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Environmental Fiscal Instruments for Industrial Pollution Control: Global Experience and Options for Lebanon

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Lebanon

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Environmental Fiscal Instruments for Industrial Pollution Control: Global Experience and Options for Lebanon

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TABLE OF CONTENTS

PREFACE

This report is one of several addressing the international experience with environmental fiscal instruments (EFIs) for environmental management and protection. It has been produced in the context of the EU-funded Support to Reforms: Environmental Governance (StREG) project being carried out through the Ministry of Environment in Lebanon.

What are EFIs?

The term "environmental fiscal instruments" is used to refer to tools that encourage sound environmental management by working through economic instruments and market mechanisms, as contrasted with "command and control" tools that protect the environment through mandatory compliance with fixed laws or regulations. These economic instruments classically include such tools as emissions taxes or cap-and-trade systems to manage pollution rather than reliance on fixed, technology-based emissions standards applicable to all industries and to all firms within them. In the solid waste arena, they include taxes on primary products to encourage recycling, and taxes on landfills or incinerators to encourage people to "reduce, reuse, recycle," and "pay-as-you-throw" pricing for trash collection to encourage households to reduce their waste streams.

In an ideal world, all countries would implement the polluter pays principle, and subsidies would not be needed to encourage environmental protection. In the real world, however, almost all countries offer some subsidies for environmental protection. In some cases they are necessary to deal with market imperfections, for example when private financial markets consider new practices like recycling too risk to offer loans for industrial development, or when lack of information makes it difficult for firms to know how to reduce emissions in cost-effective ways. In many countries subsidies have been used to ensure that smaller or low-margin firms are not put out of business by mandatory emissions controls, with consequent loss of jobs. In countries for which environmental protection is new, subsidies may be used to encourage firms to begin emissions reductions before they become mandatory, or to ease the financial burden that will be incurred throughout the economy at that time. While such subsidies are not conventional market-based economic instruments, they nevertheless create important incentives in the process of introducing environmental controls, and are therefore considered in these reports.

Some other market-related tools go beyond what can be considered "economic instruments" and are not discussed in these reports. For example, information programs to help industry find suitable "green" technologies, public information campaigns to encourage source separation of waste, and green labeling may all be understood as mechanisms for enabling markets to work more smoothly by ensuring access to information. While they certainly do help markets work better, they are not considered in these reports, as they are considered too far removed from actual economic instruments or incentive-based tools. Similarly, tools such as minimum energy efficiency standards for appliances, while designed in part to reduce prices for efficient equipment by increasing demand, are not considered in these reports, as they are primarily regulatory rather than market-based.

About these reports

One of the tasks called for from the EFI component of the StREG project was an overview of the use of EFIs elsewhere in the world. This series of reports is the response to that activity. The scope of "EFIs elsewhere in the world" has been narrowed to focus on application of EFIs to issues on which the project is focusing, and that fall under the jurisdiction of the Ministry of Environment. Each of these reports focuses primarily on the tools that can be used to encourage environmental protection and how they have been applied elsewhere in the world. The reports then more briefly consider which of the tools may be of interest to Lebanon and what additional analysis would be needed to determine how they might actually be used in that country.

These reports are being circulated within the Ministry of Environment and to key individuals outside the Ministry, to obtain their feedback on which tools they feel warrant additional analysis for possible application in Lebanon. Their recommendations will be submitted to a technical working group, which will determine what additional analytical work should be undertaken. That work will provide the more detailed information necessary to understand how the proposed instruments may interact with the market context, institutional framework, and legal context for environmental protection in Lebanon. If appropriate based on the additional analysis, more detailed recommendations and draft legislation will be prepared for the eventual introduction of the proposed EFIs.

EXECUTIVE SUMMARY

This report is one of several being produced through the Support to Reform: Environmental Governance (StREG) project in the Lebanese Ministry of Environment. These reports consider how environmental fiscal instruments (EFIs) have been used elsewhere in the world as a tool for environmental management. EFIs are tools that encourage sound environmental management by working through economic instruments and market mechanisms, as contrasted with "command and control" tools that protect the environment through mandatory compliance with fixed laws or regulations. The term is typically used to refer to such mechanisms as emissions taxes, cap and trade systems, bottle deposits, or taxes intended to encourage "prevention, reuse, and recycling" of solid waste rather than landfilling or incineration. In addition, because direct subsidies for environmental protection are a widely used in countries beginning to tackle environmental problems, they are discussed here even though they do not apply the polluter pays principle that is at the core of all environmental policy.

This report considers economic instruments tools commonly used elsewhere in the world to support industrial pollution control. The first chapter presents a conceptual overview of the mechanisms of greatest interest:

- Emissions charges
- Cap and trade systems
- Input taxes
- Direct subsidies

The field of environmental economics generally focuses on the first three mechanisms when considering economic instruments for pollution control. They fall more directly within the realm of strategies for using market forces to arrive at the most efficient way of reducing pollution, and are consistent with the polluter pays principle. Moreover, most literature on market instruments assumes that pollution control is mandatory, so the focus is on the choice between market-based and command-and-control approaches. Where subsidies are considered, the literature focuses on identifying and eliminating perverse incentives created by economic subsidies unrelated to the environment, rather than on the design of effective support for private sector pollution control as a strategy for cleaning the environment.

In Lebanon, as in many countries outside of the West, pollution control is not yet mandatory, in part because the regulatory framework is not yet in place and in part because it is not enforced. While the government has subscribed to the polluter pays principle through various international conventions, in practice the idea of providing financial support to industry to create an incentive for them to reduce their emission is widely accepted by both government and donors. This paper therefore considers direct subsidies along with other market-based instruments, and considers how the different instruments could be implemented in the context of either voluntary or mandatory pollution control. It place particular emphasis on who should receive such subsidies and why; their primary objective should be to reduce job loss in marginal firms as pollution control is introduced, while avoiding windfalls to large profitable firms that can afford to reduce their pollution without taxpayer or donor support.

The second chapter looks at how these mechanisms have been used elsewhere in the world. Although "pure" economic emissions charges and cap and trade systems are at the center of the theoretical economic approach to market-based mechanisms, in practice they

are not that common. More often, emissions charges are combined with regulatory approaches, and the charges serve several different objectives; raising revenue (often used to support other pollution-control activity), penalties for non-compliance, and to a lesser extent to create incentives to reduce pollution or pretreat liquid effluent. Input taxes are used specifically to encourage use of low-sulfur fuel; other than that they are primarily used to deal with agricultural runoff. Direct subsidies funded by donor agencies are common in many developing countries. Tax subsidies, interestingly, are quite common in the United States as well as the developing world, but they are not used in Europe. Descriptions of such subsidies are readily available; information on how they are actually used - which companies benefit from them, how much the public sector pays, and what they accomplish - is more difficult to find.

The third chapter considers which of these tools offer potential for application in Lebanon. Cap and trade systems do not seem realistic; they are difficult to manage and require enough firms in the industries involved to create a functional market for emissions permits. Both of these factors would make it difficult to use this tool in Lebanon.

"Pure" emissions charges designed to reduce emissions solely by setting charges at a level higher than abatement similarly are not likely to be effective, because they require substantial knowledge about abatement costs and the ability effectively to collect taxes. Emissions charges embedded in a regulatory system and designed to generate revenue, impose penalties, and to a limited extent create incentives to reduce pollution may be of interest if the regulatory system is put in place over the next few years, although they could not be implemented in the absence of regulations.

Input taxes probably will not be an effective way to reduce emissions from electricity generation, because consumers have no choice about whom they purchase electricity from and small-scale generators cannot change their production processes to reduce fuel use or emissions. A simple ban on high-sulfur fuel could be a more effective strategy for addressing the emissions from electricity generation, particularly from the thousands of producers selling backup power throughout the country.

Subsidies are already being used in Lebanon through the World Bank-funded Lebanon Pollution Abatement Project (LEPAP), and are likely to be the primarily fiscal instrument used in the foreseeable future. Two distinct modalities are recommended:

- Donor funds should be used to offer grants, low-interest loans, and technical assistance to firms at risk of going out of business, with consequent job loss, when they are required to transition to reduced pollution. Additional work will be needed to determine which firms should be targeted and how to identify them; as well, of course, work will be needed to convince donor agencies that this is a good use of funds. Additional work may also go into the potential to generate revenue for these subsidies (or other pollution control activities) from emissions charges in the future.

- Quite modest tax subsidies should be offered to all firms to provide a more token reduction in the cost of transitioning to pollution abatement. The objective here is to head off the objections of larger firms if some firms are receiving significant subsidy while they receive nothing. A number of questions must be considered in the design of these mechanisms:

- Which tax should be used to offer these subsidies? It is more efficient to offer only one such mechanisms, which argues that the income tax is most appropriate because it is most widespread.
- Should the mechanism be a tax deduction or a credit (at a lower rate, to make the amount of subsidy consistent between the two mechanisms)? A credit is more equitable, since a deduction provides more benefit to those in a higher tax bracket.
- How much deduction or credit should be allowed?
- Should the tax be refundable, deferrable, or neither? If neither, then firms without any taxable income in the year in which they purchase pollution control equipment will not be able to benefit from it. However a refundable tax requires direct outlays by the treasury. Therefore a deferrable tax may be the best option.
- Should the tax subsidy be available in perpetuity or only during the period of transition to pollution abatement? If the objective is to help firms facing unanticipated costs, it should only be available during the transition period.
- Should the subsidy be available to new firms or plants? For a short period this may be appropriate, since they may have done their financial planning assuming pollution control would not be required. Once abatement is mandatory, this will not be appropriate.

An additional issue of interest is whether mandatory pollution control may increase demand for equipment or professional services available in Lebanon. If so, it may not be a net burden on the economy, or the burden may be considerably reduced. Further analysis of that question may be of interest to the Ministry of Environment as part of an effort to make mandatory emissions controls more palatable to policy-makers.

Abbreviations

ALSF	Aggregates Levy Sustainability Fund
AUB	American University of Beirut
CAC	command-and-control
CDM	clean development mechanism
CDW	construction and demolition waste
CNRS	Centre National pour la Recherche Scientifique
EEA	European Environment Agency
EFI	environmental fiscal instrument
EI	economic instrument
ELV	emissions limit values
EPR	extended producer responsibility
FCCC	Framework Convention on Climate Change
FODEP	Fonds de Dépollution (Pollution Reduction Fund)
GPP	green public procurement
IFC	International Finance Corporation
JI	joint implementation
LEPAP	Lebanon Pollution Abatement Project
NGO	non-governmental organization
PAYT	pay as you throw
QPA	Quarry Products Association (UK)
RGGI	Regional Greenhouse Gas Initiative
SWM	solid waste management
SWMP	solid waste management plan
WCA	waste collection authority
WDA	waste disposal authority
WRAP	Waste and Resources Action Programme
WtE	waste to energy

1 INTRODUCTION: HOW ARE MARKET-BASED INSTRUMENTS USED TO MANAGE INDUSTRIAL EMISSIONS?

Industrial emissions are one of the "classic" cases for the introduction of economic instruments for environmental protection. From the theoretical perspective of environmental economists, several tools can offer "pure" market-based approaches to pollution reduction:

- Emissions charges, imposed per unit of discharge of a given pollutant - firms pay the charge if it is less than the cost of emitting or reduce pollution if that costs them less than the charge;
- Cap and trade systems, through which a fixed number of emissions permits are issued and firms either buy permits and continue to emit, or invest in technology to stop emitting;
- Taxes on input goods based on the quantity of specific pollutants they generate in use.

