



## Objective and Audience

The overall objective of this series of Policy Briefs is to provide those in the policy system who deal with the design and implementation of emissions trading schemes with easy-to-read documents that allow them to understand some of the key issues, what theory and (especially) experience have to offer in clarifying choices and their implications. This Policy Brief provides a short introduction and overview.

Most choices involve tradeoffs, where more of something desirable can only be had at the loss of something less desirable. In policy, as in life, there are few unambiguous ‘win-win’ situations. We alert you, the reader, to the issues and implications involved and we provide our own views as to what is likely to be most effective and useful.

The key audience will typically have little or no background in economics, but will be wise to the ways in which policy evolves and is shaped. The text limits the use of technical language, of graphs and equations, and any material that might intimidate the non-specialist. Boxes are used to highlight case studies or interesting examples.

It is informed by the research papers presented at the Concerted Action on Tradable Emissions Permits (CATEP) workshops — these are available on [www.emissionstradingnetwork.com](http://www.emissionstradingnetwork.com) and have been synthesised in Convery *et al.* (2003), Haïtes (2003), Lefevre (2003) and Peterson (2003). They will also be published in synthesis form by the OECD in 2004.

The 5th Framework DG Research CATEP (Concerted Action on Tradeable Emissions Permits) network project has held a series of workshops over three years bringing together experts from policy, academic, research and industry fields to discuss the latest thinking, research and experience on Emissions Trading as the European Directive came closer to fruition. The Network consisted of eleven partners and this series of policy briefs reflects and synthesises the results of the workshops organised by the following topics:

1. Issues in Emissions Trading—an Introduction
2. Allocating Allowances in Greenhouse Gas Emissions Trading
3. Emissions Trading Regimes and Incentives to Participate in International Climate Agreements
4. Institutional Requirements
5. Linking Emissions Trading and Project-Based mechanisms
6. International Trade and Competitiveness Effects

A complete listing and links to all papers presented at the workshops and further details about the partners and the CATEP network can be found on the website: [www.emissionstradingnetwork.com](http://www.emissionstradingnetwork.com).

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## Making Markets Work for the Environment

Environmental endowments are those parts of our existence—atmosphere, oceans, the air we breathe, our landscapes and our buildings—that we somehow share in common. By the very nature of their commonly shared characteristic, the market fails to conserve these assets. Because they are public goods, they are not exchanged in markets, and therefore no price emerges to signal relative scarcity. As population and (especially) technological capacity to transform these assets grows, unless there is intervention, the destruction of these endowments is inevitable and inexorable. And so, we have observed in the past the atmospheric commons used as a free sink to dispose of greenhouse and acid-rain-inducing gasses, marine fisheries diminished to the point of extinction, and ugliness prevailing over beauty.

Economists argue that in many cases, this market failure can be addressed most effectively by providing users of the environmental endowment in question with a price that signals that this is a scarce asset. Pigou (1960) made the theoretical case for the use of environmental or ‘green’ taxes to adjust for market failure. His case was that the optimum level of pollution abatement occurs where the marginal cost of abatement just equals the marginal benefit yielded, and a tax per unit of pollution emitted that induces abatement to this point would be the socially optimal outcome. In effect, government should take ownership of our shared assets on behalf of the people, and charge for their use by means of a Pigovian levy or tax. Ronald Coase (1960) argued that the same effect could be achieved by assigning property rights to the environment, and then facilitating transactions between the parties. They would trade until all the potential gains from exchange had been exhausted. These theoretical frameworks have found practical expression today in the use of ‘green’ taxes, and emission trading. The latter is the focus of this policy brief. Just as taxes and charges can be used to shape behaviour in regard to any resource or environmental endowment, so can versions of emissions trading. This brief provides some context that will be useful for those in the policy process who wish to combine quantitative limits with trading to achieve conservation objectives.

