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THE WORLDWIDE STRATEGY IN LAWS AND REGULATIONS FOR THE CONTROL OF ENVIRONMENTAL POLLUTION CAUSED BY COAL FIRED POWER PLANTS

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The major purpose of this Second International Seminar on Coal and Energy is to share information about how to improve the quality of the environment even as we continue to use coal to produce energy. In this part of the seminar, I hope to explore first, the evolving environmental concerns that prompt emissions controls on coal-fired power plants and, second, to provide an overview of the range of policy tools that governments are using or considering in the effort to address those environmental concerns.

I. ENVIRONMENTAL CONCERNS UNDERLYING CONTROL OF EMISSIONS FROM COAL-FIRED POWER PLANTS

The regulation of emissions from coal-fired power plants is a story that is still unfolding. Early laws in the 1950's dealt with the most obvious problems caused by the use of coal -- smoke or plume blight. Later, in the 1960's and 1970's, individual nations began to take steps to deal with the less obvious problems that result from burning fossils fuels, such as acid precipitation and ozone formation. Understandably, the international community as well grew increasingly interested in taking action against the air pollution that crosses national boundaries, in particular, that group of pollutants that contribute to the formation of acid rain. More recently, on a local and regional level, there are signs that controls may be put in place to reduce the relatively small amount of air toxics produced by coal-fired power plants. In addition, the focus of control efforts is no doubt shifting toward controlling emissions of carbon dioxide (CO_2) that are believed to affect not simply nations or regions but the climate patterns of the entire globe. Below, we discuss, briefly, trends in coas use and then discuss the environmental goals that policy makers are attempting to attain

through emission controls. In the course of that discussion, we attempt to recognize that there are varying degrees of consensus about the need to control different types of emissions from coal-fired plants.

A. Coal is an important natural resource that will certainly continue to play a role in worldwide energy production.

During the 1980's, the annual average growth rate of energy production was 1.9 percent.[1] During that same period, total world consumption of coal remained steady, representing about 27 percent of the world's primary energy consumption.[2] World consumption of coal in 1988 exceeded 92 quadrillion Btu.[3] China and the United States accounted for approximately 21 and 20 percent, respectively, of the total, followed by the former U.S.S.R. at 15 percent. Other major consumers of coal included Poland, India, South Africa, and West Germany.[4]

While not universally the case, coal continues to play a particularly important role in energy production. In the U.S., the United Kingdom, Denmark, and Germany, for example, coal is used to generate over fifty percent of each country's electricity. The simple fact is that despite concerns about the environmental effects of coal use, nations cannot afford to ignore indigenous fuel supplies that may be both plentiful and inexpensive to mine. Moreover, the continued use of coal is in part due to that fact that commercially valuable deposits of coal are found on nearly all continents. Total reserves of anthracite, bituminous,

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[1] International Energy Annual 1989, Energy Information Agency, DOE/EIA-0219(89), February 1991, at ix.

[2] Id. at p. 118.

[3] Id. at p. 69.

[4] Id.

and subbituminous coal are estimated to be about 8.1 trillion metric tons, of which 1.1 trillion tons are known to exist.[5] Of this total, 430 billion metric tons are thought to be recoverable by standard mining techniques. In 1988, the U.S. produced 862 million tons of coal, China 849 million tons, the USSR 585 million tons and Poland 213 million tons. By and large, production follows proven recoverable resources wherein the U.S., the former USSR, South Africa, Australia, Germany, and, again, Poland possess respectively the most reserves. Interestingly, despite the fact that the U.S. produced over one billion tons of coal in 1990, Australia, not the U.S., proved to be the largest world exporter of coal.

B. High level of consensus on the need to mitigate harm caused by emissions of SO_2 and NO_x: forests, water, human health and manmade structures.

Among the most common air pollutants emitted from coal-fired power plants obviously are sulfur dioxide (SO_2) and nitrogen oxide (NO_x). For example, in the OECD countries it is estimated that coal combustion contributes 80 percent of energy-related releases of SO_2, while stationary sources contribute 49 percent of energy-related releases of NO_x.[6] Most nations have taken at least some steps to reduce emissions from a range of sources, including coal-fired power plants. In large part, these efforts have been motivated by evidence that SO_2 and NO_x emissions contribute to a range of environmental problems when SO_2 and oxides of nitrogen are chemically converted into acid rain. While debate

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[5] Figures supplied by the National Coal Association (United States), 1991.

[6] Energy and The Environment: Policy Overview, International Energy Agency, Paris, France, Table I, Importance of Energy Activities in the Generation of Air Pollutants, 26 (1989). The International Energy Agency (IEA) is an autonomous body which was established in November 1974 within the framework of the Organization for Economic Co-operation and Development (OECD) to implement an international energy program.

continues in the scientific community about the degree of harm acid rain causes, there appears to be an international consensus, at least on the part of policymakers, that reductions must be made in SO_2 and NO_x emissions to deal with several confirmed and disputed problems:

- the loss of fish in lakes because of the acidity of surface waters, first noted in Scandinavia;[7]
- the effect of acid rain and air pollution on trees and forests;[8]
- the corrosion of historic buildings in urban areas;[9] and,
- suspected effects of acid mists on human health.[10]

During the early 1970's, the Organization for Economic Cooperation and Development (OECD) served as the principal international forum for research, publicity and the development of policy principles and recommendations to deal with acid rain.[11] The OECD, however, lacked legal mechanisms for implementing policies.[12] Further

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[7] Boehmer-Christiansen & Skea, Acid Politics: Environmental and Energy Policies in Britain and Germany, 36 Belhaven Press, London, (1991).

[8] "Acid Rain, Air Pollution, and Forest Decline," Environment and Natural Resources Policy Division, Congressional Research Services, Library of Congress, 1 (Oct. 12, 1990).

[9] "This Common Inheritance: Britain's Environmental Strategy," Presented to Parliament by the Secretaries of State for Environment et al. at 148 (Sept. 1990).

[10] "Clean Air Act Amendments of 1989," Report of the Comm. on Environment and Public Works, U.S. Senate, 101st Cong. 1st Sess., Rep. No. 101-228 at 279 (Dec. 20, 1989).

