Major issues in valuing and incorporating environmental externalities

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1. SYNOPSIS

Marketplace instruments are useful supplements to environmental regulation.

2. ABSTRACT

Marketplace instruments, such as pollution taxes, emission trading allowances, environmental cost adders in utility planning and resource selection and inclusion of environmental costs in national systems of accounts, can be useful supplements to environmental command and control regulation. Including environmental externalities in prices can give industry an economic incentive to select more environmentally benign resources and processes and to exceed environmental regulations. Including environmental externalities in national accounts can assist governments to do the same and avoid large pollution cleanup costs. Trading allowances can reduce compliance costs. Valuing environmental externalities and using them wisely to reduce environmental problems and increase economic efficiency is a great challenge.

3. INTRODUCTION

Increasingly marketplace instruments are being used to supplement regulation as means of mitigating environmental damages. Marketplace approaches to environmental protection take the form of pollution taxes; incorporation of environmental costs by utilities in planning and selection of resources; use of emission trading allowances to meet regulated standards at least cost; and inclusion of environmental costs in national systems of accounting.

While these marketplace instruments can be a useful supplement to regulation, it should never be forgotten that the prime purpose of environmental policy is to reduce hazards to human health and the environment, not to maximize economic efficiency. Thus, marketplace incentives should not be used to replace regulation, as some have advocated, unless it is demonstrated that the marketplace instruments will achieve the desired environmental goals. In some instances, as with asbestos and DDT, environmental policy may dictate banning hazardous substances regardless of cost.

Surprisingly, the traditionally conservative electric utilities and their regulators have pioneered in incorporating environmental costs in the United States. In eleven states, public service commissions (PSCs) have sought to quantify environmental externalities and require their consideration in utility planning and resource acquisition; ten more states require some sort of consideration; and another eight states have initiated proceedings for consideration of environmental costs. (Ottinger 1990, updated). Nevada requires consideration of economic and job impacts as well.[1]

European countries and Japan have started to experiment widely with pollution taxes as a means of internalizing environmental costs (Ottinger 1992) and the United States recently imposed a tax on Chlorinated Fluorocarbon Compounds (CFCs). The European Community has proposed a carbon tax to address the problems of global warming and there is active international consideration of such a tax.

Emissions trading allowances were pioneered in the 1992 amendments to the U.S. Clean Air Act as a means of minimizing the costs of reducing SO_2 and NOx emissions, the precursors of acid rain. The cap on emissions underlying the allowances, when implemented, will internalize some of the costs of acid rain reductions.

Lastly, a significant body of expert opinion has recognized the need to institute natural resource accounting,

accounting for the depreciation of natural resource assets like the depreciation of other capital assets. (Repetto et al 1989, at p. 7). In June 1985, the OECD endorsed adoption of "more accurate resource accounts" for consideration of environmental and economic sustainability. (Id). Several countries, including Norway, France, Canada, Japan and the Netherlands, have proposed or established systems of environmental accounts. (Id).

The United Nations Statistical Office has tentatively proposed a system of additional satellite accounts for natural resource assets as a supplement to the United Nations System of National Accounts, widely used by developing countries. This builds on the results of a number of workshops sponsored by the World Bank and UNEP, which are also considering the subject. (Id at p. 9).

Thus, in a number of different forums, and with considerable variety of application, the social costs of energy are beginning to be valued and incorporated, nationally and internationally. The need for sound, reliable, defensible valuation thus has become very important.

The United States, despite its experiment with emission trading allowances for acid rain and with a CFC tax, still relies primarily on command and control regulation to alleviate environmental threats. These regulations have been severely criticized by U.S. industry and conservatives represented by the Reagan and Bush administrations, alleging that they impose too high a cost on industry, jeopardize jobs, and impede U.S. ability to compete internationally.

The U.S. environmental community, while vigorously challenging the above assumptions, has increasingly come to recognize that command and control regulation needs supplementation because it fails to address the important challenge of pollution prevention, gives industry no incentive to surpass regulated standards and often results in unnecessarily costly after-the-fact pollution reduction.

This paper will address some of the major issues of valuation and incorporation of the social costs of energy.