## A Short History

Dales (1968) first outlined the conceptual and practical potential of trading as an instrument for addressing environmental dysfunction. In the mid 1970s, the US Environmental Protection Agency (USEPA) was faced with the situation that some parts of the country, and notably Southern California, were ‘non attainment’ areas as regards meeting air quality standards. In such areas, new sources, and existing sources that wanted to expand their facilities, were required to offset their additional emissions by acquiring emission reduction credits from existing sources. This pragmatic response to the need to allow economic development whilst also addressing the air quality constraint was gradually widened to the extent that the 1990 Clean Air Act Amendments authorised a variety of emission trading schemes. Title IV of this legislation provided the institutional and statutory framework for the US Acid Rain Program, which in 1990 established the first large-scale, long-term US environmental programme to rely on emission permits (Ellerman *et al.*, 1999, 2000).

As part of a programme to phase out the use of lead in gasoline, the USEPA set a limit of an average level of 1.1g per gallon beginning in 1982, falling to 0.5g per gallon in 1985 and 0.1g per gallon in 1987. To facilitate the phase down, EPA allowed two forms of trading—inter-refinery averaging during each quarter and banking for future use. Inter-refinery averaging allowed a refinery that was exceeding the specified thresholds to buy credits from one that was doing better than the thresholds specified. Banking allowed refineries that reduced below the specified thresholds in one quarter to hold on to them and use them in later quarter(s), when they exceeded same. This programme lasted only 4 years, and illustrates how flexible trading can be in facilitating rapid achievement of an objective at relatively low cost over a defined period.

Tietenberg (1986), Hahn (1989) and the National Center for Environmental Economics (2002) review the early experience. A key insight therefrom is the importance of keeping transactions costs under control—to keep the scheme as simple and transparent as possible (Stavins, 1995). Tietenberg (1996), Stavins (2002), Sorrell and Skea (1999), Skea and Sorrell (1999), and OECD (1999) document more recent activity.

Klaassen (1997) provided the first comprehensive review of the potential for the instrument in the European Union, and the UK and Denmark moved ahead to implement a trading scheme directed at greenhouse gasses. Emissions Trading was included as a ‘flexible instrument’—together with the Clean Development Mechanism (CDM) and Joint Implementation (JI)—in the Kyoto Protocol to the Climate Change Convention. The European Union has approved a ‘domestic’ emissions trading scheme for greenhouse gasses, to be initiated on a pilot basis in January 2005. The trading idea has also been used to create markets for water and for marine fisheries; both resources being very vulnerable to destructive overuse in the absence of appropriate market signals (Boxes 1 and 2).

1 Directive 2003/87/EC of the European Parliament and of the Council establishing a scheme for greenhouse gas emission allowances trading within the Community and amending Council Directive 96/61/EC. This text incorporates the amendments adopted by the European Parliament at its second reading on 2 July 2003 and accepted by the Council at its meeting of 22 July 2003. See Boemare and Quirion (2001) for analysis of this Directive.

**Box 1. The California Water Bank**

A water bank was operated by the State Department of Water Resources in California. In February 1991 purchases were negotiated at a fixed price of \$100/1000m<sup>3</sup>. Purchases ceased in April 1991. Purchasers paid a fixed charge of \$140 at the Sacramento Delta, with most of the difference between purchase and sale price going to pay for carriage water. Thirty per cent of the transferred water was needed for carriage water to provide salt protection in the Sacramento Delta. At this price, plus the transportation cost from the Delta, the Bank sold 488 million m<sup>3</sup>. Three quarters of the water was sold to urban agencies, at a cost—including transportation—of over \$185/m<sup>3</sup>.

The water was purchased mainly from farmers—50 per cent from irrigation water which they would otherwise have consumed, 33 per cent in the form of exchanging their surface water rights for ground water rights and selling the surface water to the Bank.

The demand was obtained from a committee representing urban and agricultural purchasers. There were far fewer purchasers than suppliers, but the fixed price approach eliminated potential market power of purchasers.