[11] Boehmer-Christiansen & Skea, Acid Politics, at 25.

[12] Id.

international cooperation was believed necessary and, in fact, developed through the 1979 United Nations--Economic Commission for Europe (UN-ECE) Convention on Long-Range Transboundary Air Pollution wherein 34 nations from Western Europe, Eastern Europe and North America promised generally to reduce emissions and use best available control technology, where economically feasible.[13] Later within the framework of the convention, a number of countries committed to at least a 30 percent reduction in SO_2 emissions in their transboundary fluxes by 1993 compared to the 1980 level (i.e., the 1985 Helsinki Accord) and to make reductions in NO_x emissions under the 1988 Helsinki Accord. A selected review of various national and transnational responses to these acid rain concerns shows that:

> [C]ountries have developed different strategies and policies for the abatement of air pollution from stationary sources. The main methods have been ambient air quality standards, fuel quality standards and emission standards. The latter involves either setting maximum permissible quantities for emissions (such as SO_2, NO_x, and particulates) by facility type or requiring the use of best available control technologies. Some countries have switched to high-sulfur coal, gas or nuclear to diminish SO_2 emissions.... Some countries have set long-term objectives to limit deposition of acid air pollutants, either nationwide or in specified areas[14]

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[13] Id.

[14] Emission Controls in Electricity Generation and Industry, International Energy Agency, III-1 (1989).

These measures, and those outlined below, illustrate a widespread belief in the environmental impact of acid precipitation and the need for increasingly tougher pollution control programs. With respect to NO_x, there is a recognized need to reduce emissions to help control ozone formation. Since, however, automobiles and trucks often represent the single largest source of NO_x, controls on coal-fired power plants for ozone control purposes are not always a primary focus of policymakers.

1. European Efforts

In response to the environmental concerns mentioned above, the 1988 Council of European Communities Directive on Large Combustion Plants established ambitious reduction targets for SO_2 and NO_x reductions at plants of over 50 Megawatts (MW).[15] By 2003, overall emissions of SO_2 in the EC countries are to decline by 58 percent, while NO_x emissions are to decline by 40 percent. Generally, new plants in EC countries will have to rely upon best available technology ("BAT") for reducing NO_x, SO_2 and PM-10.

Consistent with the EC Directive, Britain -- in which over 70 percent of SO_2 emissions come from power plants -- has taken 1980 emission levels as its baseline and made a legally binding commitment to reduce emissions from existing plants by 20 percent in 1993, 40 percent in 1998 and 60 percent in 2003.[16] In addition, Britain will rely to a degree on low-Nitrogen oxide burners to reduce NO_x emissions from existing plants 15 percent by 1993

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[15] Council on European Communities Directive on the Limitation of Emissions of Certain Pollutants into the Air from Large Combustion Plants, 24 November 1988 (88/609/EEC-OJ L 336, 7 December 1988).

[16] "This Common Inheritance: Britain's Environmental Strategy," at 149.

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and 30 percent by 1998.[17] Over the next decade, Britain will invest over 6 billion pounds in control equipment for old and new plants to meet these commitments.[18]

Germany is considered one of the "green" states of Europe[19] based upon the fact it has imposed comprehensive and stringent environmental controls on emissions of SO_2 and NO_x from energy sources, including coal-fired power plants. German law generally requires sources to install best available technology to control emissions. Regulations implementing the law establish ambient air quality standards and emission limits for existing and new power plants.[20] Using a command and control approach, each power plant must adhere to the applicable standard. As noted by one set of authors, "[t]he German air-pollution control system is considerably more legalistic, with requirements specified in great detail for a limited number of largely technological objectives."[21] The Federal Immission Control Act of 1974 establishes the general framework under which the Federal government could, through the Federal Interior Ministry, establish regulations for controlling emissions, including those from coal-fired power plants.[22]

For example, SO_2 emissions have been regulated under the Large Firing Installation Regulation of 1983, which requires units larger than 300 MW to install flue gas

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[17] Id. at 150.

[18] Id. at 149.

[19] Boehmer-Christiansen & Skea, Acid Politics, at 287.

[20] Technical Instructions on Air Pollution Control (TA Luft) 1974, 1983 and 1986.

[21] Boehmer-Christiansen & Skea, Acid Politics, at 179.

[22] BImSchG.

desulfurization (FGD) devices capable of 85 percent removal of sulfur dioxide, and units with 100 to 300 MW capacity to install partial FGD devices.[23] Under this regulation, existing units must have been retrofitted by 1988; those units which were not retrofitted due to costs or age must be phased out by 1993. Not surprisingly, the use of FGD is significant in Germany -- for 40 percent of Germany's existing coal capacity, FGD is under construction or already in place.[24] Germany's efforts to control SO_2 have largely been successful; by 1990, electricity producers had exceeded the goal of obtaining a 75 percent reduction by 1993.[25]

Unlike their counterparts in the United States, German power producers must rely upon selective catalytic reduction (SCR) for the control of NO_x. Germany's NO_x limitations, the strictest in Europe, make the use of SCR essential.[26] These strict standards were established by Permanent Conference of Lander Ministers (representatives of the states of the Federal Republic) in 1984. The Ministers tightened the standards for new large plants (over 300 MW) and required existing plants to meet those standards at the earliest date possible.[27] By 1993, SCR technology is slated to be installed on 30,000 MW of hard coal-

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[23] International Energy Agency, Emission Controls, Annex 2.

[24] Id.

[25] By 1988, FGD had been installed on 26,000 MW of hard coal-fired capacity and 10,000 MW of brown coal-fired capacity. On the other hand, 12,500 MW of small hard and brown coal-fired capacity had been shut down. Boehmer-Christiansen & Skea, Acid Politics, at 200-201

[26] International Energy Agency, Emission Controls, Annex 2, Table 2.