4. COSTS CONSIDERED BY U.S. UTILITIES

Of the social costs of energy use, environmental costs are almost exclusively the costs that have been addressed so far in the United States, and these have been addressed mostly through command and control regulation of pollution after it has occurred. It is just within the last few years that utilities and their PSCs have started to calculate environmental costs and use them in their planning and resource acquisition. A few utilities, however, also are considering other social costs.

4.1. Job & economic costs

A few U.S. jurisdictions and studies have addressed non-environmental social costs such as job and economic impacts of energy choices, national security consequences and international trade impacts. The most thorough European study of externality costs, completed for the European Economic Community, seeks to value impacts on production, employment and trade balance; depletion of non-renewable resources; public subsidies and R&D expenditures; and "induced public expenditures" such as defense costs; as well as traditional environmental costs. (Hohmeyer 1989).

A number of fairly recent studies have been done in the United States demonstrating that the economic development benefits and employment impacts of various energy options vary considerably. Through use of input-output models, it is possible to estimate the economic development (increase in earnings and employment) brought about by a specific energy procurement strategy.

The economic development which results from an energy-related expenditure includes direct impacts (wages to workers who construct and operate a facility), indirect impacts (incremental wages paid to workers in supplier industries which produce the materials and equipment needed to operate a plant, and induced impacts (the cumulative result of economic expansion which occurs as direct and indirect earnings are spent

in the economy. Direct and indirect earnings continue to ripple though the economy, creating a "multiplier" effect.

The findings of these studies are universally that investments in energy efficiency measures have far greater economic benefits and create many more local jobs than do investments in supply options, in addition to their environmental advantages.[2] The jobs created by energy efficiency measures tend to be lower skilled and lower paying than for supply investments, however.

The relative economic impacts are of sufficient significance that they should be given consideration in the selection of electricity resources. Economic and job impacts, as well as capital requirements, of different energy options are particularly important in developing countries.

4.2. Environmental costs

The most severe environmental costs imposed on society by electric utility operations derive from the risk of damages to human health and the environment from air pollutants emitted by fossil fuel-fired generation and from the radiation risks of nuclear plant operations and nuclear waste disposal.

The environmental costs of air pollutants are significant, estimated to cause billions of dollars of damages to society not accounted for under most present utility regulation. The principal culprits are the "greenhouse" gases, most significantly carbon dioxide (CO_2) emissions from the burning of fossil fuels and from the nuclear fuel cycle which causes carbon dioxide emissions during uranium mining, fuel enrichment, fabrication and power plant construction, a fact conveniently ignored by the nuclear industry[3]; acid rain and its principal precursors, sulphur dioxide (SO_2) and nitrogen oxides; tropospheric ozone resulting from chemical interactions of NOx and volatile organic compounds in the presence of sunlight; and particulate pollution, providing the medium for ingestion and inspiration of toxic co-pollutants.[4]

Many of the above air pollutants react synergistically, forming new chemical combinations after release which react together to inflict increased environmental damage. For example, NOx and volatile organic compounds combine to form ozone, which is of great proven harm to human health and the environment. A major unresolved issue of environmental cost valuation is how these synergistic effects should be considered.

Radiation damage from the operation of nuclear power plants, the risk of catastrophic accidents such as occurred at Chernobyl and Three Mile Island, the risks of contamination from decommissioning nuclear plants and nuclear waste disposal, CO_2 emissions from the nuclear fuel cycle, and impingement of fish at nuclear facilities, all impose significant costs on society that also are largely unaccounted for under current regulation. The degree of accident risks, risks from low level radiation, nuclear CO_2 and the unincluded costs of decommissioning nuclear facilities are major issues of contention.

In addition to air pollution and radiation damages, many electric service resources cause water pollution and land contamination, as well as waste disposal contamination risks. While these costs are generally much less than air pollution and radiation damages, they nonetheless are significant enough to merit consideration. Valuation of land and water damages is still very incomplete.

Environmental costs from electric utility-generated pollution emissions are often not restricted to the state or country in which the plant is located. Thus, much of the acid rain damage to the Northeastern United States and Canada derives from Midwestern power plant emissions. Similarly, water pollution in rivers often crosses state and national borders, and CO_2 emissions have world-wide global warming effects. Virtually all state jurisdictions that have addressed environmental impact costs have determined that all costs to society should be accounted for, not just those affecting the jurisdiction in which a plant is located.