The estimated critical needs dropped from 769 million m<sup>3</sup> before the Bank was fully operational, to 601 million afterwards; an indication as to how responsive to price such needs can be.

The transfers generated an estimated net income and employment gain for the economy—as a result of transferring from lower to higher value uses—of \$106 million and 3741 jobs respectively. Note however that jobs did move out of the water exporting regions, but the gain in the importing regions more than compensated for such losses.

Source: Howitt (1994)

### Box 2. Individual Transferable Quotas in Chilean Fisheries

For certain species of fish in Chile, individual quotas are allocated to fishers. These permits are defined as shares of the Total Allowable Catch (TAC). The system does not provide for any type of individual back payments if TACs diminish. Annual TAC is defined on the basis of objective biological criteria, with updated information. In Chile, the initial allocation is made through a pure market mechanism, by open bidding in a public auction. When ITQs are applied for the first time to a given fishery, the total TAC for the coming year (100%) is auctioned.

For catch control, the vessels under ITQ have to accept the presence of scientific observers. In addition, the processing plants have to receive information about the catch.

Each permit lasts for 10 years. In order to prevent operators from taking lasting control of the fishing resource and to make the system more politically acceptable, a ‘divestment’ mechanism has been introduced, whereby each year 10% of the TAC has to be re-auctioned, and the initial permits are reduced accordingly. To keep the same quota, operators have to keep re-entering the market.

Fishers that do not consume their quota during the calendar year cannot carry the remaining bit forward, that is, there is no possibility of banking. The rights are considered fractions of the total quota and as the quotas have a life time of one year, the right lasts also for one year.

Even though by law the system of ITQs is open to any investor, foreign or domestic, involved in the fishing sector or not, a barrier to new entrants is constituted by the fact that fish can only be landed by Chilean vessels.

As of 2002, the system has been applied to a very limited range of fisheries, including:

- The ‘Squat Lobster’ Fishery (*Pleuroncodes monodon*) (since 1992)
- The ‘Black Hake’ or ‘Deep Cod’ Fishery (*Dissostichus eleginoides*) (since 1992)
- The ‘Yellow prawn’ Fishery (*Cervimunida jhoni*) (since 1997)
- The ‘Orange roughy’ Fishery (*Hoplostethus atlanticus*) (since 1999)

These together comprise about 1 per cent of total landings by volume and 2 per cent by value.

Source: Borregard, *et al.*, 2001.

## Forms of Trading

There are two forms of trading systems in use: the first is rate based, whereby entities earn credits when they reduce their emissions below a defined baseline, and emissions can increase with economic growth; the second is cap and trade, whereby the total volume of allowances permitted per unit time is specified, and allowances are allocated such that the total does not exceed the cap.

## Why Emissions Trading?

Emissions trading is valuable because it provides great flexibility to polluters as to how to respond to the requirement to reduce emissions. The flexible feature comes from the fact that emitters can buy and sell allowances. This allows those for whom it is very expensive to abate to buy allowances from those for whom it is very inexpensive to do so. The burden of compliance is thereby borne in a least cost fashion—the objective is reached with minimum burden on the economy. The price signal that emerges from these trades also induces innovation, as anyone who can find a way to abate more cheaply will not only benefit themselves, by generating allowances to sell, but others will be interested in adopting this innovation if it costs less than the value of the allowances generated by its implementation. The evidence from the (mainly) US experience is that compliance to meet a given standard costs much less than would be incurred if conventional ‘command and control’ policies regulating every emitter had been followed. See for example evidence in Ellerman *et al.*, 2000, Tietenberg, 1996, and Stavins, 2002.

In considering whether and how to implement emissions trading, the following issues have to be addressed: is it better than the other policy instrument options; if so, should rate based (baseline and credit) or cap and trade be used; to what extent should it be applied (scope); what units should be traded, over what period; how should allowances be allocated, and to whom; how should compliance be monitored and enforced.