[27] Id.

fired capacity.[28] On the other hand, brown coal-fired facilities may use combustion modification techniques or devices to reduce emissions of NO_x.[29] As the result of these efforts, Germany expects a 70 percent reduction in NO_x from utilities.[30]

Poland, of course, has established priorities that would reduce SO_2 emissions by 30 percent as compared to 1980 levels and reduce NO_x emissions by 10 percent. Other eastern European nations, such as Hungary and Czechoslovakia, have or are considering similar goals given that they face serious air pollution problems caused by SO_2, NO_x and particulates. As you know may know, 44 percent of Hungary's population (including 65 percent of city dwellers) is exposed to such pollution (Orosz, 1990). Thus, for example, Hungary has committed itself to reducing air pollution at existing power plants through modifications and imposing tougher standards on new plants.[31]

By some measures, past European efforts to reduce emissions of NO_x and SO_2 have paid off. For example, the Final Report on the Second Phase of the Dutch Priority Program on Acidification, released this year, reports that acid deposition in the Netherlands decreased by nearly 30 percent between 1980 and 1989 as a result of the general decrease in European SO_2 emissions.[32] According to some critics, however, past and current efforts

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[28] Boehmer-Christiansen & Skea, Acid Politics, at 200.

[29] Id.

[30] Id at 201 (citing Financial Times Business Information (26 May 1988), Power in Europe, No. 25).

[31] Draft of Proposals and Projects for Future Cooperation in the Environmental Sector, Ministry for Environment and Regional Policy, Republic of Hungary, Budapest, Appendix C (January 1991).

[32] [14 Current Reports] Int'l Env't Rep., No. 8, April 24, 1991, at 231.

are insufficient to remedy the continent's air pollution problems. The International Institute for Applied Systems Analysis' six year study on acid rain in Europe concluded that parts of central Europe were well in excess of acceptable acid deposition loads, that current European emission goals are inadequate, that the effects of acid rain could be stabilized by reducing SO_2 emissions by 60 - 80 percent (even as efforts to reduce NO_x emissions from nonpower plant sources continue), and that Eastern and Central Europe will need financial and technical assistance to undertake such changes.[33] The United Nation's efforts to update the Helsinki Protocols on SO_2 and NO_x reductions by and large, reflect these goals and the question may only be one of determining how each European nation will meet yet more ambitious reduction goals.[34]

2. North America

In 1980, the U.S. Congress established the National Acid Precipitation Assessment Program ("NAPAP") to conduct a comprehensive 10-year research program to determine whether additional emission controls were necessary to address concerns about acid rain in the U.S. and Canada. NAPAP's Final Report was due in 1990. The U.S. Congress and the President, however, decided that the effects of SO_2 and NO_x emissions were so clear that there was no need to delay action in the U.S. any longer. Thus, Congress passed and President Bush signed into law the Clean Air Act Amendments of 1990.[35] The general contours are as follows: the title is designed to reduce annual emissions of sulfur dioxide in

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[33] Id. at No. 10, 286-7.

[34] Id. at No. 12, 326.

[35] Clean Air Act Amendments of 1990, S. 1630, 101st Cong., 2nd Sess., 104 Stat. 2399, P.L. No. 101-549.

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the 48 contiguous United States by ten million tons from 1980 emission levels. With respect to nitrogen oxides, the Act's goal is to reduce emissions by approximately two million tons from 1980 emissions levels. Under the Act, emissions of SO_2 are ultimately controlled so that emissions from all utilities do not exceed an annual aggregate of 8.9 million tons. To accomplish this goal, the Act provides a two phased program of reductions. For purposes of Phase I, the Act identifies 107 high emitting units -- those emitting over 2.5 pounds of sulfur dioxide per mmBtu of fuel heat input -- and mandates that by January 1, 1995, annual sulfur dioxide emissions from these units be reduced by approximately 2.5 to 4.5 million tons. The emissions limitations in Phase II, on the other hand, capture virtually every steam-electric utility unit in the 48 contiguous United States and effectuate the 10 million ton reduction in annual sulfur dioxide emissions. Under the Phase II program, after January 1, 2000, utility units may emit no more than 1.2 pounds of sulfur dioxide per mmBtu.[36] In general, affected utility units in the United States during Phases I and II will have new emissions limitation obligations, monitoring and reporting requirements, permitting requirements, allowance allocations, and, excess emissions liabilities. Given the extended period over which reductions will occur, and the fact that science cannot now accurately predict the effects that result from source-specific emissions reductions of sulfur dioxide and nitrogen

[36] Under the new U.S. allowance trading program, individual units will be permitted to emit in excess of the 1.2 pound limit if the unit holds sufficient allowances. Moreover, units that employ designated clean coal technologies would be eligible to obtain an extension beyond the Phase II deadline -- to December 31, 2003. Clean Air Act Amendments of 1990, Conf. Rep. to Accompany S. 1630, No. 101-952, 101st Cong., 2d. Sess., Title IV, Section 409 (Oct. 26, 1990), 42 USC 7651h.

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oxides, the success of the U.S. program will undoubtedly remain an open questions for some time.

3. Asia

Japan has not to date experienced an acid rain problem, in part, because it has for a relatively long period had a system of stringent controls in place under the Japanese Air Pollution Control Act enacted in 1968.[37] Controls are established on the basis of the air quality in a number of polluted and unpolluted regions for both NO_x and SO_2.[38] Most existing coal fired plants and all new facilities are scrubbed and more than half of the coal fired facilities are equipped with SCR.[39] Despite these strict controls, Japan may in the future face an acid rain threat from Chinese and South Korean emissions of SO_2. That fact illustrates why nations have looked to international bodies and agreements to limit transboundary pollution, for Korea itself views Chinese emissions with alarm.[40]

C. Growing concern over emissions of air toxics (metals and the like).

Some have labelled toxic trace emissions as "nontraditional" pollutants because, unlike SO_2, NO_x, CO, and lead, toxic trace emissions from coal-fired plants have neither been extensively studied nor widely regulated.[41] As you know, however, the combustion of

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[37] Emission Standards for Major Air Pollutants from Energy Facilities in OECD Member Countries, OECD, Paris (1984) p. 18.

[38] International Energy Agency, Emission Controls, Annex 2.

[39] Id.

[40] Int'l Env't Rep. (BNA), Ref. File, South Korea, 288:0101 (Nov. 1990).

[41] The State of the Environment, OECD, 42 (1990).