Site-specific considerations must be taken into account in valuing environmental externality costs. Clearly a plant's polluting emissions affecting a heavily populated metropolis will incur vastly greater human mortality and health costs than a rural plant where the emissions affect unpopulated areas. Similarly, it is obvious that agricultural damage costs will be more significant where emissions are deposited on farming communi-

ties rather than on urban areas. At the least, an attempt should be made to differentiate pollution costs in urban and rural settings; where possible, emissions and their health costs should be calculated in tons of pollutant per unit of population. This is also an under developed area of valuation.

Full fuel-cycle costs should be considered for an accurate accounting of environmental externality costs, to the extent they are not already included in the prices of fuel and equipment. Front-end costs, such as the unreimbursed health costs of uranium and coal mining are substantial and have not been adequately considered in current studies. The health effects of uranium mill tailings may be a significant proportion of total nuclear power externality costs. Even though they are relatively small, the environmental externality costs of solar photovoltaics and solar thermal resources are almost entirely composed of manufacturing and land costs incurred prior to pollution-free operations. Inclusion of all the above front end costs is essential to a full accounting of environmental externalities.

It is difficult to know how far to pursue front end costs, of course. One could go back infinitely far, estimating the costs to society from manufacturing all the equipment and machinery necessary to manufacture the equipment and machinery, etc. at each stage of the fabrication process. However, for costs not included in market prices, it seems logical to include at least the first generation costs of construction and transport to the plant site of electric power fuel and facilities and production of demand-saving or renewable materials.

5. VALUATION ISSUES

Toxic emissions from power plants have been quantified, but their transport involves uncertain calculations. It is difficult to show that a given amount of pollution from a given stack was the cause of damages to human health or to forests and crops many miles away. In addition to the difficulty of showing that particular emissions caused specified harm, the receptors are subject to many other harmful (and helpful) influences besides the stack emissions.

Once an estimate is made of the deposit of toxic substances, one must show the doses to which individual human or plant species were subjected, the means of ingestion, and the dose/response function. These calculations are also difficult.

Then there are the risks of major accidents, particularly high in coal mining and offshore oil drilling. While the risk of occurrence of major nuclear accidents is relatively small, the consequences can be catastrophic. Estimates of major nuclear plant accident risks and damages vary widely.

The back-end costs of the fuel cycle, the damage risks caused by disposal of the wastes of energy production, also must be addressed. These are particularly high for nuclear plants.

Finally, an estimate must be made of the economic value of the damages caused by the harmful impacts of the pollution or accident risk. This is the least developed area and the one on which this paper will focus. A fascinating aspect of the valuation effort is the interdisciplinary skills required, a collaboration of scientists, energy experts and economists who usually don't communicate much.

5.1. Damage vs. control costs

At present, all of the U.S. utility commissions which have acted to value and incorporate environmental externalities, have done so on the basis of cost of controlling pollution or by "implied valuation," using the costs of meeting legislated standards as a proxy for damages. They do so because control costs are much easier to calculate than damages. However, at least one commission (Oregon) has ordered the utilities to calculate damage costs[5] and the New York Commission has ordered a pooled study by all of its utilities of the damage costs of their environmental externalities.[6]

Many economists feel very strongly, however, that use of control costs is completely inappropriate, even to the extent of preferring a zero value. They maintain that control costs and legislated standards bear no

relationship to damages. Control costs usually fall short of damages since controls eliminating all harmful pollutants are virtually never adopted. Furthermore, control standards like the National Ambient Air Quality Standards of the Clean Air Act (40 U.S.C. Sec. 7409) are adopted at a level to protect the public health and welfare with "an adequate margin of safety," often without regard to the costs to society of health and welfare damages. Some standards theoretically are set to protect the most sensitive individuals in society, which would result in control costs which might exceed damage costs.