## Choice of Instrument

Emissions trading is particularly appropriate where the emission has the same effect regardless of source or location. Greenhouse gasses have this quality. However, as we have seen, differential impacts, which are characteristic of acid rain precursors, do not preclude its effective use. An emissions tax of the same amount as the emissions allowance price should have approximately the same incentive effects, so that taxing instead of emissions trading is an option. Political viability is a key reason why trading is chosen. In some jurisdictions it can be very difficult to introduce a tax. This was true of the (failed) efforts to introduce a carbon energy tax in the European Union in the 1990s, and taxation has always been politically difficult at federal level in the US. Taxation generates funding, while trading with free allocation does not. Such funding can be used to compensate losers from taxation, and it can also be used to reinforce the effectiveness of the tax. Sterner (2003) makes the point that the NO<sub>x</sub> tax applied in Sweden is very high, and therefore has strong environmental effectiveness; industry is willing to pay such a high rate because the funds generated are recycled back to the industry which pays the tax, with those being most energy efficient getting the largest refunds. Where meeting a target is a high priority, then cap and trade emissions trading is preferable to taxation, because the high losses expected if the target is missed will be avoided. Conversely, if we are relatively indifferent about meeting a specific target, then taxation is likely to be more efficient. A wide variation in abatement costs at the margin is important if emissions trading is to maximise its effectiveness. This means that it does not combine well with individual facility permit licensing, where every installation is required to install best available technology. Such a provision eliminates many of the potential gains from trade. It is for this reason that the EU Emissions Trading Directive includes a provision relaxing such requirements.



## Rate Based or Cap and Trade?

Because the rate based (baseline and credit) model does not guarantee that a specific target will be met, then cap and trade is likely to be preferable if meeting a target is crucial. Thus, in the European Union, where legally binding national caps for both greenhouse gasses and acid precursors have been fixed, if emissions trading is the policy instrument of choice, then other things being equal, cap and trade would be preferred over baseline and credit. Also, the process of setting the baseline can be complex and time consuming to both design and administer, and this can also favour cap and trade. However, industry generally favours a rate based approach, because, if it meets the standard, it can expand indefinitely without having to buy allowances. This is especially important to firms that are facing international competitors who are not in an emissions trading scheme.<sup>2</sup> In effect, it shifts the risk for meeting the overall target to the general public.

## Scope

Which emissions should be covered by the scheme, over what geographical area? Any market is better than no market. As Dales (1968) puts it: if it is feasible to establish a market to implement a policy, no policy maker can afford to do without one. The key merit of emissions trading is that it facilitates and encourages abatement to take place wherever it is cheapest to do so. Thus, having firms with a wide variety of abatement costs is important, and the more firms there are involved the more likely this will be. Also, the competitiveness of the market will be enhanced to the extent that it involves a large number of buyers and sellers who individually lack sufficient market power to influence price. Because enforcement is important, national boundaries provide a natural limitation on widening scope, unless transfrontier enforceable provisions are in place—as in the European Union—or can be agreed. The potential creation of ‘hot spots’ is another. This does not arise in the case of emissions to the global commons such as greenhouse gasses or ozone-depleting substances. It does arise with regard to most forms of emissions to water, and emissions to air such as particulates and acid precursors. However, as Ellerman *et al.* (2000) point out, with regard to the US Acid Rain Program, such concerns turned out to be unfounded, because the worst emitters turned out to have the most profitable abatement opportunities, and therefore did the most in this regard. In the case of the RECLAIM trading scheme addressed to NO<sub>x</sub> emissions in Southern California, concerns regarding the source and incidence of emissions resulted in differential arrangements depending on whether sources were upwind or downwind. (Harrison, 1999).

2 The Netherlands is implementing a national acid precursor emissions trading scheme that is rate based, even though the country faces an absolute cap on such emissions (Directive 2001/81/EC of the European Parliament and Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants). This is a product of the competitive pressures the firms involved perceive. (Nentjes, 2002).

