Key words: Environment, electricity restructuring, emissions regulation

Domestic and International Environmental Issues in Restructuring Electric Industries

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* I thank Sanford Berg, Patricia Mason, an anonymous referee, and participants in the Institute for Developing Economies workshop at Makuhari Messe, Chiba-shin, Japan in January 2000 for their comments, although I am solely responsible for any errors.

I. Introduction

Government intervention in the electric industry is an old story. Throughout the world, electric companies have been monopolies either privately owned and regulated or publically owned. Under either ownership form, the purpose of government actions has been to protect consumers by ensuring adequate supplies of power produced at low costs and sold at affordable prices. Regulation has also protected private firms from competitive entry to ensure adequate returns on investments. Today, regulated monopolies are being abandoned in favor of letting competitive market forces in a restructured industry ensure adequate supplies, low costs and affordable prices. At the same time, public ownership is being replaced by privatization in many countries.

Generally, in a competitive industry, a good is sold in the marketplace and market forces balance consumer benefits against industry production costs to yield optimum quantities of the good. This ideal outcome is more complicated in the electric power industry. While electricity is central to living standards in developed and developing countries, its production has side effects

that negatively impact the quality of life.[1] These side effects or externalities, mostly in the form of air emissions, typically fall outside the marketplace. The damages from emissions are true costs to society, yet historically they were not included along with production costs in the market for electricity; therefore, market forces delivered neither an optimum amount of electricity nor an optimum amount of emissions. Thus, on the one hand, government intervention into electric markets is becoming less necessary because of industry restructuring; on the other hand, it is becoming more necessary because generation emissions are threatening human health and natural ecosystems in all countries.

During a century of industrialization, governments rarely intervened to address externalities. With a relatively small population, two billion in the 1930s, the earth's ability to absorb pollution appeared limitless. By the late 1960s, with population approaching four billion, the earth's limits were apparent and governments became more active. Now, in a new millennium and with more than six billion people, governments are recognizing the need for international cooperation to reduce emissions, toxic wastes, ocean dumping, desertification, rain forest destruction and a host of other environmental ills.

In the electric industry, government intervention for the purposes of moving toward an optimum level of emissions can be placed into two broad categories, one that affects the supply side and one that affects the demand side of the electricity market. On the supply side, the goal of intervention is to internalize the externalities, which will have the effect of either reducing the supply of electricity via increasing the cost of generation or, for a given supply, reducing emissions by using cleaner technologies. On the demand side, the goal of intervention is to

[1] In this paper, standard of living is equated to the amount of manufactured goods people consume, a measure roughly reflected in Gross Domestic Product; quality of life is equated to a broader measure, one that includes standard of living in addition to environmental amenities such as clean air and water, healthy ecosystems, and many other nature services. (See, for example, Daly, 1997)

reduce the demand for electricity while maintaining the benefits that flowed from the original demand.

In this paper, both supply- and demand-side interventions that address domestic and global externalities are discussed. The next section briefly reviews the damages caused by generation emissions. Sections III and IV investigate the supply side of the market. Section III is a discussion of the tools available for addressing domestic damages from emissions, and Section IV is a look at the problems of global damages from the so-called greenhouse gases. The demand side of the market is considered in Section V by examining regulatory efforts to encourage conservation of energy. Finally, Section VI draws implications for developing countries, and Section VII is a brief final word.

II. Environmental Damages from Generation Emissions

The electric power industry worldwide is a very visible and concentrated source of pollutants, and it will continue to be near the center of many environmental programs. The types of pollutants and their effects traceable to fossil fuel use are as follows.[2]

NO_x – Nitrogen oxide contributes to groundlevel ozone, which decreases visibility and causes human health problems such as asthma and other respiratory illnesses. It also damages crops, forests and other plant life. In the United States, electric generation contributes about a third of total NO_x emissions.

SO_2 – Sulphur dioxide mixes with other chemicals in the atmosphere to reduce visibility and create acid rain, which damages human health and private property and leads to the acidification of lakes and streams. In the United States, electric generation contributes more than two-thirds of total SO_2 emissions.

