency (EPA) guidance. Eleven north-eastern States, the district of Columbia and Northern Virginia implemented a 'cap and trade' system in 1999 to reduce compliance costs associated with the OTC (Ozone Transport Commission) regulations of the 1990 Amendments of the Clean Air Act (Farrell et al., 1999). 1990 is the baseline level for the overall cap.

EPA distributes NO_X allowances to each State based on State wide emissions inventories and States are free to determine the allocation procedure to sources. Each State has to identify its budget sources.

How did the States to identify their budget sources ?

In 1994, the States under the OTC program (except Virginia) have signed a Memorandum of Understanding (MOU). They agreed they would implement reasonably available control technologies (RACT) on major stationary sources of NO_X in phase I (before the implementation of emission trading which only begin in phase II in 1999) and agreed to a phased approach for additional controls, beyond RACT for power plants and other large fuel combustion sources (phase II and III). The MOU establishes an emission trading system to

[4] This is true only as long as pre-existing differences in the regulatory and fiscal frameworks does not create false gains from trade, as stressed by Babiker et al. (2001). This calls for implanting the directive proposal on harmonising minimum excise duties across member States, but it is unlikely that increasing the degree of freedom of member States in the trading system would help solving the problem.

reduce the costs of compliance with the control requirements under Phase II (which began on May 1, 1999) and Phase III (beginning on May 1, 2003).

Under the NO_X OTC program, although States have to identify their budget sources, the MOU provides guidance: the budget sources include a core group of electric generating units (EGU) with a rated electrical output of 15 MW or greater, and fossil fuel-fired boilers or indirect heat exchangers with a maximum rated heat input capacity of 250 mmBtu/hour or more. Aside from these requisite budget sources, States also had the option of including other source categories (e.g. cement plants) in the program. Additional stationary sources of NO_X emissions designated as eligible by the State may choose to opt-in on an individual basis. In fact, the OTC seasonal budget was developed through a uniform process across all States.

How did the States allocate allowances ?

Under the MOU a 'model' trading rule has been developed for States in the OTC to use as a template in the development of their own regulations. While the model rule was developed as guidance for State regulatory development, the OTC is State-operated and decentralised by design. States therefore had the option of 'tailoring' individual program elements such as allocation methodology to fit State-defined criteria.

The number of allowances distributed in each State is calculated as a percentage of total (actual or estimated) 1990 emissions or the equivalent as a "performance standard" (which is basically an output-based allocation). A source may choose which standard applies to it, and the State environmental agency then allocates allowances according to this standard.

- The States are responsible for ensuring that sources are in compliance with all requirements of the program (monitoring and reporting actual emissions and compliance demonstration process).

- EPA is responsible for reviewing and approving each State's regulation into a SIP (State Implementation Plan).

- EPA is responsible for developing and operating an adequate trading registration.

7.3 Lessons for the European GHG trading scheme

The NO_X OTC program is an example of an emission trading system with common rules concerning affected sectors, compliance provisions and (partly) allocation rules. A core of

participants is defined at the federal level. Electricity generating units and fossil fuels boilers are the affected sources. Moreover, the States can include opt-in conditions to widen the system coverage.

The EU directive proposal offers quite similar provisions: a core of participants is defined, nevertheless there is no opt-in possibility at the moment. In the first period, States have a large degree of freedom to set their allocation rule provided this allocation is for free.

The NO_X OTC trading program is too recent to let us draw rigorous lessons for the EU one at the present time. However, given these similarities, the European Commission should devote prominent attention to its implementation as well as to its current extension to 19 States (the "SIP Call" program; cf. Farrell, 2001).

8. CONCLUSION

The European greenhouse gases emission trading system is supposed to start by 2005. We have seen that some parts of the directive proposal are open to criticism. Furthermore, during the co-decision process between the Council and the Parliament, this text will face major lobbying, especially from member States whose trading system or proposal is incompatible with the directive proposal, and from parts of industry that oppose trading or claim for more flexibility. The risk is high that the proposal be blocked or watered down. For these reasons, lessons from both economic models and international trading experience are useful to feed the upcoming debate.

A review of the theoretical and applied literature, and some interviews, lead us to the following assessment of the European system.

The European Commission proposal provides a wide spatial and sectoral coverage, even if, for political reasons, process emissions for the chemical industry are not covered. These emissions, as well as other gases than CO_2, are likely to be phased in later.

The coverage could have been narrowed a lot by the opt-out provision that was present in previous drafts of the proposal. It allowed a State to exclude some sectors from the system, provided that they were regulated by another instrument, such as a voluntary agreement. Such a provision, which is still pushed for by industry, may harm a lot the efficiency of the system.

Perhaps for the sake of symmetry, the opt-in provision has also been dropped in the final proposal. However, if properly framed, opt-in on a permanent basis can expand coverage without necessarily endangering environmental integrity. It is in any case environmentally safer than opt-in on a project-by-project basis that the Commission intends to introduce via another directive (European Commission, 2001b).

Turning to the allocation method, the directive proposal prevents the member States from selling the permits in the first period (2005-2007), while the rules for the next periods are to be decided later on. This is arguably the aspect of the proposal which is most open to criticism. Although an harmonisation towards auctioning would make sense in order to prevent a race to the bottom, a generalisation of free allocation does not, even taking into account political realities: some of the sectors covered are likely to see their profits rise if all permits are grandfathered.

Whether a member State can (or has to) choose pure grandfathering, pure output-based allocation or a combination of both remains unclear. If the Commission wants to be consistent with the aim of "levelling the playing field", it should give more attention to this question. An output-based allocation basically combines a payment for emissions with a rebate for production. Thus, auctioning permits in the sheltered sector and allocating them according to production in exposed sectors, as the Dutch special commission on CO_2 trade (Vogtländer) recommends, makes much sense if one is afraid of "carbon leakage" towards unregulated areas. Pure grandfathering, on the other hand, can (over)compensate firm owners, but, if capital is perfectly mobile, does not protect competitiveness.