## Units and Period

The allowances need to be expressed per unit time, typically a year. Where different emissions can be combined as regards their environmental impact, e.g., acidification effects, greenhouse warming effects—the latter usually expressed in CO<sub>2</sub> equivalents—this should be done. Where there is wide oscillation from year to year, the units can be expressed as shares of the total applying for the year in question. This is what is done in regard to individual tradable quotas (ITQs) in the case of fisheries (See Box 2), and water trading. (Borregaard, *et al.*, 2001).

*Banking* is the provision whereby an installation can ‘store’ emissions reductions or acquisitions for use in a future period. Allowing banking has many merits. It provides flexibility to the firms involved, and it typically achieves early action, as most firms abate more, or buy more allowances than they need to in order to be sure that they avoid non-compliance. A potential disadvantage is that all firms ‘cash in’ their banked allowances at the same time in a future period, to the extent that assimilative capacity in that period is damaged. This does not arise with greenhouse gas emissions, but could be an issue with acid precursors or other pollutants. In practice, this has not happened. In the EU Emissions Trading Scheme, banking is permitted over the 3-year pilot phase, 2005-2007, and it is up to Member States to decide whether to allow banking from this period into the first commitment period (2008-2012). There is no suggestion that banking will be permitted from the first commitment period to a later period, presumably on the basis that the restrictions on emissions then will be more severe than what has applied heretofore, and banked allowances could undermine the potential for meeting targets post-2012.

*Borrowing*, whereby installations could exceed their allowances on the basis that they make up the difference in a future period, is not allowed under any schemes. This lack of flexibility going forward can be costly in the event of an price ‘spike’ such as happened in California with NO<sub>x</sub> allowances; old, relatively inefficient power plants were brought back into production to take advantage of escalating electricity prices, and sharply increased the demand for NO<sub>x</sub> allowances. The rise in allowance prices was so sharp that it was ‘capped’. An ability to borrow forward would have smoothed the price rise.



## Allocation of allowances

This issue is addressed in some detail in Emissions Trading Policy Brief 2. There are two broad choices. Auction them off, or give them away for free. Chile auctioned individual transferable quotas (ITQs) for fisheries but the allowances for other existing trading schemes—mainly in the US—have been give away free. Auctioning generates funding which can be used to compensate losers from the trading scheme, and to reduce other distorting taxes, and to ensure that those who can use allowances most efficiently get them. (Bohm, 1999, 2000). Free allocation on the other hand is strongly favoured by most of the sectoral interests involved, and is likely to be crucial in securing their support in many cases. There is an additional cost associated with free allocation, namely, the time and effort involved in making the allocation. As regards the bases for making free allocations, four can be identified—historic basis, projected sectoral emissions, benchmarking, and marginal cost; economists generally favour the marginal cost approach. Thus, where not all emissions are to be included in a trading scheme, the first task is to decide what proportion of the total is to be included in the latter. Economists favour estimating the marginal costs of abatement throughout the economy, rank ordering them beginning with the least costly and then identifying the lowest-cost package that will meet the overall target. Those abatement opportunities within this envelope that are in the trading sectors then comprise the quota to be allocated to the trading sector. The same equi-marginal abatement cost principle can be used to allocate to the sectors included in the emissions trading scheme. In practise, negotiating skill and political influence are likely to be salient factors in shaping who gets how much.

A decision has to be made as to the point in the production and consumption cycle the allowances are allocated. In the case of carbon dioxide, ‘upstream’ is typically taken to refer to the producers and importers of fossil fuels, while ‘downstream’ refers to the users of same, i.e., electricity producers, smelters, steel works, etc. The extreme version of downstream is where the final consumers, i.e., householders, motorists are granted the permits. In the case of greenhouse gasses, inclusion of all carbon based fuel producers and importers would capture most of the CO<sub>2</sub> emitted in any economy, and so would be very inclusive. But this would also yield windfall gains for these interests as the price of fuel rose to clear the market, and this is unlikely to secure popular or political support. In part for this reason, free allocation is generally undertaken further downstream. With regard to greenhouse gases, this too will give rise to equity challenges as electricity and other prices rise to clear the market. The situation can be addressed whereby, for example, the regulator (in the case of electricity) requires that householders benefit from demand-side management subventions provided by the utilities.