These tools can, in principle, provide a less expensive way to reduce pollution than the conventional "command-and-control" strategy of setting emissions limits and requiring all firms to comply with them. In practice, all governments use a mix of tools to address industrial pollution:

- mandatory emissions limits implemented by regulation and enforced by government;
- a variety of taxes, fees, and charges assessed on emissions or consumption of input goods, intended to raise revenue, create economic incentives to reduce pollution, and penalize firms that do not comply with law;
- financial support and subsidies to encourage pollution reduction or reduce its cost; and
- emissions trading systems.

This paper considers this full range of economic and fiscal instruments. It is organized as follows:

- This introductory chapter reviews the different economic and fiscal tools that could be used to encourage pollution control. It distinguishes, where appropriate, between the logic for and design of these tools where pollution control is mandatory and where it is still voluntary (or where legally mandated controls are not enforced).
- The second chapter of this report discusses how each of these tools has been used elsewhere in the world.
- The third chapter considers how they may (or may not) be useful in Lebanon.

1.1 Why Economic Instruments are Considered Efficient

In a typical command-and-control" (CAC) pollution reduction system, legally binding emissions limit values (ELVs) are set for each pollutant and for each industry. Typically, the limits are based on an understanding of the production technology in the industry, which pollutants are emitted, and how emissions can be reduced. Although the legal requirements are generally specified as emissions limits, many countries also mandate use of "best

available techniques." The limits and the techniques are closely related, since the levels are set based on the technology available for achieving them.

Economists consider this approach inefficient because it requires every firm to emit at the same level, and does not take into account that some firms can do so more cheaply than others. Often what is important from an environmental perspective is that the total amount of pollution drop; it is not important whether the pollution comes from one firm or is evenly distributed among a number of firms. The CAC system requires the reductions to be evenly distributed among firms. However from the perspective of the total cost to the economy, it makes sense for the firms who can reduce pollution at the least cost do so, while the others continue to pollute and share the cost of pollution reduction by the firms with the lowest costs.

Both emissions charges and cap-and-trade systems are tools for distributing the costs of pollution control across the industry, while allowing the firms that can reduce pollution most cheaply to actually do so.

1.2 How Emissions Charges Work

Emissions charge systems - or taxes on pollutant emissions - require polluters to pay a sum of money for each unit of pollution they emit. Such charges can take a number of different forms, and can be designed to meet a number of different objectives:

- The "pure" market-based tool has driven much of the academic literature on emissions charges. This charge must be high enough to create a financial incentive not to pollute. For many firms in the industry, the cost of reducing pollution will be lower than paying the charge, so they will choose to reduce pollution. For some firms, however, the charge will be less than the investments they would have to make to reduce pollution, so they will choose to pay the fees. The charge must be set at the level that ensures that total pollution across the industry will be at the socially optimal level - that is, at the point where the harm caused (through illness, environmental damage, etc.) by one more unit (ton, kilo) of pollutant in the environment is exactly the same as what it would cost to prevent that pollution from being in emitted. In this theoretical system, it would not even be necessary to set emissions standards; the level of the charge would bring about the right reduction in emissions without legally enforceable limits.

  The argument for this approach is that, because the firms for which it is cheapest to reduce pollution will do so and those for whom it is expensive to reduce pollution will not do so, the optimum pollution level can be achieved at the minimum total cost to the society and at the lowest cost to each firm. The practical argument against it, of course, is that it is very difficult to figure out what the charge should be. To calculate the charge, regulators should know how much each firm now emits and its unit cost of emissions reduction; this would make it possible to calculate exactly how much total emissions would drop at each possible fee level. In practice, those data are not available. If the charge is set based on estimates, then it is not possible to predict accurately the level of pollution that will result; if specific reductions are essential, then this is not a suitable approach. Moreover, if new firms enter the industry, the charge would have to rise to keep total emissions below the desired level. The possibility of such changes would create considerable uncertainty for the firms involved.

- Many emissions charges are based not on a desire to ensure optimally efficient pollution control, but by a desire to generate revenue for the government. A charge designed to maximize revenue will be considerably lower than one designed to reduce pollution. If all firms faced similar pollution reduction costs, then a regulator who wanted to maximize revenue would set the charge just below that level. Such a price would provide the highest level of revenue without leading any firm to reduce its pollution instead of paying.

- In practical terms, a pure revenue-maximizing system would have to be combined with a regulatory approach to pollution reduction, or there would be no environmental protection. This leads to systems that combine mandatory ELVs with charges per unit of pollution for those who exceed the ELVs. Such systems will be socially (or environmentally) acceptable if the ELVs are more stringent than they actually need to be, so some pollution above the standards is actually acceptable. These systems are also common when industrial plants discharge into municipal sewer systems. Those whose effluent has been pre-treated to meet the ELV will not generate additional costs for the treatment plant, while those whose effluent exceeds the ELV must pay for the costs they impose. The price is set so as to cover the costs of treatment and ensure that the total effluent load across the industry does not exceed the capacity of the plant.

- In a third approach, the emissions charges are a penalty imposed on firms that do not meet the standard, when meeting the standard is still a legal requirement. Whereas in the second case, firms may legally exceed the standard and pay the charges, in this case if they exceed the standard they must pay the charges and must also meet the standard. The objective of these charges, therefore, is to induce firms to comply with the standards promptly; paying the charges does not authorize them to avoid compliance.[1]

A second issue with emissions charges is how the revenues are used. Economic theory would argue that the use of the revenues should be totally unrelated to how they were collected. The collection system should be driven by the most effective way to reduce pollution; the expenditures should be driven by an unrelated analysis of the most effective way to spend public funds. Following this logic, the revenues should go into the public treasury, to be allocated based on the same principles applied to allocation of any other public funds.

In practice, this is rarely done. From the perspective of environment ministries, one of the advantage of emissions charges is that they generate revenue that can fund related activities. Typically these revenues are allocated to several broad uses:

- Direct costs of the permitting system, including inspections and enforcement

- Operating costs of municipal sewer systems, when industry is discharging into them. In this case, plants typically face a two-part fee structure. One part covers the direct costs of the permitting system, and is paid by all plants. The second charge is based on the volume and pollutant concentration of the effluent discharged, and covers the costs imposed on the municipal sewage treatment plant. Firms below the ELV will pay a fairly low per-unit charge, while those exceeding the ELV will pay a much higher charge. The

[1] In practice, however, some countries established such fines but did not enforce the mandatory limits, so the fine became a *defacto* less expensive alternative to reducing emissions. Howe (1994, p. 152) reports a public official at an international meeting lamenting, "We have taxed pollution for twenty years, and industry just pays and goes on polluting."

higher charge for those exceeding the ELV will create the same incentives to reduce pollution as the "pure" market-based emissions charge.

- Other environmental protection activities of the government. This may include the development of environmental "infrastructure" not related to any one polluter, such as the development of databases, research activities, public education campaigns, the operating costs of the environment ministry, and so on.

- Direct subsidies to individual firms to help them reduce the cost of pollution control. These raise a wide range of other issues, which are largely independent of where the funds come from to provide them; they are discussed below in section 1.6.

1.3 How Cap-and-Trade Systems Work

In cap and trade systems, the regulators decide the total amount of pollution that is acceptable, and issue a corresponding number of emissions permits. The cap may be based purely on environmental concerns, or may reflect a tradeoff between environmental and economic considerations. Each firm may either buy emissions permits or invest in equipment to reduce its pollution. Firms that can reduce pollution cheaply will do so; firms facing high reduction costs will choose instead to buy permits. The price of the permits will be determined by the market, not by the regulators. In a theoretically perfect market, the permit price will end up the same as the cost of reducing pollution by one unit above the total acceptable level, i.e. the permit price will equal the so-called "marginal cost of pollution reduction."

A key issue in cap and trade system is how the permits are allocated at the beginning. Economists agree that the efficient way to do this is to auction them off. Each firm will bid on permits based on its own costs for reducing pollution, so from the start the permits will be used by those for whom pollution reduction is most expensive. This is economically efficient. It also generates public sector revenue that can be used for other purposes.

In practice, however, selling the initial permits is often politically unacceptable. Instead, regulators give them to the firms, usually in proportion to how much pollution they have been emitting in the past. In such a case each firm is in effect being required to reduce its pollution by a fixed percent - the ratio of number of permits to prior pollution - rather than using the market to ensure that only the firms for which pollution reduction is expensive have permits. This is economically inefficient, since pollution reduction will not come at the lowest possible cost across the economy. If firms know the system is coming, moreover, they will have an incentive to increase their pollution beforehand, so that will receive more permits to start with.

Additionally, by giving away the initial permits the public sector loses a potential revenue source, while firms with low pollution control receive a windfall from selling unneeded permits to firms with high pollution costs. The low cost firms already benefit from their low costs; there is no clear justification for them receiving the additional windfall from the sale of permits. However the high-cost firms are also better off with free initial permits, since they will have to buy fewer than if there were an auction. Therefore they will not object to low-cost firms reaping an even bigger windfall; every individual firm's calculus will lead it to prefer free initial permits, irrespective of how one firm's windfall compares with another's.

In practice, however, under the existing cap-and-trade systems the initial permits have always been given away rather than sold. This makes it politically easier to introduce the system, by reducing the opposition that would certainly arise to buying pollution permits. Moreover, over time the permits of firms with low pollution control costs will be sold to firms with high costs, so the market will still help to ensure an efficient distribution of pollution reduction. In some countries the free distribution of permits has an unrelated benefit; any firm required to reduce its pollution will come forward to claim its permit allowances. If the government did not initially know who was polluting and how much, they will once the allowances are distributed; this might be thought of as a silver lining of making them free.

1.4 Challenges of both Emissions Charges and Cap-and-Trade Systems

Because money is involved, both emissions charges and cap-and-trade systems require regulators to monitor exact pollution levels, which is difficult. It can be technically possible to install continuous monitoring systems that embed sensors at the point of emissions to detect what is going out at all times. However this is very expensive. The more affordable alternatives, such as using standard coefficients to estimate emissions for a given industry, technology, inputs, and scale of production, are all much less accurate. When firms are paying fees based on measured emissions, inaccuracy in estimating those emissions leads to discomfort with the system as a whole.

