Incentives for Eco-efficiency Lessons from An Evaluation of Policy Alternatives: a Case Study of the Steel Sector in India

Ritu Kumar, Nick Robins, A.K. Chaturvedi, R.Srinivasan and J.Gupta

Working Paper No 11

December 1996

The authors

Ritu Kumar is a Research Officer at the United Nations Industrial Development Organisation (UNIDO). She may be contacted at:

UNIDO
Vienna International Centre
P O Box 300
A-1400
AUSTRIA

Tel 43 1 211315081
Fax 43 1 535 8230
email: rkumar@unido.org

Nick Robins is Coordinator of the European Programme at IIED. He may be contacted at:

IIED
3 Endsleigh Street
London WC1H 0DD

Tel: 44 (0)171 388 2117
Fax: 44 (0)171 388 2826

A.K. Chaturvedi is Counsellor, and R Srinivasan is Executive Officer with the Environment Management Division at the Confederation of Indian Industry (CII). J. Gupta is Consultant Economist to CII. They may be contacted at:

CII
4th Floor
IV Zone
Lodi Road
India Habitat Centre
New Delhi 110003
INDIA

Tel: 81 11 464 5288
Fax: 81 11 460 2524
Email: indus%cii@sirnetd.ernet.in

The programme of Collaborative Research in the Economics of Environment and Development (CREED) was established in 1993 as a joint initiative of the International Institute for Environment and Development (IIED), London, and the Institute for Environmental Studies (IVM), Amsterdam. The Secretariat for CREED is based at IIED in London. A Steering Committee is responsible for overall management and coordination of the CREED Programme.

Environmental Economics Programme, IIED

IIED is an independent, non-profit organisation which seeks to promote sustainable patterns of world development through research, training, policy studies, consensus building and public information. The Environmental Economics Programme is one of seven major programmes of IIED; it conducts economic research and policy analysis for improved management of natural resources and sustainable economic growth in the developing world.

Environmental Economics Programme
IIED, 3 Endsleigh Street
London WC1H 0DD, UK
Tel (44 171) 388 2117; Fax (44 171) 388 2826
e-mail: JSIIED@aol.com

Institute for Environmental Studies, (IVM)

IVM is a non-profit research institute, based at Vrije Universiteit, Amsterdam. The Institute's primary objective is to carry out multi- and interdisciplinary research on environmental issues, based on cross-fertilisation of monodisciplinary sciences. Environment and the Third World is one of eight major IVM research programmes.

IVM, Vrije Universiteit
De Boelelaan 1115
1081 HV Amsterdam
The Netherlands
Tel: (31 20) 444 9555; Fax: (31 20) 444 9553
e-mail: ies@sara.nl

CREED Steering Committee members include:

Acknowledgements

This paper is based on a study on the Application of Market Based Instruments for Pollution Prevention: A Case Study of the Steel Sector in India, sponsored by the CREED programme of the International Institute for Environment and Development (IIED), London and the Institute for Environmental Studies, Amsterdam. The paper is part of a collaborative research effort between IIED, the United Nations Industrial Development Organisation (UNIDO), and the Confederation of Indian Industries (CII). The authors wish to thank and acknowledge the research inputs provided by personnel of the Tata Iron and Steel Company (TISCO), Mr. R.P. Sharma, and the Steel Authority of India Ltd (SAIL), Mssrs. Rastogi and Ghosh.

Abstract

This paper is based on the results of a case study on market based instruments (MBIs) for pollution prevention for the steel sector in India. Four policy scenarios, combining command and control measures - ie discharge standards - with market based instruments, such as pollution charges and intra-plant trades, are evaluated and ranked according to five criteria. Scenario rankings show that the performance of policy measures changes when qualitative assessments of administrative feasibility and public transparency are added to the more precise criteria of environmental efficiency, cost effectiveness and incentive provision. Assessments on the basis of the latter three give high grades to certain types of MBIs, whereas evaluations on political acceptability are not as favourable.

Resumen

Esta monografía se basa en resultados obtenidos en un estudio de caso sobre el uso de instrumentos de mercado para la prevención de la contaminación en el sector del acero en la India. Con la ayuda de cinco criterios se evalúan y clasifican cuatro escenarios de política en los que se combinan medidas de comando y control, como por ejemplo estándares de evacuación, con instrumentos de mercado, tales como gravámenes a la contaminación y comercio al interior de establecimientos productivos. Estas evaluaciones muestran que el desempeño de las medidas de política varía cuando a criterios cuantitativos como los de eficiencia ambiental, rentabilidad y creación de incentivos se añaden juicios cualitativos acerca de factibilidad administrativa y transparencia pública. Las evaluaciones inspiradas en criterios cuantitativos le asignan un alto puntaje a ciertos tipos de instrumentos de mercado; sin embargo, el uso de criterios de aceptación política no los favorece en la misma medida.

Abrégé

Ce texte repose sur les résultats d'une étude concernant des instruments basés sur le marché (IBM), destinés à la filière sidérurgique indienne pour y prévenir la pollution. Sont évalués et classés selon cinq critères, quatre scénarios combinant des mesures de commande et de contrôle - c.-à-d. des normes d'effluence - mises en œuvre à l'aide d'instruments basés sur le marché, tels que les taxes à la pollution et les échanges à l'intérieur des usines. Le classement des scénarios montre que les performances des mesures d'ordre politique changent quand on ajoute les évaluations qualitatives (faisabilité administrative et transparence publique) aux critères plus précis que sont l'efficacité environnementale, l'efficacité-coût et l'établissement de mesures incitatives. Les évaluations effectuées à partir de ces trois derniers critères aboutissent à un classement élevé de certains types d'IBM, alors que celles qui reposent sur l'acceptabilité politique s'avèrent moins favorables.

