International Experiences with Economic Incentives for Protecting the Environment

Pollution Charges, Fees, Taxes

Voluntary Programs

Deposit-Refund Systems

Information Disclosure

Trading Systems

Liability Approaches

Subsidies for Pollution Control

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INTERNATIONAL EXPERIENCES WITH ECONOMIC INCENTIVES FOR PROTECTING THE ENVIRONMENT

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EXECUTIVE SUMMARY

This report reviews experiences outside the United States with economic instruments for managing the environment, including air and water quality, water quantity, solid and hazardous wastes. It represents an update and extension of one chapter in the 1997 report by Anderson and Lohof to the US Environmental Protection Agency. That report found widespread use of economic instruments for managing the environment, including some applications not observed in the United States. Seven years later, this report identifies new instruments, more widespread application of older instruments, and greater acceptance of incentive-based mechanisms in environmental management. This report can also be regarded as an addition of international experience to a 2001 EPA report on the US experience with using economic incentives and follows the same basic organization.

Market Based Instruments (MBIs), and Economic Incentives (EIs) more broadly, have a number of advantages over traditional command and control (CAC) methods for controlling pollution. One, these tools give those responsible for sources of pollution (hereafter referred to as "sources" or "polluters") an incentive to reduce pollution below permitted amounts when it is relatively inexpensive to do so. That feature, in turn, provides a motivation for sources to become smarter regarding pollution control options and costs. Technological improvement and innovation will be stimulated, resulting in greater opportunities to reduce pollution at low cost. Finally, EIs are uniquely well suited to many of the pollution problems the world now faces. The more widely dispersed and smaller the sources, the more difficult it is to rely on traditional CAC methods of source-specific limits, inspections and enforcement. EIs harness forces of the market to give all sources, large and small, the motivation to find the least cost means of limiting their polluting activities. In principle, environmental inspections and enforcement become less necessary as sources pursue their own self-interest and control pollution. These features are especially important in developing nations where resources to deal with pollution are severely limited.

EIs also are widely used for allocating natural resources to competing users. Long ago, farmers in England recognized the problem of communal grazing lands. Without charges to control use, or fences to delineate private property, the common grazing lands were over grazed and unproductive. Similarly, groundwater tables in many parts of the world are declining rapidly because the water is free except for the cost of operating one's pump.

The guiding definition of EIs for this paper is quite broad: any instrument that provides continuous inducements, financial or otherwise, to encourage responsible parties to reduce their releases of pollutants or make their products less polluting. This definition includes fees, charges and taxes, charges on polluting inputs and outputs, tradable permits, subsidies, deposit-refund systems, as well as reporting requirements, and liability for harms. Some voluntary mechanisms also are included.

Worldwide experience with these instruments is extensive, and a number of survey reports cover portions of this topic. However, some instruments are discussed in detail for the first time in this report. The intention is to offer some depth of treatment for a relatively few examples to provide the reader with an understanding of how the instrument is designed and how it performs, particularly in the context of developing nations. This report draws on other survey literature that covers a portion of this topic, but seeks to avoid redoing their analyses.

Conclusions

There is substantial evidence of growing use of economic instruments for managing the environment. The 1997 report to EPA provides a useful benchmark against which to assess changes. Not only are more countries applying economic instruments but also they are doing so in a more sophisticated manner. Many problems from older applications have been corrected. For example, charge rates have risen to more nearly cover the cost of water deliveries in several nations.

Direct fees and taxes are the most used market mechanisms internationally, as was the case in 1997. These can affect environmental quality in two ways: first, they can directly affect polluting behavior and the choice of inputs to firms and product purchases by households. Second they can provide a source of revenue to pay for governmental oversight of environmental management or to subsidize pollution control activities. Noteworthy trends for this category of instrument include more applications and higher rates, as well as some acceptance in parts of the world where charges heretofore have been difficult to implement. In several nations where it is socially and politically unacceptable to use prices to allocate water, fees to pay for delivery costs are slowly gaining acceptance.

Deposit-refund systems are little changed over the past seven years, both in terms of applications and in deposit amounts.

Trading regimes are shifting to capped allowance systems from more open-ended mechanisms. Marketable permits systems have gained greater acceptance worldwide, particularly for the control of greenhouse gas emissions. New applications of marketable permits for conventional pollutants in nations such as Chile, China and Slovakia are also noteworthy.

Greenhouse gas emission control is an important and rapidly growing application of economic instruments. In 1997 just a handful of nations imposed carbon taxes. Now many more nations rely on carbon taxes and greenhouse gas trading regimes are in place. One can now place buy or sell orders in organized markets for the right to emit these gases.

Reductions in environmentally harmful subsidies are a noteworthy trend that has been encouraged by international lending institutions. The World Bank and other leading lenders often make the elimination of environmentally harmful subsidies a condition for lending. A related phenomenon is an agreement by a group of large international banks active in lending to developing nations. The banks agree not to lend for environmentally damaging projects.

Liability for harms caused to the environment is increasingly being used as a tool to limit polluting and environmentally damaging activities. While cases of this type go back to the 19th Century in England, only relatively recently have cases of environmental damage in developing nations found a sympathetic hearing in the courtroom.

Information is used in many new applications, including product labeling, categorizing firms according to their environmental performance, and disclosure of pollution releases.

Voluntary programs now exist in a host of programs to encourage firms to improve their environmental performance. Much greater attention is also being paid to rewards that can be offered in such programs. The one new category is liability, where a number of recent cases are cited in which firms were ordered to pay compensation for damage to the environment.

Comparisons with the United States Experience

Among the incentives more widely used in foreign countries than in the United States are environmental product labeling, differential taxation of motor fuels, effluent discharge fees, charges on noise pollution and carbon taxes. Most industrialized countries have user fees for municipal waste and water/sewage and deposit-refund systems for beverage containers. Water user fees tend to be higher in Western Europe and lower elsewhere, with the notable exception of Israel. Even in countries where water historically has been free, charges for water delivery are now finding acceptance.

Market-based permit systems were found to be more common in the United States than elsewhere in the 1997 EPA report. This situation, however, is evolving--for example, there are many tradable permit systems now in use internationally.

User and pollution charges are more frequent than in the United States, and several such charges appear to have incentive effects. Examples include Sweden's NO_x emission charge, water effluent charges in Germany and the Netherlands, product charges in Norway, waste charges in Denmark and Korea, and water user or extraction charges in Australia and several Asian countries. Water charges vary widely throughout the world. Higher charges go hand in hand with lower demand. Per capita consumption in Alexandria Egypt, where water is heavily subsidized, is about 550 liters per day, whereas in Germany, where water is now relatively expensive, per capita consumption is less than 140 liters per day.

While many user and pollution charges are primarily revenue raising mechanisms, some countries, including Denmark, Finland, the Netherlands, Norway, and Sweden, have attempted to incorporate environmental considerations into the design of their taxation systems in an effort to shift the tax burden from labor and capital to the use of natural resources.

Cash subsidies for pollution control investments appear to be more generous in Europe than in the United States and many developing nations also offer such incentives. An important new development concerns lending assistance for industrial projects. Signatories to the Equator Principles agree to lend to only to industrial developments that employ cleaner technologies and for public projects that are not damaging to the environment.

Product charges are found to be principally revenue-raising instruments with little incentive effect, attributable primarily to the low level of the charges. Moreover, some charges are not closely linked to waste generation or product consumption. However, some of the product charges described in this section, such as fertilizer taxes and the preferential taxation of cleaner motor fuels, do appear to have significant incentive effects.

With the trends already firmly in place and acceptance growing, the future looks bright indeed for additional use of economic incentives for managing the environment.

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List of Acronyms

ADF	Advance Disposal Fee
BAPEDAL	Indonesian Environmental Impact Management Agency
BOD	Biochemical Oxygen Demand
C$	Canadian Dollar (currency unit)
CAC	Command and Control
CAO	Compliance Advisor Ombudsman
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFC	Chlorofluorocarbon
Cl_2	Chlorine gas
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CRAES	Chinese Research Academy for Environmental Science
CS_2	Carbon disulfide
DENR	Department of Environment and Natural Resources
Dfl	Dutch Florin or guilder (currency unit prior to the Euro)
DKr	Danish Krona (currency unit)
ECU	European Currency Unit (a precursor of the Euro)
EI	Economic Incentive
EIP	Eco-industrial Park
EPA	Environmental Protection Agency
EPB	Environmental Protection Bureau
EU	European Union
EUR	Euro (currency of the European Union)
F	French Franc (currency unit)
GwH	Gigawatt Hour
GOE	Government of Egypt
HIID	Harvard Institute for International Development
IFC	International Finance Corporation
Kc	Ceska Koruna or Czech crown (currency unit)
kg	Kilogram
LLDA	Laguna Lake Development Authority
m^3	Cubic meter
MBI	Market Based Instrument
MJ	Megajoules
Mk	Finnish Markka (currency unit)
ml	Milliliter
MW	Megawatt
MWH	Megawatt Hour
NGO	Nongovernmental Organization
NKr	Norwegian Krone (currency unit)
NOAA	National Oceanic and Atmospheric Administration
NO_x	Nitrogen Oxides
NPDES	National Pollution Discharge Elimination System
OECD	Organization for Economic Cooperation and Development
OTML	Ok Tedi Mining Limited
PER	Perchloroethylene
PERT	Pilot Emissions Reduction Trading
PLS	Pollution Levy System

PNG	Papua New Guinea
PROPER	Program for Pollution Control, Evaluation, and Rating
PROKASIH	Indonesia's Clean Rivers Program
PRN	Package Recovery Note
PRTR	Pollutant Release and Transfer Registers
PSR	Performance Standard Rates
RESA	Restated Supplemental Agreement Act
RM	Malaysian Ringgit (currency unit)
SEK	Swedish Krona (currency unit)
SEPA	Swedish Environmental Protection Agency
S	Austrian Schilling (currency unit)
SO_2	Sulfur Dioxide
SOE	State-Owned Enterprises
TCE	Trichoroethylene
T(f)	Dilution factor by which waste water must be diluted in order to lose its acute toxic effect on fish
TL	Turkish Lira (currency unit)
TSS	Total Suspended Solids
TVE	Township and Village Enterprises
US	United States
US$	United States dollar
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WHO	World Health Organization

1. Introduction

1.1 Purpose and Relation to Earlier Reports

This report reviews worldwide experiences with economic instruments for managing the environment, including air and water quality, water quantity, and solid and hazardous wastes. It represents an update and extension of one chapter in a 1997 report to the US Environmental Protection Agency.[1] That report found widespread use of economic instruments for managing the environment, including some applications not observed in the United States. Seven years later, this report identifies new instruments, more widespread application of older instruments, and greater acceptance of incentive-based mechanisms in environmental management. This report can also be regarded as an addition of international experience to a 2001 EPA report on the US experience with using economic incentives[2] and follows the same basic organization.

Because the definition of economic incentives used here is quite broad, a great many instruments and programs potentially could have been included in this review. Worldwide experience with these instruments is extensive, and a number of survey reports cover portions of this topic. However, several instruments are discussed in detail for the first time in this report and the coverage of developing country experiences is more extensive than found elsewhere.

Worldwide experience with these instruments is extensive, and a number of survey reports cover portions of this topic. The intention here is to offer some depth of treatment for a relatively few examples of particular interest. The examples cover a broad range of instruments and a broad range of countries, discussing several of these instruments for the first time. The intent is to provide the reader with an understanding of how the instrument is designed and how it performs, particularly in the context of developing nations. This report also draws on other survey literature to provide a breadth of treatment, but seeks to avoid redoing their analyses:

- OECD reports on economic instruments and environmental funds,[3]
- Regional Economic Center (for nations of Central and Eastern Europe),[4]
- Harvard Institute for International Development review of Chinese experiences,[5]
- World Bank survey of experiences in Latin America,[6]
- A 2002 survey by the Nordic Council,[7]
- Asian Development Bank reports on the use of economic instruments in the Philippines and Indonesia[8],
- A survey of experiences with economic instruments for managing the environment in Australia,[9]
- A book on *Policy Instruments for Environmental and Natural Resource Management*,[10]
- A very recent book evaluating the performance of approximately twelve economic incentives used in environmental management in the US and in Europe.[11]
- An article by Pearce that explores the advantages and limitations of economic incentives for managing the environment.[12]

- A book chapter by Stavins reviewing economic instrument use worldwide, offering an assessment of lessons learned, and listing in table format many "market-based incentives" by type of incentive and the countries using them.[13]

1.2 Definition of Economic Incentives

The guiding definition of economic incentives (EIs) for this paper is quite broad: any instrument that provides continuous inducements, financial or otherwise, to encourage responsible parties to reduce their releases of pollutants or make their products less polluting.[14] In essence, with incentives sources view each unit of pollution as having a cost, whereas under more traditional regulatory approaches pollution may be free or nearly so once regulations have been satisfied. These incentives provide monetary and near-monetary rewards for polluting less and impose costs of various types for polluting more, thus supplying the necessary motivation to polluters. Such an approach can influence the polluting behavior of small firms, farms, and consumers, all of whom are difficult to address through traditional command and control measures. Incentives also can be used to motivate polluters to improve upon existing regulatory requirements. Included within the definition of economic incentives for managing the environment are

- pricing mechanisms, including fees, charges and taxes, for application to air pollution, water pollution and solid waste
- deposit-refund systems to encourage recycling or the proper disposal of the product as well as performance bonds, which also may be viewed as deposits with subsequent refunds
- pollution trading systems
- subsidy systems, including grants, low-interest loans, favorable tax treatment, lending practices of international banks, and preferential procurement policies for products believed to be environmentally friendly
- liability as a mechanism for compensating victims when sources release pollution that causes harm to human health and the environment and also as a mechanism for encouraging sources to comply with existing environmental regulations
- information disclosure that can affect the polluting behavior of firms and product purchase decisions by consumers
- voluntary measures and non-monetary rewards through which governments encourage firms and individuals to improve their environmental performance

Market based instruments (MBIs), which include the first four of the above approaches, and EIs more broadly, have a number of advantages over traditional command and control (CAC) methods for controlling pollution. One, these tools give those responsible for sources of pollution (hereafter referred to as "sources" or "polluters") an incentive to reduce pollution below permitted amounts when it is relatively inexpensive to do so. That feature, in turn, provides a motivation for sources to become smarter regarding pollution control options and costs. Technological improvement and innovation will be stimulated, resulting in greater opportunities to reduce pollution at low cost. Finally, some EIs such as fees and information disclosure are uniquely well suited to many of the pollution problems the world now faces. The more widely dispersed and smaller the sources, the more difficult it is to rely on traditional CAC methods of

source-specific limits, inspections and enforcement. EIs harness forces of the market to give all sources, large and small, the motivation to find the least cost means of limiting their polluting activities. In principle, environmental inspections and enforcement become less necessary as sources pursue their own self-interest and control pollution. These features are especially important in developing nations where resources to deal with pollution are severely limited.

EIs also are widely used for allocating natural resources to competing users. Long ago, farmers in England recognized the problem of communal grazing lands. Without charges to control use, or fences to delineate private property, the common grazing lands were over grazed and unproductive. Similarly, groundwater tables in many parts of the world are declining rapidly because the water is free except for the cost of operating one's pump.

1.3 Types of Economic Incentives Discussed

Each of the types of EIs listed above has particular characteristics, which are described in this section.[15]

1.3.1 Fees, Charges and Taxes

From the perspective of sources that are subject to environmental fees, charges, and taxes, these three terms are largely interchangeable in terms of their effects. They all require that the generator of a designated type of pollution pay a fee (or charge or tax) for each unit of pollution. These fees make attractive tools for managing the environment because they attach an explicit cost to polluting activities and because sources can easily quantify their savings if they reduce the amount of pollution they emit. One disadvantage is that fees do not guarantee the amount by which a source would reduce pollution.

Pollution-related fees, charges, and taxes are widely collected at all levels of government, and they are one of the most prevalent economic incentives in use today. Although fees can generate substantial revenues for the government agency that imposes them, they tend to be set at rates too low to have a significant impact on pollution. Some important exceptions are noted in this report, notably effluent fees in Germany, the Netherlands and into Laguna Lake in the Philippines; chlorofluorocarbon (CFC) emission fees in Norway; and nitrogen oxide (NOx) and sulfur dioxide (SO_2) emission fees in Sweden.

Environmental fees may not be able to target pollution directly. For example, there are no taxes on automobile emissions. Taxes on gasoline and taxes on cars can be used to address automobile emissions indirectly (Fullerton) and consequently are a second-best solution. The use of fee revenues also can affect environmental quality as demonstrated in the earmarking of pollution levy receipts in France and China for use in pollution control.

1.3.2 Deposit-Refund Systems

Deposit-refund systems require a monetary deposit at the time of sale of a product. The deposit is returned when the item is returned at the end of its useful life. Unlike the other instruments reviewed in this report, deposit-refund systems sometimes originate within the private sector and do not always require government mandates. Worldwide, deposit systems are applied to help control the disposal of lead-acid batteries, to products such as beverage containers, pesticide containers, tires, and automobile bodies and to other consumer products. When used products are valuable, as is currently the case for lead-acid batteries, the private sector often creates and

manages a disposal system. Regardless of who manages the disposal of such products, the fees charged by this system help subsidize the return of recyclable products.