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coal produces these trace emissions of toxic pollutants. These pollutants can cause birth defects, cancer, hormonal disturbances, and reproduction problems. Utility plant emissions of such substances fall into two major categories: solids found in the flyash portion of the flue gas (like manganese and nickel) and gases vaporized by the high temperature of the flue gas (like hydrochloric acid). The trace metal content and percent ash levels may vary greatly among coals from different regional areas, different mines within a particular region, and different coal seams within a particular mine.

Existing controls may or may not be effective in reducing emissions of air toxics. For example, in the U.S. particulate emissions are regulated by that nation's Environmental Protection Agency and the individual states by limitations on opacity, or density of smoke, and emission rates in lbs/mmBtu. Generally, in order to meet these standards, utilities install electrostatic precipitators with a particulate collection efficiency of ninety-nine percent, which may help reduce significantly trace emissions of air toxics. On the other hand, Czechoslovakian power plants burn brown coal that has a high arsenic sulfide content, and even when a plant has electrostatic precipitators it is capable of emitting a half a ton of arsenic daily (Tichacek & Cikrt, 1990).

Recently, in the U.S., there was intense and bitter debate over whether that country's new Clean Air Act should require further removal of air toxics at coal-fired power plants. Earlier in this decade, the U.S. Environmental Protection Agency had considered the question of whether additional regulation of power plants was necessary to control air toxic emissions in order to protect public health. The U.S. agency studied a number of compounds for which emissions data and some indicator of chronic toxicity exist: arsenic,

beryllium, cadmium, hexavalent chromium, formaldehyde, and radionuclides. The U.S. EPA generally found that with regard to these compounds additional regulation of power plants was unnecessary.

Many in the U.S. disagreed with the EPA's conclusion. Advocates of control pointed out that by virtue of the immense quantity of fossil fuel that must be burned to produce electricity -- several million tons of coal per year for a large coal-fired plant -- aggregate emissions of all such pollutants at a typical plant could well exceed 25 tons per year and, thus, make the power plant a "major source" of pollutants under the bill the U.S. Congress was considering. Of particular concern were emissions of mercury from coal-fired power plants. (Industry had estimated that for an average size electric coal-fired generating unit of 500 MW, about 340 pounds of mercury is emitted annually.) Given deep concerns about air toxic emissions, and mercury in particular, U.S. proponents of regulation argued that utility power plants should be subject to new emission standards -- requiring the installation of emission control devices beyond those required to deal with sulfur dioxide and nitrogen oxides.

In response, U.S. electric utilities argued that since there are no proven and reliable controls available for mercury emissions, the Clean Air bill, as originally drafted, would instead require the EPA to set a design equipment or work practice standard. This, they argued, could mean that utilities would be required to switch to burning natural gas or forced to install baghouses and lime injection technologies in a perhaps fruitless attempt to

control mercury emissions.[42] Forcing utilities away from abundant coal supplies or toward expensive controls without a complete and thorough scientific and technical rationale for controlling mercury emissions or other toxic emissions, utilities argued, would be the height of folly.

Given uncertainties about the availability of cost-effective controls and the lack of evidence about the contribution that utilities make to the creation of a human health problem, the U.S. Congress, in the end, decided that the U.S. EPA, over the next four years, should study air toxics emissions from utilities and the associated health risk. If a public health risk is found to exist, then the U.S. EPA must consider regulating these sources. Several OECD countries, by contrast, have passed legislation to limit emissions of individual trace pollutants that have been shown toxic.[43] Specifically, both Germany and Switzerland have required the use of best available control technology to limit such emissions.[44] On the whole, however, most nation's have not yet taken steps to monitor and control such emissions at coal-fired power plants. If any trend can be identified with respect to controlling these emissions, it would be that policymakers and the public will expect utilities to install controls, even if those controls do not hold the promise of completely eliminating all emissions of and risks from air toxics. Moreover, if the recent debate in the United

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[42] According to a utility industry sponsored cost study by Temple, Barker and Sloane, Inc., the capital cost of installing this control technology on U.S. facilities would be approximately $28.6 billion on a nationwide basis, while it would cost around $5.2 billion annually for those facilities to remain in compliance.

[43] The State of the Environment, at 47.

[44] Id.

States is any guide, this subject, when addressed, will prove contentious given the extremely high costs of control.

D. Relatively low level of consensus on the need to mitigate the greenhouse effects of CO_2 emissions.

A perhaps equally contentious issue is the "Greenhouse Effect;" and, just as concerns about acid rain helped determine the design of coal-fired power plants during the 1970's and 1980's, concerns about global climate change will likely shape the operation of coal-fired power plants in the 1990's and beyond. The reason is clear: the combustion of fossil fuel is the primary source carbon dioxide (CO_2) emissions, as well as other "greenhouse" gases. Moreover, coal combustion is a particular concern because of its high emission intensity (millions of tons of SO_2 produced per quadrillion BTu).[45] As you know, the "global" nature of the perceived climate change problem has stimulated a wide range of responses by environmental groups, national governments and international bodies.

Australia, Austria, Canada, Finland, Iceland, Japan, New Zealand, Norway, Sweden, Switzerland and the members of the European Community have committed to stabilizing CO_2 emissions by the year 2000. The Intergovernmental Negotiation Committee (INC), based upon the work of the Intergovernmental Panel on Climate Change (IPCC), is currently attempting to develop: 1) the necessary commitments for limiting and reducing CO_2 emissions and for protecting and enhancing CO_2 sinks, 2) the means of providing financial and technical support to developing nations, and 3) the legal and institutional mechanisms to enforce commitments. The third session of the INC was just completed in

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[45] "Global Climate Change," Congressional Research Service, Library of Congress, 4 (June 28, 1991).

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September and it appears that a framework for a convention will be ready in advance of the United Nations Conference on Environment and Development (UNECD) in June of 1992.