## Monitoring, Reporting and Enforcement

For any trading scheme to work effectively, the holders of allowances must have confidence in the ‘product’ they are buying and selling. This requires that the integrity of the system is maintained, and seen to be so; emitters in fact must have sufficient allowances to cover their emissions, and if they do not do so, they incur a substantial penalty. Ellerman, *et al.* (2000) point out that in the case of the Acid Rain Program in the US, emission monitoring requirements were very demanding, and compliance was close to 100 per cent. In the case of the European Greenhouse Gas Emissions Trading Scheme, each Member State will have a local ‘agent’ to maintain registries and monitor performance. The European Commission has responsibility for ensuring the full implementation of EU law, and there are substantial fines for non-compliance.



## Useful References

- Boemare, C. and P. Quirion, 2001. Implementing Greenhouse Gas Trading in Europe: Lessons from Economic Theory and International Experiences. Paper presented at Concerted Action on Tradable Emissions Permits (CATEP) International Workshop on: Trading Scales: Linking Industry, Local/Regional, National and International Trading Schemes, Fondazione ENI Enrico Mattei, Venice, December 3-4. Available on [www.emissionstradingnetwork.com](http://www.emissionstradingnetwork.com)
- Borregaard, N., Convery, F., Katz, R., 2001. Applying Trading in Developing Countries—the Chilean Experience. Presented at Workshop: ‘Trading Scales: Linking Industry, Local, Regional and National Emission Trading Schemes’, organised for the Concerted Action on Tradeable Emission Permits by FEEM, Venice, December 3 and 4, 2001. Available on [www.emissionstradingnetwork.com](http://www.emissionstradingnetwork.com)
- Bohm, P., 1999. An emission quota trade experiment among four Nordic countries. In: *Pollution for Sale: Emissions Trading and Joint Implementation*, eds. S. Sorrell and J. Skea, Edward Elgar, Cheltenham.
- Bohm, P., 2000. International Greenhouse Gas Emission Trading—with special reference to the Kyoto Protocol. In: C. Carraro (ed.), *Efficiency and Equity of Climate Change Policy*, Kluwer, Dordrecht.
- Coase, R., 1960. The Problem of Social Cost, *Journal of Law and Economics*, Vol. 3, pp. 1-44
- Convery, F. J., Dunne, L., Redmond, L., and Ryan, L., 2003. CATEP Synthesis Paper: Political Economy of tradeable permits—competitiveness, co-operation and market power. Presented at OECD Global Forum on Sustainable Development: Emissions Trading, March 17-18, Paris. Available on [www.emissionstradingnetwork.com](http://www.emissionstradingnetwork.com)
- Dales, J.H., 1968. *Pollution, Property & Prices: an Essay in Policy Making and Economics*, University of Toronto Press
- Ellerman, A. D., R. Schmalensee, P. L. Joskow, J-P. Montero, and E. M. Bailey, 1999. Summary evaluation of the US SO<sub>2</sub> emissions trading program as implemented in 1995. In: Sorrell and Skea (eds.), *Pollution for Sale—Emissions trading and Joint Implementation*, Edward Elgar, Cheltenham, pp. 27-42.
- Ellerman, D. A., Schmalensee, R., Bailey, E. M., Joskow, P. L., and J-P. Montero, 2000. *Markets for Clean Air—the US Acid Rain Program*, Cambridge University Press.
- Hahn, R., W., 1989. Economic Prescriptions for Environmental Problems: How the Patient Followed the Doctor’s Orders. *J. of Economic Perspectives*, 3, No. 2 (Spring), pp. 95-114.
- Haïtes, E., 2003. CATEP Synthesis Paper: harmonisation between national and international tradeable permit schemes. Presented at OECD Global Forum on Sustainable Development: Emissions Trading, March 17-18, Paris.
- Harrison, D., Jr., 1999. Turning Theory into Practice for Emissions Trading in the Los Angeles Basin. In Sorrell and Skea (1999) *Pollution for Sale*, Edward Elgar, Cheltenham, pp. 63-79.
- Howitt, R. E. 1994. Empirical Analysis of Water Market Institutions: the 1991 California Water Market, *Resource and Energy Economics* 16, pp. 357-371.
- Klaassen, G., 1997. Practical Experience, International Agreements and the Prospects for Emission Trading in the CEE. In Peter Kaderjak and John Powell (eds) *Economics for Environmental Policy in Transition Economies; an Analysis of the Hungarian Experience*, Cheltenham: Edward Elgar.