Deposit-refund systems appear to be most appropriate for discrete, solid commodities such as beverage containers, batteries, and car bodies that would cause environmental harm through their improper disposal. Government-mandated deposit systems for less discrete substances, like air and water pollutants, have not been attempted. One factor that limits the widespread use of deposit-refund systems is their high transaction cost. Collecting and refunding deposits on the sale of individual products such as beverage containers tends to be expensive, and additional costs are involved in collecting and returning used products for disposal.

1.3.3 Pollution Trading Systems

There are two distinct types of trading systems in rights to pollute: cap-and-trade systems and credit systems. Cap-and-trade systems have a limit on the total amount of allowed releases of pollution. They seek a specific environmental result; trading allowances to release pollution is simply an option to minimize the cost of achieving the emission reductions specified in the regulatory cap on emissions. In the cap-and-trade approach, allowances for future emissions are sold or granted to existing sources.

Credit systems, on the other hand, do not establish any fixed ceiling on total emissions. Total emissions can increase if new sources of pollution enter the market of if existing sources increase production. In uncapped systems, tradable credits are earned for controlling pollution beyond what is specified in one's permit.

Trading programs have certain features that have made them increasingly popular in such diverse locations outside the United States as Australia, Chile, China, and Slovakia. In a trading program, innovative, entrepreneurial companies can profit from low-cost reductions in emissions. Slower, less innovative firms can benefit as well by having the opportunity to purchase needed emission allowances for less than it would cost them to comply internally. Finally, cap-and-trade programs can provide great certainty about the magnitude of environmental improvement that will be achieved.

At the same time, trading programs may have several drawbacks, including the potential for high transaction costs and inactive markets, especially in credit or open-market systems. High costs can be attributed to the need to verify each reduction before authorizing the credit. Clearly, trading programs should not be applied to all environmental problems. The long-term effects of trading programs on technical innovation vary from program to program. Some have spurred considerable innovation, such as the U.S. acid rain program, while others have not due to high transaction costs.

1.3.4 Subsidy Systems

Subsidies to support reductions in pollution take many forms. Among the many subsidies that are used at all levels of government to help manage environmental pollution are grants, low-interest loans, favorable tax treatment, and preferential procurement policies for products believed to pose relatively low environmental risks. Subsidies are used to support private-sector pollution prevention and control activities, the cleanup of contaminated industrial sites, farming and land preservation, consumer product waste management, alternative automobile fuels, clean-running cars, and municipal wastewater treatment. Subsidies also can result in harmful environmental

effects. In this regard, subsidized water and energy and assistance to farmers are often cited as examples.

Subsidies for environmental management are sometimes criticized because the government entity providing the subsidy—and the taxpayer, ultimately—is helping to bear the costs that should be the responsibility of the polluter. Moreover, when products or activities are subsidized, consumers act on price signals that do not reflect the full costs of production, in the end consuming more than they otherwise would and causing harm to the environment. For example, water subsidies in Egypt encourage the cultivation of rice and sugarcane and discourage individuals from repairing leaking plumbing. By the time it reaches the Mediterranean the Nile is heavily polluted and its flow is reduced to a trickle.

1.3.5 Information Disclosure

The collection and public availability of information on environmental performance has proven to be a strong incentive for sources to reduce their emissions of pollution. The incentive derives from a number of factors. For example, when companies collect emissions information, they learn about the nature and magnitude of their emissions. When such information is made easily accessible to the public, workers and local communities have a much better idea of the environmental risks they face, so they are more prone to support or demand actions to reduce emissions. When a source's emissions are shown to decline over time, the source often reaps the benefits of better relationships with its employees and with the local community. Finally, in some cases a proven, long-term record of environmental stewardship makes a company's products more desirable to consumers.

The disclosure of environmental performance information is much more common today than a decade ago. The rating of firms' environmental performance is gaining in popularity, with ongoing programs in Indonesia and the Philippines and pilot programs in a number of other countries. Public reporting of the storage, release and disposal of toxic chemicals is required in nearly a dozen nations. Product labeling regarding recycling and other environmental attributes also is gaining acceptance worldwide.

1.3.6 Liability

The possibility of being held legally responsible for health or environmental damages can a powerful incentive for sources to reduce or avoid pollution. Some cases in U.S. jurisdiction have cost those responsible hundreds of millions of dollars or even billions in one case. With potential costs of this magnitude, sources have a powerful incentive to minimize their legal exposure. Consequently, expensive technologies that control pollution or aggressive environmental management systems can seem very reasonable to sources.

Liability mechanisms are a part of both civil and common-law systems, and can include both criminal and civil (non-criminal) sanctions. Many environmental statutes worldwide have civil liability provisions, though environmental liability actions in developing countries are relatively rare. Weak implementation of the law in developing countries is one problem. Another problem is jurisdiction: whether a case should be brought in the developing country where the damage occurred or in the home country of the firm responsible for the damage. As the examples here suggest, there is no universal rule regarding jurisdiction. Generally, plaintiffs attempt to have cases heard in the home country of the responsible firm where awards are likely to be higher.

While the norm in developing countries is that individuals harmed by spills are not compensated due to unclear liability rules or inadequate financial guarantees prior to the start of operations, some large awards in recent years are certainly garnering worldwide attention.

1.3.7 Voluntary Mechanisms

Although government programs that encourage sources to reduce pollution on a voluntary basis were virtually unheard of 20 years ago, they have become one of the fastest growing environmental management tools. Noteworthy examples include the use of negotiated agreements between industry and government in the Netherlands and Japan, eco-industrial parks in many nations, and waste exchanges.

There are a number of reasons why voluntary reductions in pollution are proving more and more popular with sources, and they are related to the incentives associated with information disclosure. When sources voluntarily reduce pollution and their employees, neighboring communities, and customers learn about it, sources gain several benefits. Voluntary actions taken by sources often reduce employees' exposure to harmful pollutants, thus lessening sources' liability and improving their relationship with labor. Sources enjoy better relations with neighboring communities, and a reputation for good environmental stewardship may attract more customers for their products. In some cases, sources also save money by taking these actions. Moreover, sources that join voluntary partnership programs can be eligible for various kinds of technical assistance from sponsoring government agencies.

1.4 Organization of the Report

The remainder of this report is organized into eight chapters corresponding to the general types of economic incentives discussed above and in the same order as used in USEPA (2001):

Chapter 2 examines pricing mechanisms, including fees, charges and taxes, for application to air pollution, water pollution and solid waste.

Chapter 3 considers deposit-refund systems to encourage recycling or the proper disposal of the product as well as performance bonds, which also may be viewed as deposits with subsequent refunds.

Chapter 4 covers pollution trading systems.

Chapter 5 discusses subsidy systems, including grants, low-interest loans, favorable tax treatment, lending practices of international banks, and preferential procurement policies for products believed to be environmentally friendly. The chapter also considers the adverse impacts of subsidies that harm the environment.

Chapter 6 addresses the use of liability as a mechanism for compensating victims when sources release pollution that causes harm to human health and the environment and also as a mechanism for encouraging sources to comply with existing environmental regulations.

Chapter 7 reviews the impact that information disclosure may have on the polluting behavior of firms and product purchase decisions by consumers.

Chapter 8 looks at a variety of voluntary measures through which governments encourage firms and individuals to improve their environmental performance.

Chapter 9 offers several observations and conclusions.

2. Charges, Fees and Taxes

Fees, charges and taxes are the most commonly used economic instrument for environmental management in the international context. Generally such fees are set at relatively modest levels and used to raise revenues to cover the costs of program administration (or other purposes) and incentive effects are limited. A few noteworthy exceptions exist in which the primary purpose of environmental fees is to control emissions or effluent.

2.1 Pricing Mechanisms for Water

According to a 1999 report from the Organization for Economic Cooperation and Development, there is a clear trend toward market pricing for water in OECD nations, with many reporting increases in the real price of water during the 1990s. In the case of industrial users, water fees are usually based on quantities of water consumed. Water charges for residential consumers are set at flat rates in some areas and based on amounts consumed in others. Agricultural users often pay according to the land area under irrigation, however there are some efforts to impose volume-based charges. In other parts of the world, however, water is supplied free of charge. Not surprisingly, higher charges go hand in hand with lower demand. Per capita consumption in Alexandria Egypt, where water is heavily subsidized, is about 550 liters per day, whereas in Germany, where water is now relatively expensive, per capita consumption is less than 140 liters per day.

Consumption-based rates are more likely to influence water use than flat rates, but relatively large price increases might be needed to induce changes in consumer behavior. A number of studies have found water consumption to be negatively related to unit-based prices. In 1982, for example, the Hunter and District Water Board in Australia replaced its fixed-rate pricing system with a pay-for-use system.[16] Water consumption subsequently declined by 20-30%, a decline that allowed the deferral of some water supply construction projects. Xenos et al. conclude that increases in water prices in Athens before and after 1990 led to significant decreases in water use. Although some of the decreases have been attributed to public education campaigns, the price increases have also been credited with significant incentive effect. The Regional Environmental Center reported that in the Czech and Slovak Republics, increases in water charges since 1991 have led to significant declines in water consumption. In Bogor, Indonesia, water rates were increased by 200-300% in 1988 and a conservation campaign was implemented in 1989.[17] Domestic and commercial water use fell by 30% within nine months. This implies a price elasticity of demand of -0.10 to -0.15. An escalating block rate tariff in Hermanus, South Africa imposed in 1996-1997 succeeded in balancing limited supplies with rising demands.[18]

Water charges are imposed for the cost of treating and delivering water to agricultural, industrial and household users. Dinar and Subramanian recently completed a survey of water charges in 22 nations some of which were developed and others are still developing. The results of that survey are summarized in Table 1, supplemented by data for additional countries from the World Bank web site. Industry generally pays the highest fees, followed by households, and agricultural users typically pay the lowest rates. A tremendous variation in rates charged is observed, however neither the state of development nor the availability of water appears to explain observed patterns.

Table 2.1. Incremental Water Use Charges

(1996, in US$s per cubic meter)

Country	Agriculture	Domestic	Industry
Algeria	0.019-0.22	0.057-0.27	4.67
Australia	0.0195	0.23-0.54	7.82
Botswana		0.28-1.48	
Brazil	0.0042-0.032	0.040	
Canada	0.0017-0.0019	0.34-1.36	0.17-1.52
Egypt		0.03-0.07	0.40-0.90
France	0.11-0.39	0.36	
India		0.0095-0.082	0.136-0.29 0
Israel	0.16-0.26	0.36	0.26
Italy		0.14-0.82	
Jordan		0.23	
Lebanon		0.32	
Madagascar		0.325-1.75	
Morocco		0.53	
Namibia	0.0038-0.028	0.22-1.38	
New Zealand		0.31-0.69	
Pakistan		0.06-0.10	0.38-0.97
Portugal	0.0095-0.0193	0.1526-0.5293	1.19
Spain	0.0001-0.028	0.0004-0.0046	0.0004-0.0046
Sudan		0.08-0.10	0.08-0.10
Taiwan		0.25-0.42	
Tanzania		0.062-0.241	0.261-0.398
Tunisia	0.020-0.078	0.096-0.529	0.583
Uganda		0.38-0.59	0.72-1.35
United States	0.0124-0.0438	0.40-1.50	
United Kingdom		0.0095-0.0248	

Source: Dinar and Subramanian and other sources.

Charges on surface and groundwater abstraction (withdrawal) differ from the water supply charges described above in that they can be regarded as taxes on the use of a natural resource rather than payments for services provided. Charges on surface and groundwater use have been imposed in several countries, including France, Spain, the Netherlands, and Denmark.[19] The Netherlands imposes a ground water tax of 0.15 EUR ($0.14) per cubic meter, while Denmark imposes a tax on household and some service sector water users of 0.84 EUR ($0.72) per cubic meter. Both of these charge levels are thought to be high enough to influence behavior.

Wastewater discharges are not directly metered in most jurisdictions; rather they are assumed to be equal in volume to water consumption, which is measured. Some discharge fees for larger businesses are based not only on water use but also on discharge toxicity, which provides them with a separate incentive to reduce the toxicity of their discharges.

Whether a water user fee has a greater effect in terms of raising revenue or reducing a potentially polluting activity depends largely on the elasticity of the demand for water, that is whether demand is responsive to changes in price. If the demand is inelastic, an increase in user fees will principally raise revenue, but will not affect consumption behavior in a significant way. If demand is elastic, however, consumption behavior is likely to be changed by a water fee, but the revenue-raising prospects are limited. Although water demand is often assumed to be inelastic, studies that separate water demand by season have found that household water demand is inelastic in winter but elastic in summer. Others have found that water demand by industrial and agricultural users is sensitive to price changes. To promote water conservation, some jurisdictions have rate schedules that impose higher rates as use increases.

2.2 Industrial Effluent Fees

This section describes effluent discharge fees systems found in France, Germany and the Netherlands, as well as in several developing nations. The intent here is to describe systems where fees are set high enough to have a positive impact on environmental quality. Many effluent fee systems in Europe and the former Soviet Union impose very modest fees with the primary objective to raise revenue to recover administrative costs, not to improve environmental quality.

2.2.1 France

France's six river basin authorities have been levying effluent charges since 1968. Each river basin has a committee and an agency, with the committee functioning like a parliament and the agency as an executive body. Each river basin board sets its own charge rates annually, subject to approval by the basin committee. Levies now total about 1.1 billion Euros annually.

The original basis for France's effluent charge was weight of suspended matter and weight of organic matter, since these two pollutants were relatively easy to detect and control. Charge parameters were later expanded to include salinity (1973), toxicity (1974), nitrogen and phosphorus (1982), and halogenated hydrocarbons, toxics, and other metals (1992). Discharges are estimated based on the emissions class and activity level of the discharger or, in the case of municipalities, on the basis of population and daily discharge per inhabitant. The basin authorities and dischargers may request actual measurement, the costs of which are borne by whoever makes the request.

The charge applies to all municipalities with more than 400 inhabitants and to all non-municipal facilities discharging at least 200 population equivalents a year. For facilities connected to a public sewage system, the charge applies only if discharges exceed 6,000 m3 per year.

It is not clear to what extent the charges have discouraged pollution since the charges are designed primarily as revenue-raising instruments.[20] Charge levels are based not on perceived environmental costs of discharges but rather on the revenue needs of the river basin authority. The effluent charges, as well as fees for extracting ground and surface water, generate revenues that are used mainly to finance water pollution control investments by farmers, industry, and municipalities. Some of the assistance takes the form of low-interest loans, but most of it is grants that usually cover 30%-50% of the total cost of a given investment.

2.2.2 Germany

Based on the 1976 Federal Effluent Charge Law, effluent charges have been collected by German states (Länder) since 1981. Although collection is left to the states, the charge calculation rules, charge amounts, and damage unit parameters are determined at the federal level.[21] German states do not have the autonomy to set effluent charges that U.S. states have in setting the NPDES permit fees.

Effluent charges for point sources are based on "damage units" dependent on quantities and types of pollutants and set to reflect actual costs of treatment. One damage unit is defined as 50kg organic matter, 3kg phosphorus, 25kg inorganic nitrogen, 2kg halogenated hydrocarbons, 20g mercury (and compounds), 100g cadmium (and compounds), 500g chromium, nickel or lead (and compounds), 1kg copper (and compounds), or 3,000m3 of wastewater divided by the dilution factor by which the waste water must be diluted in order to lose its acute toxic effect on fish.[22] Separate assessment methods are used for stormwater and for discharges from inhabitants not connected to the sewage system.

Charge assessment is based on discharges allowed in state-issued permits. Dischargers without permits or with permits lacking discharge limits pay charges based on their declared discharges. Charges are raised if permitted discharge limits are exceeded. Most monitoring is left to polluters with random spot checks by the authorities. However, if a polluter declares in advance that its discharge levels will be at least 20% below levels allowed in its permit over a period of at least three months, the charge is assessed on the basis of the projected reduced discharge level.

The charge amounts can be reduced in several ways. If a discharger uses Best Available Technology for hazardous pollutants and Generally Agreed Technology Standards for non-hazardous pollutants, its charge per damage unit is reduced by 75%. In addition, investments in treatment facilities are rewarded by reduced charges for a period of three years prior to completion of the new facility, provided that the facility will reduce pollution by at least 20%. In 2002, the average fee for wastewater discharge was 2.24 Euros per cubic meter, which equates to an average annual cost of 117 Euros per person. Significant increases in inflation-adjusted wastewater fees over the past 15 years have led to considerable technical innovation in water-saving dishwashers, washing machines and toilets.[23]

2.2.3 The Netherlands

Bressers shows that effluent charges in the Netherlands, which were introduced in the 1970 Pollution of Surface Waters Act, likely had a significant incentive effect on polluters, despite the fact that the fees were designed principally to finance effluent treatment rather than an effort to influence the magnitude of discharge. For discharges into federal waters, charges are imposed and collected by the federal government. For discharges into regional waters and into sewerage, charges are imposed and collected by regional water boards, which are also responsible for building and operating wastewater treatment plants. Regional charges are the same for indirect as for direct discharges and vary by region according to the costs of treating wastewater. Monitoring is the responsibility of polluters with occasional verification by government authorities.

