



**Tradeable permits – Ten key design issues**

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## Introduction

In this paper, we provide a guide for policymakers who consider using tradeable permits as an environmental policy tool. Most of the issues we discuss are relevant both in the domestic and the international realm, although some have particular significance in one of the two areas.

In recent years, tradeable permits (TP) have become rather widespread in use<sup>1</sup>. The following table 1 gives an overview of some of the numerous experiments, in particular in the US. There is a wealth of resources available that comment on the success of these programs (Stavins 2002). One noteworthy point is that the international experience is rather small. Europe has only relatively recently begun to develop such programs. For example, in Denmark, the Ministry of the Environment fixes annual emissions ceilings in the power generation industry, and leaves the actual allocation to the country's two power plant consortia. The UK allowed intra-firm trading of SO<sub>2</sub>-allowances among large combustion plants from 1991 to 1997. But inter-firm trading was not allowed (Sorrell 1999).

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<sup>1</sup> This should not obscure the fact, however, that tradeable permits are not the only game in town. In fact, important tradeoffs with alternative environmental policy instruments need to be considered. For space reasons, it is not possible to adequately deal with these tradeoffs here, and so we can only point the reader to the more extensive survey (Wagner and Schneider 2003) where questions like the optimal timing of environmental policy in the presence of significant uncertainties and irreversibilities and the relative merits of different policy instruments with respect to cost efficiency, environmental effectiveness, administrative practicability, dynamic efficiency and incentives for technological innovation, and political acceptability are discussed (Summary tables of the relative advantages and disadvantages can be found in the appendix of this paper). One particularly important insight developed recently in a number of papers (Abel et al. 1995; Arrow and Fisher 1974; Chao 1995; Dixit and Pindyck 1998; Hassett and Metcalf 1994; Kolstad 1992; Pindyck 2000) concerns the fact that policy decisions with respect to climate change are essentially irreversible and delay of action is possible. Under these conditions, waiting has optionality value; thus, the observed delay in climate policy implementations may at least partially be an optimal response to the prevailing uncertainties.

**Table 1: Some selected tradeable permit systems (Stavins 2002)**

Country	Program	Traded Commodity	Period of Operation	Environmental and Economic Effects
Canada	ODS Allowance Trading	CFCs and Methyl Chloroform; HCFCs; Methyl Bromide	1993-1996; 1996-present; 1995-present	Low trading volume, except among large methyl bromide allowance holders
	PERT GERT	Nox, VOCs, CO, SO <sub>2</sub> , CO <sub>2</sub>	1996-present; 1997-present	Pilot program; Pilot program
Chile	Santiago Air Emissions Trading	Total suspended particulates emission rights trading among stationary source	1995-present	Low trading volume; decrease in emissions since 1997 not definitely tied to TP system
European Union	ODS Quota Trading	ODS production quotas under Montreal Protocol	1991-1994	More rapid phaseout of ODS
Singapore	ODS Permit Trading	Permits for use and distribution of ODS	1991-present	Increase in permit prices; environmental benefits unknown
United Kingdom	Emissions Trading Program	CO <sub>2</sub> emissions	2002-present	Unknown
United States	Emissions Trading Program	Criteria air pollutants under CAA	1974-present	Performance unaffected; savings = \$5-12 billion
	Lead Gasoline Phasedown	Rights for lead in gasoline among refineries	1982-1987	More rapid phaseout of leaded gasoline; \$250 m annual savings
	Water Quality Trading	Point-nonpoint sources of nitrogen and phosphorus	1984-1986	No trading occurred because ambient standards not binding
	CFC Trades for Ozone Protection	Production rights for some CFCs, based on depletion potential	1987-present	Environmental targets achieved ahead of schedule; effect of TP system unclear
	Heavy Duty Engine Trading	Averaging, banking, and trading of credits for NO <sub>x</sub> and particulate emissions	1992-present	Standards achieved; cost savings unknown
	Acid Rain Reduction	SO <sub>2</sub> emission reduction credits; mainly among electric utilities	1995-present	SO <sub>2</sub> reductions achieved ahead of schedule; savings of \$1 billion/year
	RECLAIM Program	SO <sub>2</sub> and NO <sub>x</sub> emissions among stationary sources	1994-present	Unknown
N.E. Ozone Transport	Primarily NO <sub>x</sub> emissions by large stationary sources	1999-present	Unknown	