Contents

Introduction **1**

Methodology **3**
Pollution charges 3
Tradable permits 4

Policy Scenarios **7**
Scenario 1: Standards plus 7
Scenario 2: Pollution prevention rebate 8
Scenario 3: Eco-efficiency charge 9
Scenario 4: Intra-plant trading 9
Cost effective TSS reduction 9

Scenario Rank Ordering **12**
Criteria 12
Rank ordering 14

Policy Implications and Conclusions **17**

References **19**

.

Introduction

The 1990s have seen a growing global interest in the potential of market based instruments (MBIs) for pollution prevention. A new alliance of policy makers, enlightened industrialists and environmentalists has emerged, which sees MBIs both as a necessary complement to market-friendly economic policies, and as a powerful tool for reducing environmental damage and conserving natural resources. A number of countries, mainly in Europe and the USA, have instituted pollution prevention policies based on economic incentives and market based instruments. However, the introduction of MBIs designed on the basis of economic techniques such as cost minimisation models of pollution abatement, has so far been limited, even in developed countries. Most first generation applications of economic incentives in OECD and other countries have been based on a pragmatic approach, often conceived within an overarching command and control framework (OECD, 1994). Thus, most pollution charges have been used primarily to raise revenues for environmental action, with the aim of providing incentives for pollution prevention as a secondary or subsequent goal. The evolution of the Dutch Surface Water Charge is a good example of this first generation. Even tradable permit schemes in the USA have traditionally been based on negotiated agreements developed by the US Environmental Protection Agency (EPA), and not on economic models.

Recently, a second generation of MBIs has emerged, characterised by a comprehensive application of the economic approach both in the analysis of the environmental problem to be tackled and in the design of the instrument itself. The Swedish Nitrogen Oxide Charge is a case in point, where the Ministry of Environment linked the rate set for emissions of nitrogen oxides from power stations to estimates of abatement costs. Recent tradable permit schemes in the USA also take this comprehensive approach. Among developing countries, the Malaysian palm oil effluent charge is one example of how economic methods and techniques have been utilised to design market based instruments.

Another example is the recently completed study by the International Institute for Environment and Development, (IIED) and the Confederation of Indian Industries (CII) on "Application of MBIs for Pollution Prevention: A Case Study of the Steel Sector in India, on which this paper is based. [1]We attempt to evaluate the results of the study (henceforth referred to as the steel study) with a view to obtaining some general principles and ideas about the performance of alternative policy scenarios that combine command and control measures (CAC) with MBIs. The steel study in India proposes four policy scenarios that include various combinations of discharge standards and pollution charges and intra plant trades for five pollutants: total suspended solids, cyanide, phenol, ammoniacal nitrogen (water pollutants) and suspended particulate matter (air). These scenarios have been developed on the basis of cost minimisation models of pollution abatement of the type described by Stavins (1993). In the present paper we provide some insights gained from the results of that study relating to the performance of alternative policy options.

The paper is structured as follows. The first section provides a brief description of the methodology used in the steel study to design policy options. This is followed by a description of the four policy

[1] The present paper is based on the preliminary results of this study.

scenarios. As an example, we also state the findings pertaining to one water pollutant, total suspended solids (TSS), for each scenario. Next we describe the five criteria used to evaluate the policy options. Three of these criteria are quantifiable and can be assessed fairly rigorously, whereas the remaining two are more ambiguous and findings would vary depending on the prevailing conditions in-country and for the sector as a whole. We find that the ranking based on quantitative assessments changes considerably when the more qualitative judgements are included. The concluding section of the paper is devoted to more general policy and corporate implications of introducing MBIs in a developing country with typically weak monitoring and enforcement capabilities for pollution control.

Methodology

A basic objective of MBIs is to promote the efficient use and allocation of environmental resources so that the socially optimal level of economic activity coincides with the private optimum. In other words, the external costs of pollution, which result in the divergence between private and social objectives, should be internalised with the help of economic instruments. Full internalisation of pollution costs would occur when the marginal abatement costs are equal to the marginal damage costs. This will give an "efficient" level of pollution control. In practice however it is difficult to estimate the damage costs resulting from pollution emissions[2] and therefore difficult to arrive at an ideal "Pigouvian" tax that exactly reflects the marginal costs of pollution.

A second best approach then is to estimate "cost effective" pollution control allocations that equate the marginal costs of controlling pollution across firms. This may be done for example by levying a per unit tax on pollution discharged or by tradable pollution permits, which in turn provide the right incentive to individual firms for cost effective total investment in pollution control. Under conditions of perfect competition and profit maximisation this procedure is the least cost method for achieving specified abatement targets. The following paragraphs illustrate the theoretical framework underlying the development of two types of MBIs: pollution charges and tradable permits. This is done for a simplified abstract case to demonstrate the economic rationale and cost effectiveness of using market based instruments.

Pollution charges

Figure 1 illustrates the cost effective policy approach for a uniformly mixed flow pollutant[3] for a two firm case. The analysis assumes that firms are cost minimising and operate in a perfectly competitive world.

Taking aggregate desired abatement level to be fixed at A^* [4]we then ask the question: how can this be achieved in the most cost effective manner? If we were to consider only two firms with marginal abatement costs MAC1 and MAC2, then the least cost method would require allocating the aggregate abatement level between the two factories in a manner that equates their marginal abatement costs (MAC1=MAC2). The pollution charge is then set at t*=MAC1=MAC2, which equates the MAC of all firms but allows them to abate at different levels. The imposition of the charge induces firms to change pollution emission levels in accordance with their respective marginal abatement costs. With the pollution charge, the total costs of abatement are the sum of OXA_1 and OYA_2. If the government were to set an ambient (aggregate) standard at A^* in place of the pollution

---

[2] A number of valuation methods such as hedonic pricing, travel cost, contingent valuation, dose response functions etc. are used to estimate environmental resource prices. In practice however it can be extremely difficult and costly to undertake these valuation exercises.