Since it is damages that are sought to be avoided, use of damage costs to value externalities, for either calculation of pollution tax rates or utility resource selection, is clearly preferable. The calculation is difficult, however, and where inadequate sound research exists on damages, a good argument can be made that the costs of compliance with legislated standards is a societal "revealed preference" value for the costs involved. Of course, with respect to pollutants for which there are no legislated standards or damage valuation studies, like the carbon dioxide contribution to climate change, use of control costs is the only alternative to zero valuation.

Use of control vs. damage costs is a major issue of environmental cost valuation that rages on unresolved. Strong feelings are maintained by the conflicting parties. I believe that damages should be used when reasonably reliable valuations are available, and that otherwise use of implied valuation or control costs is better than zero valuation. It is hard to see a sharp distinction between the validity of contingent valuation surveys and the determinations by legislative bodies of the amount society is willing to pay to meet legislated standards.

5.2. Discount rates

There also is much controversy among economists and the scientific and utility experts that have dealt with the subject on what discount rate, if any, should be applied to environmental externalities. Discount rates are used to compare future economic benefits and costs to today's benefits and costs. Low discount rates weigh the future more heavily (and the present less heavily) than high discount rates do.

Many utility experts maintain that the discount rate applied by utilities to their capital investments (the marginal private rate of return on capital -- about 6-8%) should be used as a matter of consistency and because use of lower discount rates will undervalue the present value of environmental damages from a utility planning perspective. The problem with use of a commercial discount rate is that it severely depreciates the value of damages to future generations -- after 12-16 years the value is considered zero.

Many environmentalists argue there should be no discount rate applied at all because it is fundamental to environmental protection that the objective is to preserve environmental assets for future generations. They maintain that a zero discount rate should be used, particularly as applied to human life and health risks as a matter of morality, because a life in the future is as valuable as a present life. Furthermore, they argue, many of the damages such as risks of contamination from nuclear accidents or waste disposal, may continue to persist for thousands of years.

Economists tend to argue for a social discount rate of about 3%, maintaining that a zero rate is inappropriate because, over long periods of time, it is probable that new scientific and technological discoveries will be able to cure damage risks. They also argue that risks to life thousands of years from now are too remote. They assert that utility discount rates are inappropriate because the value of environmental costs and benefits to the public is being evaluated (and discounted), not the investments of the utility.

The social rate generally seems a good compromise, but consideration should be given to applying different discount rates to different risks. Nuclear wastes that pose risks for thousands of years should be given a much lower discount rate than more short-lived risks.

5.3. Uncertainty

Valuation of the environmental damage risks from energy services is very difficult. There are uncertainties at every stage, but the difficulties are not much more severe than those involved in setting standards for

pollution emissions. Informed best estimates are far better than failure to set standards or ignoring damage values, thus effectively giving them a zero value.

Uncertainty should be dealt with by showing the full range of costs in the studies reviewed and their bases, and by applying sensitivity analysis. A reasonable point within the ranges of the studies must be selected and the rationale given for the selection.

Some, particularly utilities and large industrial utility customers, maintain that the uncertainties are so great as to make any damage valuations unreliable. While they tend to avoid the issue, the result of their argument is that environmental externalities should be valued at zero, which is the effect of ignoring them.

Despite the uncertainties, however, the environmental externality damage costs of most electric utility-generated pollution can be estimated. There is a great deal of demonstrated uncertainty as well in utility forecasts of demand and of fuel prices, yet these forecasts are used routinely in utility planning. Externalities are as important to planning as forecasts and best estimates should be employed.

6. STATE UTILITY INCORPORATION OF ENVIRONMENTAL EXTERNALITIES

Of the twenty-six U.S. state public service commissions or legislatures that have taken some action to incorporate environmental externality costs or have such action under active consideration, eighteen have issued orders or passed legislation requiring their utilities to take into account these costs in planning and/or bidding.[7]

Twelve states have quantified externalities, setting dollar values for environmental costs, either done by a commission itself or by utilities under commission order. The values calculated are then added to the cost of resources in the selection process, or used in a resource rating system as in Massachusetts. Some commissions use a proxy percentage adder to polluting resources or a percentage credit to non-polluting resources (as did Wisconsin adopting a 15% non-combustion credit.