The system in the Netherlands, where electric power producers face emissions standards for SO<sub>2</sub> and NO<sub>x</sub> but can comply through cost-sharing arrangements whereby plants with higher abatement costs are compensated, has resulted in intra-firm trading (Klaassen and Nentjes 1997). In Germany, the transfer of emission reduction obligations among firms in air quality non-attainment areas is allowed. The cost-savings have been estimated to be very limited (Schaerer 1994). The most recent experiment with market-based instruments is the UK Emission Trading Scheme, aimed at achieving the UK's commitment under the - yet to be ratified - Kyoto Protocol. Schneider and Wagner (2002) describe the program in detail. Since the first auction only took place in March 2002, and trading has been somewhat limited so far, it is too early to make an assessment concerning the success of the program.

What lessons can we learn from these programs, some of which have been “grand policy experiments” (Stavins 1998)? In this guide for policymakers, we focus exclusively on design and implementation issues and we draw on theoretical and empirical work on this question. Of course, there is no blueprint for the perfect system. It is our belief, however, that when tradeable permit systems are used where they are appropriate, then heeding the lessons from the past increases the chances of the system leading to the desired outcome (in particular a cost-effective attainment of pre-set environmental goals). The balance of the paper deals with ten such key design issues.

### **Trading of emissions versus inputs**

In principle, we would want to regulate risks and impacts. However, it is quite difficult to trade risks directly. This is why policy typically moves one or two steps away from this level, leading to either emission permit trading or input permit trading. For example, a true CO<sub>2</sub> trading program would correspond to the first type; a carbon (content) trading program belongs to the second group. In general, the choice between the two depends on the degree of uniform mixing of the pollutant. For example, it would be problematic to have a sulfur-content trading program because SO<sub>2</sub> is a highly non-uniformly mixed pollutant - which is why the US has chosen to implement an SO<sub>2</sub> allowance trading program. Aside from this physical property, there is also an economic or political aspect: administrative feasibility. Clearly, the closer to the actual impacts regulation takes place, the more complex it gets. Taken together, these two factors suggest an important trade-off.

## **Mandatory versus voluntary**

Some observers have argued that a mandatory scheme is likely to be more environmentally effective. This is not necessarily true since significant emissions reductions may also be attained through voluntary participation. What is correct, however, is that mandatory schemes will in all likelihood be more cost-effective. Why? Under a voluntary scheme only entities that expect themselves to be sellers will join the scheme (even if they end up being buyers after all). In other words, there is a strong element of adverse selection involved, as has been shown for the case of the SO<sub>2</sub> program by Montero<sup>2</sup> (1999). Thus, abatement cost heterogeneity will be lower under a voluntary scheme, leading – for a given environmental goal – to lower cost-savings. Transaction costs for companies joining industrial opt-in programs have typically been high (Atkeson 1997).

## **Absolute versus relative baselines**

Typically, the difference between relative and absolute targets is argued to be as follows (Bode 2002): One limits total emissions to some absolute amount and may therefore limit “growth,” while the other is presumed to impose less of a constraint on growth in output, albeit at the cost of some growth in emissions. As Ellerman (2002) points out, the U.S. experience with both systems does not provide much support for this distinction<sup>3</sup>. But it is not clear whether this experience is also relevant for the choice of baselines in climate change policy, for example. Indeed, one of the major components of the US Climate Plan announced in February 2002 is the concept of moving away from committing to a national emission cap by a specified date (such as is embodied in Kyoto) to a targeted rate of decline in emissions intensity of the economy. Kolstad (2002) argues that this part of the proposal does have some merit, on the grounds that it addresses the problem with the emissions cap approach of Kyoto that requires continual renegotiation of the caps as we proceed through time. It also does not have the (psychological and possibly real) effect of hindering growth for developing

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<sup>2</sup> However, the environmental effects must be kept in perspective. The number of allowances that could be considered excess amounted to only 3% of the total issued during 1995-1999 and the inflation of the cap during the time when these banked allowances will be used is only about 2%. Thus, these effects do not appear to have threatened the overall integrity of the allowance program.