Charge revenues have risen significantly since they were first introduced, and are sufficient to cover nearly all wastewater treatment plant construction and operation costs. The cost of administering the program has been estimated at 3.5% of revenues. Charges are based on

pollution units. For oxygen-consuming substances, a pollution unit is defined as the average amount of oxygen-consuming material produced by one person in one day, which is further defined as 136g of oxygen-producing material. For heavy metals discharged into federal waters, one pollution unit is defined as 100g of the sum of mercury, cadmium and arsenic, and 1,000g of the sum of copper, zinc, lead, nickel and chromium.

For charge assessment purposes, there are three groups of dischargers:

1. For households and businesses generating fewer than 5 pollution units per day, charges are usually fixed at 3 pollution units. This group accounts for about 65% of charge revenues.

2. For dischargers of 5 to 1,000 pollution units (in some industries, the maximum is 100 pollution units) of organic pollutants per day, charges are determined by combining an industry coefficient with easily obtainable data such as water use and amounts of raw materials. Facilities that believe they are being overcharged can, at their own expense, conduct sampling and measurement and be charged according to the findings. This group contributes approximately 15% of charge revenues.

3. Industrial facilities and municipal sewage treatment plants generating more than 1,000 pollution units per day of organic pollutants or more than 10 pollution units of heavy metals are charged according to actual discharge, which they are expected to measure. Municipal treatment plants are not charged for discharges into regional waters and pay a reduced rate for discharges into federal waters. This group accounted for approximately 20% of charge revenues.

The first two groups face a pollution charge that is not directly linked to pollution. The third group, however, faces pollution charges directly linked to the quantity of pollution they discharge. For this group, the effluent fees are believed to have a significant effect on the quantity of pollution discharged.

2.2.4 Malaysia

Palm oil and rubber factories in Malaysia have been subject to a variable fee for BOD discharge.[24] For land discharges, the fee is purely volumetric; for water discharges, the fee is based on quantity of BOD discharged and varies with BOD concentrations. The fee is two-tiered: a low level up to the concentration standard, and a higher level above the standard. There is a minimum fee of Malaysian Ringit (RM) 150; charges are RM 0.05/ton of wastewater for land discharges; RM 10/ton of BOD for water discharges up to the standard; and RM 100/ton of BOD for water discharges above the standard. Starting in the second year of the regulations, the standard became mandatory. The two-tiered charge system continued, but mills that violated the standard faced a real threat of being shut down (between 1991 and 1994, 27 crude palm oil mills had their licenses temporarily suspended for violations; in 1996 licenses of another 4 crude palm oil mills and 4 raw natural rubber factories were suspended). In 1995, effluent charges on crude palm oil and raw rubber generated RM 1,031,439, equal to 6% of the Department of Environment's annual budget.

The regulations produced a dramatic drop in BOD emissions: a 2/3 reduction in the first year, and a 99% reduction after 7 years. Vincent and Ali (1997) argue that relatively little of this can be attributed to the effluent charges, however, as it was the threat of shutdown that appears to have motivated most action. Some mills might have reduced their concentrations below the standards due to the charges, but because of the minimum payment, this was probably negligible. There were several problems with the use of the BOD charges as an incentive to reduce

emissions. First, due to the minimum charge, mills had no incentive to reduce water discharges below 15 tons. Second, when the standard became mandatory, the main instrument became the standard and threat of shutdown, not the charge. Third, charge levels were not linked to any estimate of marginal benefits and marginal costs of pollution abatement, but were instead based on agency estimates of the level that would reduce discharges without imposing a major burden on industry.

2.2.5 Philippines

Laguna de Bay, also known as Laguna Lake, covers 90,000 hectares making it the second largest freshwater lake in Southeast Asia. Located partially within the confines of Metro Manila, the lake is an important fishing area for the local people, provides water for commercial, industrial and household use, and also serves as a disposal area for liquid wastes. Over time, the lake was overwhelmed with wastes, resulting in polluted water and large-scale fish kills. The Laguna Lake Development Authority (LLDA) was created by a Republic Act in 1966 as a quasi-governmental agency to manage development activities within the lake basin.[25]A 1975 executive order expanded the role of LLDA to include environmental protection and sustainable development of the water, fisheries and shore lands.

LLDA's jurisdiction includes 21 river tributaries of Laguna de Bay, five provinces (referred to as CALABARZON), sixty-six municipalities, and nine cities (including the capital, Manila). Within this area, LLDA identified fifteen industrial estates with approximately 3,200 facilities, as well as about 10,000 stand-alone manufacturing facilities. Although the Philippine Department of Environment and Natural Resources supervises LLDA, it remains an independent body through a special charter. The government owns 94 percent of it and private investors own the rest. LLDA receives no funds from the national budget. As such, it retains, invests, and uses collected fees without turning them over to the national treasury.

Hagler Bailly Consulting conducted a study for the World Bank reviewing effluent charge systems used in France, Germany, Malaysia, the Netherlands, and the United States as possible mechanisms for improving water quality in Laguna Lake. The study suggested that a charge system could be a very effective tool in stimulating effluent reductions. The bank recommended that LLDA be allowed collect fees at Laguna Lake because it is a government-operated and -controlled corporation with its own budget and board of directors. It is an attached agency of the Department of Environment and Natural Resources (DENR), but unlike DENR, LLDA can directly use revenues from the fee to pay for the administration of the program and finance wastewater treatment programs.

Officially launched on January 29, 1997, the user fee program focused on reducing the biological oxygen demand (BOD) of wastewater flowing into the lake by charging industries and commercial operations a pollution fee. Initially, the program targeted industries in sectors responsible for 90 percent of the industrial wastewater flowing into the lake and its major tributaries. These include food processing, beverage firms, hog raisers, slaughterhouses, and textile mills. Later, the program will also include major municipal and household sources of wastewater.

LLDA requires that firms pay their estimated user fees for the year before a discharge permit is issued. LLDA established its fee schedule using a numerical model of discharge activities and the objective of achieving a 50 percent reduction in the BOD load of the lake water within the

first year of implementation. To achieve this reduction, the fees had to be higher than the incremental costs of pollution prevention or treatment for many sources.

LLDA assesses two concurrent fees at the plant level on pollution discharges based on both volume and pollution load, providing incentives for water conservation and pollution abatement. LLDA levies a fixed fee based on the volume of wastewater discharged by the facility and a variable fee based on the amount of BOD discharged. The fixed fee is P5,000 for daily discharge up to 30 m^3, P10,000 for discharges between 30 and 150 m^3 per day, and P15,000 per year for more than 150 m^3 per day (P35 ~ $1 at the time the program was implemented). For wastewater that meets the government Class C standard of less than 50 milligrams per liter BOD concentration, the variable fee is P5 for every kilogram of BOD released. Wastewater that does not meet the standard is charged P30 per kilogram. For existing industries, the P30/kg rate is higher than the cost of installing wastewater treatment facilities, giving firms a financial incentive to invest in treatment or pollution prevention.

LLDA maintains an environmental fund to help administer the system. Fee revenues are placed here to (1) subsidize owners' clean technology investments through grants or loans, (2) recover the costs of administering the system (data management, monitoring, and so on), and (3) obtain loans in the capital market to build domestic wastewater treatment plants. As fees are collected, LLDA has hired more staff and added more firms to the system. By the end of 2002, the discharge fee system covered 914 of the 4,000 firms in the basin.

Relative to a 1997 baseline, the program had achieved a reduction in BOD of 96% by 2003 for those firms brought under the permitting system in 1997 and a 95% reduction for firms brought under the permit system in 1998. The lake has maintained its Class C status -- indicating it was suitable for fish culture and industrial use.

The effort to improve environmental conditions in the Laguna Lake watershed also involves a number of voluntary efforts. LLDA enlists the support of local industries, communities, media, and NGOs to help improve the water quality of the lake and its twenty-one major tributaries. LLDA recruited industries along the tributaries to work with local governments, local fishing organizations, and environmental and church groups to devise and implement a rehabilitation plan for their adopted tributary. Activities include collecting baseline data, cleaning solid waste from the tributary and its banks, planting vegetation along the banks, installing low-cost garbage traps at the mouth, and dredging where necessary.

2.2.6 China

The People's Republic of China initiated the pollution levy system (PLS) in 1978, based on the "polluters pay principle". First stipulated in *the Environmental Protection Law of the People's Republic of China (Tentative*) in 1979, the system is referred to in subsequent legislation on air pollution, water pollution and waste. In *the Tentative Regulation on Levying Discharge Fee* (1982) and *the Tentative Regulation on the Repayable Usage of Specific Fund for Pollution Sources Control* (1988), the State Council describes the targets, scope, standards, fee calculation methods and procedure of a system for levying fees, as well as fee management and use. The system now is operational in all the provinces, cities, and counties in the country. The pollution charge system may be characterized as a comparatively mature and effective environmental management system, though Chinese authorities regularly implement reforms of the system.

From the outset, the PLS was viewed as a means of implementing the polluter-pays principle and providing a source of funding for provincial and local Environmental Protection Bureaus (EPB). Another important feature of the PLS is that a large portion of the funds that are collected are returned to the enterprises for pollution control investments. China's PLS covers air, water and waste.

The water law establishes a system of concentration-based standards for effluents from point sources. Pollution levies are imposed on all releases for the substance that exceeds the standard. In 1993 the effective levy rate on wastewater discharges not meeting the standard was 0.13 yuan per cubic meter.

Many of the important polluters in the nation are state-owned enterprises (SOE) and many Township and Village Enterprises (TVE) operate in a financial collaboration with local government authorities. While China has freed most internal prices, the profit motive of an SOE or a TVE that is run in cooperation with a local government cannot be as strong as in a private company. Consequently, the response of firms in China to a pollution levy also may not be as strong as it would be in other economies. While the PLS seems to have been reasonably effective in reducing pollution, other factors such as responsibility contracts signed by enterprise managers and local government officials as part of the five-year planning process may be more important in determining the pollution intensity of industrial activity.

As originally implemented, the PLS had the following features:

- It applied to 113 items that belonged to one of five groups of pollutants: air emissions, effluents, solid waste, noise and radioactive substances.
- The amount of levy was based on pollutant concentrations at the point of release, rather than mass or volume. In 1993 volume became a determinant of the levy on wastewater and in 1998 mass emissions of SO_2 were subject to the levy.
- Generally the levy applies only to the portion of discharges whose concentrations exceed national or local emission standards. This changed for effluents in 1993 and for SO_2 in 1998, and now applies to all releases of these substances.
- For sources releasing several pollutants into the same medium, only the most highly taxed pollutant was levied.
- The magnitude of the levy is much lower than incremental pollution control costs, suggesting that the levy itself cannot have a major influence on polluting behavior.
- The pollution levy was assessed only on industrial sources. Sources such as municipalities, hospitals and schools are exempt.
- Discharge concentration standards apply nationally, however provincial and local governments may adopt more stringent standards
- Other charges (known as the "four small pieces") provide further incentives for sources to comply with the PLS.

Environmental supervision and management divisions of local Environmental Protection Bureaus collect the levy. Generally about 80% of the amount collected is returned to sources to help finance pollution control investments. The remainder is the principal source of income for local and provincial EPBs. The partial recycling of PLS revenue to polluting enterprises finances between 20% and 25% of total Chinese investment in pollution abatement. The PLS revenue retained by local and provincial EPBs contributes importantly to environmental management capacity in China.

Since the early 1990s, the PLS has been the subject of several evaluations by the Chinese Research Academy for Environmental Science (CRAES), HIID and the World Bank. While recognizing its important positive role, these reviews have identified deficiencies in (1) the design of the pollution levy, especially the tax base and charge rate, (2) the extent to which the pollution levy applies to polluters and pollutants; and (3) mechanisms for distributing levy revenues.

While many reviewers have criticized the Pollution Levy System, analysis of plant cost functions suggests that it should achieve positive results. A World Bank study by Dasgupta et al. estimates that effluent charges as low as $1 per ton should induce an 80% abatement of suspended solids. If charges were $3, $15 and $30 per ton respectively for TSS, chemical oxygen demand, and BOD, firms would have an incentive to reduce effluent by 90%. This suggests that the current pollution levy should have a significant effect on cost-minimizing firms, an effect that could be strengthened by increasing charge levels and, especially, applying charges to all effluents, not just effluent in excess of the standard. Wang and Chen note that recycling of about one-half of charge revenues for pollution control at the paying facilities should further increase pollution control efforts.

By 1996, China had imposed pollution levies on 496,000 polluting units with charge collections that year of 4.1 billion yuan and accumulated charges of 29.06 billion yuan. About 25% of the country's industrial enterprises currently are levied. Levy collections have not kept pace with the value of industrial output because the charge rates have been fixed while price changes have been significant. Also, some enterprises have complied with emission standards because of enforcement and as a result are not subject to levies for air pollution. Many Township and Village Enterprises (TVE) are not levied at all because local Environmental Protection Bureaus (EPB) do not have the resources to pursue all sources within their jurisdiction or find that the potential revenues from levying smaller sources does not justify the effort.

During the ten years from 1986 to 1995, charge revenue increased about four-fold in nominal terms, or 2.13 times in real terms. In the whole country, the proportion of total charge revenue to the value of industrial output decreased from 0.106% in 1986 to 0.040% in 1995. For TVEs, the proportion of charge to TVE industrial output value decreased from 0.025% in 1986 to 0.009% in 1995. Since TVEs generally use less advanced technologies, one would expect them to be paying relatively more in pollution levies, not less than average. This suggests the desirability of increasing efforts to impose the pollution levy on a larger proportion of the TVEs.

2.2.7 Other Developing Countries

Egypt imposes effluent fees on industrial discharge equal to one piastre (about one-sixth of one U.S. cent) per cubic meter. Several Eastern European countries have imposed effluent fees on industrial discharge. These countries, as well as China and most of the former Soviet Union, also impose non-compliance charges for discharge in excess of certain specified amounts. Revenues from most of these charges are used to fund environmental protection activities, but Slovenia's charge generates revenues for the general federal budget.

Like other environmental charges in Eastern Europe and the former Soviet Union, many of the effluent charges are limited in their effectiveness by problems such as weak enforcement, polluters' inability or unwillingness to pay, and inflation. Lack of widespread interest in

environmental issues, limited experience with incentive mechanisms, and complicated charge mechanisms have also been cited as problems with charges in Eastern Europe.

Several states in Brazil have introduced (or begun to introduce) charges for water and industrial sewage discharge based on pollution content.[26] While the charge rates differ across states, water charges are based on consumptive use and discharge of BOD plus a public unit price on all withdrawals. Eventually the states plan to add other discharge parameters. Sewage charges in Sao Paulo State, which are based on pollution content, have been found to have a significant impact on pollution. Reductions have been achieved through changes in production methods, use of cleaner inputs, and recycling. Having significantly underestimated the responsiveness of polluters to increased charges, the state sewage treatment company now suffers from excess capacity at a treatment plant.

Since 1991 India has imposed a combined fee for industrial use of water and discharge. The Water Cess Fee on discharge varies according to use, with cooling water charged the least, process wastewater an intermediate amount, and polluted wastewater charged the most. Seventy percent of the Water Cess Fee can be rebated if users treat their wastewater.

2.3 Air Emission Fees

2.3.1 Japan

Japan has levied sulfur emissions charges to generate revenues to compensate victims of pollution-related diseases. Since SO_2 was believed to cause the greatest harm, it was chosen for the tax. Both stationary and mobile sources are subject to the charge, the latter in the form of differential taxation dependent on vehicle weight. Since mobile sources are thought to generate about 20% of NOx and SO_2 emissions, the tax ratio between stationary and mobile sources is 4:1. For stationary sources, tax rates vary from $0.625 to $56.25 per cubic meter, depending on whether the source is located in a designated area. Since many diseases date back to the 1980s, there is also a levy of $0.82 per cubic meter based on SO_2 emissions between 1982 and 1986. Ambient SO_2 concentration levels have fallen significantly in Japan, but it is unclear to what extent this decrease is due to the tax.

2.3.2 France

France imposes a charge on emissions of hydrochloric acid, sulfur-containing compounds, nitrogen oxide-containing compounds, non-methane hydrocarbons, solvents, and other volatile organic compounds. The tax rates and base were expanded in 1990. The fee, 150 F ($30) per metric ton, has been imposed on combustion facilities with a maximum thermal power of at least 20 MW, waste incineration facilities with a capacity of three metric tons per hour, and facilities emitting more than 150 metric tons per year of taxable pollutants.