Nine states have ordered or have under consideration orders that their utilities take into account environmental externality costs in planning and/or resource selection, without specifying how they are to be calculated or considered -- sometimes with an express or implied threat that the rate of return will be affected by the result. The still early results of state efforts to consider externalities indicate that quantification is much more effective in altering utility resource selection than mere qualified consideration.

In nine states commissions award an increased rate of return to utilities, either on particular non-polluting resource investments (usually DSM and/or renewables or resource recovery plants), or on their total investments as an incentive for their installation of non-polluting resources. Seven states have required consideration of externalities in calculation of avoided costs, important because avoided costs are the limits usually set for acquiring conservation and renewable resources.

So far, all states incorporating environmental externalities apply them only to acquisition of new resources. To maximize reduction of power plant pollution, however, externality values should be applied as well to existing power plants which are almost universally the most heavily polluting, thus encouraging early retirement of expensive, old, inefficient equipment. Most U.S. utilities belong to power pools, often including utilities from several states, which dispatch existing power plants on a least cost basis. Total cost dispatch, including environmental costs in dispatch decisions, is now being considered in several jurisdictions.

A method of utility consideration of environmental externalities that has been proposed, but not yet adopted by any state, is to set emission reduction targets for principal power plant pollutants like CO_2, SO2, NOx and particulates, and require the utilities to meet these targets in a least cost manner. As an enforcement mechanism, utilities could receive a positive rate of return incentive for meeting or exceeding the targets and a negative incentive for failing to meet them.

The advantage of this proposal is that it avoids the necessity for calculating environmental externality costs and is designed to achieve specific emission reduction targets. The disadvantage is that it requires calculation of the emission reduction targets, a calculation with which commissions may have as much trouble as environmental externality costs, and which utility regulatory commissions may not have the power to implement.

Still another innovative proposal would charge utilities with the quantified environmental costs of each resource selected and provide for deposit of the proceeds in an environmental trust fund. This proposal has the enormous advantage of making resource owners pay the costs of the environmental damages they impose on society instead of just using these costs in resource selection. It would also create a very substantial fund to finance environmental mitigation or marginally cost-effective renewable energy programs. It is very much like a pollution fee or tax and might require legislative authorization

A number of important policy issues are raised by utility incorporation of environmental externalities. For example, requiring incorporation of environmental costs could have a significant impact on rates. So far this has not been a significant problem because the environmental adders (or credits to non-combustion sources) have not been great enough to have a significant effect, and the costs have been applied only to selection of new resources rather than to more highly polluting existing resources.

If the true environmental damage costs are ascertained and used, however, and particularly if application is made to existing resources, the impact on customers could be considerable. The rate impacts would be alleviated to the extent that use of environmental externalities induces utilities to invest in economic demand-side energy efficiency and load management resources that lower customer bills.

There are also by-pass problems related to rate increases from utilization of environmental externality costs. If significant environmental costs are utilized, it could lead to greater customer use of more polluting fossil fuels to replace electricity or to self-generation of electricity, where environmental costs do not have to be considered.

These policy questions need to be more thoroughly addressed, and more research is needed also on damage values. Additional externalities valuation research is being performed in two major multi-million dollar studies. One study for New York is being executed by the consulting firm, RCG/Hagler, Bailly and is scheduled to be completed in about two years. On a similar time table, the Department of Energy and the European Community are undertaking a major study of fuel cycle environmental costs. The DOE subcontractors are Resources for the Future and Oak Ridge National Laboratory.

Action on incorporation should not await completion of these studies, however. In the interim, utilities will continue to select resources which, unless environmental costs are considered, will impose large mortality, health and other environmental costs on society.

The incorporation of environmental externality costs by so many utilities and commissions is a salutary, pioneering endeavor that will have impacts beyond the electric utility industry and beyond the borders of the United States. Already, the steps taken by these utilities and commissions are steering utilities towards more environmentally benign resources, enhancing their use of energy efficiency and renewable resources, and setting a pattern for others to follow.

7. EMISSION TRADING ALLOWANCES

Emission trading allowances were introduced in the U.S. Clean Air Act Amendments of 1992. Under emissions trading allowances, a cap on total emissions of a pollutant is set, in the case of the Clean Air Act Amendments, for SO_2 emissions for the entire country. This differs from the usual command and control regulation by which emission limits are set for each plant or, in the case of air quality standards, for air shed regions. Within the cap, each emitter is given allowances or they are auctioned. Emitters with low cleanup costs can sell their allowances to emitters with high remediation costs, thus lowering the societal cost of compliance.