<sup>3</sup> On the one hand, the consumption of coal has not been perceptibly reduced by the imposition of a cap on sulfur dioxide emissions. Rather, more low-sulfur coal is produced and a number of units have retrofitted scrubbers. On the other hand, the lead phase-down, which is the prototypical averaging (i.e. relative baseline) program, has not lead to more output of leaded gasoline.

countries. Finally, an intensity target has the advantage of resolving some uncertainty, since other the absolute baseline significant cost uncertainty arises from a combination of uncertainty over how much an economy may grow by the time the commitment period arrives. The last word is still out on this issue.

Apart from this, two other reasons argue for using absolute baselines in national programs. The problem is that without a specified baseline, reductions must be credited to an unobservable hypothetical – what the source would have emitted in the absence of the regulation. Second, as was experienced with EPA’s Emissions Trading Program, relative baselines create significant transaction costs by essentially requiring prior approval of trades as the authority investigates the claimed counterfactual from which reductions are calculated and credits generated (Nichols, Farr, and Hester 1996).

### **Grandfathering versus auction**

Almost all emission trading programs in action have started with grandfathered permits. For example, the most important emission trading program so far, the Clean Air Act amendments of 1990 dealing with SO<sub>2</sub> trading provide for annual auctions in addition to grandfathering - but such auctions involve less than three percent of the total allocation. Overall, the auctions have proven to be a trivial part of the overall program (Joskow, Schmalensee, and Bailey 1996). This is astounding since on the theoretical level, there seem to be compelling reasons for auctioned permits.

First of all, with perfect information and no transaction costs, trading will result in the economically efficient outcome independently of the initial distribution of permits (Montgomery 1972). Second, auctions are more cost-effective in the presence of certain kinds of transaction costs. Third, the revenue raised can be used to reduce other distortions (Goulder and Bovenberg 1996). Note also that while instruments such as tradeable permits can create entry barriers that raise product prices, reduce the real wage, and exacerbate preexisting labor supply distortions, this effect can be offset if the government auctions the permits, retains the scarcity rents, and recycles the revenue by reducing distortionary labor taxes. Fourth, auctions provide greater incentives for firms to develop substitutes (see the section on technological progress). Fifth, due to the revenue raised by auctions, administrative agencies may have a bigger incentive to monitor compliance (Ackermann and Stewart 1985).

Finally, grandfathering can lead unregulated firms to increase their emissions in order to maximize the pollution rights that they obtain if there is a transition to a market-based system (Deweese 1983). Overall, under almost any circumstances to be encountered in the real world, an auction of emission rights is preferable to grandfathering.

In addition to these considerations, questions of equity but also of dynamic efficiency will guide the treatment of new sources. Obviously, the decision will depend on the competitiveness of the market – the policy decision here is as much industrial policy as it is environmental policy.

### **Allocations and efficiency in the international context**

Chichilnisky (1993) and Chichilnisky and Heal (1994) point out that the presumption that equal marginal abatement costs are the correct condition for efficiency is not strictly correct. The reason for this is that, simply, a dollar to a person in the developing world does not have the same welfare implications as a dollar to a developed world person. What matters are the real opportunity costs. Formally, the authors find that Pareto efficiency requires that the marginal cost of abatement in each country must be inversely related to that country's marginal valuation for the private good. This has strong policy implications: If richer countries have a lower marginal valuation of the private good, then at a Pareto-efficient allocation, they should have a larger marginal cost of abatement than the lower-income countries. With diminishing returns to abatement, this implies that they should push abatement further. Summarizing, the allocation of property rights in a tradeable permit system is important if environmental quality has a direct impact on wellbeing and marginal valuations of private goods differ strongly across countries.