[2] For more detail on damages, see Rosen et al. (1995) from which most of this section was taken.

Particulates – When fossil fuels are burned, dust, soot and other solid matter are sent into the atmosphere. These particulates reduce visibility and have been traced to human mortality. Power generation contributes about a third of the total particulates in the United States.

Heavy metals – Coal and oil contain heavy metals that are released in the atmosphere during combustion. These end up in soil and water and can be toxic to humans and wildlife. About a quarter of the mercury emissions in the United States are from power generation.

Green house gases (GHGs) – These include CO_2, methane, NO_x and chlorofluorocarbons. GHGs reflect long-wave radiation that otherwise would escape into space back into the earth's atmosphere. Although the meteorology and geophysics behind this greenhouse effect are complicated, the weight of the scientific evidence is leaning toward the notion that human-made GHGs are accumulating enough to warm the climate. CO_2 is the major GHG, and power generation contributes about a third of the CO_2 in the United States from human sources.

Non-emissions – The generation of electricity impacts the environment in many ways besides air emissions. Fossi-fuel mining damages rivers, streams and groundwater, as well as scarring landscapes. Power plants can contribute to local groundwater problems and heat up water temperatures in lake and river water used for cooling. These and other non-air emission damages will not be addressed below.

III. Reducing Domestic Environmental Damages from Generation

What is the potential benefit from restructuring the electric industry? Presumably, relying more on competition among firms and less on regulatory oversight will increase efficiency by decreasing the costs of production.[3] If competition works, then consumers will benefit because the lower costs will be passed along to them in the form of lower electric rates. This is good

[3] In spite of the potential benefits, White (1997) finds that the real impetus for restructuring in the United States was regional price differences.

news for consumers' standard of living, but can be bad news for their qualities of life if the lower prices and concomitant greater demands lead to more emissions. To ensure that the latter effect does not occur, it is important to incorporate into the price of electricity the environmental costs of generation. If this is done correctly, then the future might be one in which the industry is restructured but prices do not fall even though competition is successful because the cost of emissions damage is included in the price. In this case, restructuring may not improve living standards, but will improve quality of life. Because rising prices are unpopular, restructuring offers an opportunity to maintain prices while protecting the environment. Whether this will occur depends on the policies governments adopt.

Reducing air pollution in general can be thought of as a two-step process: determine the optimum level of pollution and then determine how the reductions to achieve the optimum are allocated across polluters. Understandably, some people abhor the notion of "optimum" pollution as anything more than zero, but we live in a world of difficult choices. Given current technology, zero pollution would mean shutting down industry.

The first step comprises most of the controversy. Should benefit/cost analysis be used to determine the optimum? Should risks to human health be the driving criterion? How do we factor in the value of healthy ecosystems? In short, what are the air pollution damages and what are the costs of cleaning it up? Answers vary by interest groups because this first step is the one that determines the ultimate level of air pollution.

In practice, in the United States, measurement methods are still too crude for finding an optimum, so after all groups have had their say, a target pollution level is chosen, usually on the basis of human health. When the target is lower than current pollution, reductions are required. Which polluters should reduce their emissions and by how much is addressed in step two.

Reductions should be assigned across polluters efficiently, which means minimizing cost of cleanup, given the target level. Because the cost of reducing emissions varies considerably across polluters, efficiency calls for polluters for whom reducing is expensive to reduce less than polluters for whom reducing is cheap. Unfortunately, governments do not have the information to distinguish between expensive and cheap polluters, so the traditional approach, labeled "command and control," has called for all polluters to reduce by the same percentage. This is inefficient, and the costs above the efficient solution can be very large.