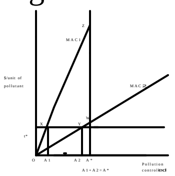
[3] A flow pollutant does not accumulate in the environment over time. A uniformly mixed pollutant is one for which the location of individual emissions has no effect on ambient pollution concentrations. The more complex case of non uniformly mixed pollutants can be developed by examining charges and permit schemes based on ambient levels rather than emission levels and permits.

[4] Note that the desired level of pollution control is taken as exogenously determined and remains a question mark. One way to ascertain the level of A^* is to use prevailing ambient or emission standards as benchmarks.

tax, the total costs of abatement would be higher at OZA^* plus OWA^*. Moreover the government would require detailed information on the costs faced by each source.

It should be noted that the above result is valid only under the assumption that cost curves are accurately estimated. If the true marginal abatement cost curve is above the estimated curve then depending on the elasticity of the marginal benefits with respect to the pollutant, it may well be that a uniform standard would minimise the net loss in social surplus. In addition, the approach is useful only if the marginal abatement costs across different sources are very different.

Figure 1



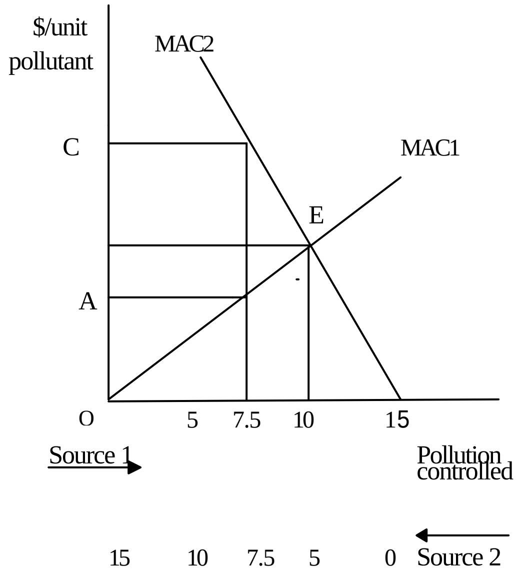
Tradable Permits

Tradable permits offer an alternative way to minimise the total costs of abatement and achieve cost effective pollution control. For purposes of illustration it is assumed once again that there is perfect competition and firms maximise profits. The government uniformly allocates a fixed amount of permits to each firm. Firms are free to trade permits amongst themselves. It is also assumed for the moment that there are no transaction costs and that there is no entry or exit from the permit market. In reality, of course, the assumption of zero transaction costs[5] is highly improbable. The implications of this for tradable permits have been studied in some detail by Robert Stavins (Stavins 1993).

Assuming that the government allocates emission permits equivalent to 7.5 tonnes of pollutant each to the two firms facing marginal abatement cost functions as depicted in figure 2, the firms will start to exchange permits until they reach point E where any further gains from trade have been eliminated. At all points to the left of E firm 2 will be willing to buy permits at a price less than C and therefore controls less (since it is has higher costs of control), and firm 1 will sell permits at a price greater than A and therefore controls more. This exchange will continue until point E where the total level of pollution control is equal to the desired level.

Figure 2

[5]Transaction costs of exchanging permits can be classified into three broad categories: search and information costs; bargaining and decision costs; and, monitoring and enforcement costs. Search and information costs arise because a potential buyer of an emission permit spends time, effort and possibly money (if a broker is hired) in locating a seller. Bargaining costs are incurred for fees for legal, brokerage and insurance services . Monitoring and enforcement costs are borne by the government to ensure that emission reductions are compatible with permits exchanged.



There are two main variants of the trading system, depending on the manner in which the "bubble" is defined. The first type is inter plant trading (as described above) which allows routine shifts in emission limits among existing plants if total emissions under the bubble do not increase. In this case the bubble is usually a geographical boundary defined over a fairly vast area that covers a number of polluting industries. A second variant, in which the bubble is defined on the basis of a single large firm, is that of intra plant trading. This allows large firms with more than one discharge outfall to make trades that offer them the option of reducing pollution loads beyond discharge limits at one or more outfall, and crediting it to other outfalls at the same facility so that the predetermined level of pollution reduction or environmental standard is met. The trades may also be subject to additional restrictions such as the requirement that net discharge of traded pollutants must be less than the discharge allowed without trades by a certain reduction factor. The basic rationale and concept is however the same as in inter plant trading.

It should be noted that inter industry trades of pollution permits as a means of cost effective pollution prevention may not be a viable alternative in many developing countries if transaction costs of exchanging permits are very high (Stavins, 1995). Since these costs are lower in the case of intra plant trades, it may be better to design trading schemes for single large firms with multiple discharge outfalls as a first step. Success in this initiative could pave the way for more ambitious ventures if prerequisites for successful application, including low transaction costs, are met.

Policy Scenarios

The steel study in India has used the basic conceptual framework described above to elaborate three scenarios that combine the use of discharge standards and pollution charges. The fourth scenario relates to intra plant trades. Due to data limitations it was not possible to rely purely on the economic approach for this scenario, and therefore a “negotiated settlement” approach of the kind used by the US EPA in its steel water bubble was also used (Industrial Economics Inc. 1994)

Pollution abatement cost functions were estimated for five pollutants (TSS, cyanide, phenol, ammoniacal nitrogen, suspended particulate matter) discharged from different facilities operating in two large integrated iron and steel mills. The data was collected by means of a questionnaire. This was followed by personal interviews with the environment division staff of the two plants to verify the data, fill in data gaps and elaborate engineering cost functions for the five pollutants. A separate engineering cost function for each discharging unit was estimated.