Emission trading allowances do not internalize environmental externalities; it is the emissions cap which performs this function. A perverse effect of emission trading allowances is that the system nullifies efforts by any state or region to regulate emissions more stringently than the adopted cap, since additional regulation just results in the creation of allowances that can be sold to another emitter.

Areas that wish to protect particularly vulnerable areas, such as the Adirondack Park area in New York, find that they are frustrated in doing so by the emission allowance system. If New York regulates its utilities beyond the nationally established cap, the utilities can sell the resulting allowances to other utilities. If the purchasers happen to be Midwest utilities, the result could be greater New York damages since Midwest emissions migrate East over the Adirondacks. The only recourse left for New York is to prohibit the sale by the New York utilities of their allowances or to purchase those allowances.

This peculiarity of the allowance system has resulted in proposals that SO_2 emissions above the cap be valued at zero by the two major externality valuation studies presently being conducted, on the basis that reductions beyond the cap would be frustrated by the system -- despite the fact that the cap was set in the Amendments at a reduction of only 9 million tons of SO_2 nationally, while the National Academy of Sciences found that to stabilize national acid rain emissions, a reduction of 12 million tons would be required. The SO_2 emission allowance system also means that a tax on SO_2 emissions would be rendered less effective.

Thus, under a national or regional emission trading allowance system, it becomes vitally important that the cap be set with sufficient stringency to alleviate the damages from the pollutant regulated. Where there are areas particularly vulnerable to a pollutant, consideration should be given to excluding that area from the trading allowance system.

8. POLLUTION TAXES

The rationale for pollution taxes is that prices for goods and services should reflect the total costs they impose on society. Pollution taxes give to the producers of goods and services accurate market place signals that will cause them to select their resources taking into account the environmental costs. Where there are pollution standards, polluters will be given an incentive to exceed the standards to the extent that the tax reflects the environmental costs of the exceedance.

The ultimate objective of a pollution tax is to correct a failing of the marketplace in that the environment is a common good the value of which is not reflected in the purchase price of the polluting good or process. The pollutant is taxed so that the price of the good or process which produces it reflects the true cost. To save money the polluter will look for ways to avoid paying the tax. Profits and fiscal self-interest will act as a motivating force to abate pollution.

Government regulation of pollution has proved to be generally inadequate to address the severe threats to the planet posed by global warming, stratospheric ozone depletion, acid rain, urban smog and toxic contamination of our air, water and food supplies. While some improvements have resulted from regulation, particularly where contaminants have been totally prohibited as with asbestos, lead in gasoline and DDT, generally pollution increases stay well ahead of mandated regulatory controls. Inevitably economic growth, in both developing and industrialized countries, receives higher government priority than environmental protection.

Regulations establish pollution levels based on technology standards or emission levels. They are set at a politically acceptable level rather than at a level to maximize protection of human health and the environment. Also, it takes too long to promulgate and set standards, so that they are generally quickly outdated.

Furthermore, regulations only encourage industries to lower their pollution to a set level without offering incentives to surpass that level. Thus, abatement of pollution only proceeds as quickly as the government can establish regulations that reflect both currently available pollution reduction technologies and politically feasible and enforceable levels. Even if regulations were adequate, the penalties for failure to meet the

standards are often so low that it is cost effective to pay a fine rather than purchase pollution control technology.

Pollution taxes can address pollution from all polluting sources (rather than just for utilities, for example). They are also politically attractive. Governments requiring additional revenues may find that it is much more acceptable to tax polluters, making them pay for the damages they impose on society, than to further tax gasoline or other energy sources which directly affect the taxpayer, even though the pollution tax will be indirectly reflected in higher energy and product prices. It also is more politically attractive to tax a negative such as pollution than to tax a positive like one's personal income.