Proponents of preventative CO_2 controls have argued that industrialized nations should be prepared to reduce emissions by 20 percent to 50 percent from current levels within ten to twenty years.[46] Over time, the United States, the Soviet Union, Saudi Arabia and other oil producing nations have opposed specific targets and timetables for the reduction of CO_2 because of the scientific uncertainties about the nature of the problem, the questionable efficacy of reductions, and the high economic and social costs of controls.[47] Among the OECD countries, the U.S. and Turkey have not made commitments to stabilize or reduce emissions of CO_2. Instead, the U.S. will allow a 15 percent increase in emissions by the year 2000. Other nations have not been so reluctant, arguing that the uncertain state of the science should not be stand in the way of emission reductions immediately since the stakes for the environment are so high. Britain, for instance, has agreed to stabilize emissions at 1990 levels by the year 2005, while Germany plans to reduce emissions 30 percent by that same year.

Unfortunately, removing "greenhouse" gases after combustion is both difficult and expensive. Thus, policies designed to reduce emissions must rely upon increased energy efficiency, conservation, fuel switching, and renewable energy. Control proponents have

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[46] "Global Warming: The Debate - A Presentation on The Economic Debate: Preventative or Curative Action?," D.H. Perlman, The Royal Society, London, at 6 (March 7, 1991). The consensus recommendation of the 1988 Toronto global warming conference was for a 20% reduction compared to 1988 levels in human-sourced CO_2 emissions by the year 2005.

[47] The New York Times, November 5, 1990, at A5.

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suggested a number of means developing policies for reducing or offsetting CO_2 emissions that will be discussed below.

II. THERE ARE A RANGE OF POLICY TOOLS BEING USED TO CONTROL EMISSIONS FROM COAL-FIRED POWER PLANTS

If there is an emerging trend in the control of emissions from coal-fired power plants, it may be that there is growing sophistication in the approach that governments and international bodies are taking to limit emissions. The clearest contrast between the old and new is the movement from command and control toward the use of market incentives and tax policies. In part, innovative market and tax incentives/disincentives may be necessary because as mentioned CO_2 emissions are not as susceptible to traditional standard setting approaches. Below, we discuss generally the use of command and control, technology standards, marketable allowances or offsets, and, briefly, tax policies.

A. The most traditional approach is "command and control" in which uniform standards are promulgated by the government and adhered to by individual power plant operators.

1. Emission standards

As discussed initially, the earliest and still most common forms of air pollution control are requirements to install technology or to adhere to a particular emission rate. Thus, for example, most nations in Europe that have set emission standards have chosen 400 milligrams of SO_2 per normal cubic metre for existing facilities, and even stricter

standards for new facilities.[48] Adherence to these standards implies the use of technology capable of 85 percent to 90 percent removal, on par with flue gas desulfurization.[49] Similarly standards have been put in place for the control of NO_x emissions in both Europe and the U.S. The United States' new Clean Air Act established standards designed to achieve emissions reductions through the application of low-nitrogen oxides burner ("LNB") technology to wall-fired and tangentially-fired steam electric coal-fired utility boilers through a traditional command and control approach.[50] Poland, of course, has set a range of permissible limits on SO_2, NO_x, and dust emissions from coal-fired facilities depending upon the age of the facility and the type of coal used at the facility.[51]

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[48] International Energy Agency, Emission Controls, at III-6.

[49] Id.

[50] One of the major points of contention in the U.S. Congressional debate was whether utilities ought to be required to do more than install low nitrogen-oxide burners. The President's original proposal to the Congress contained an approach to NO_x reductions required utilities to control NO_x emissions through the use of "technology at the performance level of low NO_x burners." Various generations of low NO_x burners (LNB) have been and are being commercially developed and demonstrated for many types of boilers and appear to be a cost-effective and economical way to reduce NO_x emissions. The Senate bill sought to limit NO_x emissions from coal-fired utility boilers to specific numerical standards. It was argued that these standards could double the NO_x reductions sought by the Administration's bill and were so stringent that some sources would not be able to comply through the use of LNB technology. Instead, the use of selective catalytic reduction (SCR) technology could have been required. European experience with SCR did little to allay the concerns of U.S. utilities about the reliability and cost of SCR technology.

[51] Executive Order No. 92 of the Ministry of Environmental Protection, Natural Resources, and Forestry dated 12 February 1990.

2. Best Available Control Technologies

Emission standards, however, are often directly or indirectly determined by the availability of emission control technology, and there are a number of countries that employ so-called direct technology based standards, variously termed the best available, best practicable, or maximum available technology. The New Zealand Clean Air Act, for example, does not set fixed emission standards but requires the application of the "best practicable means" for reducing emissions.[52] This approach is in turn based on the British approach wherein the "best practicable means available" concept:

> ... takes into account a wide range of factors including potential environmental impact, available technology, cost and local circumstances. New BPM notes (or guidelines) for new plants over 700 MW^{th} were issued in 1988. These require 90% removal of SO_2 from flue gas.[53]

Similarly, Norway, in dealing with its few coal-fired facilities, imposes requirements on a plant by plant basis, requiring typically the installation of best available technology.[54] Once again, recent developments in the United States illustrate the extent to which technology based standards can be used to control air emissions.

Prior U.S. law required that nation's Environmental Protection Agency to list as a "hazardous air pollutant" any substance which could be reasonably anticipated to result in mortality or increase serious illness. Once a substance was listed as a hazardous air pollutant, the EPA under the Act had to establish an emission standard to protect the public

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[52] International Energy Agency, Emission Controls, Annex 2.

[53] Id.

[54] Energy and the Environment, at 40.

health.[55] In past years, the U.S EPA, however, had only listed eight such substances (mercury, beryllium, asbestos, vinyl chloride, benzene, radionuclides, inorganic arsenic and coke oven emissions) and issued air emission standards for seven of those.

Title III of the new U.S. Act, however, requires the EPA to list nearly 200 hundred specific substances as hazardous air pollutants and to regulate emissions of those substances through an initial technology-based regulatory scheme to be augmented by a subsequent standard based on health risk. As noted earlier, any facility that in the aggregate emits either (1) ten tons per year or more of any single pollutant or (2) twenty-five tons per year or more of any combination of pollutants would be a "major source" subject to regulation.[56] In addition, the Act permits regulation of an "area source," which it defines as any stationary source of hazardous air pollutants that is not a major source.[57] In the new program, the U.S. EPA will have to establish a list of all major sources of these pollutants and promulgate standards to achieve the maximum degree of reduction in emissions of each air pollutant, relying on the installation of the maximum achievable control technology ("MACT").[58]

Again, MACT or a similar concept may emerge as other nation's attempt to deal with air toxic emissions from coal-fired power plants. Essentially, MACT in the U.S. is the

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[55] Title III, Section 112(d)(1), 42 USC 7412.