Effluent charges and tradable permits are alternatives to command and control. The former requires emitters to pay a charge for each unit of emissions pumped into the atmosphere, and ideally the charge reflects the cost of the emissions' damages. Using the permit approach, the government issues permits to polluters, and each permit allows the polluter some stated level of emissions. The sum of all permits equals the target pollution level. Who gets how many permits is usually based on historical emissions, and the permit holders can buy permits from and sell permits to one another. (In the SO_2 permit program in the United States, non-industry groups such as the American Lung Society may hold and retire permits.) The polluters for whom it is expensive to clean up will buy permits and clean less, while the polluters for whom it is cheap to clean up will sell permits and clean more. Efficiency is achieved because the least-cost means of reaching the target pollution level is realized. The government does not need to identify those for whom cleaning up is expensive or cheap because the newly created permit market does it automatically.

There are some difficulties with permit systems. The permit market may be difficult to set up and maintain, especially if there are few firms or if their costs of reduction are similar. If the agency charges a fee for the initial allocation of permits, the system will be politically

unpopular. The method of allocating the permits could be controversial, and if total costs are a more important consideration than total emissions, a permit system is less desirable than a charge system, since the agency does not know the eventual price of permits in the market.[4]

If environmental damages are internalized by a charge or permit system, they are included in the costs of generation and in electricity prices. Inclusion in generation cost is desirable in that it gives emitters an incentive to develop cleaner technologies or invest in conservation to lower either their charges or permit costs, or to increase their permit revenues. Inclusion in electricity prices is desirable in that consumers have an incentive to conserve and at the same time be more willing to switch to new technologies. Solar and wind power, for example, are more likely to penetrate the supply side of electric markets when prices for fossil-fueled generation are economically correct.

Tietenberg (1995) offers a number of reasons why tradable permits would be desirable in developing countries. First, the opportunity cost of capital is high in developing countries; thus, any investments made in cleaner technologies ought to take advantage of the cost-minimizing properties of permit systems. Second, the incentive effects with permits will help to stimulate progress in designing new and better pollution control technologies. Third, tradable permits and fees for excess pollution can raise revenue in countries where more government revenues are needed.

Regarding the third reason, there is the possibility of a "double dividend." That is, if revenues raised from taxing 'bads' such as pollution are used to displace taxes on 'goods' such as income, the economy benefits twice. However, whether the double dividend is really attainable has been the subject of considerable debate. As Parry and Bento (2000, p. 67) state:

[4] The above is a very brief presentation of charges and permits. For a good, detailed description, see Tietenberg (1998).

> These debates arose in response to the so-called double dividend hypothesis, that is, the claim that environmental taxes could simultaneously improve the environment and reduce the economic costs of the tax system. The latter effect seemed plausible, if the revenues from taxes on carbon emissions, gasoline, traffic congestion, household garbage, fish catches, chemical fertilizers, and so on were used to reduce the rates of pre-existing taxes that distort labor and capital markets.

Studies by Bovenberg and Goulder (1996), Goulder (1995) and others suggest that the double dividend does not exist because the environmental taxes can exacerbate the distortions being caused by the taxes on capital and labor, thus adding to an inefficient tax system. In contrast to these studies, Parry and Bento (2000) find that the double dividend is real if one accounts for the fact that some goods such as housing and medical care receive favorable tax treatment. Labor taxes distort the relative prices of consumption goods as well as wages, and displacing some labor taxes with environmental taxes can reduce the distortions when one accounts for the favored consumption goods.

There is concern that developing countries may not be able to achieve adequate organization and monitoring capabilities to operate a permit system. But a tradable permit system probably requires little additional infrastructure beyond what developing countries are investing in price and entry regulation of their utilities. According to Tietenberg (1995, p. 29), "Most emissions monitoring is based on a system of self-reporting. Although self-reporting systems immediately raise concerns about possible abuse, in practice they work remarkable well, particularly when complemented by an effective system of criminal penalties for falsification."