The decision to use engineering cost functions based on technological treatment processes and parameters rather than economic or behavioural cost functions was guided by practical constraints of data and time availability. A similar analysis would be possible by deriving marginal cost equations from well behaved production functions maximised subject to input constraints of different units in the steel plants.

Marginal abatement cost functions were derived for each pollutant by differentiating total abatement costs. These equations were used, together with data on emissions and abatement levels to do a number of simulations and iterations in order to equate marginal costs across units and arrive at combinations of charges and standards that result in higher abatement levels at least cost to the industry as a whole.

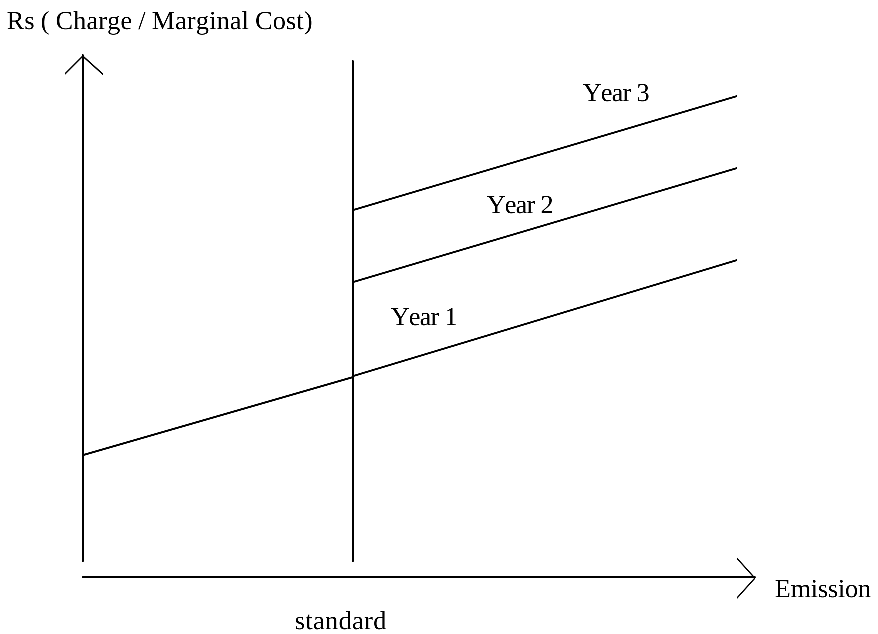
The following paragraphs describe four scenarios or policy options that are relevant for the introduction of MBIs for pollution prevention in the steel industry in India. All four scenarios allow for the development of "hybrid" instruments that combine command and control measures with economic incentives.

Scenario 1: Standard plus

A practical environmental management system is likely to revolve around effluent standards which reflect a social consensus (or technocrats' judgement) on an acceptable level of environmental quality. A system based on MBIs would also need to employ some benchmark to indicate a desired level of environmental quality, which it would try and achieve in the most cost effective way. This desired level of environmental quality is implicit either in ambient standards for air and water pollution or in discharge standards. Each standard corresponds to a total level of pollution abatement for the specific pollutant it pertains to. The "standards plus" scenario describes an option where a charge is levied on those firms whose pollution levels exceed discharge standards.

Figure 3 illustrates the general idea behind the standards plus scheme for a pollutant " P". The upward sloping lines indicate that pollution charges are directly proportional to levels of emission, being set at marginal abatement costs at each level.

Figure 3 Standard plus



The above diagram attempts to index the charge to inflation on an annual basis. This is reflected in the annual upward escalation of the charge in accordance with the inflation rate.

Scenario 2: Pollution prevention rebate

This option is an extension of the standard plus scenario whereby a rebate is provided to those firms or units that are able to reduce pollution emission levels below a specified amount (eg, the level inherent in the discharge standard). The idea of a rebate is to provide further incentives for adoption of pollution prevention methods and techniques. A rebate may be given to units who abate more than the recommended standard. The amount of rebate will vary depending on how much revenue is collected from pollution charges, and on the criteria for disbursement of environmental funds. In general it is recommended that the rate of rebate should be lower than the charge level. One example of a similar system is the Swedish nitrogen oxide charge, where the charge revenue is returned to the polluting source in proportion to final energy output.

In the above two examples the charge is levied on the concentration of pollutant eg, on total suspended solids per unit of waste water. If firms exceed the concentration based standard, they are charged a certain fee. This type of incentive scheme has the inherent disadvantage that firms could meet discharge standards and avoid fees by diluting their waste streams with fresh water.

Moreover, it provides incentives for firms to meet discharge standards but not to go beyond the level of abatement specified in the standards, even if the marginal cost of abatement is small. This has been the experience in China where pollution control levies have not had the desired incentive effect. As reported by Florig et al, "fees are not indexed for inflation, and, for state owned enterprises, they can be included under costs and later compensated through price increases or tax deductions". To induce firms to go beyond compliance, a volume or mass based waste water discharge fee would be more effective (Florig et al, 1995). We now turn to what is termed an "eco-efficiency" charge that addresses some of the problems inherent in a concentration based charge.

Scenario 3: Eco-efficiency charge

The "eco-efficiency charge" differs from the two scenarios already described in that the charge is levied on emissions per tonne of steel produced rather than on emission concentrations. The scheme would necessarily require that emission standards also be specified in terms of emissions per tonne of steel. This would require a substantive reform of the existing system of concentration based discharge standards.