[56] Title III, Section 112(a)(1), 42 USC 7412.

[57] Title III, Section 112(k), 42 USC 7412.

[58] As noted, earlier, during the course of the U.S. clean air debate, there was a heated controversy over whether or not electric utility boilers -- which emit a range of substances subject to control under the air toxics titles, including mercury -- ought to be subject to these MACT requirements.

highest degree of emission reductions mandated for a given group of source categories. The MACT standard can require a facility to utilize a wide range of control measures to reduce emissions. For example, a facility may have to install new control equipment, or achieve the necessary reductions through changing the materials being utilized, work practice changes, or, with process sources, tightening controls where leaks frequently occur. For new sources in the U.S. MACT is defined as a quality no less stringent than the emission controls achieved by the best controlled similar source. MACT is defined for existing sources as a standard no less stringent than:

1) For categories having 30 or more sources, the average emissions limit achieved by the best performing 12 percent of the sources; and

2) For categories having less than 30 sources, the average emissions limit achieved by the best performing 5 sources.

In determining the MACT standard for both new and existing sources, technological feasibility and cost are supposed to be considered.

It is generally agreed that fixed requirements for the installation of technology are a blunt policy instrument for controlling emissions. Such requirements may result in the installation of obsolete technology and often do not take advantage of cost effective reductions obtainable by "bubbling" emissions from two or more facilities and reducing emissions where it is the least costly. Concepts like MACT -- which is not a static standard and is supplemented by health-based residual risk standards -- may be used, however, to fill the gap between simple standard setting and market based approaches, especially when emissions are not easily controlled and, generally have more localized effects.

B. Emerging market approaches that allow sources to develop the most cost efficient means of reducing emissions on a national, regional or worldwide basis.

Beyond recent U.S. efforts to institute a market based approach to deal with emissions of SO_2, which will be discussed below, marketable pollution allowances, credits or offsets have been most widely discussed in the context of dealing with CO_2 emissions. In fact, the concept of CO_2 emissions credit trading was outlined in a report released by the IPCC last year, and it has been pursued with some vigor by Finland, Norway and Sweden.[59] The IPCC outline discussed a relatively straightforward system of tradeable emissions permits:

> An emission permit system is based on the concept that the economic costs of attaining a given environmental goal can be minimized by allowing for the trading of emission rights. Once an overall limit on emissions has been set, emission entitlement amounting to that limit could be provided to emitting sources and free trading of such entitlement allowed. This would reduce the costs of meeting a given emission target because: (a) as in trade, comparative advantages between trading entities would be maximized; and (b) economic incentives would be created for the development of improved greenhouse gas limitation technologies, sink enhancement, and resource use efficiency (energy conservation).[60]

Various U.S. policymakers, perhaps caught up in the excitement of that country's experiment with a SO_2 trading program, have embraced the concept of a CO_2 trading

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[59] Int'l Env't Rep., at 242.

[60] Overview and Summaries issued as a part of the IPCC First Assessment Report, 31 (August, 1990).

program. An influential report prepared with the sponsorship of two U.S. Senators called for the establishment of an international trading system for greenhouse gases.[61] In addition, the U.S. Congress may soon consider a more limited approach that requires new and modified sources to obtain "offsets" of their greenhouse emissions.[62] Under the proposal, a large coal-fired power plant, for example, would have to purchase offsets from a variety of sources that have actually gotten real reductions in CO_2 emissions through fuel switching, sink creation, or conservation and efficiency improvements. While this and other "allowance" proposals may be part of a trend toward the use of market approaches, they, generally, are subject to a number of criticisms:

- there is the noninherent problem that nations have limited experience with these policy instruments (which means there is no tested administrative structure);
- there are concerns about the potential scope and size of the trading markets;
- existing subsidies and tax incentives can distort a potential market;
- lesser developed nations may lack the resources to either produce or purchase allowances or offsets; and,
- distortions in the market -- hoarding or market cornering -- are possible.

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[61] Project 88--Round II, Incentives for Action: Designing Market Based Environmental Strategies (1991).

[62] S. 1323 and H.R. 2663, 102nd Cong. 1st Sess. (1991) The bills have the title "The Carbon Dioxide Offset Policy Efficiency Act" and were introduced in the U.S. House Representatives and U.S. Senate on June 18, 1991.

Many of these types of concerns were raised during the course of the U.S. debate over its new SO_2 trading program and, to a degree, were addressed. That program is perhaps the most fully developed market approach to controlling pollution. There are a number of features of the U.S. system that could be helpful in the development of trading schemes elsewhere. Below, we outline the nature of that system and point out some of the ways in which it was modified to take into account the concerns of competing interests.

1. U.S. example of marketable pollution allowances.

While the goal of the U.S. Acid Deposition program (Title IV of the new U.S. Act) -- to reduce emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x) -- is not novel, the marketable allowance system instituted in that title ties the U.S. electric utility industry together in entirely new ways. In the past, the various private electric companies may have shared common concerns about clean air regulations but, in the end, each electric utility faced the costs and consequences of clean air regulation alone. Under the regime established by the 1990 Act, a power producer in the United States may not be able to meet the emission reduction requirements without taking into account the plans and activities of other utilities or power producers.