2.3.3 Sweden

In 1992 Sweden imposed a nitrogen oxide emission charge of 40 SEK ($5.9) per kg ($5,400 per short ton) on energy producers with a capacity in excess of 10 MW and production exceeding 50 GwH.[27] Approximately 120 heating plants and industrial facilities with about 180 boilers are subject to the tax. One interesting aspect of this tax is that revenues are rebated to the sources subject to the tax based on their energy generation. At the beginning of every year, facilities

report their NOx emissions and energy production for the previous year to the Swedish Environmental Protection Agency (SEPA). On the basis of these reports, SEPA calculates total revenues and refunds per generated MwH. Those facilities facing a net charge must pay by October, and those entitled to rebates receive them in December. The charge system in effect transfers income from high-emitting to low-emitting plants. In 1992, for example, approximately 15,300 metric tons on NOx emissions were subject to the charge, generating about 610 million SEK ($90 million). As a result of the revenue and rebate calculations, over 100 million SEK ($15 million) was transferred from high-emitting to low-emitting facilities. Most facilities subject to the taxes have installed measuring equipment so that the tax can be properly assessed. For facilities that either have no measuring equipment or whose equipment is temporarily out of order, a standard of approximately 1.5 times the average emission level applies. This standard rate, 600 mg NOx/MJ for gas turbines and 250 mg NOx/MJ for other installations, gives polluters a strong incentive to install measuring equipment.

An accredited laboratory must inspect measuring equipment once a year. Measuring and reporting are monitored by SEPA. Since other factors, such as the introduction of tighter emissions standards can influence NOx emissions in Sweden, it is difficult to determine the effect of the NOx charge. However, emission reductions appear to have been greater than they would have been without the charge. Incentive effects were evident as early as 1990 when many plants took measures to reduce emissions in anticipation of the charge. Millock and Sterner note that with the NOx charge and the installation of NOx monitoring equipment sources have both the ability and an incentive to fine-tune combustion processes to reduce emissions. In 1992, the first year in which the charge was in effect, emissions from taxed plants were 15,300 metric tons, down 36% from their 1990 level of 24,000 metric tons. This decrease was not due to a decrease in energy consumption: emissions per mega-joule fell from 150 mg NO /MJ in 1990 to 99 mg NO /MJ in 1992. Some plants have even linked staff compensation with emissions reductions.

The charge for NOx emissions was set at 40 SEK ($5.9) per kg because studies by the Swedish Environmental Protection Agency (SEPA) had indicated that control costs varied from 20 to 80 SEK ($2.9-11.8) per kg. SEPA has stated that the value of NO emission reductions is at least as high as the amount of the charge. The taxed plants were able to reduce emissions at an average cost per kg of approximately 10 SEK ($1.5) in 1992. Costs have ranged from 5 to 20 SEK ($0.7-2.9) per kg. Since these costs are significantly lower than the 40 SEK per kg charge, rational facilities will probably implement more abatement options in future years. Abatement measures used since the introduction of the charge include not only investments in new equipment but also measures to limit emissions by optimizing combustion.

Annual administrative costs of the charge are approximately 2 million SEK ($290,000) for SEPA and 300,000 SEK ($44,000) for each firm using measurement equipment. (SEPA appears not to have included its 2 million SEK administrative cost in its cost-benefit table, but this exclusion does not have a significant effect on the conclusions of its analysis.) Assuming 2 million SEK in administrative costs for SEPA and 18 million SEK ($2.6 million) in measurement costs for those taxed facilities that have installed measuring equipment, the annual monitoring and administrative costs amount to 20 million SEK ($3 million), or roughly 3% of charge revenue. One limitation of the charge is that it reportedly covers only about 6.5% of total NOx emissions, partly due to some energy producers' tendency to supply just under 50 GwH to avoid the tax. (Because of the 50 GwH threshold, the marginal taxation of quantities of energy just over 50 GwH is high.) Subsequently the threshold was lowered to 25 GwH. Another potential problem is

that the charge on NOx may cause some plants to increase emissions of other substances, but other control standards are in place to limit such emissions.

2.3.4 China

The Pollution Levy System was described previously. The air law regulates emissions. Charges are applied to all emissions of SO_2, not just emissions in excess of the standard. For other emissions, pollution levies are applied to the emissions in excess of the standard. For example, a fee of 0.04 yuan/kg (or $5/mT) applies to Cl_2, CS_2, CO, HCl, fluoride, and NOx emissions in excess of the standards. For coal dust and cement dust, the fee is 0.02 yuan/kg. Coal is charged a fee of 3.0 yuan/kg if emissions exceed standards by no more than four times.

The first formal indication of interest in limiting SO_2 emissions in the China is the State Council's 1990 "Suggestions on the Development of Acid Rain Control." The document recommends the creation of two control areas or zones, one for acid rain in the south of the country where the pH of precipitation is below 4.5 and one for SO_2 in several industrial cities in the north where ambient concentrations exceed Class II standards. Together the two control zones cover approximately 11.2% of the national territory and include over three-fourths of the population. A total of 47 of the 275 municipalities within the two control zones were declared "key" and they are targeted for the most ambitious control efforts.

National minimum rates were increased once in 1991; however, many provinces impose higher rates. In the recently designated SO_2 and acid rain control zones, excess SO_2 emissions have incurred a fee of 0.20 yuan/kg since 1998. Several large cities in the SO_2 and acid rain control zones also have raised their rates above 0.20 yuan/kg. Beijing's is the highest at 1.2 yuan/kg (equivalent to $150 per metric ton and approximately the same price as SO_2 allowances in the US Acid Rain trading program).

2.4 Municipal and Other Waste Charges

Bresser’s 1994 survey of economic instruments reports that municipal waste user charges are levied in 18 of the 21 industrialized countries (all but New Zealand, Portugal, and the United Kingdom) that it surveyed. The charges are usually (but not always) flat rates for households and unit rates for commercial generators. Note that unit rates are likely to have a greater incentive effect than flat rates that are independent of quantities of waste generated. The charges usually fund waste collection and/or disposal, but in many countries are also set high enough to exert an incentive effect to reduce waste.

Denmark, for example, levies the highest fee on waste delivered to landfills and a somewhat lower fee on waste delivered to incineration facilities.[28] Recycled wastes are not charged. Since the charges were introduced in 1987, the quantity of waste registered at disposal facilities has dropped and the reuse of building waste as filling material for road construction and other purposes has increased.

In the Netherlands, a charge equivalent to approcimately$18 per ton on landfill disposal of waste came into effect January 1, 1995 as part of a broader environmental tax law.[29] The main purpose of the charge is to raise revenue for the national budget, but a secondary purpose is to discourage waste generation. To promote incineration as a disposal method, incineration is exempt from the tax. The size of the charge relative to the average waste treatment costs of 82 Dfl ($50) per metric ton suggests that the tax could have significant incentive impact.

The United Kingdom landfill tax, which dates from October 1, 1996, is managed by Entrust.[30] The tax rate was 2 £ ($3) per metric ton for inactive waste such as bricks and 7 £ ($10.7) per metric ton for other waste. Landfill operators pay the tax and can raise disposal fees to recover their tax payments. The British Customs and Excise office said that the tax is "designed to use market forces to protect the environment by making the disposal of waste in landfill sites more expensive." Businesses' national insurance contributions were cut to compensate for the effect of the tax on business. A tax credit scheme allows landfill operators to donate up to 6.5% of their landfill tax liability to environmental projects in return for a 90% tax credit.[31]

Outside the OECD, South Korea introduced a system in 1995 under which household waste can be disposed of only in standardized bags sold in officially designated places. Bag prices in the metropolitan areas of the capital city of Seoul range from 60-80 won ($0.08-0.10) for five-liter bags to 1,090-1,450 won ($1.41-$1.88) for 100-liter bags. Prices are determined by local governments and vary slightly from area to area. The amount of waste sent to landfills was approximately 40% lower for the six months after implementation of the system. Unfortunately, a large quantity of the decrease was attributable not to waste reduction or recycling, but rather to uncontrolled incineration or private disposal. The plastic bags themselves are not biodegradable and thus pose disposal problems; moreover the bag fees are too low to cover waste disposal costs.

In 1994, Turkey introduced an Environmental Cleanup Tax on waste to raise revenue and to discourage waste generation.[32] The monthly rate was set at 25,000-100,000 TL ($0.37-$1.47) for households and 25,000-5,000,000 TL ($0.37-$295) for other generators. The Cleanup Tax was also imposed on wastewater.

Australia, Austria, Belgium, Finland, France, and several German states impose charges on hazardous waste disposal. Austria's tax of 200 S ($19) per metric ton is used to fund the cleanup of contaminated land. France has imposed a tax on the disposal of "special industrial wastes," a category including asbestos, chrome, lead, solvents, and other specified substances. The tax rose from 20 F ($4) per metric ton in 1994 to 40 F ($8) per metric ton in 1998.

The Netherlands and the Flanders region of Belgium impose charges on animal manure disposal to limit soil pollution. In the Netherlands, individuals are permitted to dump the manure equivalent of 125 kg of phosphate per hectare per year free of charge. Quantities between 125 and 200 kg are subject to a charge of 0.25 Dfl ($0.15) for every kg over 125 kg, and quantities over 200 kg to a charge of 0.5 Dfl ($0.3) per kg.

Waste charges have also been levied in a number of less industrialized countries, including the Czech Republic, China, Estonia, Hungary, Poland, Russia, and the Slovak Republic. Municipal waste charges for households and businesses in the Czech Republic, which have been in place since before World War II, were significantly increased in 1992. Municipalities determine prices. One problem with the increased charges is that they appear to have led to an increase in illegal dumping.

Since 1992, the Czech Republic has also levied two types of charges on landfill operators. The first charge, imposed on all landfill operators, generates revenue for the municipality where the landfill is located to finance environmental protection activities. The second charge is imposed only on those landfills that do not adhere to specified waste disposal standards. One report indicates that the charge "very positively motivated the establishment of new dumps in accordance with the strict required criteria concerning the safe storing of waste." The amounts of

both charges vary significantly according to the type of waste, the highest being 5,000 Kc ($184) per metric ton for dangerous waste. The Slovak Republic has similar charges.

In much of Eastern Europe and the former Soviet Union, charges on waste as well as air and water pollution are higher for quantities in excess of permitted levels or for improperly handled quantities. These higher incremental rates for levels in excess of standards could be looked upon as non-compliance fees.

2.5 Product Charges

Levied in numerous industrialized countries, product charges are imposed either on a product or some characteristic of that product. Although some of these charges may discourage consumption, many of them are advance disposal fees intended to finance the proper disposal of the products after their use. Products on which charges have been imposed include automotive air conditioners (Canada), batteries (Canada, Denmark, Portugal, and Sweden), beverage containers (Belgium, Finland, Norway, and Sweden), building materials (Denmark), CFCs (Australia and Denmark), dry cleaning solvents (Denmark), fertilizers (Austria, Finland, Norway, and Sweden), light bulbs (Denmark and Korea), lubricating oil (Finland, France, Italy, Norway, and Spain), packaging (Belgium and Germany), pesticides (Belgium, Denmark, Norway, and Sweden), plastic and paper bags (Italy, Iceland, and Denmark), sulfur in oil (Finland, Norway, and Sweden), and tires (Taiwan and Canada). South Korea in 1993 imposed advance disposal fees on several products that are difficult to treat or recycle, but the rates are rather low.

Several countries have imposed product charges on pesticides and fertilizers. Estimates of price elasticity of demand for these products vary widely, depending perhaps on the time period studied, crops, geographic area, and other factors. However, some of these charges are likely to have an incentive effect. Norway has levied charges on fertilizers and pesticides since 1988. The fertilizer taxes are NKr 1.17 ($0.18) per kg of nitrogen and Nkr 2.23 ($0.35) per kg of phosphorous, resulting in average taxation of approximately 7% of the wholesale price. The pesticide tax is 13% of the purchase price. In Finland, charges of Mk. 1.5 ($0.32) per kg were imposed on phosphate fertilizers in 1990. Relatively low charges on fertilizers in Austria, which are no longer in effect, are reported to have had a significant impact on fertilizer use.

In Denmark, retail sales of pesticides are subject to a 20% tax. Hansen estimated the price elasticity of demand for pesticides in Denmark at -0.45. This estimate suggests that the 20% tax reduced pesticide use by 9%. Sweden imposed two different charges on fertilizers in the 1980s. At their highest level, in 1991, the charges equaled 30-35% of the sales price of phosphate and nitrogen. Subsequently, charges were reduced. The charges have had a significant impact on fertilizer use. The amount of land under cultivation has also decreased but not in the same proportion as fertilizer use. The reduction in use appears to be most significant during the period when the tax was at its highest. The Swedish Board of Agriculture administers the charge. Its annual administrative costs associated with the charge have been estimated at 500,000 SEK ($74,000), roughly 0.4% of the total annual charge.

Effective in 2000 Norway imposed a product charge of 50 Norwegian kroner ($7.50) per kilo on purchases of trichloroethylene (TCE) and perchloroethelyne (PER). Firms have the right to reclaim half of the tax upon delivery of TCE sludge to authorized recyclers and treatment plants. The product charge is noteworthy because it is more than three times the market price of TCE

(which is between 10 and 15 crowns per kilo). Such a product charge would be expected to have strong incentive effects. Sterner (2004) notes preliminary data show that consumption of TCE fell from more than 500 tons in 1999 to 139 tons in 2001, while PER use fell from 270 tons in 1999 to 32 tons in 2001. Some care should be taken in interpreting these data because 1999 purchases were inflated about 25% by hoarding in anticipation of the tax.

Energy taxes can be considered product charges. One type of energy tax that has become a frequent topic of discussion in environmental protection is a carbon tax. Levied on fuels based on their carbon content and intended to limit emissions of carbon dioxide, carbon taxes have been adopted in several European nations, including Belgium, Denmark, Finland, France, Italy, Luxembourg, the Netherlands, Norway, and Sweden. Poland has a small tax on CO_2 emissions. Carbon taxes are generally small relative to other fuel taxes, although the relative size of the carbon tax varies according to the type of fuel. Rates often vary depending on the sector or use of the fuel. In Finland and the Netherlands, the taxes are assessed partly on carbon content and partly on energy content. OECD (2004) provides a useful review of these and other energy taxes in OECD countries.

Many developed and developing countries have imposed higher taxes on leaded gasoline to encourage motorists to switch to unleaded fuel, with Austria, Denmark, Bulgaria, Denmark, Finland, France, Germany, Greece, Netherlands, Philippines, Poland, Portugal, Sweden, and the United Kingdom providing some examples. Hammar and Lofgren note that the price differentials generally ranged from the equivalent of one to ten US cents per liter.

2.6 Preferential Taxation of Environmentally Friendly Products and Activities

This is a very broad topic that can be covered only in a cursory fashion. Preferential taxation of environmentally friendly products is found in many nations. Tax breaks may take the form of reduced excise taxes (e.g., for unleaded gasoline), reduced custom duties for equipment embodying certain advanced technologies, low interest loans, income tax concessions, etc. The section on subsidies later in this report offers a number of specific examples.

3. Deposit Refund Systems and Performance Bonds

3.1 Deposit-Refund Systems

Deposit-refund systems or "deposit systems" combine a product charge (the deposit) and a subsidy for recycling or proper disposal (the refund). Manufacturers or vendors of products that are subject to deposits incur additional costs in handling returned products, but these costs are often partially offset by the interest earned on deposits, unclaimed deposits, and sales of collected, used products. Performance bonds, discussed later in this section, are closely related to deposit systems.

One of the objectives of a deposit system is to discourage illegal or improper disposal. Waste products that are discarded improperly have higher social costs than those disposed of properly, since such discards can become an eyesore or even an environmental or health threat. Improperly discarded waste is also quite expensive to redirect to the legal waste stream. Deposit systems are commonly applied to beverage containers, in part because these containers make up a large proportion of roadside litter. Another important objective of a deposit system is to divert recyclable items from the waste stream.

In addition to being used for beverage containers, deposit systems have also been used for other products such as pesticide containers, lead-acid batteries, and tires. Firms voluntarily implement some of these systems while state and local authorities develop others.

Several studies conclude that deposit systems are more cost-effective than other methods of reducing waste disposal, such as traditional forms of regulations, recycling subsidies, or advance disposal fees (ADF) alone. However, the relatively high administrative costs of a deposit system could outweigh these cost savings, particularly for low-valued items.

Administrative costs are an important consideration when determining the efficiency of deposit systems. Ackerman et al. estimate that administrative costs in the U.S. average about 2.3¢ per container, equivalent to more than $300 per ton for steel containers and $1,300 per ton for aluminum cans, in states with traditional beverage container deposit systems. Palmer et al. estimated that waste disposal in a deposit system costs about one-half as much as an advance disposal fee or recycling subsidies. A full accounting of the desirability of deposit-refund systems would compare administrative costs and the costs imposed on consumers with the benefits of reduced disposal costs, energy savings, reduced litter, avoidance of the environmental costs of extracting raw materials, and other environmental benefits. Deposit-refund systems appear best suited for products with high value, or whose disposal is difficult to monitor and potentially harmful to the environment. When the used product has economic value, the private sector may initiate the program.

3.1.1 South Korea

The OECD (2001b) notes that among middle-income countries, South Korea has one of the most extensive deposit systems in terms of items covered. Under a 1991 amendment to its Solid Waste Management Act, South Korea introduced a comprehensive deposit program in 1992. The products affected by the system and the deposit amounts are shown in the following table.