Since the charge is linked to steel production it automatically adjusts to the rate of inflation. However, there is a danger that with continuous increases in steel production accompanied by less than proportionate changes in emissions, the incentive to reduce pollution beyond compliance may erode. In order to safeguard against this possibility a gradual tightening of the charge linked to annual rates of increase in steel production is introduced.

Scenario 4: Intra plant trading

As mentioned above, intra-plant trading schemes can be devised using second best cost minimisation models of the type used for modelling the first three scenarios. Ideally we should use such an economic analysis, based on marginal abatement costs to devise a permitting system. An alternative approach is to arrive at permit allocations through negotiations between polluting units. This negotiated settlement route was adopted by the US Environmental Protection Agency for its steel water bubble policy (Industrial Economics Inc. 1994). The steel study combines the economic approach with the "negotiated settlement" route to devise a set of experimental intra plant trades for TSS[6] in one of the steel plants.

An illustration: cost effective TSS reduction

Modelling results for the policy options described above indicate that substantial gains in terms of pollution reduction and cost savings are possible if existing discharge standards are combined with pollution charges. Mass based schemes perform even better than concentration based schemes since they pre-empt the option of diluting waste water. Tables 1 and 2 give a summary of the results achieved for TSS abatement for scenarios one and three:

[6] Cyanide, phenol and ammoniacal nitrogen were not suitable pollutants since there is only one discharge outfall in the factory.

Table 1: Scenario one: Standard plus (concentration based)

Scenario	Total abatement	Total abatement cost	Total revenue
Current standard (Concentration based): 100 mg per litre of wastewater	1.16 million tonnes	Rs 56.87 million	Nil
Standard plus: Current standard and a charge of Rs 1,100 per litre of wastewater	7.76% increase	0.27% decrease	Rs 10.1 million
Standard plus: a tightened standard of 75 mg per litre of wastewater and a charge of Rs 1,100 per mg per litre of wastewater	9.48% increase	0.24% decrease	Rs 13 million

Table 2: Scenario three: Eco-efficiency standards plus (mass based)

Scenario	Total abatement	Total abatement cost	Total revenue
Current standard(mass based): 1.6 kg of TSS per tonne of finished steel	26023.23 tonnes	Rs 623.47 million	Nil
Standard plus: Current standard and a charge of Rs 82,000 per kg of TSS per tonne of finished steel	570% increase	0.58% decrease	Rs 88.9 million

The benefits of the two scenarios result from a combined reduction in abatement cost and in pollution reduction, which in turn is a consequence of the fact that industries are trying to achieve a certain level of pollution abatement at minimum cost. With scenario one (concentration based standard plus charge) the percentage increase in total abatement, compared to the existing "standards alone" policy is 7.76 and the percentage reduction in total abatement costs is 0.27. The corresponding figures for scenario three (eco-efficiency) are 570 per cent and 0.58 per cent respectively.[7] This demonstrates the additional advantages of switching to a mass based eco-efficiency charge system.

An additional advantage of the eco-efficiency charge is that it is more amenable to the introduction of intra-plant trades where the "bubble" covers the steel plant, and standards - in terms of emissions per tonne of steel - are set at the factory gate.

The results described above point to the fact that a switch to mass based standards and charges and/or intra-plant trades would result in substantial reduction in pollution discharges at a

[7] It should be noted that the figures for total abatement and total abatement costs are not comparable under scenarios one and three i.e. calculation of total abatement (and costs) under scenario three is made on the basis of a direct translation of concentration based standard of 100 mg/litre to a mass based standard of 1.6 kg of TSS per tonne of steel. This does not mean that the total abatement levels are comparable in absolute terms. What is comparable is the percentage change in abatement and abatement costs when pollution charges are added on in both schemes.

considerable saving to the industry as a whole. If these scenarios are compared with the existing CAC system of discharge standards (which must be met by each unit within the plant) and ranked according to criteria of environmental efficiency and cost effectiveness, it emerges that eco-efficiency standards plus charges perform the best followed by concentration based standards plus charges (with or without rebate). One explanation for the better performance of a system based on total pollution loads per tonne of steel, is that it encompasses volume of waste water discharged. A concentration based scenario may be ineffective in bringing down pollution loads (unless accompanied by a wastewater charge) if firms resort to dilution of waste water. With a mass based standard or charge, dilution would no longer be an attractive option for industry, and correspondingly pollution discharge levels will decrease. The results indicate, in addition, that this may well be at a lower cost to industry.

Scenario Rank Ordering

The previous section described four hybrid scenarios, combining command and control measures with MBIs,[8] within the general decision framework of cost effectiveness. However, cost effectiveness may not be the only objective of policy makers. Issues pertaining to distributional justice, political acceptability, administrative feasibility, corporate response, monitoring, enforcement, legal and institutional requirements, are also important. Any evaluation of options open to policy makers should investigate the impact the chosen option will have on these aspects as well. In this paper we consider five criteria for ranking policy scenarios; these broadly cover the three 'Es' an environmental policy should satisfy: environmental effectiveness, economic efficiency and equity (O'Connor, 1996). As discussed below not all criteria can be measured in quantitative terms; in particular measurements of distributive and equity impacts are difficult and necessitate a degree of qualitative judgement.

In this paper the distributive implications per se of the proposed policies are not directly analysed. We have instead concentrated on a related aspect of "political acceptability", which is also dependent on qualitative assessments. Two considerations become important: one is the potential opposition from steel producers on whom the tax is to be levied; and the other is that of public transparency of the policy instrument. The former problem ie. that of political opposition from industry, is addressed by maintaining revenue neutrality of the tax in two ways: offering the possibility of a pollution prevention rebate and setting up a pollution prevention fund from the proceeds of the charge. The question of public transparency is discussed further in the following paragraphs.