On the other hand, pollution taxes have negative economic impacts similar to those of any other tax. Pollution taxes also tend to be regressive, falling as heavily on the poor as on the wealthy. The economic impacts of pollution taxes can be offset by reductions in other taxes, however, in some cases providing a net economic gain in job creation and GNP. To address the impacts which higher pollution taxes would create for low-income individuals, governments can offset pollution taxes with reduction of regressive taxes. They can even make pollution taxes revenue neutral if this adds to their political acceptability.

Pollution taxes also inevitably create hardships on some polluting businesses and their employees. Thus, a carbon tax of sufficient magnitude to affect CO_2 emissions would probably put many coal companies and workers out of business. These sectoral impacts offset some of the political advantages of making polluters pay for their damages. Sectoral impacts can be offset, but only partially, by using some of the proceeds to retrain and find jobs for the displaced workers and give readjustment assistance to the affected business.

It is often difficult to set pollution taxes at an optimal level. Ideally, the taxes will reflect the damages to society from a pollutant, but this economically ideal level may not be sufficient to cause polluters to undertake economically optimal pollution reductions.

Where the damages caused by a pollutant, such as carbon dioxide, cannot be adequately determined, control costs or an arbitrary tax figure can be adopted, high enough to provide an incentive to avoid pollution, yet not so high as to be seriously damaging to the economy. For instance, the United States has imposed a tax on CFC's even though damage done to the ozone layer can not be measured monetarily. A few European countries have also set taxes on carbon dioxide emissions without calculating damages.

Lastly, on the negative side, pollution taxes do not offer the same assurances of pollution reduction as do command and control regulations. One can never be sure, as is the case with adequately enforced regulations, that the response of the polluters subject to the tax will result in the desired pollution reductions.

The European countries and Japan have experimented with a variety of pollution and effluent taxes, generally with favorable results on pollution reduction and without adverse effects on their economies. The European Community is actively considering a carbon tax. The U.S. has imposed a tax on CFCs and is considering a variety of other pollution taxes.

Thus, there is a lot of momentum behind the pollution tax concept. If the taxes are high enough to affect industry behavior, pollution taxes are likely to have a significant effect on pollution reduction and technological innovation to reduce pollution. To avoid severe economic and equity impacts from such taxes, however, they must be offset by reductions in other taxes and some of the tax proceeds must be spent to alleviate sectoral impacts.

Pollution taxes are best imposed internationally to prevent competition between countries on the basis of the leniency of their pollution tax laws. If they are imposed unilaterally, measures must be taken to avoid damage to domestic economies.

9. ENVIRONMENTAL COSTS IN NATIONAL ACCOUNTING SYSTEMS

In order to properly consider environmental costs in energy and development plans, countries should incorporate environmental assets and their depletion in their national accounts. In most countries today, the value and "expenditure" of natural resources is not considered in computation of GNP or asset accounts. This can lead to grave distortions of wealth and economic performance and to misguided and ultimately unsustainable policies.

> The present national income accounts, and hence the gross national product and such measures as the net national product, do not reflect the depletion and degradation of natural resources -- even where, as is the case in many developing countries, those resources are a primary source of national income. If a country whose primary wealth is in its forests, for example, were to cut down those forests and sell off the lumber, under the current system its GNP would increase. Yet such a country, having consumed its source of wealth, would be poorer and would have a less promising economic future. (Repetto 1991).

A significant body of expert opinion has recognized the need to institute natural resource accounting, accounting for the depreciation of natural resource assets like the depreciation of other capital assets. In June 1985, the OECD adopted a position endorsing adoption of "more accurate resource accounts" for consideration of environmental and economic sustainability. (OECD 1986 at pp. 19, 20).

Several countries, including Norway, France, Canada, Japan and the Netherlands, have proposed or established systems of environmental accounts, reviewed and assessed for the United Nations Environment Programme (UNEP). (Weiller 1993).

The United Nations Statistical Office has tentatively proposed a system of additional satellite accounts for natural resource assets as a supplement to the United Nations System of National Accounts which is widely used by developing countries. This builds on the results of a number of workshops sponsored by the World Bank and UNEP. The proposal, while better than ignoring depletion of natural resource assets, fails to provide for their full incorporation in development planning, however. An alternative transitional measure treating natural resource assets consistently with the treatment of other types of assets, which can be adopted more readily into core national accounts by redefining net national product, has been proposed by World Resources Institute. (Repetto 1989).