Moreover, these systems can only work if the impacts of pollution are geographically dispersed. This is clearly the case for greenhouse gas emissions, whose impacts are global. However, many pollutants will have much more serious impacts close to the plant than further away. In this case an economic instrument that could allow emissions to be highly concentrated in one place will not be acceptable. This is referred to as a problem of "hotspots," i.e. geographical locations where emissions are concentrated, because all the polluters in that place find it less expensive to purchase allowances from polluters elsewhere than to reduce their own emissions. If the cost of pollution reduction does not vary spatially, however, then these systems can be effective even where the impacts of the pollution are felt locally.

A third significant limitation of these systems is that they will only be effective if there are significant differences in abatement costs among companies. If per-unit abatement costs are uniform, there will be no efficiencies gained from a system designed to enable those with high costs to pay for the right to continue polluting while those with low costs invest in pollution control equipment.

Countries interested in these two approaches will choose between them based on several factors. If it is very important to achieve a specific pollution reduction target, then the cap and trade approach would be more appropriate. However, emissions charges are generally less expensive to implement (EEA 2005, p. 19). Consequently, where the exact target is not crucial - that is, the environmental harm from missing the target by a small amount is low - then emissions charges may be preferable.

1.5 Taxes on Input Goods

Taxes on input goods are typically applied when it is easier to quantify or tax the consumption of a product that leads to pollution than to quantify and tax the emissions. For

example, they are often assessed on the sulfur content of gasoline or fuels burned in power plants, to create an incentive to generate energy from less polluting materials. Input taxes are also commonly applied in the case of non-point-source pollution, when it is fairly straightforward to quantify inputs, but quite difficult to quantify outputs. This is the case in particular for agricultural runoff, where farmers know how much fertilizer or pesticide they use, but they do not know how much of it washes off their fields and how much is taken into the plants. In this case it is much easier to tax agrochemical inputs than effluent.

In all of these cases, input taxes are typically regarded as a second-best solution, because they do not take into account different technologies that may change the ratio between inputs and emissions. For example, two cars, one of which has a catalytic converter and the other of which does not, will have very different emissions for identical fuel inputs. Similarly, a farmer who spreads his entire field with fertilizer will have very different runoff patterns from a farmer who uses the same quantity of fertilizer but applies it directly to the roots of individual plants. Such a tax may create a general incentive to reduce consumption, but that may not be directly related to the amount of pollution that results. However, because it does not require measurement of actual emissions, the lower costs of implementing an input tax may make it compare favorably with emissions charges as a regulatory tool. (Kampas and White 2002)

1.6 Subsidies for Pollution Reduction

Subsidies for pollution reduction are a very common tool in many countries. A subsidy, as we use the term, is any instrument that shifts some portion of the cost of reducing private sector emissions from the polluter to the public sector and thus the community at large (as taxpayers). Such subsidies can take a wide range of forms. Some involve explicit transfers from government to companies, in the form of grants, loans, loan guarantees, reduced interest rates, rebates for purchase of specific input or investment goods, and so on. They may also involve per unit payments for reducing emissions, which can be understood analytically as the equivalent of emissions charges, except that those who perform well receive money instead of those who perform badly paying it. Other subsidies, such as tax deductions, credits, or exemptions, reduce government revenues rather than increasing outlays. Fiscally they are the same as rebates or grants, but they are a less transparent way for government to give money to the private sector.

The definition of subsidies is sometimes understood to go well beyond these forms of direct support for pollution reduction. International organizations offering loans, grants, and technical assistance to the private sector, such as the International Finance Corporation (IFC), often require recipients to comply with local environmental law, and include environmental and social considerations in their evaluation criteria. While the IFC funding often has no connection with pollution abatement, the availability of this support only to those firms that manage their environmental impacts is certainly a lever to encourage environmental compliance, so the funding can be understood as a subsidy to firms in return. Even beyond this notion, some analyses interpret lax environmental standards as a form of subsidy, since they require the society at large to bear the harm caused by pollution rather than requiring the polluter to bear the cost of preventing it; thus society is subsidizing the polluters by allowing them to pollute.

Economists and environmentalists consider subsidies a problem because they run counter to the polluter pays principle. There are two arguments for this principle. One is basic equity. One person (or company) does not have the right to impose harm on others, and

discharging pollution into the shared environment hurts everyone while benefiting only the polluter. Shifting the cost of pollution control to the polluter should not ultimately impose the burden on the company; the assumptions is that they will pass it on to the consumers who will ultimately pay for it.

This relates to the second argument for the polluter pays principle, which is based on efficiency. When pollution abatement becomes mandatory, the price of goods for which it is expensive will rise relative to price of goods for which it is cheap. Consumers will purchase the goods that are relatively cheaper, i.e. that have lower abatement costs. This will work against firms with high pollution control costs, creating a financial incentive for them to produce more efficiently with less pollution. So a direct subsidy to cover private sector pollution control loses both on equity grounds, since those paying the subsidies bear the cost instead of those causing the problem, and on efficiency grounds, because there is no market pressure for firms to develop less expensive abatement methods.

1.6.1 When are subsidies justified?

In light of the fact that virtually all countries in the world subscribe to the polluter pays principle, it is important to consider why pollution control subsidies are so common and under what circumstances they may be appropriate even though they shift the burden from the polluter to the society at large.

One answer is political. It is easier for many governments to implement pollution control requirements if they reduce the costs that this entails for polluters; such subsidies can help reduce political opposition to environmental protection. In many cases polluters are much more readily able to organize against having to pay for environmental protection than the public is to resist paying for it through their taxes, their health, or the quality of the environment around them. This can make it much easier for the government to give in to pressure from polluters and assume some of the costs than to force polluters to clean up their act at their own expense. Moreover, in developing world foreign aid donors or lenders are often willing to pay for such subsidies, so both industry and the government can benefit. (Kim 2000 p. 116)

Aside from the political reasons for pollution control subsidies, there are cases in which they may have social benefits. Such cases include:

- To encourage the use of new technology. Often an environmentally friendly technology is available, but too expensive to compete with more harmful technologies. In part it may be too expensive because demand is low, so there are no economies of scale in its production or distribution. The conventional unfriendly technology, in contrast, may already be in widespread use, so its production benefits from significant economies of scale. In this case a temporary subsidy for the preferred technology can increase demand, making it possible to benefit from economies of scale that will make it competitive with the unfriendly technology even once subsidies are removed. This is the argument for subsidies offered in some US states for solar technology, although it is not clear whether the mechanism has actually worked as well as its proponents hope it will.

- To meet other social objectives. The introduction of across-the-board pollution control requirements could force both marginal firms and small enterprises that do not benefit from economies of scale out of business, with consequent loss of employment. If one region of the country is much worse off than others, mandatory pollution control could

have a devastating impact on such areas. Subsidies for pollution control that are available only to firms that are unable to cover the cost may be considered socially desirable, even if economic theory might suggest that such inefficient firms should not stay in business if they cannot compete. If the subsidy covers investment but not operating costs, i.e. only the transition to pollution control, it can be justified more easily. It is essential, in such a system, to ensure that the subsidies only go to firms that cannot survive without them, and are not available to firms that can afford to cover their own costs without public support.

A third argument for pollution control subsidies is to avoid harming the country's competitive position in international markets. Whether this is an issue depends on who the country's trading partners are and what their pollution requirements are. At present this argument often works the opposite way; the trade partners require pollution control before they will allow goods to be sold in their markets.

1.6.2 When will firms accept subsidies if pollution control is voluntary?

When pollution control is not required, the logic for subsidies would be that the reduced cost would induce some firms to introduce pollution control measures whose benefits outweigh the social costs. In the absence of any specific targeting of the subsidies, firms might accept the money and invest in pollution control under several circumstances:

- The subsidy is greater than the total cost of reducing emissions (including transactions costs) so they make money from it.

- When subsidy doesn't exceed gross expenditure, pollution control might still bring some financial returns, and the subsidy tips the balance towards it being profitable. This could be the case for energy conservation measures, or where a firm can reclaim materials from filtered emissions and save on new input purchases. It may also be the case where pollution control is required for access to lucrative markets, so there is a financial return to being "green."

- If the firm expects that pollution control will be required in the future and the subsidy is only available now, it could be more cost-effective to reduce now with subsidy than reducing later without. However if firms make an educated gamble that the required pollution control could be put off for a long time, this argument may not be sufficient to induce them to accept the subsidy.

- Accepting the subsidy in itself may provide a public relations benefit to the firm. They may be able to market themselves as environmentally sensitive because they have chosen to participate in a public program to reduce pollution. The benefits of this so-called "greenwash" might not have been sufficient to lead them to reduce pollution without public subsidy, but participating may both serve as a kind of eco-label and reduce the costs through the subsidy itself.

Firms that benefit from this type of subsidy will probably be the largest and most efficient ones, for which pollution control represents a small share of total costs and has only a minimal impact on the bottom line, rather than those that could not afford to cover their own pollution control costs without a subsidy. The large firms are also most likely to have employees who know how to sort through the procedures required to access the subsidy, so

their transactions costs will be lower than those of smaller, less profitable firms. So subsidies when pollution control is voluntary may end up going to firms that need it least. Moreover, if firms accept the subsidy now because they know that abatement will be mandatory in the future, then this subsidy will place these firms in an even better position relative to their (poorer, less profitable) competition once pollution control is required, unless even more subsidy is available in the future for firms that cannot cover the costs.

1.6.3 Objectives and targets of the subsidies

What social objective is actually achieved by subsidizing pollution control? This question is closely related to how firms are targeted to receive the subsidy. In the situation described above, where abatement is voluntary and all firms are eligible, the environment will become somewhat cleaner. How much it is cleaner depends on the firms' cost structure, the amount of subsidy offered to each firm (relative to its total pollution control cost), and the total amount of subsidy available (how many firms can be subsidized).

Instead of allowing all firms to receive subsidies, the government might target specific firms. If abatement is voluntary and will remain so for the foreseeable future, it will make sense to offer the subsidy to the industries or firms that can achieve the greatest reduction in pollution-related harm for the money. If perfect information were available (which is quite theoretical, of course), these firms would be identified based on:

- What pollutants each firm emits and how much
- Their cost structure for pollution abatement – that is, for a given sum, how much would pollution be reduced (by pollutant)
- The harm caused by emission of each unit of pollution. This will vary based on whether the plant is in a dense or sparsely settled area and due to differences in the local environment (hydrology, soil types, wind patterns, geology, and so on).

With all of this information, we could determine where a given expenditure on abatement would do the most good, and target the subsidies accordingly. In practice all of this information would not be available, of course. A real-world proxy might be to target subsidies to the most polluting industrial sectors and to industrial plants located in areas of highest population density or areas of particular environmental sensitivity (e.g. protected areas or biodiversity hot-spots).