The main policy implication for the design of efficient permit trading programs concerns the allocation of rights. Even after choosing to go with tradeable permits as the environmental policy instrument, we need to carefully use the degree of freedom left in terms of the distribution of property rights<sup>4</sup>. Whenever politicians bring up equity issues, economists are

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<sup>4</sup> Chichilnisky et al. (2000) concentrate on the first welfare theorem in markets in which agents trade, at a uniform price (that is, not at personalized Lindahl prices), permits to produce privately produced public goods. They take the total quantity of permits fixed by the government at a level consistent with Pareto efficiency. They show that the equilibria are nevertheless generally inefficient, due to the public good character of one of the traded goods. But the main surprise is that there exist certain allocations of rights to emit from which the market overcomes the "free rider" problem and achieves

quick to point out that those have nothing to do with efficiency. For once it seems that politicians are right, if not in their reasoning.

### **Banking and borrowing**

The US has had significant experience with programs that allow intertemporal trading, in particular banking. Two lessons emerge from this experience (Ellerman 2002): First, when allowed and coupled with a phased-in reduction requirement, banking will be used and it will accelerate the timing of emission reductions. Studies of the US Acid Rain Program also find that firms have learned very well how to optimally accumulate and draw down banks (Ellerman and Montero 2002). Second, the ability of banking to dampen allowance price fluctuations may be important when the spatial scope of the cap is limited<sup>5</sup>. In fact, this second point hints at the importance of a temporal safety valve that may allow agents to borrow in times of extraordinary demand. Of course, there is good reason to restrict temporal flexibility when the environmental problem is other than a stock pollutant.

### **Market power and the design of emission permit markets**

In order for cost minimization gains to be fully realized, the emission trading market must work in a competitive manner. If some agents have the capacity to influence the transaction price of traded permits or can prevent the entrance of competitors by hoarding permits, efficiency losses may ensue (OECD 2001). For example, Hahn (1984a) shows that the deviation of abatement costs from the cost minimum is related to the extent to which the initial distribution of permits differs from the equilibrium distribution (and to the price elasticity of demand).

Another type of strategic behavior occurs if firms use the permit market to drive up rivals' costs (exclusionary manipulation). Note first that this can only occur if firms operating in the same industry also participate in the same permit market. Misiolek and Elder (1989) conclude that, surprisingly, this may not necessarily have a negative impact on cost efficiency. It is unclear to what extent this result survives the inclusion of uncertainty. Experimental studies and anecdotal evidence from existing permit markets suggest that this is probably not a major

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efficiency. This is a key characteristic of competitive markets for privately produced public goods.

<sup>5</sup> This was important to bring price levels back to normal in the RECLAIM NO<sub>x</sub> program in the US after the California electricity market crises in late 2000 and early 2001.



problem – at least for domestic programs. On the international level, things may look different. As regards carbon trading, a particularly important danger seems to be that Russia and the Ukraine exert market power. In a first attempt to estimate the costs of such a situation, Burniaux (1999) finds that by 2010 the price of Assigned Amount Units (the term for emission permits that the Kyoto protocol uses) would be about 20 per cent higher than under the competitive scenario (for a discussion see OECD (2001)). Clearly, the best way to avoid such situations is for governments to devolve their assigned amounts to their legal entities and promote industry-level trading (Bader 1996; Hahn 1984b).

### **Market efficiency, transaction costs**

If we want to rely on environmental markets to give us efficient results, we must be able to rely on them in providing informational or market efficiency first. One key to a smooth functioning of the tradeable permit market is a low level of transaction costs.