10. CONCLUSION

As can be seen, there has been a great deal of interest in the United States and around the world on various ways of considering the social costs of energy use. While most attention has been focussed on environmental costs, there has been some work done as well on valuing job and economic impacts.

U.S. utilities and their regulatory commissions have led the way in establishing and incorporating environmental externality values in electricity planning and resource selection. The European countries and Japan have experimented with a variety of pollution and effluent taxes, generally with favorable results on pollution reduction and without adverse effects on their economies. The European Community is actively considering a carbon tax. The U.S. has imposed a tax on CFCs and is considering a variety of other pollution taxes. The United States has pioneered in testing use of emission trading allowances to lower costs of compliance with regulations. Finally, implementation of the Global Climate Treaty signed at the UNCED conference in Brazil in June 1992 will surely consider imposition of carbon taxes.

The valuation of environmental externalities is still very difficult and a lot of research remains to be done. Nevertheless, there are many externalities that can be valued with reasonable limits on uncertainty. Revealed preference values from the costs of control, while very controversial, are much easier to calculate than damage costs and in fact are being used by U.S. utilities and commissions in many jurisdictions.

As countries, states and local governments seek more effective means to control pollution, seek to minimize

the costs of pollution control and look for new sources of revenue, it is likely that pollution taxes will be considered more widely in the future. Emission trading allowances will probably be used increasingly as well to reduce the cost of compliance with environmental regulations. And increasingly, international lending institutions and nations will come to see the importance of including environmental values in their national accounting systems.

Thus, use of a variety of marketplace instruments to supplement regulation is likely to increase exponentially in the years ahead, with favorable results both economically and environmentally.

ENDNOTES

1. Public Service Commission of Nevada, Docket No. 89-752, Order of November 19, 1990.

2. See for example: "The Impacts of Accelerated Energy Efficiency Investments Upon the Virginia Economy," Economic Research Associates, Eugene, Oregon, Feb. 25, 1991; Clark, Matthew. 1991. "Narragansett Electric Preliminary DSM Employment Analysis, Environmental Incentives, Inc., Boston, Massachusetts); Clark, M., I. Goodman & M. Anthony. 1991. "A Comparison of the Employment Creation Effects of The AES-Harriman Cove Coal-Fired Generating Station and Maine Demand-Side Management, The Goodman Group, Boston, Massachusetts; "Granite State Electric Preliminary DSM Employment Analysis," Environmental Incentives, Inc., Boston, Massachusetts, Nov. 1991.

3. Electric utilities accounted for 33% of national CO_2 emissions in 1988 (Machado & Piltz 1989). CO_2 emissions from the nuclear fuel cycle is documented in a British study asserting that nuclear fuel cycle CO_2 emissions could become comparable to CO_2 emissions from fossil fuel plants. (Hill 1989). Hill says that a Meridian Corporation study, "Energy System Emissions and Material Requirements," prepared for the Deputy Assistant Secretary for Renewable Energy, U.S. DOE, Washington, DC, February, 1989, most frequently cited for minimal CO_2 emissions from nuclear plants, showing nuclear CO_2 emissions at just 8.590 tons/GWh, totally failed to take into account nuclear fuel processing from which most CO_2 is emitted.

4. Electric utilities in 1985 contributed 68% of national SO_2 emissions (16,204,000 tons of 23,699,000 tons nationally), and 33% of national NO_x emissions (6,989,000 tons of 21,054,000 tons nationally). (NPAP 1987).

5. Re Least Cost Planning, UM 180, OR PSC Order No. 89-507 (April 20, 1989).

6. NY PSC Case 28223, Electric Utility Conservation Plans, Opinion and Order 89-15 (May 23, 1989). The ordered study is being carried out by RCG/Hagler, Bailly and is sponsored by the N.Y. State Energy Research & Development Administration (NYSERDA), the Electric Power Research Institute (EPRI) and the Empire State Electric Energy Research Council (ESEERCO -- the NY utilities' research organization) and the NY Department of Public Service (PSC).

7. The statistics on state incorporation in this section are taken from the Ottinger 1990 study, updated by actions that have taken place subsequently.

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