If mandatory controls are anticipated in the near future, it may make more sense to target firms least able to afford pollution control rather than those whose impact is worst. The objective here would be totally different from the previous case; it would be to prevent unrelated social harm through job loss, burdens placed on poor regions of the country, and so on. The challenge in this case is to design a system that makes subsidies available to firms that need them without giving them to firms that can easily cover their pollution reduction costs. This might be done in at least an approximate way by offering subsidies to firms below a certain size, below a certain number of employees, located in specific impoverished regions, or relying on traditional or artisanal technologies rather than modern ones. Where it is possible to access detailed firm-level cost data, for example from tax returns, they may provide a justification for the need for subsidies; however such data may not exist or may not be available for the firms targeted by such programs.

Because of the difficulty and cost involved in introducing and paying for pollution control in small inefficient firms without modern technology, some countries may decide that the

largest firms will be required to reduce their emissions first, and smaller firms will come later. In this case, the large firms may use their political leverage to insist on subsidies, arguing that it is not fair that they are the only ones to be required to reduce their pollution, and therefore subsidies to cover at least some of their costs are appropriate. They may also argue that they would be unfairly disadvantaged relative to their (smaller, less efficient, lower-tech) competitors if they are the only ones required to reduce their pollution. Whether or not this is the case depends, of course, on the different cost structures of different segments of the market; however obtaining the data with which to evaluate such claims would likely be difficult. Thus the somewhat logical approach of beginning mandatory pollution control with the largest and most efficient firms may push countries back into the political logic for subsidizing the firms that are best able to pay their own way.

Alternately, the objective of such a subsidy program might be primarily public education about pollution control. Helping a few firms to reduce pollution now – especially if this is done with great fanfare – might get the country used to the idea that pollution control for everyone is coming in the future. More cynically, such a program might enable the country to say it has done something about pollution control, even if in reality the impact is minimal and the recipients of the funds might be those who least need them. Of course if a foreign donor funds the program (with grants, not loans), then there may be no cost to the country itself, in which case there is less need to carefully evaluate the program's impacts. Moreover, because efficient large firms are likely to be the best able to lobby for creation of such programs, the government may find itself under pressure to support them even if they do not serve a significant public purpose.

1.6.4 Factors in the analysis of tax subsidies

The literature on the design and impacts of tax subsidies for environmental protection is for the most part fairly theoretical. The subsidies tend to take several forms:

- Corporate income tax deductions or credits for some share of a company's investments in pollution control equipment.[2]

- Accelerated depreciation of investments in pollution control equipment. Each year firms routinely deduct from their income tax base a share of the value of their capital equipment, in recognition that the decline in value of that equipment over its lifetime is a loss to company that should be balanced against its earnings. In "straight-line" depreciation, the total value of the asset is divided by the years of its useful life and the result is deducted from the tax base each year. Accelerated depreciation allows the firm to depreciate faster - for example, an asset expected to be used for twenty years might be depreciated over ten years. That allows the firms to reduce their tax burden in years 1-10 and pay more in years 11-20, raising the net present value of their expected income net of tax payments. Thus accelerated depreciation of pollution control equipment provides a financial benefit to the firm; how much it is actually worth depends on the tax rate, the life of the asset, the discount rate, and other variables.

[2] Tax credits are amounts that are subtracted from the tax owed. Tax deductions are subtracted from the income on which tax is calculated. A tax credit of a given amount is therefore much more valuable to the company and much more costly to the treasury than a tax deduction of the same amount.

- Full expensing of pollution control investments. "Full expensing" means the investment is treated as if it were a routine operating cost, and the entire value is subtracted from taxable income in the year the equipment is purchased. This is in a sense equivalent to the most accelerated depreciation possible.

These tax measures can be analyzed from a number of perspectives (Jenkins and Lamech 1992). For economists focusing on public finance and taxation, the basic concern is whether a tax measure distorts the free operation of markets; the freely flowing market is considered to be the most efficient way to allocate resources, and any distortions that change resource allocation patterns increase the cost of generating the same level of income. They focus, therefore, on whether these tax measures affect different firms or investments in different ways.

Clearly, the subsidies will increase investments in pollution control and decrease investments in assets that are not eligible for the tax subsidies; that is their objective. This in itself is considered socially undesirable, because investments in pollution control do not generate income, while investments in productive assets do. However that is the expected cost of pollution control; income will decrease when the environmental externalities from production are internalized.

More importantly, when pollution control is mandatory, these subsidies will reduce the cost of investments in equipment relative to process or maintenance expenditures that could otherwise reduce pollution more efficiently. For example, a firm might be able to deduct the cost of purchasing a filter, but they won't be able to deduct the cost of cleaning its productive equipment regularly to reduce the pollution that must be removed by the filter. More cleaning might be a less expensive way to reduce pollution in the absence of the subsidy, but a more expensive approach once the subsidies are factored in; this will lead the firm to choose an inefficient approach to pollution control.

Economists also consider whether the tax subsidies change the choice among pollution control investments; this is regarded as an undesirable distortion and a sign of poor tax design. Jenkins and Lamech point out that accelerated depreciation and full expensing create an incentive to invest in equipment with a longer life, all else being equal; this could lead to inefficient investment choices. Investment tax credits or deductions, on the other hand, will create a bias in favor of shorter-lived assets, also distorting the investment choice.

The impact of income tax subsidies also depends on whether they are refundable or can be carried over to future years if the firm has no income from which to deduct them. A "refundable" tax break is one that will lead the government to refund money to the firm if its income is negative after the tax deduction or its tax would be negative after the credit. Where direct refunds are not permitted, the firm may be allowed to carry over the tax deduction or credit to the future if it does not have enough income to be able to take advantage of it in the current year. If neither of these options is available, then the subsidies are not available to firms that are not doing well; they will provide an advantage to the most profitable firms and do nothing for the low-profit firms that can't afford to invest in pollution control equipment. They may also create a bias against new firms, which typically do not expect to earn a profit at the start of their operations. However, new firms facing pollution control requirements may often achieve them through the design of their plants rather than through the purchase of identifiable equipment only used to reduce emissions, in which case they would not be eligible for the tax breaks anyway.

This relates to another problem with tax subsidies; it can be very hard to determine which equipment should be eligible. Many items could be used for pollution control or for many other purposes (e.g. pipes, valves, filters, etc.). If they are eligible for the tax subsidies, then firms could deduct equipment actually purchased for other uses. If they are not eligible, then the tax could distort the choice of equipment used for pollution control. Over time, as new plants open up, pollution control will increasingly be integrated into the production process, and it will be impossible to identify certain equipment as environment-related.

Not all tax subsidies are implemented through the income tax. Other common approaches include reductions on import duties or VAT on pollution control equipment. Since firms do not actually pay VAT – it is reimbursed annually by the government – for the firm the VAT mechanism serves primarily to avoid the need to lay out that cash in the first place. The incentive from a reduced VAT will be felt by the final consumer, for whom the higher price of goods with pollution control "embedded" in their production will be slightly less with a VAT subsidy. Both of these measures pose the same challenges of defining pollution control equipment and creating a distortion in favor of equipment rather than process-based approaches to pollution control. The import duty mechanism could also work against the creation of a domestic industry manufacturing pollution control equipment, which is part of some countries' approaches to "greening the economy."

2 USE OF ECONOMIC INSTRUMENTS TO MANAGE INDUSTRIAL POLLUTION OUTSIDE OF LEBANON

2.1 Emission Charges

Emissions charges are widely used throughout the world. However, they are rarely (if ever) used as the "pure" market-based tool that economists envision. Rather, they are combined with mandatory emissions controls, and usually are designed to achieve a mix of objectives; revenue generation, pollution reduction, and imposing penalties on non-compliance so firms will follow the regulations from the start. Moreover, notwithstanding the best theory of the economists, the revenues rarely flow to the treasury; they are generally used to support the pollution control regulatory system and other environmental protection activities.

2.1.1 East Asian Water Effluent Charges

Several East Asian countries have well-documented emissions charge systems in place to manage water effluents. The Laguna Lake Development Authority (LLDA) in the Philippines introduced a discharge fee designed to create a financial incentive to reduce water emissions to Laguna Lake, east of Metro Manila. This is the largest freshwater lake in the Philippines and a significant source of fish, water, and other resources. It has also been threatened by pollution for many decades. The discharge fee system, first introduced in 1997, has become a frequently-cited example of this type of system.

The fee initially introduced on a pilot basis applied only to discharges of BOD (biochemical oxygen demand).[3] It applied to industrial plants discharging into the lake, which at the time accounted for a major portion of the effluent that could easily be monitored. The legal emissions limit was defined in terms of the concentration of BOD in discharge water; it was fixed at 50 mg/liter. Firms whose discharges were below that level pay 5 pesos per kilogram of BOD released, while firms whose concentration exceeded the standard pay 30 pesos per kilogram of BOD.[4] Each firm must pay the charges in advance for the year to which they apply; discharges for that year are estimated based on the previous year, monitoring by the firm, inspections by the LLDA, and other sources of information. Firms that do not pay the charges or whose estimates are significantly out of line with their estimates may be assessed penalties or not granted permits (closing the operation), as may be firms that do not grant entry to LLDA inspectors or in other way violate the terms of the charge system. In addition, each firm pays a fixed annual charge based on the volume of waste water it discharges; that initially ranged from 5,000 to 15,000 pesos and now ranges from 8,000 to 24,000. The fixed fee is used to cover the administrative costs of the effluent permitting system.

The discharge fee of 30 pesos/kg was set based on a model that analyzed the emissions reduction costs of 535 plants discharging into the lake. The model found that increases in the fee up to 50 pesos/kg would cause increasing reductions in emissions; after that price

[3] The Global Water Program has prepared a case study on the introduction of this fee; most information in this section comes from that source.

[4] This fee system is still in place; current details are available from the Laguna Lake Development Authority at http://www.llda.gov.ph/index.php?option=com_content& view=article&id=146&Itemid=499

the emissions rate would level off. The choice of 30 pesos/kg was therefore intended to lead some firms to reduce their emissions while others continued to discharge and paid the fees.

The charges first went into effect in January, 1997. The system was phased in, with the number of firms required to comply growing from 109 in 1997 to 293 in 1998 to 520 in 1999; the most polluting industries were required to comply first. Initially only industrial polluters were required to pay the charges; in later years municipal, commercial and residential polluters were also brought in. Although data on how many firms paid the charges vs. reducing their pollution are not available, the discharges into the lake from the affected plants decreased by 88% between 1997 and 1999, suggesting that reducing emissions was cheaper than paying the fees for most firms. The monitoring and enforcement actions of the LLDA in connection with the charges also led to them closing about 50 companies for significant violations during the first three years of the system. (Global Water Program, p. 6)

The significant decreases in emissions in the first three years, combined with the fact that this charging system is still in place in 2015, suggest that it has been a fairly effective way to reduce emissions into Laguna Lake. However, the fact that the charges have not increased since 1997, while development in the area has, mean that the system may have become less effective over time. An emissions charge system based only on the concentration of effluent in the discharge water cannot keep total emissions from rising as new plants open in the area or the local population grows. If the charge per kilo rose with time, then the share of plants choosing to pay the fee would drop, so total emissions might remain constant. However with a constant charge, the total pollution will rise with growth in the region.