Three potential sources of transaction costs in tradeable permit markets can be identified: (1) search and information; (2) bargaining and decision (Dwyer 1992; Kohn 1991); and (3) monitoring and enforcement. Anecdotal evidence abounds regarding the prevalence of significant transaction costs in tradeable permit markets. Atkinson and Tietenberg (1991) surveyed six empirical studies that found trading levels in permit markets to be lower than anticipated by theoretical models. On the other hand, it has been recognized that success stories like the EPA's leaded gasoline phasedown can partially be attributed to the program's minimal administrative requirements and the fact that the potential trading partners (refineries) were already experienced at striking deals with one another<sup>6</sup>. Transaction costs in the SO<sub>2</sub> market in the US – the most successful TP market - are now minimal. The lesson for policymakers is to make administrative procedures as simple as possible and to equip potential trading partners with means to efficiently communicate market-relevant information with each other<sup>7</sup>.

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<sup>6</sup> For an overview of quantitative empirical estimates across various programs, we refer the reader to Wagner and Schneider (2003)

<sup>7</sup> Not only the level of transaction costs is important. Stavins (1995) shows that when transaction costs are dependent on the volume traded, this may imply that the final equilibrium, and hence cost efficiency, is no longer independent of the initial distribution of permits (the precise result depends on the exact shape of transaction costs)..

A final word is in order on the international realm. When governments themselves trade, transactions could be the result of bilateral bargaining where emission permits are not the only element of the transaction; in other words, governments will in general be motivated by other factors than strict economic ones. Prior notification by parties and, more generally, the establishment of specific exchanges has been advocated to promote competitive behavior (Bohm 1998). First experiments (Hizen and Saijo 1999) seem to indicate, however, that disclosure of contract information does generally not improve market efficiency. Similarly, trading through an exchange does not seem to improve significantly the efficiency of the trading regime as opposed to bilateral trading. These results are surprising and merit further investigation.

### **Enforcement and management framework**

There are two aspects to an enforcement framework: One is the monitoring of compliance with the regulatory framework and detecting violations. The other is responding to violations in a way that ensures that it is always in the interests of participants to comply. Often, the first aspect is the simpler of the two. For example, for CO<sub>2</sub>, since it is a mostly uniformly mixed pollutant, we do not have to monitor each and every source of CO<sub>2</sub> emissions, but can focus on the sales of the major distributors of carbon-based fuels. In fact, just from such sources, estimates of the consumption of various carbon-based fuels in each country are already available from data on production, import, export, and inventories<sup>8</sup>.

The enforcement poses much more serious problems, in particular in the international context. Malik (1990) demonstrates that with imperfect compliance, firms set the level of emissions such that marginal profits equal the permit price plus the expected fine. It can also be shown that if the marginal penalty of noncompliance is constant, tradeable emission permits lead to less noncompliance than does regulation. With increasing marginal penalties (as a function of the violation), all firms will comply if the permit price below the expected per unit violation penalty. With decreasing marginal penalties, firms that decide not to comply will pollute more than under regulation. In sum, with imperfect enforcement, whether or not tradeable permits meet the environmental goal depends on the structure of the penalty function.

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<sup>8</sup> It should be noted that if the lives of quotas are not synchronized - if they specify a total of emissions over a multiyear life - matters could be more difficult

With respect to market management more generally, the clear recommendation from economic theory is to allow market participants to fully exploit cost-saving opportunities and risk-management possibilities, for example through the use of derivatives (as they are already traded in the SO<sub>2</sub> and NO<sub>x</sub> allowance markets in the US). In addition to facilitating hedging price risks, derivatives also help achieve market depth and liquidity and so improve market functioning.

### **Interaction between international and domestic policies and needs**

Sometimes it is argued that it does not matter how countries enforce given total emission levels domestically, as long as the allocation of quotas among countries is clear "...in principle, any domestic policy regime is possible." (Chichilnisky and Heal 2000). Hahn and Stavins (1999) deal critically with this important point, which has received surprisingly little attention in the literature on international environmental agreements.