III. Global Impacts of GHGs and the Kyoto Protocol

Greenhouse gases that trap long-wave radiation include CO_2, methane, NO_x and chlorofluorocarbons, although CO_2 is the main concern from the burning of fossil fuel by the electric industry. The atmospheric concentration of CO_2 is about 0.04 percent. There were 280 parts per million of CO_2 in the air during preindustrial days; today the parts per million has risen

to 350. This increase is not disputed, nor is the fact that it is largely attributable to human activity. What is in dispute is how much the earth's climate will change from this increase in CO_2. Even more controversial is what should be done about it.[5]

Typical predictions call for a warming of the earth's atmosphere by several degrees. Because humans have adapted to climates all over the world, physically adapting to a change of a few degrees will not be problematic. However, many plants and animals are less tolerant, and habitat ranges could change significantly even with small temperature changes. Placing a value on these changes is difficult because the benefits from most plants and animals fall outside the marketplace.

The loss of land if the sea level rises according to predictions could have a potentially enormous impact. The sea has risen 8-12 centimeters over the last 80 years, and some estimates call for a 44-centimeter increase over the next century. The U.S. Environmental Protection Agency (EPA) has estimated $100 billion in capital costs would be needed to protect coasts should this rise occur (EPA, 1989). When aggregated over the world, the costs are not large, but disaggregation is important here because a rising sea will not affect countries uniformly. Indeed, some low-lying island countries could be submerged.[6]

Weather changes will impact industries to varying degrees. The most severely affected will be agriculture and resource extraction industries such as logging and fishing. Construction, water transportations, recreation and the energy industries will be moderately affected, the latter because of an increased demand for cooling and decreased demand for heating. Only minor

[5] See Solow (1991) for a synopsis of the global warming problem.

[6] In a panel discussion at the American Economic Association's January 2000 meetings in Boston, leading economists in the field of climate change addressed what has been learned in the past ten years about the impacts of GHGs. There was disagreement about the level of action that should be taken now. Some argued that current aggregate economic damage estimates do not justify substantial action now, while others questioned this view because the economic damages are so unevenly distributed across countries; e.g., some countries will likely

impacts are expected in industries such as mining, manufacturing, finance, and so on. (Nordhaus, 1991)

Because the effects of global warming are so uncertain, the benefits of avoiding it are uncertain as well. Moreover, most benefits fall well into the future. Quick action means the costs begin now and fall on current generations, which makes the costs easier to estimate than the benefits.

In spite of the uncertainties and uneven distribution of costs and benefits, representatives of 160 countries met in Kyoto, Japan, in December 1997 to map out a course of action at the Third Conference of the Parties to the United Nations Framework Convention on Climate Change. Countries agreeing to the Kyoto Protocol to reduce GHGS were to sign on between March 1998 and March 1999. The United States was the sixtieth country to sign, although the U.S. Senate has still not ratified the treaty and there is strong domestic opposition to ratification. In March 2001 President George W. Bush announced that the U.S.A. would withdraw from the Kyoto Protocol because it was "fatally flawed." Nevertheless, delegates from 178 countries met in Bonn, Germany in July 2001 to set emissions requirements for developed countries. Japan was reluctant to join the agreements without participation from the U.S.A., although before the meetings ended, Japan accepted the requirements with the understanding that negotiations on enforcement would be postponed.

Shogren (1999) characterizes the Kyoto Protocol as "broad and deep": Deep in the sense that the proposed cuts in carbon emissions by developed countries are substantial in some instances, broad in the sense that developing countries, which have no obligations under the protocol, are encouraged to join once convinced it is in their best interest to do so. In Article 3,

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experience little change, but others may be inundated with rising seas. Both sides agreed that the potential for unknown catastrophe may justify action now.

the protocol calls for legally binding targets on thirty-nine of the most developed countries for an aggregate 5.2% reduction from 1990 levels of GHG emissions by 2008-12. The cuts vary across countries.

A major feature of the protocol, Article 17, allows for emissions trading across countries. GHGs are excellent candidates for a tradable permit system. Regardless of where in the world the gases are emitted, they are believed to contribute uniformly to climate change. In economic jargon, the benefits of reducing GHGs are a pure public good that would be underprovided in a market system without government intervention.