Malaysia used a somewhat similar system to reduce biological oxygen demand (BOD) discharges into water (USEPA 2004, p. 11). That country established a two-tiered variable fee for discharges by palm oil and rubber factories. Discharges into water below a standard level were set at 10 Malaysian ringgit (RM) per ton, while those above the standard were ten times as much, at RM 100/ton. There was a minimum charge of RM 150 imposed on all companies, however, so any company discharging less than 15 tons had no financial incentive to reduce its emissions. Firms discharging above the standard were faced with a serious threat of being temporarily shut down for non-compliance; between 1991 and 1996 thirty-five plants had to close until they could reduce their emissions. The total level of emissions decreased dramatically when this system was imposed, by two third in the first year and 99% in five years. However, it is not clear that this may be attributed to the fee structure; the threat of shut-down may have been more important in leading firms to comply with the rules.

2.1.2 Europe

Emissions charges have been used widely in Europe both prior to and since the development of common policies through the European Union. In the 1970s and 1980s France imposed charges on emissions to water bodies, the revenues being used to fund the discharge permitting system and environmental activities in the same watershed or region. (Hahn 1988, p. 104) Because they were designed primarily to raise revenue rather than to create an incentive not to pollute, they were set well below the average cost of pollution reduction. While the charges did relate to environmental improvements through the allocation of the funds, they did not constitute a direct financial incentive for firms or municipalities to improve their own environmental performance. Germany had somewhat similar fee systems in place at that time, again set at relatively low rates with the revenues used to fund environmental improvement projects. The Netherlands system at the time had

higher charges than France or Germany; French charges averaged $2 per person, German ones $6 and those of the Netherlands $17. Nonetheless, even the Dutch system was designed for revenue generation rather than to create an incentive not to pollute, so the charges were maintained below the cost to industry of reducing its emissions to avoid the fees. (Hahn 1988 p. 105) In contrast, a system designed primarily to discourage pollution would end up bringing in much lower revenues, since its success would be measured by the number of polluters who changed their behavior rather than paying the charges.

At present most European countries have a complex mix of tools in place for managing industrial emissions. The relevant EU directives - 2010/75 on industrial emissions and 91/271/EEC on urban waste water (including industrial discharges into municipal sewer systems) - mandate the application of emissions limit values, permitting, and other standard regulatory approaches, but make no mention of economic incentives. Most countries use a mix of emissions charges, user fees, and penalties for non-compliance along with the standards in implementing these directives. Charges are commonly assessed for point-source discharges into water. The amount is related both to the total volume of output and to the concentration of specific pollutants within the effluent. Firms that pretreat their waste to the ELV before discharging into the sewer pay a low rate; those that depend on municipal treatment pay a much higher one, creating an incentive to pretreat as much as possible. When the discharges are into the municipal sewer system (rather than directly into the environment), the charges are also designed to ensure that effluent not exceed the capacity of the treatment plant, and to cover the firm's share of operating costs of the system. (Speck 2006)

A number of new EU members in Eastern Europe have introduced complex charges on stationary source emissions to air, in order to bring down pollution levels. Different rates apply to different pollutants, and in some countries (e.g. Estonia) the rates are higher in denser urban areas. (Hogg et al 2015, p. 45) An internal audit of Estonia's experience (Estonia National Audit Office 2008) found that the pollution charges were ineffective in reducing pollution, possibly because they were too low. Moreover, some firms neither paid the charges nor reduced their pollution. This should have subjected them to greatly increased pollution charges as a penalty, but this was not enforced. The revenue from the charges was used to pay for pollution control; firms that paid pollution charges could apply for funds to spend on pollution control equipment. However, the amounts available were not sufficient to fully cover the costs of the pollution control equipment, and there was no monitoring to ensure that firms receiving the subsidies actually used them for pollution control rather than to cover other routine costs. The only circumstance in which pollution actually did drop, according to the audit, was when a separate legal mandate required it. This example suggests that relying on the economic incentives of emission charges in the absence of regulation may be inadequate in practice, especially where enforcing financial penalties in cases of non-compliance is difficult.

In all European countries, emissions charges are used to support environment-related activities. Most directly, they fund the implementation of the permitting systems and the operation of sewage treatment plants. They are often used as well to support other environmental protection activities, in some cases through a dedicated environment fund. While in a few cases the rates are clearly high enough to create a financial incentive not to pollute, in many cases they are relatively low, and therefore serve more to generate income than to directly protect the environment. Thus these charges cannot be clearly defined as only a single type of tool; they mix the characteristics of market-based instruments creating incentives not to pollute, revenue generating taxes, fees assessed to cover the cost of

specific services, and penalties for non-compliance, overlaid on top of regulatory limits on pollution.

Two major studies of environmental fiscal instruments recently carried out in Europe offer an additional perspective on the use of emissions charges. One, commissioned by the EU Directorate-General for Environment, looks at practices in fourteen countries, evaluating a wide range of tools including emissions charges. (Hogg et al 2014, Hogg et al 2015). The overarching focus of this work is on how to increase revenues from EFIs; it does not prioritize use of market-based instruments to create incentives to protect the environment. The second study (Withana et al 2014), carried out for the Netherlands Ministry of Infrastructure and the Environment (and including many of the same authors as Hogg 2015) takes a much broader approach. It assesses opportunities to "green" the entire tax structure of European countries, by substituting revenue from taxes designed to reduce environmental pressure for revenue from taxes that may create incentives to reduce employment (such as payroll taxes) or those that harm workers (such as individual income taxes). (This approach is sometimes referred to in shorthand as "taxing bads, not goods".) This work focuses, as well, on opportunities for European countries to collaborate in the design of green taxes, so that they do not hinder trade or create competitive advantages or disadvantages among countries. The effort that has gone into these two very detailed analytical studies in the past few years suggests that there is substantial interest in increasing the use of environmental taxes in the future, narrowly as a source of revenue and more broadly as a way to shift the entire fiscal system to create incentives to protect the environment without reducing employment or economic activity.

2.2 Cap and Trade Systems

Cap and trade systems are much less common than emissions charges. While they are theoretically appealing, they are more complex and much less versatile, as they do not lend themselves to the mix of revenue-generating, incentive, and penalty objectives offered by the charges. At present the best-known trading systems are those used to reduce greenhouse gas emissions. Cap and trade has also been used in some other contexts, however. This section discusses examples both for greenhouse gases and for other pollutants.

2.2.1 US SO_2 trading system

One of the earliest and best-known emissions trading programs is the United States' sulfur dioxide (SO_2) trading system, which was in operation from 1995 to 2010. (University College Dublin, 2008) It targeted power plant emissions of gases that are precursors to the formation of acid rain. Introduced through Title IV of the 1990 Clean Air Act Amendments, the first emissions reductions were required in in 1995. Under Phase 1, which was in effect from 1995 to 1999, all power plants producing more than 100 MWe, and whose emissions in 1985 were greater than 2.5 pounds per million Btu of heat input, were required to bring 1995-1999 emissions down to 2.5 pounds per million Btu of heat input. With Phase 2, in 2000, all firms greater than 25 MWe were brought into the system and the maximum concentration was 1.2 pounds per million Btu of heat. The baseline Btu levels used for setting allowable emissions for each firm were based on its 1985 production, ensuring that total emissions across the economy stayed below a fixed cap rather than growing if the power sector grew. Initial Phase 1 allowances were given away rather than sold, in quantities proportional to prior emissions. New plants opening up during Phase 2 not given any allowances; they had to buy them if they wanted to emit.

Under the program all emissions had to be accompanied by an allowance. Firms given allowances could use them (i.e. emit SO_2 and submit an allowance in justification), sell them in the allowance market, or bank them for future use. (Borrowing against allowances to be purchased in the future, in order to justify current emissions, was not permitted.) During Phase 1, many firms reduced emissions to below the required levels and banked allowances, which they then used when emissions requirements dropped further at the start of Phase 2. This enabled them to bring in their emissions reductions in a way that minimized the overall costs of pollution reduction. All participants in the system were required to install continuous monitoring systems, which EPA uses to track actual emissions.

Early assessments suggested that this system led to satisfactory reductions in SO_2 emissions. There had been fear of hotspots in the Midwest, where plants might not reduce emissions sufficiently, leading to continued acid rain problems in the north east; as of 2008, reviews of the system indicated that this had not occurred. The market was reasonably efficient, as evidenced by allowance prices evolving to a uniform level before the Phase 1 requirements went into effect, and remaining consistent enough that firms could rely on them in making decisions about whether to abate or purchase allowances.

However, the SO_2 trading was replaced, beginning in 2005, in a series of steps working towards two regional markets instead of the single national one. This change suggests that in some way the national trading system did not address the hotspot problem. Initially the issues were to be addressed through the Clean Air Interstate Rule; it was replaced by the Cross-State Air Pollution Rule, which after some legal delays will go into effect in 2015. The new system splits the country into eastern and western trading groups for SO^2. Tighter emissions standards apply to the eastern group than to the western group, and trading is not permitted between the two markets, so separate caps would apply to the two regions. This presumably reflects the predominance of coal-fired power plants in central states (which fall into the eastern group) and the predominant wind patterns, which move pollution from west to east, which led to eastern states being unable to meet ambient air quality standards. The effectiveness of this new system clearly cannot yet be determined. (USEPA 2011, Argus Media 2012)

2.2.2 US introduction of controls on lead in gasoline

Another interesting trading system emerged in the United States with the introduction of unleaded gasoline. (Hahn 1988, pp. 101-103) This system was unusual in that it was in place, by design, for only a few years while oil refineries converted their manufacturing technology to produce unleaded rather than leaded gasoline. It was a given from the start that all plants would have to make the conversion, and would do so at their own expense. However, rather than mandating a fixed date by which each plant had to change its production system, plants had the option of trading lead permits with each other, so that within the overall conversion period from 1982 to 1987 each plant could either convert in a given year or purchase permits to permits to continue manufacturing leaded gasoline and put off conversion.