Criteria

The evaluation criteria used in this paper derive from the broader concerns of efficiency, effectiveness and political acceptability. These are as follows (see Kumar and Sherif, 1994):

1. Does the policy achieve the stated goals in terms of pollution reduction?
Each of the four scenarios is designed to achieve a certain level of pollution reduction. The base case takes this as the level inherent in the specified discharge standard for each pollutant. All scenarios considered above surpass the total abatement levels inherent in the existing standard, and are therefore recommended in terms of environmental effectiveness.

2. Is the policy cost effective?
For each policy, the total pollution abatement cost of achieving the targeted level of pollution reduction is calculated and compared to the costs of the existing "standards alone" policy. Ideally we should add a cost component corresponding to the monitoring and enforcement costs that would be borne by the regulatory authorities. However, due to the lack of accurate data , only a qualitative and rough idea of the latter is possible.

[8] These are by no means the only options open to policy makers and various combinations of instruments are possible.

Policy combinations considered by the steel study were selected only if they resulted in a lower or similar total abatement cost than the abatement cost incurred if the existing standard is to be met. This makes the proposed policies more cost effective than the existing standards alone policy.

3. Does the policy provide incentives for research and innovation for better pollution control and pollution prevention technologies?

This is an important criteria since a major advantage of MBIs is precisely that they provide incentives to go beyond compliance. An interesting study by Jung et al (1996) has evaluated the incentive effects of five environmental policy instruments and ranked them, from most to least incentive, as follows: auctioned permits; emissions taxes and subsidies; issued marketable permits; and performance standards. This ranking is found to be invariant with respect to the size of firms, the size of the industry, or the industry's abatement cost structure (Jung, Krutilla and Boyd, 1996). Our findings are in line with this rank ordering, in that we find that intra-plant trades with mass based standards and charges have the largest incentive effect, followed by the pollution prevention rebate and standards plus approach.

4. Is the policy administratively feasible to monitor and enforce?

The administrative feasibility of policy implementation depends to a large extent on the effectiveness of the administrative authority charged with monitoring and enforcing environmental protection measures. In the Indian context this is the State Pollution Control Boards (PCBs). Their effectiveness varies a great deal between Boards in different states, but the general feeling is that the pollution control boards are understaffed and lack adequate resources and facilities to effectively monitor and enforce the existing system.

Any of the four policy options described above would require effective monitoring and enforcement. A study conducted by Mehta et al (1993) has used a simple model developed by Malik (1992) to show that although enforcement costs can be higher for incentive based policies than for policies based on direct controls, no general result is available regarding which policy minimises the sum of abatement and enforcement costs. One recent paper by Gangopadhya, Goswami and Sanyal (1991) has examined the enforcement question on the assumption that enforcers are corrupt and want to maximise their own expected incomes. It has been shown that incentive compatible enforcement systems are feasible even if we assume that regulators are prone to corruption.

In any event, there is a case for investigating the possibility of first, lessening the monitoring burden on the pollution control boards by encouraging self monitoring or third party monitoring; and second, augmenting the resources of the PCBs and making them more effective. The mix of policy instruments in the four scenarios elaborated in the steel study addresses both these issues. A third aspect that becomes important in the case of pollution charges or eco-taxes is the administrative ability to collect tax revenues. A fourth issue that is of relevance to tradable permits is the existence of an institutional machinery for issuing permits and monitoring trades (O'Connor 1996). This can be a serious constraint in the Indian case. Fortunately however the institutional demands of intra-plant trading (as opposed to inter-plant trades) are confined to the management of the steel plant. The plant authorities are responsible for allocating permits to their different facilities and for recording and checking trades against actual emissions. The effectiveness of this task is therefore an internal managerial problem and not an additional burden on the PCBs.

5. Is the policy publicly transparent?

Public transparency of an environment policy instrument embraces a number of aspects. The first and simplest is that of visibility. Generally standards are a more visible policy measure than pollution taxes. However if the latter are well advertised and public announcements are made by the government in advance of the imposition of pollution levies, the transparency of pollution charges to the general public can be enhanced. A more complicated aspect is that of transparency of policy impacts. As noted by O'Connor (1996) transparency can also increase risks of failure. Since MBIs make the costs of control more apparent than discharge standards, the taxed party, in this case the steel industry, may object much more to pollution charges than to discharge standards, even if the loss in producers surplus is smaller. If standards are combined with pollution charges, the transparency problem of pollution charges is mitigated to some extent. The same argument is true for the eco-efficiency charge cum standard policy. Transparency is enhanced if the charge is combined with a standard.

Rank ordering

The above discussion reveals that going beyond the criteria of cost effectiveness and environmental efficiency to issues relating to political acceptability and transparency does affect the ranking of the four scenarios. Table 3 below gives an overall assessment of how the scenarios perform when ranked according to the criteria discussed above.

Table 3: Ranking the scenarios

	Environmental efficiency	Cost effectiveness	Incentives	Feasibility	Transparency
Standard plus	**	**	*	***	**
Tax/Rebate	**	***	**	**	**
Eco-efficiency	***	***	**	*	**
Intra-plant trade	***	***	***	*	*

All policy combinations achieve more pollution abatement for less cost than the existing CAC system. However, the eco-efficiency and intra-plant trade scenarios perform better in terms of effectiveness, efficiency and incentives than the standards plus and tax/rebate scenarios. This picture changes somewhat when we consider political feasibility and transparency as evaluation criteria. It should be noted that unlike the first two criteria the latter two depend on qualitative assessments, and are therefore correspondingly more subjective. Any assessment of the administrative feasibility and public transparency of a policy would have to be based on an assessment of the existing administrative capabilities and effectiveness for monitoring and enforcement of industrial pollution, as well as of the socio-political environment in the country. In the Indian case we were able to make a first analysis of the administrative feasibility of introducing MBIs based on discussions with regulatory authorities and enforcement agencies. Clearly this is not an ideal assessment since it is not able to estimate the costs involved in moving towards a market based system. Nevertheless some conclusions can be reached and are summarised in the following paragraphs.