The system envisioned would allow permits, or units of national emissions quotas, to be traded across countries as other homogeneous commodities might be traded. At the end of five-year commitment periods, there is a check to make sure the permits held by a country cover its actual emissions. Trading centers would operate as stock exchanges and could be located around the world so trades could be made twenty-four hours a day.

Monitoring emissions is critical if countries are to have confidence and agree to participate. Rather than monitor emissions directly, an alternative is to monitor fossil-fuel use, then multiply the amount of each fuel used by its carbon content. A country's fossil-fuel use will equal its production plus its imports minus its exports. Because an exporter has an incentive not to underreport and an importer has an incentive not to overreport, there is a check on traded quantities of fuel. Tracking inventory changes within countries will be more problematic.

Under the Kyoto protocol, only Annex B countries (those that have committed to emissions limits and have ratified the protocol) can participate in trading. The maximum number of traders would be thirty-six plus the European Union. The United States has 35% and Russia

18% of the assigned GHGs by 2008-12. In spite of these large participants, the expectation is that the trading will be competitive (Bohm and Carlen, 1999).

Whether developing countries will join a trading system is speculative (Tschirhart and Wen, 1999). They would need to be issued sufficient permits to be fully compensated for the first five-year period. According to Bohm and Carlen (1999), nine of seventeen developing countries asked whether they would join said they would. Having more countries enter trading is advantageous to all countries. As new countries enter, there would be new lower cost-abatement opportunities, which lowers the price of permits and the cost of emission limits for Annex B countries. The joining countries benefit from having a commodity to sell to increase their export earnings. All countries benefit from greater levels of the public good, viz., diminished costs of climate change.

Participating countries must decide how they will allocate their allotted permits domestically. A popular approach will probably be to use the international tradable permits in a domestic tradable permits system. Thus, a country accepts its permits and either gives them away or auctions them off to domestic emitters. The domestic firms then hold or trade the permits as they would permits for other pollutants such as SO_2. If the domestic firms are allowed to trade the permits in the international market, this would mean many more traders in the market, which would ease the fears of market dominance in the international market by the United States, the largest emitting country.

V. Conservation

Integrated resource planning (IRP) became a widespread practice for electric utilities in the United States during the 1980s. Kahn (1992) depicted it as one of the two major industry

developments in the decade, the other being the advent of competition. IRP pertains to minimizing the cost of electric energy needs, where cost includes not only the usual production cost associated with whatever technologies are adopted, but also the cost of externalities and conservation.

Conservation practices are also referred to as demand side management (DSM). DSM encourages consumers to cut back on their use of electricity through conservation, thereby reducing the need to construct and operate new generation facilities, and DSM is often considered a resource in the same way that new new generation facilities are.

Public utility commissions (PUCs) have been active in promoting DSM. Twenty-one states were providing some sort of incentive for DSM to utilities at the start of 1993 when IRT Environmental, Inc. (http://solstice.crest.org/efficiency/irt/) reported that hundreds of utilities were running thousands of DSM programs in North America.[7] Although a wide variety of programs were employed, most relied on incentive instruments since PUCs confronted a tradeoff in making DSM attractive to utilities on the one hand and consumers on the other hand.

A utility's disincentive to participate in DSM was rooted in traditional rate-of-return regulation and the utility's role as a supplier of electricity only. A utility was unlikely to promote programs that reduced demand for its core product. During the period after a regulatory hearing, the utility's price of electricity was fixed at a level that typically exceeded the marginal operating cost of production. A successful conservation program reduced sales of electricity, thereby

[7] But DSM has been controversial. One controversial aspect is the effectiveness of DSM, with estimates showing a wide range. For divergent views and measures, see Fickett, Gellings and Lovins (1990) and Joskow and Marron (1992). Critics argue that investment in conservation is better left to the marketplace unless there is compelling evidence of market failure. If evidence of failure exists, then DSM programs should address the failure directly instead of promoting broad-based DSM programs that are often misguided and ineffective. See, for example, Hirst (1989), Kahn (1992) or Costello (1992). Wirl (1995) emphasizes that DSM is risky under price caps because of strategic behavior and inefficient under rate-of-return regulation because of overinvestment incentives.

reducing the utility's profit. Because the utility's profit rose and fell with sales and because conservation dampens sales, the utility had a strong disincentive to participate in DSM.