Producers and importers of the listed products pay the deposits into a "Special Account for Environmental Improvement" and receive refunds as they collect and treat the resulting post-consumer waste. The products covered and the magnitude of the deposit were modified in 1993 and again in 1996. The largest deposit applies to large tires and amounts to about $0.40. The deposit on paper, metal, glass and plastic packaging is a fraction of a US cent per container.

Table 3.1. South Korea

Material	Size	Deposit
Paper pack	Less than 250 ml Greater than 250 ml	0.3 won 0.4 won
Metal can	Lid attached Lid separated	2 won 5 won
Glass bottle	Less than 100 ml 100 to 350 ml over 350 ml	1.5 won 2 won 3 won
PET bottle	Less than 500 ml 500 to 1500 ml Over 1500 ml	4 won 5.5 won 7 won
Batteries	Mercury Silver oxide	120 won 75 won
Tires	Large Medium Motorcycle	450 won 130 won 50 won
Lubricating oil		25 won/liter
Televisions		38 won/kg
Air conditioners		38 won/kg
Washing machines		38 won/kg

Exchange rate (2003): 1 won = $0.00084

3.1.2 Yukon Territory, Canada

Canada's Yukon Territory implemented a deposit-refund system in 1992. Consumers pay a deposit when they purchase beverage containers and receive a refund when they return the empty container to one of about 25 registered recycling depots in the territory. Beverage wholesalers send the deposit to the Recycling Fund, which then reimburses recycling centers for refunds made, collection, processing and shipping costs. During the period 2000-2001 the return rate for containers was nearly 85%.

Table 3.2. Yukon Deposit and Refund Rates

Container Type	Deposit	Refund
Aluminum can	$.10	$.05
Large (glass, plastic, tin and tetrapack >1 liter)	0.35	0.25
Small (glass, plastic, tin and tetrapack <1 liter)	0.10	0.05
Large liquor container (>500 ml)	0.35	0.25
Small liquor container (<500 ml)	0.15	0.10
Refillable beer and cider bottles	0.10	0.10

Source: government of Yukon Territory[33]

3.1.3 Germany

Germany has been a leader in promoting recycling. Its Green Dot or Duales system is now operating in several countries such as Austria, France and Spain where the Green Dot on packaging indicates that the manufacturer has paid a fee to Duales, which is responsible for recycling. A new German package recycling law went into effect January 1, 2003. Single use containers incur a fee of 0.25 euros (or 0.50 for containers 1.5 liter or larger). Beer cans are included but liquor, wine, fruit juice, milk, and non-carbonated beverage containers are exempt. Until October 1, consumers must return the empty containers to the point of purchase along with a receipt or other proof of purchase. After that date, retailers and beverage suppliers must have a system for accepting returns. According to a recent press release from the German Environment Ministry, sales of non-refillable cans and bottles have dropped by 60% since the start of 2003.

3.1.4 Automobile Body Deposits

Norway, Sweden, the Aland Islands (a self-governing territory of Finland) and Greece have mandatory deposit-refund systems for automobile bodies. These systems are reviewed in a recent report from the Nordic Council of ministers. Under the Swedish system created in 1975, mandatory deposits on new cars finance payments to individuals who return old cars to authorized scrap dealers. Originally, the deposit was 250 SEK ($37) and the refund was 300 SEK ($44), but in 1988, the deposit was raised to 300 SEK ($44) and the refund to 500 SEK ($74). In 1992, the deposit was increased to 500 SEK and the refund was set at 1,500 SEK ($221) for cars returned within nine months of an inspection and 500 SEK ($74) for other cars. The purpose of the differentiation was to encourage the scrapping of older cars emitting more pollutants. Although the scrap car refunds have lowered the number of abandoned cars, the incentive effect has been reduced by deductions of some motorists' unpaid taxes and fines from their refund payments and by their desire to keep old cars for spare parts. Administrative costs of this system are relatively low at approximately 2% of revenues. The deposit-refund system in Greece, under which motorists must purchase a new vehicle with a catalytic converter to qualify for a refund, has significantly increased the prevalence of catalytic converters.

3.2 Performance Bonds

Performance bonds are fees levied upon companies that extract certain natural resources, such as timber, coal, oil and gas, and may also be imposed on a variety of construction activities. Amounts deposited as the performance bond can be refunded when the payer fulfills certain obligations. In that sense, a performance bond acts like a deposit-refund system.

While performance bonds give companies a direct economic incentive to reclaim mining sites, follow timber-harvesting regulations, and perform construction activities in compliance with applicable rules, there is also a second and perhaps stronger incentive. A firm’s ability to obtain future mineral leases, timber harvesting contracts, or construction permits is dependent in large part on satisfying today’s regulatory requirements.

China uses a performance bond to ensure sufficient financial resources for environmental management, and in particular to ensure compliance with its "three simultaneous" policy. That policy seeks to have projects (1) designed, (2) constructed, and (3) operated in compliance with

all environmental regulations. The use of performance bonds to ensure financial responsibility is administered by Provincial and local EPBs, and overseen by the Ministry of Finance or by the relevant economic sector institution.

Beginning in 1997, Indonesia's Director General of Mining required mine operators to post a reclamation guarantee reflecting the value of the potential environmental damage the mining operation could cause.[34] The amount of the guarantee is set at the estimated reclamation cost should the damage be caused. The Indonesian government refunds the guarantee upon satisfactory performance by the operator.

Beginning in 1991, the Philippines required a Forest Guarantee Bond (a returnable performance bond) to encourage responsible long-term management by timber leaseholders, to provide a means for promptly penalizing lessees if there is a violation of the agreement, and to provide a market-based measure of profitability of a forest lease with harvesting rights by having would-be leaseholders bid against one another for the right.[35] The government set a floor price for leases of P6,000/ha (US$217). This amount approximated 10% of the value of the standing timber. The government suspended the scheme in 1995 after it was clear that it encouraged clear-cutting and did not produce the desired investments in planting and protecting forests.

4. Trading Mechanisms

4.1 Trading of Air Emission Rights

At least three different forms of emission trading exist: emission cap and allowance trading programs (e.g., the U.S. Acid Rain Program), emissions averaging or rate-based trading (e.g., fuel efficiency standards for vehicles), and credit trading programs such as emission offsets.[36]

The general principle of emissions trading systems is that sources may satisfy their obligations by one of two means. First they may limit their releases of pollution to no more than the permitted amount. Second they may release more (or less) than the permitted amount and exchange credits representing any deficiency (or surplus) either internally or externally. Sources with marginal costs of pollution control that are about average are likely to meet their obligations without trading. Sources with relatively high marginal control costs are likely buyers of pollution reduction credits and sources with relatively low marginal costs of control are likely sellers of excess credits. The broad objective of emissions trading is to lower the total costs of achieving a given environmental goal.

Cap and trade programs have a number of technical and regulatory requirements that have limited its use (particularly in developing countries):

- A clear legal and regulatory framework, including a delineation of the roles and responsibilities of the different parties (regulators, emission sources, and others);
- Definition of the overall emissions cap, and which sources to include;
- A process for allocation of emission quotas to the sources that are included;
- Timing and spatial issues, such as how long the program will run, whether banking will be allowed, whether there will be trading zones or other mechanisms to account for differences in the environmental impact of emissions from different sources;
- Accurate methods for measuring emissions (often a sophisticated and costly continuous emission monitoring device);
- Accurate allowance tracking system; and
- Effective enforcement and penalty requirements.

While the U.S. has considerable experience with emission trading, there are relatively few other examples elsewhere in the world. Germany has an offset program that allows new sources to be located in areas with poor air quality without causing further deterioration in air quality. Santiago, Chile established a program in tradable particulate credits in 1992. A 1993 revision of Taipei, China's Air Pollution Control Act included provisions under which individual sources may be exempted from emission standards if they can control sufficient amounts of the same types of emissions elsewhere in the same air pollution control region. Several emission trading programs are under development in the People's Republic of China: nationwide trading of SO_2 emissions from electric utilities, patterned after the U.S. Acid Rain program; trading of SO_2 emission reduction requirements in the city of Taiyuan (Shanxi Province) and in other cities. Several years ago, the Asian Development Bank also insisted on a number of one-off trades in

China as conditions for loan approval. Slovakia has established the foundation for trading in SO_2 emissions, with actual trading not slated for another couple of years. Ontario, Canada has a pilot emission reduction trading (PERT) program dating from 1997 that includes VOC, SO_2, CO_2, and NOx. Many countries have started to design programs in tradable greenhouse gas emission credits. This section reviews several of these experiences.

4.1.1 Particulate Trading in Santiago Chile

This example concerns total suspended particulate matter (TSP) in Santiago, Chile and a novel emissions trading program designed to help the city solve a serious air pollution problem. Santiago is located in a broad valley that is prone to temperature inversions. Rapid industrial growth brought with it severe air pollution problems, notably TSP, inhalable particulate matter (PM 10), carbon monoxide and ozone. Epidemiological studies linked the high concentrations of PM 10 to daily mortality in adults and respiratory disease in children.

In 1987, stationary sources produced an estimated 21,780 kg and mobile sources 13,570 kg of TSP per day. Through an aggressive program to control industrial emissions of particulate matter, a decade later the industrial source contribution had been reduced from 61.6% to just 34% of total TSP.

Santiago's Emission-Offsets Trading Program was designed to address cost-effectively the inherent conflicts between industrial growth and ambient air quality goals.[37] As described by Montero et al., industrial sources of TSP registered at the time the program was promulgated receive *daily emission capacity rights* in perpetuity. New sources and expanding sources receive no emission capacity rights, so they must buy emission capacity rights from existing sources. This means there is an emissions cap equal in magnitude to the sum of the individual emission capacity rights at the time the program was created.

At the time the program was established in March 1992 there were 563 existing sources, primarily industrial boilers that exceed an emissions threshold of 1,000 m^3 per hour. By July 1993 another 117 new sources were registered and included in the program. Sources of process emissions can be included in the program, but in practice the difficulty of estimating process emissions has resulted in these sources being left out.

The maximum emissions level from each source is calculated from a uniform permissible emission concentration that was applied to all sources and two source characteristics that are verified during annual inspections: the type of fuel used and size. Sources can trade any excess between their rights as computed above and their computed maximum emissions. Because what are measured are not actual emissions but rather the potential to create emissions, what are traded are capacity rights not actual emissions. In no case may a source exceed the national concentration standard of 112 mg/m^3.

DS4 empowers the Metropolitan Health Service of the Metropolitan Region through its Office for the Control of Stationary Sources to enforce the program through inspections. DS 32, a Supreme Court order from 1990, provides additional enforcement power through the authority to order temporary shut downs of the top 50% of important sources of TSP whenever there is a forecast or actual emergency situation with respect to air quality. From the onset of the program, industry switched to cleaner fuels to lower their emissions capacity so that they no longer are counted among the largest 50% of TSP emitters. Completion of a natural gas pipeline from

Argentina in 1997 has led to rapid conversion of industry, power generators, commercial sources and households to a clean alternative fuel.

The amount of trading of emission rights has been lower than would be expected and the prices for rights higher than expected. A number of factors may explain these results. By 1998, ownership of emission rights had become quite concentrated. Five firms (as distinct from sources) owned 31% of the rights and 21 firms owned 50% of the rights. Transaction costs are high due to a time-consuming approval process and because there is no organized market in the rights.

In terms of environmental results, Santiago's efforts to control TSP have been remarkably successful. In 1993 when the program started, 4,604 kg/day of rights were outstanding, compared to an emission capacity 7,442 kg/day. By 1999, outstanding rights were modestly lower at 4,087 kg/day, but capacity to produce emissions had been lowered to 1,637 kg/day. However, the market in emission rights is less well developed than might be desired, with few transactions and prices that have fluctuated wildly from one transaction to the next. In the first six months of 1998, inter-firm transaction prices for the right to emit one kg/day in perpetuity ranged from a low of about $1,100 to a high of about $11,500.

4.1.2 SO_2 Trading in Slovakia

A 1998 law authorizes the Ministry of Environment to establish a national cap and trade program for large and medium scale sources of several pollutants. The Ministry established an emissions quota for each of 79 administrative districts, which in turn set quotas for individual sources in 2002. Sources may trade all or part of these quotas. Currently only sources greater than 50 MW thermal input are included in the program.

4.1.3 Emissions Trading in China

In the early 1990s China began to require that emissions be offset at selected new facilities. With assistance from Environmental Defense (a U.S. non-governmental organization), the first real emissions trading projects in China began in 2000 in the cities of Nantong (Jiangsu Province) and Benxi (Liaoning Province). These pilot tests revealed that emission trading was feasible, at least in a primitive form.[38]

Following on those initial pilot projects and with the blessings of China's State Environmental Protection Adminstration, in 2002 Environmental Defense expanded its emissions trading pilot programs to include four provinces, three metropolitan areas and one enterprise. The project includes Jiangsu, Shanxi, Shandong and Henan Provinces; Tianjin, Shanghai, and Liuzhou Municipalities; and the Huaneng Company (China Resources). In addition efforts are underway to develop a national SO_2 emissions trading program.

As described by Morgenstern et al., in 2001, the city of Taiyuan, Shanxi Province agreed with the Asian Development Bank to participate in a demonstration of SO_2 emissions cap and allowance trading system trading patterned after the highly successful U.S. Acid Rain program. Sources are granted emission allowances for each year of the program. Allowances may be used to meet source emission limits, traded with other firms in the program, or banked for future use. Initially 26 sources will participate in the program, which has as a goal a 60% reduction in emissions during the Tenth Five-year Plan (2000-2005). Yang and Schreifels report the first demonstration trades took place in December 2002.

4.1.4 Ontario Canada Pilot Emissions Reduction Trading

Established in 1996, Pilot Emissions Reduction Trading (PERT) is an experimental program in the Windsor-Quebec corridor designed to develop practical experience in emission trading as a means to control smog and other air pollutants.[39] Sources have generated over 150,000 tons of NOx credits since the program's inception but there have been no official trades (and hence uses) of the credits.

4.1.5 NOx Trading in the Netherlands

In 2001 the government of the Netherlands and industry agreed to a rate-based emission trading program for NOx emissions that allocates credits to sources based on performance standard rates (PSR) multiplied by the sources consumption of fossil fuels. As described by Zijistra, sources with a capacity equal to or greater than 20 MW must meet this PSR through own abatement actions or the purchase of credits from other sources. The environmental goal of the program is an industrial emission target of 55,000 tons of NOx in 2010, a 55% reduction from 1995 base year emissions of 122,000 tons. Because a rate-based program does not control total emissions, the government set an interim goal of 75,000 tons for 2005 to indicate whether tightening of the performance standard of 50 grams of NOx per GigaJoule will be necessary. To add additional flexibility, the program allows pollution sources to bank credits for future use as well as borrow credits from their allocation for next year.

4.1.6 EU Greenhouse Gas Emissions Trading

On July 2, 2003 the European Parliament approved a directive on emissions trading that will create a market in carbon dioxide emissions across the EU beginning January 2005.[40] As described in the EU Green Paper, emissions trading will establish limits on carbon dioxide emissions from energy intensive sectors. Sources that reduce emissions to a level below their limit can sell this surplus or bank it for future use. The EU mechanism will be the first multi-national emissions trading scheme in the world. One key feature is the right of member states to auction a portion of the allowances. The rest of the allowances will be granted to existing sources without charge.

4.2 Tradable Salinity Credits in Australia

Two examples of salinity credit trading systems are found in Australia. As described by Newman and Gross, one is in the Murray-Darling Basin Commission, which manages water resources in a three-state area that produces over half of Australia's agricultural output. The basin system is naturally saline, with some stream inflows saltier than the sea. Extensive irrigation activities in the upstream states of New South Wales and Victoria, encouraged by the sale of irrigation water to farmers at low prices, increased the flow of salt into the river system, reducing water quantity and quality to the downstream state of South Australia. Irrigation activity in South Australia further added to salinity levels of the water before it reached downstream urban users. Under the Commission's salinity and drainage strategy, each state is responsible for its actions affecting river salinity and no actions are permitted that increase overall river salinity. Credits can be earned for investments that limit the entry of salt into the river system. The tradable credits are used to offset debits for drainage into the system.

The second concerns the Hunter River, which experiences naturally saline conditions that adversely affect agricultural productivity and drinking water quality. To protect river water quality from further deterioration due to saline discharge, coal mines and other sources along the river are subject to salinity discharge limits. When the river is at low flow, no discharges are permitted. At high flow limited discharge of saline water is allowed. In flood state, unlimited discharge is allowed provided salinity levels (measured by electrical conductivity) in the river do not exceed a stated threshold. Beginning in 1995, mines were allowed to trade allowances for discharge during high flow conditions. The program is considered highly successful.[41] Salinity in the river is much lower now than before the scheme was implemented and at the same time new mines have opened.

4.3 Tradable Water Rights

Trading in water rights is a relatively new phenomenon, with most examples dating from the 1980s or 1990s. Three cases are discussed briefly: the Murray-Darling Basin in Australia, New Zealand and Chile. Until about ten years ago, tradable water rights were an important feature of water management at some of the oases in the Western Desert of Egypt.