Although firms were apparently skeptical about the trading system when it was introduced, in fact there were far more trades registered than anticipated or than observed in other emissions permit markets. (Hahn 1988, p. 102) Half of the firms in the industry participated in the market, and some 15% of permits were in fact traded, suggesting that it offered useful flexibility to a significant proportion of manufacturers. Analysts suggest that this market

worked well both because it was of limited duration, and because there was consensus on the need to remove lead from gasoline and thus no disagreement over the basic objectives. There was no motivation, therefore, for individual firms to totally avoid converting; the only issue was whether they might be better off waiting a year or two vs. making the needed investments up front. (Hahn 1988, pp. 102-103)

2.2.3 European Union Emissions Trading System (EU ETS)

In 2005 the European Union introduced a carbon trading system through which it hoped to establish efficient procedures for the reduction of greenhouse gases. The system has gone through three phases, each with a lower emissions cap than the previous one. The third phase began in 2013 and runs through 2020.

The ETS appears to have had only modest impact on carbon emissions in the EU so far, for several reasons. First, there is a consensus that too many allowances were granted from the beginning, so firms were not forced to reduce emissions as much as needed in order to meet the targets. Second, the global recession that began in 2008 caused significant drops in European manufacturing and energy consumption. This led to an even greater surplus in emission allowances, up to about two billion by the end of 2013 (Sandbag, p. 15); this is equivalent to a full year's emissions. It also led to a drop in the price of allowances on the market from above €25 per ton in 2008 to as low as €2.75 per ton in April, 2013. (The Economist, April 20 2013) The surplus of allowances and their low price mean that the system puts little or no pressure on firms to reduce emissions, either through shifts to low-emissions products or through technological change in producing current products. Third, European firms may offset their emissions either by purchasing European allowances or by investing in emissions reduction in developing countries, through the international carbon trading mechanisms of the UN Framework Convention on Climate Change (FCCC) and the Kyoto Protocol. The reliance on international credits has the effect of increasing the total supply of allowances on the European market; this has been a significant driver of the build-up of the large surplus in Europe. (European Commission 2012, p. 9)

The EU has little flexibility during Phase 3 of the system to reduce the allowance surplus and thus make the market more effective. The one action they can take is to "backload" – i.e. postpone – auctioning off some allowances to tighten the market in the short run. They are doing this with 900 million allowances, which will be sold in 2019-2020 rather than earlier in Phase 3. This will tighten the market somewhat before 2019, presumably driving up allowance prices and forcing more short-term emissions reductions. However it will not address the underlying problems or reduce Phase 3 emissions, so the market will again be flooded in 2019.

A number of proposals are under discussion to change the structure more significantly in Phase 4, which begins in 2021. These include the establishment of a market stability reserve, which will enable market managers to keep the total number of allowances within set floor and ceiling levels. They also include decreasing the total European cap more rapidly than had been planned (i.e. increasing the "annual linear reduction factor" used to automatically reduce the cap each year), reducing access to international credits, and expanding system coverage to sectors not now required to reduce their emissions. Whether these changes can create a more effective emissions market remains to be seen. (Sandbag 2014, European Commission 2012)

2.2.4 Carbon Markets Outside Europe

Whether or not the European ETS can be revived, its experience has served as an example and perhaps a lesson to other countries considering the introduction of carbon emissions trading systems. Some 45 other carbon markets exist or are under development around the world, taking a wide range of approaches, with varying degrees of effectiveness. (Hope, 2014, World Bank 2014) Some European countries responded to the problems of the EU ETS by establishing their own floors on carbon prices, although it is not clear how effective these have been. Although the United States has no national carbon policy, California has established a regional trading system, as have a group of nine northeastern states through the Regional Greenhouse Gas Initiative (RGGI, www.rggi.org). The RGGI has set a region-wide cap on fossil-fuel-based power plant emissions, which will decline by 2.5% per year from 2015 to 2030. They auction off almost all of the allowances, and allow only 3.3% of the allowance requirement to be met through purchased offsets rather than emissions reductions.

The most ambitious country-level carbon trading program is surely that of China, which announced in August 2014 that it would open a national carbon market in 2016. Given the size of the country's economy and the number and diversity of firms involved, China could offer a suitable context for a vibrant national market. However, the country's background as a managed economy leads to much doubt as whether these objectives can be realized.

China began this venture with seven municipal or regional pilot markets created in 2011, each following somewhat different procedures and goals, and ranging in size from individual cities to large industrial regions. Six of the seven markets set fixed caps on total emissions, while the seventh set a cap on emissions per unit of economic output, an approach that will not ensure climate targets are met if the economy continues growing at a rapid rate. All seven pilot markets aimed for around 20% emissions reductions relative to 2010 levels by 2015, which is probably unrealistic given that none became operational before 2013. Many of the markets have experienced very low volumes; given that China has relatively little experience even with conventional market-based activity, it should not come as a surprise if firms are not sure how to make best use of carbon markets. (Hope, September 2014, Han et al 2012)

Most of the details of the upcoming nationwide Chinese market are not yet known. The government has explained that it will involve combining and integrating the policies of the various regional markets so as to gradually expand coverage to a national scale. (Hope, February 2015) Such issues as whether the system will have fixed emissions targets, what they will be, which sectors will be required to participate, or how the trading mechanisms will work remain to be seen. While the challenges to creating this market will be significant, if it succeeds it will become a major player in the global carbon trading realm.

2.2.5 Global carbon markets

The global carbon trading system developed under the FCCC adds a level of complexity beyond the national and regional ones because it includes both players who are obligated to reduce their emissions and players who are not. Two markets exist under the FCCC; joint implementation (JI) allows trades among countries with mandatory reductions (Annex II countries) while the clean development mechanism (CDM) allows firms in countries with mandatory reductions to instead purchase so-called "certified emissions reductions" from projects in countries without them (Annex II countries). The primary interest of these global

markets to Lebanon, as an Annex II country, is as a potential source of revenue to fund projects that would reduce greenhouse gas emissions. Thus while these markets are of major importance from the perspective of global greenhouse gas management, they do not offer a model for how Lebanon could use cap and trade systems domestically. They will not be discussed further in this section.

2.3 Taxes on Input Goods

As anticipated in chapter 1, industrial input taxes are assessed primarily on the sulfur content of petroleum and natural gas. Such taxes are in place in half a dozen European countries, including Norway, Australia, Belgium, Germany, the Netherlands, Slovakia, and Denmark. (Hogg 2015 p. 44) These taxes create an incentive to reduce fuel consumption or to switch from high-sulfur to low-sulfur fuel; either strategy would reduce the firm's tax burden.

Denmark has a broader and more interesting approach. They tax the sulfur content not only of fossil fuels, but also of biomass-based fuels, when burned to generate energy in plants above a specified size. In addition, Danish firms may choose between paying an input or an emissions tax. This combined approach combines the management efficiency of an input tax with the economic efficiency of an emissions tax, allowing each firm to opt for the approach that lowers their total cost of compliance with the regulations. However, it makes the system more complex both for the firms and for the government. For each fuel choice, the firm must calculate what an input tax would cost, how much emissions they generate, and what an emissions tax would cost. In addition, to determine an optimal strategy each firm must assess whether process changes to reduce emissions of a given fuel would pay off in lower emissions taxes. In principle the government should do the same analyses economy-wide to know how to set the tax rates so they arrive at the desired aggregate emissions reductions; this is clearly very complex. Nevertheless, Denmark has the lowest per capita SO2 emissions in the OECD, which suggest that this may be an effective approach to regulation. (Hogg 2015 p. 44-45)

2.4 Direct Support (Subsidies)

Public expenditures for pollution control activities are common throughout the world. They take a wide range of forms; direct public responsibility for municipal sewage, research funding, development of publicly accessible databases on pollutant emissions, support for energy conservation and use of renewable energy, and so on. Notwithstanding widespread commitment to the polluter pays principle, support for private sector pollution control is also very common, especially through tax deductions and credits, subsidized loans, and occasionally direct grants.

2.4.1 Poland: Supporting mandatory environmental protection

Poland's National Fund for Environmental Protection and Water Management provides a typical example of how public funds support environmental protection where industrial pollution abatement is mandated. (Poland NFEPWM 2013, 2014) The fund was created in 1989, following the country's transition out of the Soviet bloc. While the fund is used to cover a wide range of investments that reduce pollution, it is founded on the polluter pays principle, and does not directly support abatement expenditures by private firms. A

significant portion of its expenditures have gone to helping municipalities establish sewage collection and treatment systems, which is required for integration into the European Union. Projects to improve energy efficiency and reduce the pollution from energy production in public buildings have also received significant funding. A third funding target is residential use of solar energy for hot water heaters; in some cases the funding goes through municipal projects encouraging the whole community to invest in solar power. The rationale for funding solar, in particular, is as discussed in Section 1 of this report, that an increase in demand will encourage economies of scale in manufacture and reduce the cost of solar energy even to those not benefiting from the public funds. (Poland NFEPWM 2013)

The fund's revenues come both from international donors and from environmental charges and fees Over the period from its creation until 2013, the fund has received €12.7 billion euros in funding, €8 billion from domestic sources and the remainder from foreign donors, including substantial contributions in connection with the country joining the European Union. The domestic sources include fees and penalties for using resources, mining charges, recycling fees, and other revenues; the fund website does not provide more specific information. (Poland NFEPWM 2014)

2.4.2 The Arab World: Supporting environmental protection with ineffective enforcement

A number of mechanisms for subsidizing private investment in pollution control have been established in the Arab world, often with donor support. Fairly detailed information is available about the case of Tunisia. In that country, pollution abatement is required under Law 88-91 of 1988, which says (article 8) that pollution is not permitted and specifies (article 11) a range of fines to be imposed on those who do not comply. However, recent reporting Tunisia suggests that this has never been enforced, due both to the power of large, sometimes state-controlled industry and to the weakness of the government agency expected to enforce the law. Moreover, the country's new constitution, enacted in 2014, says that "The state guarantees the right to a sound and balanced environment and contribution toward climate safety. The state shall provide the necessary means to eliminate environmental pollution." (Goldstein 2014) This seems to suggest that the new constitution calls for the state to pay for pollution control, rather than making any reference to the polluter pays principle.

Tunisian tax law offers a range of subsidies to industries investing in pollution control, as presented in Figure 1. Since the mandatory abatement apparently is not enforced, these are effectively being offered in a context of voluntary pollution control. It would be very interesting to determine which firms have taken advantage of these tax subsidies, how much it saved them relative to the cost of pollution abatement, why they are choosing to make these investments if they don't have to, and whether they would have done so without the tax subsidies. Unfortunately, such data are not available, so we cannot determine whether the subsidies have led to any pollution control that would not have occurred without them.

Tunisia has also created a fund to support environmental activities, FODEP (the Fonds de Dépollution or Pollution Reduction Fund). It provides resources for (among other things) private industry investments in reducing pollution control, through direct grants and loans and through subsidized loans offered by commercial banks. The German government has been supporting FODEP through a series of projects which aimed to provide support to small and medium sized enterprises as they transformed their operations to reduce pollution. Thus they were making an effort to ensure that support would go to the firms most likely to

be unable to reduce pollution on their own. Moreover, as pollution abatement was nominally mandatory when their funding was provided, they expected that this support would help firms in need of help to comply with laws applicable to all industry. Thus their support follows the logic presented in the first section of this paper for subsidies when abatement is mandatory, that they should ease the transition for more marginal firms, ensuring that jobs are not lost because of pollution control.