Utilities have since repositioned themselves as multiproduct suppliers, with electricity at the core of related electric services, but regulators responded to utilities' initial disincentive to promote conservation with a variety of programs that can be characterized by their use of the following three instruments: 1) a direct charge for conservation, 2) a promotional or marketing plan, and 3) a transfer scheme. The first instrument allowed the utility to charge consumers for conservation. This represented a significant shift in emphasis because the utility entered the business of selling conservation in addition to electricity. Depending on the cost of supplying conservation and the price charged, a utility could increase profit through conservation sales. In practice, the conservation price was usually set by PUCs and could be as low as zero. Therefore, whether the price instrument was effective in removing the utility's disincentive to sell conservation depended on the specific DSM program.

The second instrument was the marketing plan. PUCs were very explicit in dictating what the utility must do to promote conservation. A plan might include advertising, energy audits, education and measurement of savings. Marketing plans were thought to be important because of the possible market failures that discouraged consumers from investing in cost-effective conservation. Lack of knowledge, lack of access to credit and the tenant/landlord relationship were cited as sources for possible market failures.

The third instrument was a transfer scheme. The term "transfer" is used broadly here to represent any scheme wherein the utility raised revenue from some source other than the price charged for conservation. The utility stood to lose profit if its electricity sales decreased, if it sold

conservation below cost, or if it expended resources on a marketing plan. To ensure that the utility was able to maintain the rate of return set at the most recent hearing, a transfer would be necessary.

Transfers took a variety of forms. Some regulators permitted a surcharge on the price of electricity while others used a flat, per-customer charge to recover the cost of conservation. Direct government transfers, while popular in the economics literature on incentive schemes, are rare in the United States. Another form of transfer was decoupling, wherein the utility's revenue was decoupled from actual sales. The revenue received by the utility was fixed at its expected level in the absence of any conservation. With the revenue fixed, the reduction in electricity sales attributable to conservation did not reduce the utility's profit. California has used a form of decoupling, the Electric Rate Adjustment Mechanism (ERAM), and Maine, New York and Washington have used other forms of decoupling.

One might expect that because conservation efforts were ongoing for more than a decade, PUCs would have honed in on the optimum combination of the three instruments. Instead, across the United States, regulators continued to use varying combinations of these three instruments. This suggests that the optimum combination may vary across regulatory jurisdictions with the parameters that characterize the jurisdictions.

DSM practices encouraged by PUCs in 1996 produced 61,800 gigawatt-hours of savings (a 2% savings) and a 29,900 gigawatt-hours decrease in peak demand at the zenith of traditional DSM (Energy Information Administration, 2000, p. 75). However, today the situation has changed. The electric industry is undergoing significant restructuring, and conservation has taken a back seat to questions about competitive generation markets, alternative forms of regulation, supplier of last resort, and so on. DSM expenditures by utilities declined steadily in the 1990s as

the electric industry moved to more competition. This has happened in spite of the President's Climate Change Action Plan of 1993 that stipulated energy efficiency as the most cost-effective way to reduce CO_2 emissions (Meyers and Hu, 1999).

Some initiatives in the United States encourage continued conservation. Sixteen states, including California and New York, have established public benefit charges to be levied on electric distribution companies. The revenues are used to fund energy efficiency, renewable energy, research and development and low-income assistance (Eto et al., 1998). A similar charge has been proposed at the national level as well in the Comprehensive Electricity Competition Plan (Department of Energy, March 1998). According to Meyers and Hu (1999), the states see it as a tradeoff: they exercise less regulatory oversight in the generation and transmission stages of vertically integrated firms while collecting the benefits fee on distribution.[8]

In the U.S.A., the ongoing California "energy crisis" that resulted in brown and black outs has brought conservation and the search for new supplies to the forefront. Interest groups and the public have pointed their fingers in many directions when arguing about what caused the crisis. Was the deregulation of generation poorly designed and too quickly implemented? Was it the drought conditions in the Pacific Northwest that prevented that region from exporting hydro power? Was it lifting price controls on wholesale rates while the retail rates remained regulated, resulting in large utility losses? Did environmental groups prevent the construction of new power plants in the state? Whatever the cause, the future of industry in California may be a sign for the structure of the industry elsewhere.