Lefevre, J., 2003. CATEP Synthesis Paper: Links between emissions trading and project based mechanisms. Presented at OECD Global Forum on Sustainable Development: Emissions Trading, March 17-18, Paris.  
Available on [www.emissionstradingnetwork.com](http://www.emissionstradingnetwork.com)

National Centre for Environmental Economics, 2002. The US Experience with Economic Incentives for Protecting the Environment, US Environmental Protection Agency, Washington DC.

Nentjes, A., 2003. NOx Emissions Trading in the Netherlands. Presented at CATEP Workshop: Maximising the Potential of Emissions Trading in Advancing Sustainability Agendas in an Expanded European Union—the role of Research, organised for the Concerted Action on Tradable Emission Permits by UCD, Brussels, May 22, 2003.  
Available on [www.emissionstradingnetwork.com](http://www.emissionstradingnetwork.com)

OECD, 1999. Implementing Domestic Tradable Permits for Environmental Protection, OECD, Paris.

OECD, 2004. Greenhouse Gas Emissions Trading and Project-based Mechanisms in OECD and non-OECD Countries, OECD, Paris

Peterson, S., 2003. CATEP Synthesis paper—Monitoring, accounting and enforcement in tradeable permit regimes, presented at OECD Global Forum on Sustainable Development: Emissions Trading, March 17-18, Paris.  
Available on [www.emissionstradingnetwork.com](http://www.emissionstradingnetwork.com)

Pigou, A.C., 1960. The Economics of Welfare, 4th Edition, Macmillan, London.

Sorrell, S., and J. Skea, 1999. Pollution for Sale, Edward Elgar, Cheltenham.

Skea, J. and Sorrell, S., 1999. Emissions trading, Number 2, Environmental Policy Briefs, Environmental Institute, University College, Dublin. Available on [http://www.ucd.ie/envinst/envstud/UCD\\_2.PDF](http://www.ucd.ie/envinst/envstud/UCD_2.PDF)

Stavins, R.N. 1995. Transaction Costs and Tradable Permits, Journal of Environmental Economics and Management, Vol. 29, pp. 133-148.

Stavins, R.N., 2002. Experience with Market-based Environmental Policy Instruments. In: The Handbook of Environmental Economics, Eds Karl-Goran Maler and Jeffrey Vincent, North-Holland/Elsevier Science, Amsterdam.

Stern, T., 2003. Policy Instruments for Environmental and Natural Resource Management, Resources for the Future, Washington DC.

Tietenberg, T. H., 1985. Emissions Trading: an exercise in Reforming Pollution Policy, Resources for the Future, Washington DC.

Tietenberg, T. H., 1996. Environmental and Natural Resource Economics, 3rd Edition, Harper Collins, New York.

## Author

**Frank Convery**

Environmental Institute, University College Dublin

## CATEP active partners

|   |  |
|---|--|
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