4.3.1 Australia

To protect water quality, the Murray-Darling Basin Commission imposed a cap on water use and water transfers out of the basin. Under the cap, individual sources received tradable water rights. The Commission also holds periodic water allocation auctions. Volumes traded, although small compared to total water allocations, have increased steadily.[42]

4.3.2 New Zealand

New Zealand’s Resource Management Act encourages local authorities with responsibility for managing natural resources to consider alternative mechanisms. The Manawatu-Wanganui Regional Council's Oroua Catchment Plan is the first regional plan developed under the RMA to include a transferable water permit system.[43]

4.3.3 Chile

Under Chile's 1981 Water Code, water use rights are completely separate from land use rights and can be purchased, transferred, or sold.[44] New water rights are awarded by competitive bid. Partly because most water rights (perhaps 50%-65%) are traditional but not legally recognized, water leases are far more common than sales. In one area north of Santiago, the price of a three-month lease was estimated at $90-120 per liter per second (equivalent to about 1.5 cents per cubic meter). Transaction costs are said to be relatively high because of the need for infrastructure investments to transfer water, the need for approval from government authorities, and the lack of legally recognized water rights. In general, however, the system appears to promote efficient water allocation.

5. Subsidies

5.1 Subsidies for Improving the Environment

Subsidies are the mirror image of emission fees or taxes. Rather than imposing charges on firms for their emissions, the subsidy approach offers cash payments to firms for reducing emissions. Polluters who release emissions forgo the cash payment. Subsidy systems provide incentives to polluters to control all units of pollution whose marginal control cost is less than the subsidy. Subsidy systems for pollution control are especially popular in two sectors: farming and municipal government. However, economists point out a major drawback of subsidy systems. While subsidies provide incentives to existing firms and other sources to reduce their pollution, new entrants may be attracted by the higher profits earned as a result of subsidies. In some extreme situations this could have the perverse effect of increasing total pollution.

Several examples of subsidy instruments in Asian nations are summarized in Table 5.1.

5.2 Subsidies for Environmentally Friendly Agriculture and Land Management

Numerous countries use subsidies to promote environmentally friendly agriculture. Canada's Land Management Assistance Program offers many land management subsidies and provinces subsidize farmers' efforts to comply with codes of acceptable environmental practices. In the Province of New Brunswick, for example, the Ministry of Agriculture offers payments for practices that increase the organic content of soil and reduce soil erosion, including payments of C$15 ($11) per acre for winter crops and of C$50 ($30.5) per acre for green manure crops.[45] Faced with serious manure waste problems, Hong Kong introduced a program in the late 1980s to pay allowances to farmers if they stopped maintaining livestock.

The European Union's Common Agricultural Policy requires member countries to offer financial assistance to farmers for recommended practices in environmentally sensitive areas such as water protection zones. Germany, Finland, Norway, and Sweden offer grants to farmers who convert from traditional to organic farming. The United Kingdom is one of several European countries that reward farmers for not spraying around the edge of crops. The crop-edge program in the U.K. has enhanced bird and butterfly populations while having minimal impact on crop yields. Farmers in nitrate-sensitive areas of the United Kingdom can receive annual per hectare payments for limiting their use of nitrogenous fertilizers and animal manure, establishing crop cover to avoid bare land in the fall, and keeping hedges and woodland. Under Germany's Nature Conservation Act, farmers are rewarded for adopting environmental management practices such as reducing fertilizer use, refraining from converting grasslands into cropland, and refraining from using meadows while insects are hatching.[46] Also, several alpine countries subsidize sustainable agriculture and animal husbandry activities in mountainous areas to prevent environmental degradation.

Table 5.1. Environmental Subsidies in Asia

Country, instrument, and source of data	Description of instrument
Indonesia—tariff reductions for wastewater treatment equipment[47]	Tariffs are reduced on imported wastewater treatment equipment.
Korea—low interest loans and income tax deductions for purchase of energy-saving equipment. [48]	Under the Energy Utilization Act of 1979, low interest loans are provided for a variety of energy-efficiency investments. Firms that produce energy-saving equipment receive a corporate income tax deduction of 10%; firms that import this equipment receive a deduction of 3%.
PR China – reduced tariffs for pollution control equipment and advanced technology goods	The PR China has made great efforts to encourage the use of imported high-technology goods, including pollution control equipment, through reductions and exemptions from tariffs and customs duties.
Philippines—tax exemptions for pollution control equipment[49]	Exemptions of up to 100% of import duties and local taxes are given on anti-pollution devices for industries covered by the Investment Priorities Plan. (Before 1984, the exemption was for up to 50% of tariffs on imported pollution control equipment.) A tax exemption for pollution control devices of up to 5% of income is being considered. Because operating costs of pollution-control devices is typically greater than the expected value of existing fines for violating pollution standards, it is unlikely that the policy has reduced pollution.
Thailand —import and income tax exemptions for pollution control activities	Pollution control equipment not produced in Thailand is exempt from import duties, and foreign specialists working on pollution control activities are exempt from income taxes.
Taiwan —corporate income tax deduction on pollution control equipment	In 1981, the Taiwan government approved income tax deductions for corporations purchasing pollution control equipment or clean technology.
Indonesia, Korea, Taiwan and Thailand — soft loans for pollution control	With assistance from international donor organizations, firms in Indonesia, South Korea, Taiwan and Thailand can borrow for pollution control equipment and clean technology at favorable interest rates and other loan terms.

A number of countries subsidize reforestation activities. In the Belgian region of Flanders, private forest owners can obtain subsidies for reforestation, granting access to the public, and forest grouping. In 1994, Finland announced revisions in its tax structure for forests. Under the revised system, forest reserved for noncommercial purposes and designated in officially approved management plans will not be taxed based on its prospective yield as before, but rather will remain tax-free for a 13-year transition period. The United Kingdom provides grants for the planting of trees and hedges on agricultural land. In Portugal, farmers can obtain subsidies and concessional loans for reforestation and creation of permanent pastures, and Spain and Turkey offer grants for afforestation and other land restoration activities. In Japan, forest owners can

receive grants, low-interest loans, and favorable tax treatment in return for observing specified land management practices (OECD, 1994).

5.3 Subsidies for Resource Conservation

Another area where subsidies have been used extensively is the promotion of resource conservation. Denmark has offered grants for activities such as renewable energy source power generation, energy-saving measures, and used oil collection and exempted energy-efficient light bulbs from the aforementioned product charge on bulbs. The Netherlands has exempted recycling wastes from its recently imposed waste tax, and exempted water used to wash recyclable beverage containers from its new groundwater tax. Both of these taxes were described above.

In the western Australian mining community of Kalgoorlie-Boulder, where water is supplied by a 550-km pipeline, a $2.6 million (US$2.0 million) campaign in 1995 sought to reduce water use from 7,000 million liters per year to 6,300 million liters per year. The campaign targeted businesses, institutions and households, and included water consumption audits of businesses provided at 50% of cost, a $300,000 (US$232,000) revolving loan fund to finance water-efficient technologies, free installation of water-saving toilets and shower heads, and subsidies for a host of similar water-saving devices. The campaign achieved a reduction in demand of about 13%, an improvement over the 10% reduction that was originally sought.[50]

In Switzerland, individuals may deduct energy-saving improvements from their taxable income, and businesses' expenditures on energy-efficient equipment, solar power, and other similar investments are subject to accelerated depreciation. Australia exempts certain recycled paper products, solar power equipment, and alternative fuel technology from its Wholesale Tax.

5.4 Environmentally Harmful Subsidies

5.4.1 Developing Countries

In much of the world, forest resources, waste collection, water, and electricity are priced far below their long-run marginal cost. It has been estimated that tax benefits for businesses contributed to 5% of the total area deforested in the Brazilian Amazon. Fertilizers and pesticides, which are taxed in several European countries, are subsidized in parts of Asia. In much of the world, forest resources, waste collection, water, and electricity are priced far below their long-run marginal cost. Electricity is far cheaper in developing countries than in OECD countries. The World Bank (1992) has estimated that developing countries use about 20% more electricity than they would if consumers paid the true marginal cost of supply.

The government of Egypt, for example, subsidizes many activities, a number of which could be termed environmentally unfriendly. Some of these subsidies are being reduced or eliminated. For example, as a condition for project lending, the World Bank succeeded in having Egypt reduce substantially its subsidies for agricultural fertilizers and pesticides (American Chamber of Commerce in Egypt). Historically, Egypt has subsidized the market price of diesel fuel and fuel oil, setting domestic prices at approximately one-half of world market levels. Recently, petroleum exploration companies have discovered large quantities of natural gas in the Western Desert and in coastal areas of the Red Sea. Contract terms for these exploration and production concessions give the GOE a 50% share in any production but also compel the government to buy

the other 50% at world market prices. Finding markets for all of the natural gas has been a problem, especially with the subsidies already offered to diesel fuel and fuel oil. The Egyptian government has decided to subsidize further the use of natural gas through the construction of pipelines and below-cost sales to certain large consumers. Although not the primary motivation of these policy decisions, urban air quality is improved through these measures.

5.4.2 OECD Review

Based on an analysis and review of the literature on environmentally harmful subsidies, a 1998 OECD report concluded:

- A subsidy can be defined as environmentally harmful if it encourages more environmental damage to take place than that which would occur without the subsidy.
- The largest percentage of support has been implemented through minimum price regulations, which increase the marginal revenues of the producer at the expense of consumers and taxpayers.
- Support in the OECD countries is mainly given to inefficient firms in mature industries in order to protect them from foreign competition.
- The tax jurisdiction under which the support measures are applied has a significant effect on the economic and environmental aspects.
- Support measures consist of a combination of direct financial mechanisms and regulations. Removing only one element from such combination will often have only limited influence.
- Support measures may also represent a rather weak beneficial effect on income, growth and employment, while having adverse effects on the environment.
- It is difficult to calculate the exact environmental effect of support policies across the sectors. A rough estimate can be based on the elasticity of demand and supply in a given sector, the point of impact of the support measure in the market exchange, and direct and indirect links between the point of impact of the support and resulting pollution or other adverse impact.
- The positive effects of the support removal will often become apparent only after relatively long time span. Any estimates of the environmental benefits of support removal will necessarily depend on assumed technical development and the time horizon examined.
- Because of the increasing benefits that accrue over a longer time period the total environmental benefits of support removal will be larger than estimates based on empirical evidence.

5.4.3 International Lending: The Equator Principles

In response to pressure from environmental activists that international banks too often financed projects that were environmentally damaging, the International Finance Corporation in collaboration with ABN Amro, Barclays, Citigroup and WestLB AG developed a banking industry initiative for addressing environmental and social issues in project financing. The initiative applies to projects in excess of $50 million, placing projects in one of three risk categories. Borrowers developing projects in the two higher-risk groups will be required to carry out an environmental assessment covering issues such as the project's impacts on indigenous

populations and biodiversity, pollution prevention and the efficient use of energy. As of March 2004 twenty international banks had adopted the Equator Principles.

The Equator Principles seek to achieve three main results. First, banks use common terminology in categorizing projects into high, medium and low environmental and social risk, based on the IFC categorization process. They apply this to projects globally and to all industry sectors. This should be helpful in encouraging lending for environmentally sound projects.

Second, banks require that their customers demonstrate in their environmental and social reviews, and in their environmental and social management plans, the extent to which they have met the applicable World Bank and IFC sector-specific pollution abatement guidelines and IFC safeguard policies, or to justify exceptions to them. This should give banks much better information on which to make judgments.

Third, banks must insert covenants into the loan documentation for high and medium risk projects covenants to ensure that borrowers comply with required environmental and social management plans. If those plans are not followed, and if deficiencies are not corrected, banks have the ability to declare the project loan in default.

The IFC uses two sets of guidelines for its projects. The Pollution Prevention and Abatement Handbook was adopted in 1998 and compiled by environmental staff from the World Bank and IFC. That document covers 40 industrial sectors. The IFC also uses a series of environmental, health and safety 'safeguard' guidelines that cover other sectors.

The safeguard policies generally represent methods for dealing with issues that cross industry sectors, such as nature protection or population resettlement, where it is important to apply consistent environmental and social principles. The World Bank pollution prevention guidelines, on the other hand, mostly are sector-specific environmental standards that apply to processes, technology, and issues in specific industries, and represent good practice within that sector. In these respects the policies and guidelines support each other. It is instructive to provide examples of these guidelines and safeguard policies to characterize their scope and content.

Coke manufacturing guidelines from the Pollution Prevention and Abatement Handbook are quite detailed and discuss many aspects of manufacturing and environmental performance:

- Typical manufacturing processes
- Typical waste characteristics
- Pollution prevention and control methods
- Target pollution loads for air and water per unit of coke produced
- Concentration guidelines for wastewater discharge
- Noise limit guidelines
- Monitoring and reporting guidelines

A few of the IFC guidelines are similar to the World Bank guidelines, e.g., Gas Terminal Systems, which specifies discharge and emission limits in terms of concentration (but not per unit of output), workplace noise and air quality limits and general environmental considerations. Most of the IFC guidelines are much more general, offering broad recommendations for planning and conduct of activities but without any numerical recommendations.

The World Bank and IFC guidelines have been used routinely for project appraisal and as criteria for lending. With the recent adoption of the Equator Principles by several important international banks, the World Bank and IFC guidelines surely will have broader visibility, potentially leading to their greater use and impact.

6. Liability

The imposition of liability for damage to human health and the environment can be a powerful incentive to encourage good environmental behavior by corporations, as well as a means to compensate those who are injured. If polluters are liable (and must pay) for the damage they cause, they will have an incentive to limit pollution. The profit-maximizing firm will control pollution to the point where the marginal pollution damage equals the marginal costs of control. At this point, their total payments for controlling pollution and compensating victims are minimized.

Liability mechanisms are a part of both civil and common-law systems, and can include both criminal and civil (non-criminal) sanctions. Many environmental statutes worldwide have civil liability provisions, though environmental liability actions in developing countries are relatively rare. Weak implementation of the law in developing countries is one problem. Another problem is jurisdiction: whether a case should be brought in the developing country where the damage occurred or in the home country of the firm responsible for the damage. As the examples here suggest, there is no universal rule regarding jurisdiction. Moreover, in some cases individuals harmed by spills are not compensated due to unclear liability rules or inadequate financial guarantees prior to the start of operations.

More than a decade ago, the United States passed the Oil Pollution Act and CERCLA, both of which have provisions for natural resource damage assessment and restoration. More recently, the European Union responded to the difficulty of pursuing environmental liability claims under traditional legal remedies. In 2002 the European Commission of the European Union adopted a proposed directive on environmental liability that seeks to prevent and restore environmental damage. That directive, approved by the EU Parliament in 2003, should be approved by EU member states over the next three years. The directive holds operators of environmentally risky or potentially risky activities responsible for damage and for restoration in the event of a situation that causes damage. Operators also are responsible for costs of necessary preventative measures to counter the risks of environmental damage (e.g., when the dike of a holding pond weakens or there is the threat of an explosion because of excessive pressure). Under the directive, public interest groups and other non-governmental organizations can require public authorities to respond to environmental threats and can challenge in court the decisions of public authorities when the decisions appear to contravene the directive.

Examples are given below of instances when liability was imposed on firms for causing environmental damage. The first example concerns the Ok Tedi mine in Papua New Guinea. The second example is of a mercury spill in Peru. A third set of examples concerns damage assessments for coral reefs, including one case in Egypt.

Several implications may be drawn from this review. First, pursuing liability claims is very costly and the outcome is highly uncertain, arguing that liability is most appropriate only for large incidents and not routine polluting activities. Second, smaller and more poorly capitalized enterprises may find bankruptcy an attractive option in the event of a large pollution incident. Consequently, performance bonding or some other type of guarantee may be desirable for enterprises that have the potential of causing significant environmental harm.