[8] In the United Kingdom, a tariff containing a "fossil fuel levy" is used by electric suppliers to support the use of renewable energy sources. (See McDaniel, 2000.)

With respect to the supply side, what seems certain is that the mix of generation will gradually change from heavy reliance on coal to heavy reliance on natural gas. New technologies allow relatively small gas fired plants to be competitive with large coal units. Relying on natural gas will greatly reduce SO_2 and NO_x emissions, although carbon emissions will remain a problem. With respect to conservation, one very promising possibility is real-time pricing wherein consumers can respond instantly to price changes. If environmental damages are built into those prices, then the incentives that consumers will have to conserve may be more effective at promoting conservation than traditional DSM programs.

VI Developing Countries

As developing countries increase their productivity and enjoy higher living standards, the energy and communications industries will be key sectors. Therefore, devising sound regulatory policies is an important component in devising sound economic policies in general. However, "national and international economic policy has usually ignored the environment" (Arrow, et al., 1995, p. 520). The demonstrations at the 1999 World Trade Organization meetings in Seattle illustrate the depth of concern among some groups that international agreements do not take into account environmental and natural resource issues.

One justification for ignoring environmental problems when promoting economic growth is the professed relationship between growth and environmental quality. As a country's per capita income rises, there is a deterioration of the environment up to a point, followed by improvements. The explanation seems obvious: for people who live in grinding poverty, environmental amenities are luxury goods. These people must attend to the basics, including where their next meal will come from. Only when they achieve a more comfortable standard of

living can they begin to devote resources to protecting the environment. This inverted U phenomena has been shown to apply to sanitation, water supplies and SO_2, NO_x and CO (Grossman and Krueger, 1993). However, to conjecture that the inverted U applies to environmental quality more generally is misleading. Raising living standards is neither sufficient to promote environmental quality in general, nor sustainable if the earth's natural resource base, which makes possible the improved living standards, is sufficiently depleted (Arrow, et al., 1995). In other words, while the inverted U may apply narrowly, it says nothing about accumulations of stocks of waste such as CO_2, depletion of natural resource stocks, or how the gains in one country may be at the result of exporting pollution to another country.

The concern that economic growth and environmental preservation may be at odds with one another has spawned a vast literature on sustainability, a concept that is universally accepted, perhaps because nobody knows what it is. Different groups paint their own picture of what it is. The most quoted definition is from the Bruntland Commission. Sustainable development "…meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (World Commission on Environmental and Development, 43:1987).

Of course, as we embark on this new millennium, the needs of present generations are not being met in many developing countries. Understandably, these countries want a better standard of living, with affordable food, shelter and clothing, not to mention the good life enjoyed by many people in the developed countries. To achieve this goal requires greater productivity, which, in turn, requires more energy use. The largest countries, China and India, are typical. Their current energy consumption is small per capita, and they want to increase this usage, largely through burning more coal. China, for example, is the second largest emitter of GHGs

after the United States, but its per capita emissions are one-seventh that of the United States. If China alone among the developing countries consumed as much energy per capita as the United States, using current technologies, then the world's emissions would more than double what they are today. Yet to ask developing countries to follow a different energy path than the ones pioneered by developed countries promotes such responses as "What they [developed nations] are doing is luxury emissions, what we are doing is survival emissions" (Huber and Douglass, 1998).