Figure 1. Tax subsidies for private pollution control in Tunisia (Table 5.1 in source document)

Table 5.3. **Green investment incentives in Jordan**

Purpose of the incentive (and legislative or policy basis)	Type of benefit	Beneficiary
To promote RE in light of rising oil prices in 2009; (REEE Law 2012)	All locally-manufactured RE/ EE equipment and imports are exempted from custom and sales taxes	Project developers using RE/EE equipment and machinery for projects
To provide off-taker assurance for small-scale electricity generation (REEE Law 2010)	NEPCOis obliged to purchase electricity sold by residential and small-scale producers. NEPCO bears the cost of connecting renewable energy from source to the grid	Residents and small-scale producers selling electricity in local markets
To attract investment in electricity generated from renewable energy sources	Feed-in tariffs – but they have not yet been implemented	Eligible power producers
To increase access to energy saving equipment (National Energy Strategy)	Sales tax and customs duty exemptions on solar heaters and street lights	Industrial and residential consumers
To encourage uptake of solar energy among citizens: (REEE Law 2010)	Individuals that have installed solar panels in their homes or places of work are allowed to sell any excess electricity to NEPCO at a full retail rate	Households and enterprises.
To reduce energy consumption (National Energy Strategy)	Reduction in customs duties and sales tax and other fees on vehicles of small engines or hybrid vehicles	Individuals and corporations that purchase such vehicles
To encourage the purchase of fuel efficient vehicles	The tax on small-engine hybrid vehicles was reduced from 55% to 25%; a ban was imposed on importing vehicles older than 5 years into the Kingdom, as older vehicles tend to emit more. However, in 2012, the tax incentives for reinstated.	Individual car-owners, automobile manufacturers
To encourage generation of renewable electricity (REEE Law 2010)	Power Purchase Agreements NEPCO assumes cost of connecting power plants to the grid; NEPCO is also obligated to purchase the IPPs' generated electricity	Independent power producers

Source: OECD 2013, p. 218

KFW's evaluation of Phase III of their funding finds that the subsidies have been ineffective. (KFW 2014) They found that their support was mostly likely to contribute to an ongoing sustainable reduction in pollution in companies whose managers had a personal commitment to good performance. Although they assumed that the investments in pollution control would open access to new international markets for the firms, creating an incentive to seek FODEP funds, in fact very few of the businesses they supported were exporting. From

the perspective of the KFW evaluation this is a lost opportunity; however it raises the question of why those firms participated if they were not going to obtain that kind of benefit. A key concern in the evaluation was that for the most part firms did not have an incentive to seek FODEP funds and invest in pollution control, because they knew that enforcement of legal pollution limits and sanctions on those who do not comply would be ineffective.

KFW support to FODEP was designed in part to create financial mechanisms for offering subsidized loans for pollution control even after the project ended. The project was expected to spur the interest in pollution control of other firms not receiving KFW support. The evaluation found that this did not happen. The subsidies are small relative to the cost of pollution control, and demand has been limited. The banks through which the loans were offered did not have a financial interest in developing additional instruments outside the context of the KFW support, and other firms were not spurred to invest in pollution control. The evaluation concludes that if the existing regulations were enforced, the situation would be different, but in the absence of such enforcement they did not expect this to change. Notwithstanding these findings, KFW signed a fourth credit agreement with FODEP in 2014[5]; this presumably reflects an expectation that enforcement may become more effective as the political situation calms down, so future funding may contribute to improved environmental quality more than it has in the past.

Funds similar to Tunisia's FODEP also have been created in Morocco, Jordan, and Egypt. Morocco's fund has the same name as Tunisia's, and has also been supported through German foreign aid. (Morocco 2012) The Moroccan funding, which can include both direct grants and loans or a combination, is available only to industrial or artisanal firms whose total revenues are below 400 million dirhams (about $US 36 million); this suggests that they hope to avoid supporting large firms that do not actually need subsidies. Within that limit, the highest priority criteria for FODEP funds are the pollutant load and the sensitivity of the environment in which the plant is located, which aims to ensure maximum impact on the environment. Special funding lines are also available to two traditional industries, pottery and olive oil, to help them upgrade their activities; these are probably among the most marginal industries, but ones with cultural significance to be protected from the costs of pollution control. By 2012 FODEP had supported 116 projects. Total value of the projects was 645 million dirhams, of which 246 million came from FODEP as a mix of grant and loan. As elsewhere, it is not possible to assess from the available information how effective this spending has actually been. (Morocco 2012, Morocco undated)

Jordan has created a national environment fund that was designed in 2008 with USAID support. (Francis et al 2008) The fund's regulations allow it to support activities of the private sector that lead to improved environmental conditions, with priority given to air and water pollution, hazardous materials, and biodiversity & desertification. It began operation in 2011, with 1.5 million euros from a public sector CDM project. (Namrouqa 2011) It is not clear how those funds were used, however, nor is more recent information available about the fund. The expectation discussed in Francis et al was that the fund would continue to be supported through the sale of carbon credits. Given the evolution of that market and the low price of carbon, it is possible that the fund has not been able to be active in the past few years.

Egypt has supported industrial pollution reduction through an Environmental Protection Fund and a wide range of donor projects. (EcoConServ 2010) The basic government approach is

[5] http://www.tap.info.tn/en/index.php/economy/19657-finance-agreements-signed-for-fodep-as-part-of-4th-credit-line-of-kfw

to provide resources to industry to reduce pollution if the social benefits exceed the social costs, without concern about whether subsidies are being provided to firms that do not need it. Significant funding for industrial pollution control has come from the Egypt Pollution Abatement Project, itself funded by the World Bank, the European Investment Bank, the European Commission, and a group of bilateral donors. Phase II of EPAP, which ran from 2007 to 2012, received 190 million euros. (Phase III is currently under development.) The project provides low-interest loans for pollution reduction to industrial plants in the Cairo and Alexandria areas. Eligible firms must meet several criteria: they comply with Egyptian law (including with respect to pollution, of course); they decrease their pollution by 50% with the project funds; and the activities proposed are technically and environmentally feasible. There are no limits on the size of the firms, and no concern about whether the firms could afford the abatement without subsidized financing.

The Egyptian Environmental Protection Fund was created by law in 1994, with a broad mandate to stimulate sustainable environmental projects, support compliance with environmental law, and mobilize public and private interest in tackling environmental problems. Its revenues come from an array of charges and fees, the most important of which (as reported by Egypt ESP 2007, p, 9) were fines, penalties and protected area revenues. The EPF funds were used primarily to support pollution control activities in small and medium enterprises (EcoConServ pp. 84-85), while EPAP and other donor projects supported much larger projects. EcoConServ (pp. 84-85) estimated that between 1996 and 2015 some 13,000 projects would be funded between the EPF and the donor projects, although again it is not possible to assess how much impact this has had on pollution in Egypt.

2.4.3 Tax Incentives

Tax reductions for investment in pollution control have been implemented all over the world. Investment tax breaks are a common strategy at all levels of government to encourage economic development; extending this to tax breaks for investment in pollution control is almost routine. Such measures are in place in many US states, including Virginia, Tennessee, Texas, Louisiana, California, New York, Pennsylvania, Michigan, Ohio, and so on. [6] (Tax Policy Center, 2006) The details of the credits offered vary from state to state, and they apply only to state taxes, not to the federal corporate income tax. Such mechanisms are also available in developing countries, as mentioned above in connection with Tunisia. They are less common in Europe, where the industry is generally expected to cover the costs of its pollution abatement. The management consulting firm KPMG has created a "green tax index" designed to advise companies about how environmental taxation is used in countries where they may be considering investing. They find that the US ranks highest based on tax incentives to reduce pollution; European countries in their study rank much lower. Developing countries are for the most part not included, as they are not as frequent investment targets for KPMG clients. (KPMG 2013 p. 4)

[6] Virginia: http://www.deq.virginia.gov/Programs/LandProtectionRevitalization/RecyclingandLitterPreventionPrograms/TaxCredits.aspx
Tennessee: http://www.tn.gov/ecd/BD_tax_incentives.html
Texas: https://www.tceq.texas.gov/airquality/taxrelief
New York: http://www.tax.ny.gov/pdf/stats/policy_special/effectiveness_of_the_itc.pdf
Louisiana: http://www.deq.louisiana.gov/portal/DIVISIONS/WastePermits/TaxIncentives.aspx
California: http://www.arb.ca.gov/ba/fininfo.htm
Michigan: http://www.michigan.gov/taxes/0,1607,7-238-43535_43537-154819--,00.html
Ohio: http://web.epa.ohio.gov/ocapp/p2/funding/funding4.html

Empirical analyses of how tax subsidies actually affect investment in pollution control or public revenues are hard to find. The theoretical literature – for example Jenkins and Lamech (1992), Alberini and Segerson (2002), and Arguedas and van Soest (2008) – address the distortions that can be created by different tax structures, and the conditions under which subsidies might lead to voluntary pollution control, particularly if mandatory controls are the "stick" behind the "carrot" of the subsidy. Actual data on the empirical impacts of specific tax subsidies, however, are harder to find.

3 LEBANON

The options for using EFIs in Lebanon will differ widely depending on whether pollution control is mandatory or voluntary. At present, firms are not required to comply with ELVs, and industrial operating permits are often issued without the approval of the Ministry of Environment. However, the Ministry is working to establish new ELVs, and negotiations are underway with the Ministry of Industry to establish a deadline by which they will become mandatory. There is, therefore, clearly a hope that pollution abatement may become mandatory in the foreseeable future. Whether this is effective will have major implications for how EFIs might be introduced to support industrial pollution control. This section takes an optimistic stance, and for the most part assumes that EFIs might be introduced to aid the transition to mandatory pollution control, rather than under a policy of purely voluntary abatement.

3.1 Emissions charges

“Pure” emissions charges set at a level that could create a financial incentive for firms to reduce pollution to socially optimal level are not likely to be realistic in Lebanon; indeed, they are rarely realistic anywhere. Too little is known about the cost of pollution abatement to design such tools, and many sectors that are significant sources of pollution have too few players for such tools to be effective. Moreover, given that conventional permitting systems are not yet in place, this would be adding a significant layer of complexity to a system that does not yet exist even in a simple form. Using such tools in place of regulatory approaches and uniform standards will not be effective.

In the future, however, if pollution control is mandatory and if an effective permitting system is introduced that requires environmental compliance for plants to receive operating permits, "impure" emissions charges will be worth at least considering. As in many other countries, they would be used primarily as a revenue generation tool and perhaps to create incentives for timely compliance with the regulations. Their eventual introduction could be considered now, in conjunction with the development of ELVs and permitting procedures, even if their implementation is likely to be fairly far in the future.