6.1. Ok Tedi Mine, Papua New Guinea

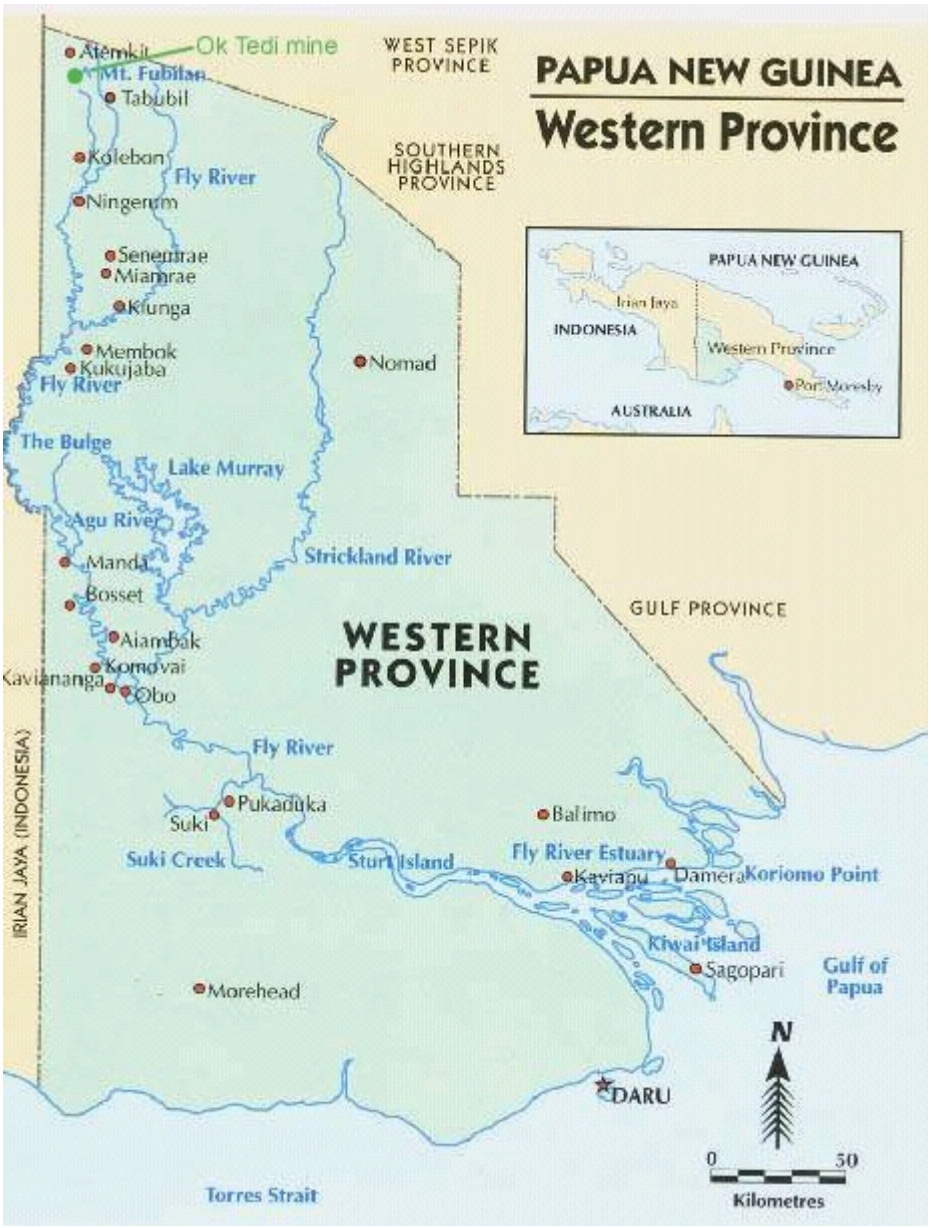
The Ok Tedi mine is located on Mt. Fubilan at the headwaters of the Ok Tedi River in the Star Mountains in western Papua New Guinea, not far from the Indonesian border.[51] The Ok Tedi River flows 200 km to the south where it joins the Fly River. The Fly River meanders over 450 km of floodplain until it joins the Strickland River and empties into the Gulf of Papua. The mine is at an elevation of 1,800 m, in a geologically unstable region marked by frequent landslides and earthquakes due to very high rainfall (10 meters annually). Mining is conducted by the Ok Tedi Mining Limited (OTML).

Originally the PNG government required in the Environmental Impact Statement that the mine have a tailings pond as a condition of operation. After foundations for the tailings dam were destroyed by major landslides in December 1983 and January 1984, OTML received permission from the government to dump some 65 million tons of tailings and waste rock annually into the Ok Tedi and Ok Mani rivers. The tailings are sand-sized and smaller, while the waste rock is gravel to boulder size. The waste material contains copper, cadmium, lead and other heavy metals.

The tailings and waste rock dumped into the Ok Tedi river system have caused much greater adverse impacts downstream than originally envisioned. The riverbed at Tabubil where most mine employees live, has risen by approximately 4 meters. Downstream where the Ok Tedi flattens out and loses some of its velocity, sand has accumulated to the extent that the riverbed is six meters higher. Elevation of the riverbed has increased the frequency and severity of flooding, as well as contaminating the floodplain of the Fly River with heavy metals and sand. Several hundred square kilometers of formerly productive lands have experienced forest dieback and areas near the river are no longer suitable for cultivation. In the Ok Tedi, fish catches have declined by 90% from baseline (pre-mine) levels, while on the middle stretches of the Fly River, catches have declined by about 70%. It is important to note that fish and water quality both meet WHO standards, meaning that human health impacts have not been an issue.

There have been at least six different compensation agreements designed to address these environmental impacts. The first agreement covered land loss during construction of the mine, and also provided compensation in the event of unanticipated adverse environmental impacts within the area covered by the mining leases. The subsequent compensation agreements were the result of litigation by affected parties living outside the area covered by the mineral lease.

Courts in Papua New Guinea would not accept cases brought by those outside the original compensation agreement. As a result, plaintiffs filed suit in the Australian courts. BHP Billiton (a large Australian natural resources company) worked with the PNG legislature to draft legislation that would bar such suits and protect BHP and the other owners of Ok Tedi from liability for harm to people or the environment. Adverse publicity effectively stymied these efforts and eventually the Australian courts found that several groups of plaintiffs had been injured. The PNG legislature enacted the Restated Supplemental Agreement Act (RESA) also known as the Mining Act of 1995 to codify these settlements from the Australian courts.



Source: http://www.oktedi.com/okTediDocuments/oktedimap.pdf

Victories in the Australian courts enhanced the bargaining position of the affected landowners by providing them with resources necessary to hire outside legal representation and seek greater compensation. The 1995 act is noteworthy because it provides compensation without proof of loss to communities deemed affected by changes to the river system.

A 1996 settlement agreement between BHP and 30,000 landowners has three elements: creation of a tailings pond to receive wastes from continued mining; rehabilitation of the Ok Tedi and Fly Rivers; and compensation of A 110 million ($ 70 million US) to the affected landowners, and an agreement to pipe tailings to unused land at the bottom of the mountain at a cost of between A 300 million and A 450 million. In addition, OTML agreed to dredge about 20 million tons of rock annually in parts of the Ok Tedi River to reduce siltation, erosion of the riverbanks and flooding of adjacent farmland, and BHP agreed to pay the plaintiffs' legal costs. While the

compensation was paid, the mine continued operations while it conducted a risk assessment of the planned tailings pond and the ongoing dredging activities.

In August 1999, the PNG government asked the World Bank to review OTML's risk assessment for its waste disposal operations and to consider broader issues of environmental and social stewardship and responsibilities between the government and the peoples of the Western Province. The World Bank concluded that the best option from an environmental viewpoint was to close the mine immediately. However, there had been no preparations for closure in the affected communities and, as the World Bank (2000) pointed out, the social costs of closure needed to be considered.

The PNG Government interpreted the risk assessment as supportive of continued mining until 2010, the date originally planned for mine closure. BHP recognized that the mine was an increasing liability and announced in May 2000 that it wanted to end its involvement in Ok Tedi Mining Limited by June 2001. Atlas Mining, a Philippine company, emerged as the most likely buyer. The Papua New Guinea government has expressed concern regarding the sale, citing recent litigation by landowners in the Western Province where the mine is located and possible compensation that may be ordered by the Victoria (Australia) Supreme Court.

Certainly not all impacts have been adverse. The OTML has been the principal agent of economic development in the Western Province. It employs 1900 people and at least four times that many jobs are created indirectly as a result of the mine. During its first 15 years of operation, infant mortality has fallen from 300 to 15 per 1000 live births, life expectancy has increased from 30 years to 50 years, and the incidence of malaria has fallen by at least two-thirds. In addition, substantial sums have been paid in taxes and royalties to the PNG government, governments of the Western Provinces, and local landowners.

An important aspect of the litigation and settlement concerns what precedent it might have for mining operations of foreign companies and whether injured parties could seek redress in the home nation of the company. The fact that a mining company could be sued in its home country for damage caused in another country where it had operations is an important precedent. Moreover, that it could be found liable for environmental damage even when it complied with all environmental regulations and permit conditions of the host country also is remarkable. Compensation paid to adversely impacted parties in the host country has been substantial; the consequences of environmental damage were a major drain on corporate resources, enough so that BHP is trying to sell or otherwise dispose of its interest in the project.

6.2. Yanacocha Mine, Peru

Yanacocha is a large gold mine in the Peruvian Andes. On June 2, 2000 a truck traveling from the Yanacocha gold mine spilled 151 kg of mercury between the villages of Choropampa and Magdalena. The truck driver allegedly went on to Lima without informing residents of the hazards posed by mercury (Langdon). Local residents collected as much mercury as possible, believing it was valuable. According to Yanacocha sources, symptoms of mercury poisoning affected more than 900 individuals and several individuals were hospitalized (IFC, 2000). Interestingly, a risk assessment of the spill conducted for the mine owners did not address exposure resulting from the collection activity.

Newmont Mining is a 51% owner of the mine, along with Minas Buenaventura with 44% and the International Finance Corporation, a private sector branch of the World Bank, with 5%. The

Compliance Advisor Ombudsman (CAO), an evaluation unit of the IFC, investigated the accident and reported:

- The mine had no emergency response plan for mercury spills outside its property
- Newmont did not apply global standards for the transport of hazardous wastes
- The mine did not follow safety procedures for loading and transporting mercury, and
- The mine owners and the Peruvian government were not forthcoming about the dangers posed by mercury exposure.

Under protest Newmont paid a fine of 1.74 million soles (approximately $500,000) to the Peruvian government. The company also agreed to provide health insurance for five years for individuals with symptoms of mercury poisoning, to construct a number of public works projects in the affected area, and to respond to the recommendations of the CAO. Newmont took a charge of $10 million in its financial statements for 2000 to reflect these costs. In September 2004, lawyers representing individuals claiming injury from the spill were successful in petitioning a U.S. court to hear their case. Newmont acknowledged that it could not predict the magnitude of its future liabilities from the spill.

6.3 Coral Reef Damage Assessments

These are several instances where liability has been imposed for damage to coral reefs, and compensation paid for restoration and cleanup, as well as lost tourism revenues, etc.

6.3.1 Egypt

On April 4, 1996 Cunard Lines' *Royal Viking Sun* strayed from course and ran into a coral reef off Tiran Island near Ras Mohammed in the Red Sea. Before the vessel was freed, it damaged approximately 2,000 square meters of reef. Egyptian authorities impounded the vessel and demanded $23.5 million (equivalent to over $10,000 per square meter of reef) in compensation for lost tourism revenues and damage to the environment. Cunard Lines settled the case and paid that amount.

6.3.2 Puerto Rico

On July 24, 1997 the 326-foot *Fortuna Reefer* went aground near a Nature Reserve off the west coast of Mona Island in Puerto Rico (Anderson). The vessel damaged a barrier reef that extends about 10 miles from the eastern end of the island around the south coast and to the northwest. The reef contains large, branching elkhorn corals that were damaged by the grounding. Because of the remoteness of the site, salvage efforts were hindered and the vessel remained aground for ten days. While no fuel oil was spilled, the grounding and later salvage activities caused physical damage to an area approximately 8,000 square meters.

Restoration experts advised reattaching the largest pieces of coral to reestablish the physical structure of the reef (Elkhorn coral often survive reattachment). In a September 11 settlement agreement with the Commonwealth of Puerto Rico and the National Oceanic and Atmospheric Administration, the ship owner, Rama Shipping Company of Thailand, agreed to pay $1,250,000 for natural resource damage (equivalent to about $190 per square meter of damaged reef). The settlement provides $650,000 for emergency reattachment of 400 large pieces of coral, to be

conducted under NOAA leadership, and $400,000 for compensatory restoration to the Commonwealth. By September 20, NOAA had initiated emergency restoration efforts.

6.3.2 Australia

On November 2, 2000 the container vessel *MV Bunga Teratai Satu* ran aground on the northwest side of Sudbury Reef, a part of the Great Barrier Reef of Australia.[52] The 22,000 ton, 184 meter long cargo vessel was registered to Malaysia International Shipping Corporation and carrying 1200 tons of fuel oil. After two days of effort, the ship was freed without loss of fuel or cargo, however the reef sustained considerable damage. The Australian government conducted a cleanup in two phases. The first phase involved a relatively small 50-meter by 30-meter scar from the ship in the coral. This area was heavily contaminated with a tin-based anti-fouling substance that had been applied to the vessel. At the end of the first phase of cleanup, several large blocks of reef were replaced to facilitate regeneration of the coral. The second phase of cleanup involved a larger debris field 100 meters by 300 meters. The shipping company has agreed to pay the Australian government at least $2 million to compensate for the cleanup and restoration efforts and long-term monitoring. One of the other outcomes of the incident will be a thorough review of shipping practices near the Great Barrier Reef.

7. Information Provision

The provision of information can be a powerful tool to encourage firms to pursue environmentally responsible behavior. This chapter discussed three such mechanisms: performance rating of firms; pollutant release and transfer registers; and product labeling.

7.1. Performance Rating of Firms

7.1.1. Indonesia

In Indonesia, the Environmental Impact Management Agency (BAPEDAL) created the Program for Pollution Control, Evaluation, and Rating (**PROPER**) to rate factories on their compliance with national wastewater discharge standards; the ratings are then disclosed to the public through the media. The program operated for three years from 1995 until the financial crisis of 1998 but is now being revived.[53] The first of these surveys in June 1995 rated 187 factories. Five color categories were used to rate environmental performance: gold for firms that use best technology and reduce pollution to 5% of the national standard, green for firms that reduce pollution to 50% of national standards, blue for compliance with national standards, red for firms that fail to meet national standards, and black for those without pollution controls.

Formal as well as informal sanctions applied, depending upon the color class. For example, the Indonesian stock exchange would not list securities of firms that fall short of the blue classification. Cultural factors such as shame avoidance and citizen lawsuits also play a role in motivating polluters. Evidence suggests that this system influenced behavior. In the first survey in June 1995, 35.3 percent of the 187 factories were in compliance with the government's water pollution regulations. Two years later, 49.2 percent of the factories were in compliance.

7.1.2. Philippines

The Philippine Department of Environment and Natural Resources introduced the *Industrial Ecowatch Project* in 1995 as a voluntary compliance monitoring system, and formally implemented it by regulation in 2003.[54] The idea is to use public disclosure to pressure firms that value their reputation to manage their pollution. A "gold" rating means that the firm is practicing resource conservation and pollution prevention, using clean technology and implementing self-regulation beyond the requirements of environmental regulations. A "green" rating indicates very good performance. A "blue" rating refers to minimum compliance with all applicable environmental regulations for at least one year. A "red" rating refers to compliance that falls short of the standards. Lastly, a "black" rating pertains to the absence of any effort to comply with regulations and a pollution level that is damaging to the environment.

Ecowatch is being implemented in the jurisdictions of the Laguna Lake Development Authority and the DENR-National Capital Region. The ratings of seventy-two firms were calculated in the DENR-NCR area. Based on initial confidential disclosure to the firms, only 4 industries made it to the blue rating. Before disclosure to the public was made, 22 firms improved their performance to a blue rating. Former President Ramos honored firms with blue ratings in April 1998. These firms have benefited from the recognition as full-page advertisements were launched to announce their environmental achievement. It appears that resources invested in the Industrial Ecowatch Project will pay dividends in the future. The payback is not only to the

environment but also to the firms that get good media exposure for their products. Sooner or later, this will translate to more demand for their goods. With color-coding, firms have an economic incentive to manage their pollution.

The success in the adoption of Ecowatch is partly attributed to the assistance of two World Bank divisions: the Agriculture and Environment Division - East Asia I and the Policy Research Department, Environment, Infrastructure & Agriculture Division. Furthermore, the industries' reception of Ecowatch was not adversarial due to the participatory framework used in planning the project's mechanics. The industries themselves were partly responsible for the design of the Ecowatch system, which includes area coverage and criteria for rating & timing. Also, the country's larger industry associations came together and supported the launching of the project.

The database of Ecowatch will be merged with the databases of the Pasig River Rehabilitation Program and the Management and Information System Office of the Environmental Management Bureau. This integration of data gathered from monitoring activities will strengthen the regulatory network as inspection and reporting will become easier. Also, other users will be given the opportunity to tap into this information resource.

Similar programs are being developed in Mexico, Columbia and the People's Republic of China.

7.2. Pollutant Release and Transfer Registers (PRTR)

For certain kinds of environmental problems and in certain social and institutional situations, the best regulatory solution may be to encourage the generation and dissemination of information about a problem. This approach recognizes that disclosing information can put pressure on businesses indirectly (rather than directly through administrative penalties such as fines or closures), and encourages them to engage in low cost measures to address the environmental problem rather than seeing business always as "the problem" to be regulated.

The US Toxics Release Inventory reporting system dates from 1987. Since then several other nations have developed similar systems. Known internationally as Pollutant Release and Transfer Registers (PRTR), these programs have their origin in the 1992 Earth Summit, officially called the United Nations Conference on Environment and Development (UNCED). Chapter 19 of Agenda 21, the Summit's action plan, calls on nations to develop such programs. The OECD, the World Bank, and UNEP have developed PRTR guidelines and offer assistance in developing such programs.