2. The allowance system.

As noted earlier, emissions of SO_2 in the U.S. are ultimately controlled so that emissions from all utilities do not exceed the annual aggregate cap of 8.9 million tons (with each ton represented by one allowance). To comply with the Act, a U.S. power producer[63]

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[63] Under the U.S. Act, a "utility unit" that can be an "affected unit" (and, therefore, subject to the SO_2 cap and other provisions) is defined as a unit which serves as a generator that produces electricity for sale. Unless they opt voluntarily to participate in the allowance

will have a range of options: it can reduce or end utilization of a high emitting unit, install emission control technologies, switch to "cleaner" fuels, and/or rely upon the new allowance system to provide offsets for emissions at a facility. The only constant is that the power producer must hold emission allowances equal to the tons of SO_2 emitted from all of its units. Through the system of marketable allowances, the SO_2 reduction program is intended to maximize the range of choices that sources have in complying with the emissions limitation requirements. To reduce compliance costs and increase flexibility, electric utilities across the United States may in fact rely upon the sulfur dioxide emission allowance trading system to obtain additional allowances and, thus, meet the compliance goals of the Act.

3. What is an allowance?

An allowance under the program is an authorization issued to an affected source by the United States Environmental Protection Agency Administrator that permits the source to emit, during or after a specified calendar year, one ton of sulfur dioxide.[64] If a utility or power generator does not have any units eligible to receive emission allowances as "existing units," its new projects will have to obtain allowances from other sources in order to operate. New units may meet their obligations under these subsections of the Act by acquiring allowances from any source or person lawfully holding allowances anywhere in the country.[65]

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program, industrial sources of sulfur dioxide and nitrogen oxides will not have to reduce emissions in either Phase I or Phase II of the Acid Deposition program.

[64] Title IV, Section 402(3), 42 USC 7651b.

[65] Title IV, Section 403(e), 42 USC 7651b.

As noted, the Act specifies that an allowance is a limited authorization to emit, during or after a specified calendar year, one ton of sulfur dioxide.[66] Once created, an annual allowance does not expire until used. Thus, for example, an allowance allocated to an existing unit under the bill in 1996 could be "banked" and used to offset one ton of SO_2 emissions during the year 2001. While allowances are issued to the owners and operators of existing utility units, the Act specifically states that an allowance does not constitute a property right and may be limited or terminated, impliedly, without compensation from the government.[67] At the same time, allowance transfers are supposed to be designed to carry out the "full menu" of prerogatives enjoyed by parties to conventional commercial contracts in the U.S. In other words, parties will be able to transfer allowances between and among themselves through commercial arrangements such as leases, sales agreements, and exchanges of emission allowances for electric power or capacity. In fact, "ownership" of allowances by brokers, investors and other market makers is encouraged to maintain fluidity in the allowance market, to link buyers with sellers, and to facilitate rational price-finding.

4. How many allowances will a power plant have or need?

Existing utility units are allocated allowances in Phase I and Phase II. The Act establishes a "baseline" for each unit. Based upon a calculation of baseline fuel consumption and emission rates, each Phase I unit is allocated allowances in a table provided in the Act. The baseline is the annual quantity of fossil fuel consumed by an affected unit, measured in millions of British thermal units over a given period -- generally

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[66] Title IV, Section 402(3), 42 USC 7651a.

[67] Title IV, Section 403(f), 42 USC 7651b.

1985 through 1987 for most existing units.[68] The baseline is then multiplied by an emissions rate -- the 1985 emission rate for most existing facilities -- to yield the number of allowances to which a unit is entitled. In Phase II, allowances are allocated on the basis of this same type of calculation, with some variations in the formula to take into account the special circumstances of various types of utilities and utility units. For example, existing utilities pointed out that many "clean" coal-fired units were underutilized during their baseline period. Accordingly, the Congress attributed to some existing units either a higher capacity factor or a higher emission rate in order to increase the number of allowances available for the units and, thus, permit increases in emissions from those units.[69] For new units coming on line after the date of enactment of the law, the baseline is the average annual quantity, in Btus, consumed in fuel by that unit multiplied by the allowed emission rates.[70]

5. Will allowances be "traded"?

The theory underlying the allowance system is straightforward. The Act, in stages, reduces the amount of sulfur dioxide that can be emitted at the nation's fossil-fired power units. To meet those new emission rates, an owner or operator of a unit can either reduce tons of emissions through some form of pollution control or purchase allowances that "cover" the emissions a utility unit produces in excess of those allowed by law. Again, in

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[68] Title IV, Section 402(4), 42 USC 7651a.

[69] Some 300,000 allowances will be available on a first-come-first-serve basis to utilities that utilize energy conservation measures and renewable energy technology. Title IV, § 404(f), 42 USC 7651c.

[70] Title IV, Section 405(g), 42 USC 7651d.

theory, allowances will be available to "cover" these excess emissions because the installation of controls at a given plant will reduce sulfur dioxide emissions to a point below the new emission standard. The U.S. Senate Report on the original version of S. 1630 gave this hypothetical to explain the incentive underlying a possible allowance transfer transaction:

> Unit A emits 25,000 tons of SO_2 annually and is allocated 10,000 allowances, requiring it to remove 15,000 tons of emissions to meet a 10,000 ton emissions limit. Unit A can remove 18,000 tons of emissions at a cost of $500 per ton. If it did so, it would need only 7,000 annual allowances to cover its own operations, leaving it with 3,000 unused allowances. Unit B emits 15,000 tons per year and is allocated 12,000 allowances. To remove 3,000 tons to meet its 12,000-ton/allowance limit would cost it $1,000 per ton. Unit B would clearly save money by purchasing unit A's 3,000 allowances at a price somewhere between $500 (unit A's cost) and $1,000 (unit B's cost) rather than incurring the $1,000 per ton cost of removing the emissions itself.[71]

The incentive to profit through sale of allowances should exist in those instances in which the market price for allowances exceeds the incremental cost of control at a particular unit. Thus, those utilities capable of controlling emissions relatively cheaply may "produce" and sell allowances. Moreover, efforts were made to ensure that allowance market would be structurally competitive. The initial allocation of allowances under the Act was developed so that allowances would spread over a range of utilities and somewhat evenly between the states. To emphasize this lack of market concentration, the authors of the U.S Senate Report, citing the President's Council of Economic Advisers, suggested that of the 5.1 million allowances issued to existing units with affirmative reduction obligations in Phase II

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[71] S.REP. No. 101-228, 101st Cong., 1st Sess., 318-19 (1990).