The broad shifting of fiscal policy towards green taxes and "taxing bads not goods" that is under consideration in Europe is similarly not realistic in Lebanon at this time. There are simply too many problems in the existing tax system and in the ability to collect taxes for this approach to make sense, appealing as it might be in a conceptual way.

3.2 Cap and Trade

Similarly, cap and trade schemes also are not realistic in Lebanon at present. They are too complicated, require too much information, and are too difficult to manage to make sense in the Lebanese context. Moreover, quite aside from these constraints, tradable permit markets only work if the industry is fairly competitive, i.e. if there are many firms with varying pollution control costs, so there are opportunities for trading. This is not the case in many sectors of Lebanese industry, particularly some of the most polluting sectors.

3.3 Input taxes

Input taxes are most often used to control the emissions from petroleum-based fuels, particularly in electricity generation. Such taxes could be worth considering in Lebanon to achieve the same objectives. The relatively simple management of input taxes could be of interest in particular in dealing with the emissions from the thousands of small-scale electricity generators across the country, for whom emissions permitting clearly is not an option.

However it is not clear that the economic logic of such charges applies in this case. For power generation in manufacturing, changing fuels may involve process changes whose costs vary from plant to plant, so some plants will choose to change fuels while others will choose to pay the higher tax to use high-SO_2 fuel. The market pressure as consumers choose which firm's product to purchase will create an incentive for the manufacturers to find low-cost ways to shift to fuels with less tax burden.

Firms running generators to produce backup electricity will all face the same cost structure, however, so there will not be different incentives to switch fuels vs. paying taxes depending on the processes they use. Moreover, consumers do not have a choice about whom they purchase backup power from; only one producer is wired into each apartment. So consumer choice will not create a market pressure for greater efficiency. Instead, the taxes or the cost of low-sulfur would simply be shifted to the consumers. In this context the most plausible way to reduce emissions of SO_2 would simply be to ban the importation of high-sulfur fuels, in a purely regulatory system. Of course this would also impose costs on the consumers of backup power, which would be politically difficult given the already-high costs and poor performance of the electrical system; however it would help to resolve the complaints that the Ministry of Environment receives about the emissions from electrical generators.

An analysis of the economic and practical feasibility of banning high-sulfur fuels may be useful to address these emissions problems. Such a ban is clearly not an EFI, so this analysis could more appropriately fall within the realm of ongoing work on ELVs; one way or another, however, it would be useful to carry it out.

3.4 Subsidies

Subsidies for industrial pollution control are already being used in Lebanon through the World Bank-funded Lebanon Pollution Abatement Project (LEPAP), and they seem to be the most plausible EFI for use in the foreseeable future. A number of different considerations will go into the choice of instruments and their design.

Most fundamentally, the design of instruments will differ depending on whether pollution control is required or not, or whether they are primarily intended to ease the transition into mandatory pollution control. Our hope is that we will begin the subsidies in the current situation (as indeed they have already begun), with the primary objective being to assist the transition to mandatory abatement. The subsidies would be for investments in both physical and human capital, but not for operating expenditures for the pollution control equipment. As long as there is no serious expectation that the regulatory situation will change, subsidies would have to be fairly substantial for many firms to be interested in taking advantage of them. This may be one reason why LEPAP is advancing rather slowly in bringing firms to take advantage of its offerings; most companies do not expect that they will be forced to comply, and the incentives are not large enough for them to do so voluntarily.

Subsidies designed to ease the transition to mandatory pollution control may have two different modalities. The first would apply to marginal firms or sectors, including firms in specific industries in which retrofitting is particularly expensive, very old plants where major upgrading would have to accompany the retrofitting to reduce pollution, plants in regions where employment loss would place a very heavy burden, and some small businesses that simply do not have the margins to pay for the needed investments. For such firms, subsidies may have to be fairly substantial to prevent significant job loss. They could usefully be combined with technical assistance, as these firms might not have the knowledge or skilled staff to determine what needs to be done. In addition to the actual support to the companies themselves, this kind of subsidy will require staff to work with the firms, determine who is eligible, assist with the procedures involved, and provide technical assistance. Donor support, if it can be found, may provide the best way to offer this kind of assistance, especially if it involves grants rather than loans to Lebanon.

Determining which firms, sectors, or regions of the country should be eligible for this kind of support will take some work; although the general principle is clear, its application may not be. Marginal firms could be defined as those below a certain size, those in specific locations where job loss would be crucial, those using specific old technologies, those with the lowest profit margins, those older than a specified age, or in other ways. Some of these criteria may be easier implement, while others may better capture the firms that actually need subsidies the most. Tradeoffs will be involved in determining how to target this support most effectively to ensure that it does not simply provide a windfall to firms that don't actually need it; this will require further analysis.

The second modality for support would not focus specifically on marginal firms. While larger, more modern firms are not likely to need subsidies or technical assistance to cover the costs of pollution abatement, some token assistance may be useful to overcome their opposition. Small tax subsidies may be useful here. While the costs do come directly from the taxpayers, in contrast with donor grants (though not donor loans), at least the transactions costs are low, especially if all firms are eligible and no screening is required.

If tax subsidies are introduced, additional analysis will be needed to determine which subsidies will be most useful and how high they should be. Law 444/2002 on the protection of the environment authorizes subsidies through any tax that could affect environmental protection, but this does not mean that Lebanon should offer this support through all possible taxes. A few points should be considered in the design of tax subsidies:

- The simpler the mechanisms involved, the easier it will be for the government to track what they are actually costing in revenue loss; a somewhat higher subsidy offered on only one tax will be less distorting, easier to manage, and more transparent than lower subsidies offered through several taxes.

- The income tax may offer the best single target for subsidies. It offers a more direct means of support than VAT or import duties, and the subsidies may distort investment decisions less.

- A choice is also needed between tax deductions and credits. The former reduce the tax base, while the latter reduce the tax owed. If the tax is progressive – i.e. firms with

higher net income pay at a higher rate – then for a given deductible expenditure, a tax deduction will benefit firms with high income more than those with low income. In contrast, with a tax credit the two firms would benefit equally. Thus a tax credit does more for less profitable firms than a tax deduction, and may be considered more equitable. (Of course the eligible share of the investment would be much lower for a credit than a deduction, based on what the tax rates are.)

- A more complex analysis may be needed to determine how much tax subsidy is appropriate. Clearly it should be the lowest amount needed in order to generate the desired objective. If it is being provided to eliminate opposition when mandatory controls are going into effect, rather than actually to offer the financial support that will determine whether or how much firms reduce pollution, a detailed and reliable analysis of the subsidy level may not be that essential. Nevertheless, this question will require some additional consideration, including assessment of how much use might be made of the tax and what it will cost the government.

- A decision is also needed about whether such tax subsidies would be refundable, could be carried over to future years, or neither. If neither is allowed, then firms with no taxable income in the year they invest in pollution control equipment – i.e. the more marginal firms or the new ones – would receive no benefits from the tax subsidies whereas more profitable firms that can afford to pay for their pollution control would receive a subsidy; this is not an equitable tax design. Making the subsidies refundable to address that inequity would impose a direct cost on the treasury, as firms earning no net income would ask to be directly paid the subsidy for their pollution control investments. This could be difficult for the government to manage in terms of revenue projections and cash flow. For this reason carrying over the subsidies to future years may be preferable; on the one hand it does ensure that marginal firms will be able to benefit once they are earning net income, while on the other it does not force the treasury to pay out directly for pollution control investments.

- It will also be necessary to consider whether the tax subsidy will be available permanently or only for a defined period. If the subsidies are intended to assist in the transition to pollution control, then they should not be permanent; they should be available for a period of perhaps ten years, to coincide with the expected time required to bring firms into compliance. If mandatory pollution controls will be phased in, beginning with category 1 and 2 firms (i.e. those posing greater environmental risk), the tax subsidies could also be phased. That would make them more difficult to manage, but it could ensure that only firms transitioning to pollution control benefit from them.

- A related question is whether the tax subsidies would be available to new plants or firms. In some industries, new plants can be designed with integrated pollution control technology that is less expensive than retrofitting and often cannot even be distinguished from other operating features of the plant. In this case subsidies are not needed and would be difficult to apply. Even in industries where this is not feasible, however, the expectation should be that once pollution control is mandatory, companies will be able to factor in the costs involved, so new plants should not be eligible for subsidy. When the subsidies are introduced, we might conceive of a time cut-off; any plant that will go into operation before a certain date might be eligible. This would permit plants now being designed or built under the old cost assumptions to receive the subsidy but those not yet planned would not receive it.

A broader question about the economics of pollution control is whether it can have multiplier effects that will benefit the economy. To the extent that mandatory abatement increases demand for Lebanese goods and services – for equipment and for professional services in particular – this will provide a direct stimulus to the economy that may counter some of the political opposition. The World Bank's study of the costs of environmental degradation in Lebanon considers the direct benefits from an improved environment, but does not consider the opportunity for development of new economic activity as a result. An analysis of these opportunities may be interesting in order to ensure that the country benefits as much as possible from the introduction of mandatory pollution controls.

A final question that applies to both modalities for supporting pollution control is whether there are sources of funding other than the two mentioned here, foreign donors and the treasury via tax subsidies. Other countries have created environment funds supported with the revenue from pollution charges and fines. The amounts of money available from such sources is typically small compared with the support provided by the donors, and compared with the cost of retrofitting firms to reduce pollution. Moreover the retrofitting is required now, and if an emissions charge system were to be created that could feed into such a fund, those revenues would not be available for some years. Where the charges are designed as a fee for service, as in the cost of a household wastewater charge or an emissions charge designed to cover the costs of the permitting and inspections system, these revenues will not be available for other purposes (such as subsidies). The same would likely apply to possible revenues from the sale of carbon credits obtained through retrofitting existing power plants; they would be claimed for use on energy issues and would not be available to fund industrial pollution control. (In the current carbon market, these revenues are not likely to be significant anyway.) In light of all these caveats, these revenues sources probably will not be sufficient to fund the private sector transition to pollution control. However as mentioned above in the section on emissions charges, it will be useful to analyze the possibility of using emissions charges and fines to cover some of the operating costs of the environmental protection system in the future.

3.5 Conclusions: Where to Go From Here

The next step is to carry out the more detailed analyses of the mechanisms recommended in this report, in order to determine how they should actually be implemented. As described above, these analyses should focus on:

- How to target substantial subsidies, presumably made available through foreign donor support, to the firms that need them the most, and how to ensure that they do not provide windfalls to firms that do not need them.
- How to design tax subsidies available to encourage all firms to reduce pollution
- The potential for emissions charges to provide revenues in the future to cover operating costs of the government's environmental management systems.
- If considered of interest, the potential for growth of new "green" sectors that will meet industry's new needs for pollution abatement

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