The early PRTR programs include Canada's National Pollutant Release Inventory (1993), the United Kingdom's Chemical Release Inventory, and Australia's National Pollutant Inventory. The Czech Republic, Denmark, Finland, France, Ireland, Japan, Mexico, the Netherlands, the Republic of South Africa, Sweden, Switzerland, and Trinidad and Tobago presently are in various stages of implementing PRTR programs.[55] Currently, pollutant release data by facility and for geographic regions are available on the Internet for the United States, Canada, Australia, and the United Kingdom.

7.3 Product Labeling

Product labeling programs normally are voluntary in nature, relying on third-party verification of positive or environmentally neutral attributes of products. Labeling programs that focus on positive or environmentally neutral attributes of products may be classified as *Seal of Approval*

Programs or *Single Attribute Programs*. A number of international seal of approval programs are summarized in Table 7.1 and the Korean program is described in somewhat more detail in Table 7.2.[56] Single attribute programs that focus on whether a product can be recycled or is biodegradable also should be noted.

Table 7.1. Summary of Environmental Product Labeling Programs

Country	Seal	Type of Label	Year started	Number of Products (as of 1998)
Austria	Austrian Eco-label	Seal of Approval	1991	35
Canada	Environmental Choice	Seal of Approval	1988	49
China		Seal of Approval	1994	12
Croatia	Croatia's Env. Label	Seal of Approval	?	33
Czech Rep.	Environmental Label	Seal of Approval	1994	17
Denmark	Nordic Swan	Seal of Approval	1989	42
EU	EU Ecolabel	Seal of Approval	1992	11
Finland	Nordic Swan	Seal of Approval	1989	42
France	NF-Environment	Seal of Approval	1992	6
Germany	Blue Angel	Seal of Approval	1977	88
Germany	Green Dot	Single Attribute	1990	7
Iceland	Nordic Swan	Seal of Approval	1989	42
India	Eco-Mark	Seal of Approval	1991	16
Japan	Eco-Mark	Seal of Approval	1989	69
Korea	Eco-Mark	Seal of Approval	1992	36
Luxem-bourg	EU Ecolabel	Seal of Approval	1992	11
Malaysia	Product Certification	Seal of Approval	1996	1
Netherlands	Stichting Miliekeur	Seal of Approval	1992	32
New Zealand	Environmental Choice	Seal of Approval	1990	17
Norway	Nordic Swan	Seal of Approval	1989	42
Singapore	Green Label	Seal of Approval	1992	21

Country	Seal	Type of Label	Year started	Number of Products (as of 1998)
Spain	ANEOR	Seal of Approval	1993	3
Sweden	SIS-Nordic Swan	Seal of Approval	1989	42
Sweden	Environmental Choice	Seal of Approval	1990	17
Taiwan	Green Mark	Seal of Approval	1992	35
Thailand	Green Label	Seal of Approval	1993	6
UK	EU Ecolabel	Seal of Approval	1992	11

Source: Abt Associates

Most product labeling programs describe positive features of products, but the EU has a few labeling programs that describe negative environmental attributes of products, such as drinking water contaminant reports, pesticide warning labels, and workplace material safety data sheets.

Table 7.2. Korean Ecomark Criteria

Product category	Criterion
Products made with reused paper	> 50% reused paper
Tissues made with reused paper	> 50% reused paper
Reused plastics	> 60% reused plastic
CFC free aerosol sprays	0% CFC content
Reusable diapers	100% cotton
Non-asbestos brake lining	0% asbestos
Aluminum cans with stoppers	Should use aluminum
Filter for kitchen sinks	Holes no larger than 1.5 mm diameter
Non-bleached and non-dyed towels	Made without dyes or bleach
Water valves	Water should not run with closed valve
Packaging materials using wastes	Made with 100% waste
Soap made with waste edible oils	Contain > 50% waste edible oil

Korea initiated its Eco-Mark Labeling program in June 1992, under supervision of the Korean Ministry of Environment.[57] A committee within the Korean Environmental Labeling Association determines if applicants for eco-certification meet its criteria. Unlike other labeling schemes, Korea's program has focused on one important criterion in each product category. Labeling criteria for the first 12 product categories approved under the program are far simpler than the life cycle assessment criteria employed in some other countries. The program appears to have

had incentive effects. Sales of recycled paper increased by 30% after the introduction of the program.

8. Voluntary Agreements

Voluntary pollution control programs and agreements are increasingly common in both develop and developed countries as regulatory seek ways to motivate firms to go beyond compliance with existing environmental regulations.

8.1 Covenants and Agreements

The Netherlands' use of covenants, agreements between industry and government, to address environmental problems has attracted considerable attention in recent years. Covenants generally have the legal status of private law agreements, allowing the authorities to seek legal recourse for enforcement. Covenants have been signed between industry and the government concerning products, packaging, waste, and other matters. In the field of air pollution, covenants have been concluded on the reduction of SO_x and NO_x from power plants, the reduction of VOC emissions from industry, small businesses, and households, and the phaseout of CFCs.

In Japan, voluntary pollution control agreements date back to the 1950s. Tens of thousands of these agreements are now in force.

Under Indonesia's PROKASIH (or Clean Rivers Program), the largest polluters are encouraged to sign agreements to reduce pollution by specific amounts over a specific time period. In the first 2 1/2 years after the start of the program, about 1,000 polluters signed agreements, the majority of which took measures to reduce pollution. The government has released information on which signatories have complied and which have not and encouraged press coverage of signatories' performance under the program.

8.2 Industrial Estates and Eco-Industrial Parks

Several thousand industrial parks have been established around the world, many with the specific objective of using waste materials from one industrial operation as raw material input to another. A number of factors may be cited as stimulating the formation of eco-industrial parks (EIPs) and industrial estates, notably preferential tax policy, direct subsidies, and increasingly strict government regulation. Because many industrial estates and EIPs were established without any special economic incentives, they are classified with voluntary actions. The Kalundborg EIP is a case in point.

8.2.1 Kalundborg, Denmark

Kalundborg’s voluntary industrial networks to re-use wastes have been described extensively (Gertler & Ehrenfeld, 1997; Erkman, 1997). The discussion here will review the factors leading to the development of the network. Six industrial plants are included in a network based on reuse of waste products:

- Novo Nordisk/Novozymes A/S (insulin and enzymes)
- Asnæsværket A/S (electricity)
- Statoil raffinaderiet A/S (petroleum products)
- Gyproc Nordic East A/S (gypsum wallboard)

- Soilrem A/S (microbiological cleaning of polluted soils)
- Asnæs fiskeindustri A/S (trout fish farm)

Among the six industries there are at least 19 different exchange activities: seven water exchange projects; six energy exchange 6 projects; and six solid waste projects. In addition, there are also a number of ancillary projects to share laboratory capacity, common contracts with external entrepreneurs, and personnel recruiting. The network evolved spontaneously in response to ever-stricter environmental regulations. The Asnæs plant and the refinery were started around 1960, but it was not until in the 1970s that the first exchange linkages were established. Gas was piped from the refinery to the Gyproc plant from its start in 1972. In 1976 Novo Nordisk began shipping sludge to farmers. The Asnæs plant began in 1979 to sell fly ash to cement producers and in 1981 to supply heat to the municipality. The number of exchange activities has doubled since the early 1990s with the identification of more opportunities for profitable exchange.

The annual economic savings from the exchange activities amount to about 100 million DKr ($10 million US). With a total investment or about 500 million DKr, the payback times for individual projects average approximately five years. These economic profits arise primarily as an effect of resource savings. For example, recirculating water between companies saves about two million cubic meters groundwater and one million cubic meters of surface water every year. About 200,000 tons of raw gypsum is saved through the use of gypsum produced from scrubbing operations and approximately 20.000 tons of oil is saved through steam exchange.

Environmental legislation has been the major driver for the evolution of the Kalundborg EIP. Most exchange activities have been a response to pollution legislation or initiatives to save energy and water. Initiatives to use water more efficiently stem from relative water scarcity in the region. Danish environmental legislation rests on negotiations between government and the regulated community and not on rigid technological demands or emission standards. This flexibility allows for local problem resolution, which is manifest in the exchange activities. The commune of Kalundborg, which together with the regional government is responsible for the implementation of environmental legislation affecting the EIP, has been well informed and supportive but not directly involved in negotiations between the companies.

8.2.2 Nanhai, Guandong Province, China

The Nanhai EIP is a new site focusing on the environmental protection industry. The park, which is currently under development, seeks to co-locate new businesses that implement ecological-industrial principles and conduct business with networks outside the park.

Four types of environmental businesses are sought most:

- Environmental equipment manufacturing, such as sewage and waste treatment equipment;
- Manufacture of environment friendly products;
- Environmental protection research and service; and
- Wastes recycle, reuse and regeneration, solvent recycle, etc.

A number of economic incentives are being offered to entice firms to locate within Nanhai, including discounted land costs and favorable land financing terms. The city maintenance fee is

reduced. Firms locating within the park are offered many tax breaks (such as reduced property taxes, reduced business fees, reduced taxes on equipment purchases, etc.). Preferential policies also are offered regarding the introduction of experts and other human resources.

8.3 Waste Exchanges

The London Environment Exchange promotes trading in materials such as metals, plastic, paper and glass.[58] It is a response to new European Union regulations that require member states to achieve 50-65 percent recovery of waste packaging materials by 2001 and recycle at least half of that amount. The exchange was set up with assistance from the OM Group, which manages the Stockholm Exchange and trades financial and pulp wood futures and options in London. The OM Group hopes the Environment Exchange will help UK companies meet their EU obligations. Waste exchanges may be viewed as a voluntary response to command and control regulations.

The UK is the first country to adopt the EU Environmental Directive in national law. Businesses with annual sales of more than five million pounds and handling more than 50 tons of packaging must hold Package Recovery Notes (PRNs) to prove they are fulfilling their packaging recovery and recycling obligations. Those that recover or recycle more than required can sell their excess PRNs to others. There are six types of PRN: glass, aluminum, paper, plastic and steel, and a general note is issued for recovery of non-specific materials.

9. Conclusions

This report provides an introduction to international use of economic instruments for managing the environment. Because of the literally thousands of such instruments in use, the report can only highlight some of the more interesting applications. In the case of fees, charges and taxes, the report can only cover a small fraction of the many applications, particularly those in Europe. For other types of instruments, such as tradable permits, it is possible to summarize most applications.

The 2001 USEPA report *The United States Experience with Economic Incentives for Managing the Environment* provides a useful table, reproduced here as Table 9.1, of the general applicability of different types of instruments, reflecting international as well as US experience. It goes without saying, however, that the success of many instruments depends critically on details of both design and implementation.

There is substantial evidence of growing use of economic instruments for managing the environment. The 1997 EPA report provides a useful benchmark against which to assess changes. Not only are more countries applying economic instruments but also they are doing so in a more sophisticated manner. Many problems from older applications have been corrected. For example, charge rates have risen to more nearly cover the cost of water deliveries in several nations. Trading regimes are shifting to capped allowance systems from more open-ended mechanisms.

Among the incentives more widely used in foreign countries than in the United States are environmental product labeling, differential taxation of motor fuels, effluent discharge fees, charges on noise pollution and carbon taxes. Most industrialized countries have user fees for municipal waste and water/sewage and deposit-refund systems for beverage containers. Water user fees tend to be higher in Western Europe and lower elsewhere, with the notable exception of Israel. Even in countries where water historically has been free, charges for water delivery are now finding acceptance.

The 1997 EPA report found that market-based permit systems are more common in the United States than elsewhere, however this situation is evolving- for example, there are many tradable permit systems now in use internationally.

The application of user and pollution charges elsewhere is more frequent than in the United States, and several such charges appear to have incentive effects. Examples include Sweden's NO_x emission charge, water effluent charges in Germany and the Netherlands, product charges in Norway, waste charges in Denmark and Korea, and water user or extraction charges in Australia and several Asian countries. However, many user and pollution charges are primarily revenue raising mechanisms. Several countries, including Denmark, Finland, the Netherlands, Norway, and Sweden, have attempted to incorporate environmental considerations into the design of their taxation systems in an effort to shift the tax burden from labor and capital to the use of natural resources.

The use of economic instruments to limit green house gas emissions is an important and rapidly growing application. In 1997 just a handful of nations imposed carbon taxes. Now many more nations rely on carbon taxes and greenhouse gas trading regimes are in place. One can now place buy or sell orders in organized markets for the right to emit these gases.

Table 9.1. Economic Instruments for Managing the Environment

Instrument	Situation Where Instrument Works Best	Examples	Pros and Cons
Pollution charges, taxes and fees	• Damage function relatively flat • Monitoring data available	• Emisson/effluent charge • Emission charge • Sewage charge • Solid waste charge	Pros: • Stimulates new technology • Useful if damage per unit of pollution varies little Cons: • Limited control over the quantity of pollution • Potentially large distributional effects
Input or output charges, taxes and fees	• Numerous sources • No monitoring data • Damage function relatively flat • Linkages between input or output and environment	• Carbon tax • Leaded gas tax • Fertilizer tax • Water user fee • Sewer fee • CFC tax	Pros: • Simple to administer • Raises revenue Cons: • Weak incentive effects for pollution control • Potentially limited environmental impacts
Subsidies for environmentally friendly activities	• Monitoring data available • Subsidy is not likely to stimulate new entrants	• Industrial pollution control • Agricultural activity • Municipal sewage plant	Pros: • Politically popular Cons: • Potentially large budgetary cost • Uncertain effects • May stimulate too much of the activity
Removal of environmentally harmful subsidies	• Environmental harms from the subsidies can be documented • Political will exists to remove subsidies	• Fuel subsidies • Agricultural subsidies	Pros: • Should improve efficiency and welfare Cons: • Unpopular with those receiving subsidies
Deposit-refund	• No monitoring data • Recyclable product	• Beverage container • Lead-acid batteries • Automobile bodies	Pros: • Deters littering • Stimulates recycling Cons: • High administrative costs

Instrument	Situation Where Instrument Works Best	Examples	Pros and Cons
Performance bonds	• Specific actions desired	• Mining • Timber harvesting	Pros: • Can stimulate desired actions Cons: • High administrative costs
Tradable permits	• Damage function steeply sloped • Precise control over amount of pollution important • Marginal control costs vary across sources	• Emission • Effluent • Water rights • Fisheries access	Pros: • Good control over amount of pollution • Stimulates technological change Cons: • Little control over amount spent on pollution control • Potentially large transactions costs
Liability	• Large impacts	Natural resource damage assessment	Pros: • Strong incentive Cons: • High transaction costs • Difficult burden of proof
Information provision	• Recipients understand information	• Toxic releases • Product characteristics	Pros: • Low cost Cons: • Uncertain results
Voluntary mechanisms	• Firms willing to exceed applicable standards	• Energy conservation • Water conservation • Pollution prevention	Pros: • Low cost Cons: • Uncertain results

The use of incentives such as cash subsidies for pollution control investments appear to be more generous in Europe than in the United States and many developing nations also offer such incentives. An important new development concerns lending assistance for industrial projects. Signatories to the Equator Principles agree to lend to only to industrial developments that employ cleaner technologies and for public projects that are not damaging to the environment.

The use product charges were found to be principally revenue-raising instruments with little incentive effect, attributable primarily to the low level of the charges. Moreover, some charges are not closely linked to waste generation or product consumption. However, some of the product charges described in this section, such as fertilizer taxes and the preferential taxation of cleaner motor fuels, do appear to have significant incentive effects.

Finally, liability for harms caused to the environment are increasingly being used as a tool to limit polluting and environmentally damaging activities. While cases of this type go back to the 19th Century in England, only relatively recently have cases of environmental damage in developing nations found a sympathetic hearing in the courtroom.

With the trends already firmly in place and acceptance growing, the future looks bright indeed for additional use of economic incentives for managing the environment.

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About the Report

This report has been prepared by the National Center for Environmental Economics (NCEE) in the EPA Office of Policy, Economics, and Innovation, which is a part of the Office of the Administrator. It builds on three previous reports (USEPA, 2002, Anderson and Lohof, 1997, and USEPA, 2001) with similar titles. This report both updates and expands on the non-United States portions of these earlier reports and was authored by Robert C. Anderson. The report has been revised as a result of reviews by a number of EPA staff both inside and outside of EPA. Helpful comments were received inside from the staff of NCEE and the EPA Office of International Activities, as well as Richard Morgenstern of Resources for the Future and Byron Swift of the Environmental Law Institute.

Because of the desirability of making possible future reports in this series as comprehensive as possible, readers who are aware of interesting applications of incentive mechanisms that they believe should be included in subsequent reports are encouraged to send that information to Alan Carlin (Carlin.alan@epa.gov) at EPA Mailcode 1809T, Washington, DC 20460, who served as the EPA coordinator for this report.

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Endnotes

Chapter 1

[1] Chapter 11 of Anderson and Lohof. 1997. In this update the sections on product labeling and information disclosure have been combined, and the section on debt for nature swaps has been replaced with a new one about liability mechanisms.
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Chapter 2

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Chapter 8

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