They start from the observation that the Kyoto Protocol's greenhouse gas trading mechanism will lead to minimized costs if all countries use domestic tradeable permit systems to meet their national targets and allow for international trades. Thus, the European Union's proposal to introduce a trading system within Europe to fulfill the requirements of Kyoto, indeed is very important for the overall performance of Kyoto's system. By contrast, political practice suggests that many countries will use non-trading approaches such as greenhouse-gas taxes or fixed quantity standards. Hahn and Stavins show that in these cases, achieving the potential cost savings of international trading requires some form of project-by-project credit program - like joint implementation. However, large transaction costs, likely government participation, and absence of a well-functioning market may be obstacles for this route. Overall, there is an important trade-off between the degree of domestic sovereignty and the degree of cost-effectiveness.

A related question is how to link existing schemes, for example the Danish and the UK CO<sub>2</sub> schemes (Bode 2002). Again, as long as the abatement costs in separated trading schemes are different, the linkage of two schemes can result in increased overall cost-effectiveness. There will be equity considerations, however, since prices will change compared to the previous equilibrium. This may raise resistance by the losing participants in advance of the linking of

schemes. Bode (2002) discusses in detail how the linkage of schemes and differences in design features like those discussed in the present paper interact with each other. Obviously, there are also often difficult legal issues involved (Rodi 2002).

## **Summary**

Tradable permit programs have been in use in the United States for a long time and are also on their way to becoming a very popular environmental policy instrument in Europe. This guide has aimed to highlight ten of the most important issues in designing a successful tradable permit program.

1. The choice of trading of emissions versus trading of inputs (e.g. CO<sub>2</sub> trading versus carbon content trading) depends on the degree to which the pollutant is uniformly mixed.
2. In most instances, mandatory schemes will be more cost-effective. They avoid adverse selection problems in participation.
3. Many arguments speak for the use of absolute baselines in national programs. We have also pointed out, however, that the concept of targeting a decline in CO<sub>2</sub> emissions intensity in the economy may have some merit.
4. The clear economic advice is to auction off permits instead of grandfathering them. Of course, political feasibility considerations will often make this impossible.
5. Initial allocations may be important for efficiency when there is a high degree of inequality in wealth between the trading entities, for example, in the international context.
6. Temporal flexibility should be allowed to as large extent as environmental effectiveness allows it.
7. The market management authority needs to be careful to avoid anti-competitive behavior on the market, although existing studies seem to indicate that strategic behavior on tradable permit markets is not an important phenomenon.
8. Participating firms and other entities must have the ability to quickly communicate in order to keep transactions costs low.
9. Continual monitoring of compliance and enforcement of the “rules of the game” of a tradeable permit program are essential ingredients in reducing uncertainty for market participants and to secure environmental effectiveness.
10. The design of national emissions programs in the presence of international agreements is difficult. Linking existing schemes inevitably produces losers who may need to be compensated.

## Appendix

**Table A1: Instruments of environmental policy and criteria to evaluate them**

Dimension	Instrument		
	Emission Charges	Tradeable permits	Regulation
Cost efficiency	+	+	-
Environmental effectiveness	-	+	+
Administrative practicability	+	+	+
Dynamic efficiency	+	+	0
Political acceptability	0	0/+	+

"+"=high, "-"=low, "0"=neutral.

Source: Klaassen (1996), Wagner and Schneider (2003)

**Table A2: Conditions affecting cost efficiency and environmental effectiveness**

	Cost efficiency			Environmental effectiveness		
	Charges	Permits	Regulation	Charges	Permits	Regulation
Uncertainty about costs	-	0	-	-	0	?
Imperfect markets	-	-	?	-	0	?
Transaction costs	0	-	0	0	0	0
Imperfect enforcement	0	-	?	0/-	-	-
Discontinuous control	0	0	-	-	0	0
Cost-saving techn. Progress	-	0	?	?	0	0
Economic growth	0	0	0	-	0	-
Inflation	0	0	0	-	0	0

"-"= negative impact; "0" = no impact; "?" = unknown

Source: Klaassen (1996), Wagner and Schneider (2003)

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