The problem is that the traditional models of economic growth pursued by developed countries may be inappropriate for developing countries because the economic activity needed to eradicate poverty may also eradicate ecosystems and deplete the natural resources needed to sustain the activity. According to Tietenberg (1998), the former director of the World Commission on Environment and Development, Jim McNeill, put it this way, "If current forms of development were employed, a five- to ten-fold increase in economic activity would be required over the next fifty years to meet the needs and aspirations of a population twice the size of today's 5.2 billion, as well as to begin to reduce mass poverty." And Tietenberg (1998) states:

> "Whether increases of this magnitude could be accomplished while still respecting the atmosphere and ecological systems on which all economic activity ultimately depends is not at all obvious. Increased energy consumption to support new industry would add GHGs. Increased refrigeration would add more of the gases depleting the stratospheric ozone level. The industrialized nations have freely used the very large capacity of the atmosphere to absorb these gases. Little absorptive capacity is left. Most observers seem to believe that in order to meet the challenge, we need to take an activist stance by controlling population, severely reducing emissions of these gases in the industrialized world, and discovering new forms of development that are sustainable." (p. 404)

If the carrying capacity of the planet cannot be sustained with the business-as-usual approach to economic development spread over all countries, what is the alternative? Certainly emphasizing human capital in developing countries is important both for productivity increases

and quality of life. At the same time, environmental policies should be integrated with general economic and regulatory policies at the outset, and not relegated to a side street to be run out only after significant and even irreversible environmental damage has been done.

For the electric industries, the first challenge is to get the prices right. The price of power should reflect the true social cost (production cost plus environmental damage cost) of delivering the power to consumers, and this can be accomplished best through either charges for emissions or tradable permits as outlined in Section III. To be sure, internalizing externalities would lead to higher prices, which is seemingly a cruel prescription in countries where prices are already beyond the reach of many citizens. But making electricity affordable at the expense of environmental degradation is also a cruel prescription because the burden of such degradation often falls disproportionately on the poor. If greater electricity penetration is a social goal, then aiding the poor through low-income electricity subsidies made available through taxes on a more efficient electric sector is a better remedy.[9]

In addition, consumers should take advantage of conservation that is cost-effective, and the best incentive to get consumers to conserve is higher energy prices, which will follow if the price of power reflects the true social costs. Finally, all countries should participate in CO_2 trading so that all countries can take advantage of the lowest cost methods for reducing emissions.

This latter strategy does not appear to hold enough direct benefit for many developing countries to obtain their participation, but there may be ways to provide incentives. For example, consider that the Annex B countries will be trading CO_2 permits among themselves. After some time, the price of these permits can be expected to settle at some stable level that reflects the opportunities for low-cost abatement in these countries. If the developing countries do not join

in, there will be more emissions and climate change than is desirable worldwide, which harms all countries, and some of the lower cost abatement opportunities in the developing countries will not be utilized. However, if developing countries do participate, the Annex B countries would benefit by the lower permit prices that would follow as lower cost abatement techniques are used. Consider, therefore, the following proposal, which would provide incentives to developing countries to join the Kyoto initiative:

> *Following entry of the developing countries into the permit system, the Annex B countries commit to transferring all of the benefit from lower permit prices to the developing countries with the stipulation that this transfer be used for investment in renewable energy.*

The result would be that the developed countries would be financially no worse off than when the developing countries did not participate, developing countries would have permits to trade and subsidies available to invest in non-polluting renewable energy, and all countries would be better off because overall there would be fewer emissions and a more rapid move away from fossil fuels.

VII. Final Word

As developing countries privatize their utility industries and developed countries restructure their utility industries, the former are in a position to adopt regulatory policies and incentives mechanisms based on the new models that the latter are discovering. In other words, developing countries do not have to follow the same path as developed countries did with traditional regulatory models; instead, developing countries can jump directly to the new forms of regulation that developed countries are moving toward.

The same strategy can be followed with environmental issues. Developing countries need not pursue the same path the developed countries followed for years, one of largely ignoring

[9] Noll (2000) makes this argument in the context of the telecommunications industry in developing countries.

environmental problems; instead, they can pursue sound environmental policies similar to those that are finally finding their way into the agendas of developed countries. All countries will enjoy the resulting benefits.

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