Concerning temporal flexibility, the directive proposal allows for the banking of allowances but not for the borrowing. Both provisions seem sound, the former because there is no risk of "temporal hot spot" in the context of climate change, the latter for all the reasons mentioned above. The resulting loss of cost-effectiveness in eliminating borrowing is a reasonable price to pay for easing enforcement and compliance.

For the trading organisation, the EU directive proposal sticks to usual practices by allowing bilateral transactions without government approval but with mandatory registration.

High quality monitoring is essential to assure effectiveness of both compliance and trading systems. The Commission decision to start with the sole CO_2 reflects the importance given to monitoring. However, even for industrial CO_2 emissions, calculation using activity data,

emission factor and oxidation factor is not without problems. The accuracy of current national inventories based on this method falls far short of what is needed for a trading scheme, so further guidance has to be provided at the EU level.

Compliance penalties seem to be set at a sufficiently high level: 50 €/t CO_2 in the first period, 100 afterwards, plus restoration of excess tons in the following year.

Lastly, the European Commission should devote prominent attention to the US NO_X OTC program, as the only example of integration between the federal and State levels.

Table 1	Unity and target	Participants		Permits allocation
		Upstream/ Downstream	Sectoral / geographical scope	
1. US Acid rain program	1 t SO_2. Cut nation-wide emissions 50% below 1980 levels by 2010	non applicable	electricity generating units (2000 units) national system	grandfathering + auctioning for new entrants (3% of total allowances)
2. US Ozone Transport Commission's NO_X budget program	1 t NO_X. Cut emissions nearly 75% below 1990 levels by 2007	non applicable	electric utilities, fossil fuel boilers ≥ 250 mmBtu/h and all electric plants ≥ 15 MW (471 sources). Northeastern States	grandfathering. 1990 baseline level for the overall cap. States set aside portion of their allowances for new sources
3. Reclaim	1 pound of Reclaim pollutant (NO_X, SO_2). Cut local emissions 80% below 1990 levels by 2003	non applicable	any point source which emissions are above four tonnes per year (electric generating plants excluded of the SO_2 program) local system, South Coast of California	grandfathering (1987-1992) reference period for the overall cap.
4. Denmark	1 t CO_2. cut emissions 70% below 1998 levels by 2003	downstream	electricity producers or association of electricity producers which CO_2 emissions above 100 000 tons/year. National system	grandfathering. Base historical level 1994-1998. A portion of quotas is withhold by the Minister for Environment for new entrants
5. Chile	suspended particulates: kg/day	non applicable	industrial boilers, ovens with a flew volume ≥ 1000 m^3/h in the Santiago area.	grandfathering based on 1992 emissions
6. U.K. Emission trading Scheme	1 tCO_2 equivalent	downstream	voluntary scheme: direct participants (absolute targets) through the financial incentive, agreements participants (absolute or relative targets) through voluntary agreements. Nation-wide system	grandfathering or output-based.
7. The Netherlands NO_X emissions permits	NO_X tonnes. cut nation wide emissions 50% below 1995 levels by 2010	non applicable	all stationary sources larger than 20 MW; about 200 firms. Nationwide coverage	Free allocation. Yearly allocation of NO_x emissions on the basis of performance standards per facility
8. Norway	1 t CO_2 equivalent	undefined yet	the most comprehensive system possible, technically feasible. National system	in principle quotas should be sold
9. BP	1 t CO_2 equivalent (CH_4 and CO_2) reach 10% below 1990 levels by 2010	downstream	150 businesses units operating in 100 countries (annex I countries)	grandfathering: the base year is 1998
10. Shell (STEPS)	100 tonnes of CO_2 equivalent (CO_2 and CH_4). 2% less than 1998 emissions by 2002	downstream	the participating businesses units (annex I countries)	grandfathering: the base year is 1998
11. EU directive proposal	1 t CO_2 equivalent	downstream	Combustion installations, oil refineries, coke ovens, ferrous metals, cement, lime, glass, ceramic, pulp, paper and board plants	grandfathering or output-based. compliance with the EU burden sharing agreement and competition rules

Table 2	Compliance			Temporal flexibility		Trading organisation	
	Sanctions	**Liability**	**Reference period**	**Banking**	**Borrowing**	**Bilateral trade**	**Registry**
1. US Acid rain program	penalty $2000/ton	seller liability	annual budgeting	yes	no	yes	yes
2. US OTC NO_X budget program	allowances deducted from the subsequent year at the rate of 3:1	seller liability	seasonal (May to September)	limited	no	yes	yes
3. Reclaim	penalty $500 per violation per day	seller liability	annual	no	no	yes	yes
4. Denmark	$6 per ton of CO_2	seller liability	annual quotas	yes	no	yes	yes
5. Chile	penalty fee	seller liability	daily emissions permits	no	no	Yes with prerequisite approval	yes
6. U.K. Emission trading Scheme	penalties levels still have to be worked out.	seller liability	annual allowances	unlimited until the end of 2007	no	yes	yes
7. Dutch NO_X emissions permits	still have to be worked out	seller liability	annual	no	no	yes	yes
8. Norway	yes	?	2008-2012	yes	no	yes	yes
9. BP	no	seller liability	annual allowances	regulated	no	through a central broker	yes
10. Shell (STEPS)	fine of three times the average fourth quarter trade for each permit shortfall.	seller liability	three years	yes	no	through a central broker	yes
11. EU directive proposal	100 € per ton of CO_2 (50 in the first period) + restoration	seller liability	2005-2007 then 2008-2012	yes	no	yes	yes

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