The introduction of MBIs will change the existing regulatory system and require new skills and resources in government. According to a Winrock International report for USAID, these include the capacity of government to "(a) design and administer the instrument, (b) monitor experience with it; (c) enforce the conditions of instrument use; and modify the instrument in response to changing conditions" (Winrock, 1992).

Scenarios three and four clearly require a major change in the regulatory and administrative set up. One particular need would be to increase the number of personnel skilled in environmental economics to design and upgrade any MBIs; in addition, more general awareness raising and training sessions could be required to inform existing pollution inspectors of the new regulatory issues raised by MBIs. Greater understanding of the dynamics of industrial innovation would also be required to allow the cost functions governing the MBIs to be revised in line with technological change. In the case of intra-plant trades, and pollution charge and standards set at the factory gate, the Government would need to set conditions of the establishment of more environmental laboratories to cater to the growing needs of industry, specially for the purpose of verification of compliance. A switch to a hybrid system of market-based instruments and command and control may in fact increase the number of disputes relating to monitoring results and the collection of revenues. One suggestion is to ask industry to submit periodic pollution generation returns on the basis of data generated through monitoring and analysis carried out by the environmental laboratories recognised by Central/State Governments under the Environment (Protection) Act, 1986.

Reporting requirements and procedures would also need to be adapted. In particular, the Government would need to establish clear definitions of pollution abatement costs and then require companies to report these on a regular basis so that the MBI could be adjusted to changing conditions.

All of this would place additional burdens on the administrative system. This burden is less in case of scenarios one and two, which are an extension of existing concentration based schemes, but increases progressively for scenarios three and four.

In terms of administration then, there is often a 'virtue of simplicity', and Winrock adds that "there is a trade-off between designing a simple system that can be implemented with limited effort and a complex system that is capable of yielding "optimal" results but is beyond the administering agency's capabilities".

The following general conclusions emerge from the foregoing account

- MBIs must be introduced on a case by case basis for each pollutant and policy mix since a blanket prescription is not possible.

- All scenarios that combine CAC measures with MBIs are more cost effective than existing standards ie, they achieve more pollution abatement for less cost to the industry.
- Low pollution control cost companies benefit from a mixed policy and high cost polluters lose unless they change to cleaner technologies.

- A fairly precise quantification of environmental efficiency and cost effectiveness is possible and MBIs perform well according to these criteria.

- It is more difficult to assess administrative feasibility and public transparency of policy instruments. Even so, the most efficient and effective instruments rank lower when assessed against criteria of feasibility and transparency.

- A pragmatic MBI strategy should start with a politically acceptable and publicly transparent standards plus scheme based on existing concentration discharge standards and gradually evolve a more efficient and effective system based on pollution loads per tonne of finished product.

Policy Implications and Conclusions

India's existing environmental policy system makes little use of MBIs. If any of the four policy scenarios are to be considered for action, new sectoral analysis will be required. The IIED/CII steel study examines a number of issues that must be addressed if existing regulations are to change.

These issues relate to:

- compatibility of existing laws, legal sanctions and fines with MBIs to ensure avoidance of double penalties;

- coherence between the existing water cess (the only economic incentive being used at present) and proposed pollution charges. In particular it is important to analyse the extent to which an effluent charge impacts on water use.

- effectiveness of MBIs in the presence of currently subsidised water rates for industrial uses. For any system of MBIs to work effectively, the pricing of resources must reflect the true scarcity and opportunity cost of the resource.

- the use of revenues raised from pollution charges in a manner that would minimise competitiveness impacts on industry. The possibility of setting up an environmental fund should be investigated. Revenues from the fund may be used to: strengthen the monitoring and enforcement capabilities of the PCBs; or provide industry with incentives for adoption of cleaner production techniques. A third and attractive option may be to use the funds for promoting environmental awareness among the public and industry. The Indonesian PROPER programme could be a useful model in this regard.

Apart from the implications for government policy and action, the introduction of MBIs has major implications for corporate management. MBIs make it necessary for companies to develop accounting procedures as part of their environmental management systems, which enable them to accurately allocate costs (such as pollution charges) and benefits (such as rebates) to the appropriate unit: environmental accounting is thus a natural corporate complement to MBIs, both aiming to make the polluter pay. Companies would be required to move from an essentially legal response to environmental regulation (are we in compliance?) to a financial response (are we minimising our environmental costs?). For example, in the case of a pollution charge, companies would need to be able to assign the payments to the polluting units; distributing the costs of a charge as an overhead would defeat the economic purpose of MBIs. A company's capacity to respond effectively to the incentives provided by MBIs would depend very much on both its corporate culture and its financial accounting systems. Companies that retain a planning culture could fare less well compared with those with a market culture, reflected in the allocation of environmental costs and benefits to the appropriate units throughout the organisation.

In conclusion , introducing market-based instruments in India to accelerate the spread of pollution prevention measures will require a subtle combination of pragmatism and vision. It is likely and desirable that instruments will be introduced on a step by step basis, tailored to the specific circumstances of particular problems of air or water pollution and waste generation. There can be no single plan for an across the board introduction of MBIs. But similarly, if India starts to move towards a market-based structure for environmental protection, then a strategic approach will be needed on the different steps needed to phase in MBIs.

No country has or is likely to have MBIs designed for every industrially produced environmental problem. Governments world-wide are still experimenting with both the methodology and practice of market-based instruments. India's special advantage is that it can learn from the successes and failures of others, but also contribute to world-wide progress through a careful and well-thought out introduction of MBIs. It also has the advantage of not having made existing commitments to either charges or permits as the preferable route to provide incentives. Indeed, both approaches could be used for different pollutants as the circumstances determine. India should now demonstrate that the economic approach to pollution prevention is as relevant to a fast growing emerging economy as to the industrialised world.

References

Anderson, F.R. et al. 1977. *Environmental Improvement Through Economic Incentives.* Johns Hopkins University Press.

Baumol, W.J. and Oates, W.E. 1988. *The Theory of Environmental Policy*. Cambridge University Press: Cambridge.

Bhatia, R., Rogers, P., Briscoe, J. and Sinha, B. 1994. *Water Conservation and Pollution Control in Industries: How to Use Water Tariffs, Pollution Charges and Fiscal Incentives*, UNDP/World Bank Water and Sanitation Currents. The World Bank : Washington, DC.

British Telecom. 1996. *Environmental Accounting in Industry - A Practical Review.* British Telecom, London.

CII. 1995. *Strategy for Rational Integrated Energy Pricing Policy*. Confederation of Indian Industry, New Delhi.

CSE. 1992. *Ecological Tax Reform.* Centre for Science and Environment, New Delhi.

Factor 10. 1994. *The Carnoules Declaration*. Factor 10 Club, Wuppertal Institut: Germany.

Industrial Economics Inc. 1994. *The Use and Impact of Iron and Steel Industry Intra Plant Trades*. Prepared for the Office of Policy Planning and Evaluation., US Environmental Protection Agency.

Jung, C., Krutilla, K. and Boyd, R. 1996. "Incentives for Advanced Pollution Abatement Technology at the Industry level: An Evaluation of Policy Alternatives." *Journal of Environmental Economics and Management* 30: 95-111

Kallaste, T. 1994. "Economic Instruments in Estonian Environmental Policy." In T. Sterner (ed). *Economic Policies for Sustainable Development.* Kluwer Academic Pulbishers, the Netherlands.

Kumar, R. (forthcoming). *Pollution Charges and Marketable Permits: Application and Implementation in Industrialising Countries.* Kluwer Publications: the Netherlands.

Kumar, R. and Sherif, Y. 1995. *Economic Incentives for Pollution Prevention: A Case Study of Coal Processing Industries, Dhanbad, Bihar, India*. Environmental Economics Programme Discussion Paper Series, DP 95-01. IIED: London

Mehta, S., Mundle, S. and Sankar, U. 1993. *Incentives and Regulation for Pollution Abatement with an Application to Waste Water Treatment.* National Institute of Public Finance and Policy: New Delhi.

Ministry of Environment and Forests. 1992. *Policy Statement for Abatement of Pollution*. New Delhi.

Ministry of Environment and Forests. 1995. *Task Force on Market Based Instruments for Industrial Pollution Abatement* Office Order: New Delhi.

NEERI. 1995. *Regional Environmental Impact Assessment: Studies for the Jamshedpur Region*. National Environmental Research Institute: Nagpur.
Oates, W.E. and Strassman, D.L. 1988. "Effluent Fees and Market Structure." *Journal of Public Economics* 24.

O'Connor, D. 1996. *Applying Economic Instruments in Developing Countries: from Theory to Implementation.* OECD: Paris.

OECD. 1994. *Managing the Environment, The Role of Economic Instruments*. OECD: Paris,

OECD. 1993. *Economic Instruments for Environmental Management in Developing Countries.* OECD: Paris.

OECD. 1992. *Use of Economic Instruments for Environmental Protection in Developing Nations*. OECD: Paris.

OECD. 1991. *Environmental Policy: How to Apply Economic Instruments.* OECD: Paris.

Opschoor, J.B. and Turner, R.K. (eds): *Economic Incentives and Environmental Policies: Principles and Practice*.

Panayotou. T. 1992. *Getting Incentives Right: Economic Instruments for Environmental Management in Developing Countries*. Harvard Institute for International Development: Cambridge, MA.

Schmidheiny, S. 1992. *Changing Course*. MIT Press.

Stavins, R. 1989. "Clean Profits: Using Economic Incentives to Protect the Environment." *Policy Review* 48.

Stavins, R. 1995. "Transaction Costs and Markets for Pollution Control in Resources." *Resources* Spring: 9-20.

Tietenberg, T. "Economic Instruments for Environmental Regulation." *Oxford Review of Economic Policy* 6(1).

UNCED. 1992. *Agenda 21*. United Nations Conference on Environment and Development, New York.

van Amelrooy, M. 1994. *Indian Environmental Policy and the Use of Economic Instruments.* Indo-Dutch Programme on Alternatives in Development: The Hague.

Vincent, J. 1993. *Malaysia's Palm Oil Effluent Charges*. Harvard Institute for International Development: Cambridge, MA.

Weitzman, M. 1974. "Prices vs. Quantities." *Review of Economic Studies* 41.

Winrock. International. 1992. *The Use of Economic Instruments for Environmental Protection in Developing Nations*. Winrock International Environmental Alliance. USAID, Washington, DC.

World Resources Institute. 1994. *World Resources 1994-95*. WRI: Washington, DC.

World Resources Institute. 1995. *Green Ledgers: Case Studies in Corporate Environmental Accounting*. WRI: Washington, DC..

Zylicz, T. 1994. “Environmental Policy Reform in Poland.” In .T. Sterner (ed). *Economic Policies for Sustainable Development.* Kluwer Publishers, the Netherlands