(representing only approximately 56 percent of the total allowances issued), only 26 percent would be awarded to the top 3 private utility holding companies. In turn, according to the U.S. Senate Report, the top 13 private holding companies together would be granted only 57 percent of this partial total, and the six states holding the most allowances would account for less than half of this partial total.[72]

In Phase I, the Act also provides incentives for overcontrol through the installation of scrubbers that may generate excess allowances which could also be marketed.[73] This provision was added to the Act to gain the support of representatives from high sulfur coal regions. Even with this provision, many high sulfur mines in the midwestern United States are expected to close, with a significant loss in mining jobs. As noted above, the Act does not limit a purchaser's ability to bank allowances for use in years subsequent to those for which they are issued. Thus, many believe that the allowance cap, the durable nature of allowances, the lack of market power on the part of major allowance holders, variations in the costs of emission controls, and the recent decision of the Chicago Board of Trade to become involved in stimulating allowance transactions through futures contracts will combine to create a market for allowances.

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[72] Id.

[73] Owners and operators of Phase I plants that elect to install continuous systems of emission reduction, in part, can qualify for an two year compliance extension and receive early-reduction bonus allowances for reductions achieved between 1995 and 1997. Title IV, Section 404(d), 42 USC 7651c.

6. How much will allowances cost?

According to some authorities, the estimated cost of each allowance available in the open market could range between a low of $200 and a high of $1500 (based on the allowance price set in a direct sale provision of the Act). There is, however, a surprising consensus of opinion on a narrower range in the value of Phase II allowances. The various U.S. consulting firms that have worked on allowance issues generally seem to agree that a Phase II allowance usable after 2000 is currently worth between $400 and $900 (in today's dollars). There is no reason to assume, however, that each private sale of allowances in any given year will be at a uniform price.

7. When and where can a U.S. utility purchase allowances for the operation of a project?

Currently in the United States, limited competition in the utility industry is permitted through so-called independent power producers who are allowed to build and operate generating units in a traditional utility's service territory. Throughout the clean air debate, there were a number of Independent Power Producers concerned that the market for allowances would not be as robust as the designers of the allowance system might wish. These power producers and a number of interests believed that they would be denied allowances by those who are eligible to receive the most allowances -- "traditional" utilities. Thus, they argued that the law should set aside a number of allowances for use by the Administrator to stimulate the sale of allowances and to protect the interests of IPPs. In the end, the Act was amended to include provisions that would withhold a fixed percentage of all available allowances for government run auctions and sales.

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The other means by which a utility might be able to obtain allowances is simply through contracting with holders of Phase I or Phase II allowances. Transactions involving allowances could be completed relatively soon because the Act specifically permits the transfer of allowances prior to their issuance. In other words, prospective holders of allowances will be permitted to record "pre-issuance transfers" and deduct the allowances already sold or transferred from the number of allowances that they will receive in 1995. As noted earlier, in the Phase I, the Act provides incentives for overcontrol that may generate excess allowances available on the open market. [74] In any event, the market for allowances may open quickly and should remain open so as long as there are willing buyers and sellers. Every utility in need of allowances probably will probably consider purchasing allowances not necessarily through a government sponsored auction or sale but through a private contract with an allowance holder.

8. Unresolved Questions about the U.S. Allowance System and its Application to Other Nations

Despite the steps taken in the U.S. Act to ensure the existence of a workable market, there are a number of concerns about the U.S. sulfur dioxide allowance system that illustrate the limits of market based approaches generally. First, there is a concern that individual states will encourage utilities to hoard allowances for future use, rather than transfer them at market prices, because allowances are thought to be a prerequisite for state economic growth. Obviously, this same type of problem would be just as likely to arise in a multinational or international allowance system because nations, rather states, would have

[74] Title IV, Section 404(e), 42 USC 7651c.

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concerns about the availability of SO_2 or CO_2 allowances during periods of economic growth and increased energy use.

Second, the current U.S. pattern of state control over certain aspects of environmental regulation may allow states to limit the use of allowances if emissions associated with allowances create environmental problems. In an international or transnational context, pockets of stricter environmental regulation which could interfere with a free trading of allowances are perhaps just as likely to exist -- particularly if "regional" pollutants like SO_2 or NO_x are the targeted pollutants, as opposed to pollutants of "global" concern like CO_2 or, perhaps, mercury.

Third, the U.S. electric utility industry is a complex amalgam of investor-owned, customer owned and quasi-governmental utilities. In addition, these various types of utilities are subject to a mix of state and federal rate regulation (and in some cases no regulation). Despite these complexities, the creators of the U.S. allowance system hoped that utilities, whether private or public, would have incentives to reduce the cost of compliance in their service territories. The allowance trading system may in fact reduce compliance cost but no one can be sure that utilities will embrace it with uniform vigor. Regulators in the United States are grappling with how utilities can be encouraged to participate in the system and bemoaning the fact that the most heavily regulated U.S. industry has essentially been asked to develop an entirely new free market. Given vast differences in the way that nations operate or regulate utilities and the fact market economies are only now being create in a number of countries, it probably is not safe to assume that utilities will be able to maximize the opportunities created by a new market for any particular pollutant.

C. Taxation of emissions to internalize externalities.

One of the other economic instruments that has been widely discussed as a means of controlling emissions, particularly of CO_2, is the application of a tax on emissions. Once again, the IPCC considered the concept of levying specific charges on emissions and a number of countries have given such proposals serious consideration. For example, in the U.S. some have suggested imposition of a "carbon tax" that would set a graduated rate for each fossil fuel -- natural gas, oil and coal -- based on carbon content. Obviously, the hope would be to drive users away from higher emitting fuels.[75] The EC, of course, is considering a very similar approach which would be expected to raise $35 billion and help stabilize carbon dioxide emissions at 1990 levels by the year 2000.[76] Denmark is expected to have in place by January 1, 1992 CO_2 tax on electricity, which will result in a tax in about $15 per metric ton of SO_2.[77] Germany and France have taken independent steps in the same direction.[78] Generally, all of these efforts are designed to reduce emissions, even as they "generate revenue which could provide a funding base for further pollution abatement, research, and administration, or allow other taxes to be lowered."[79]

Opponents of such taxes have made fairly consistent arguments. First, if a nation, or even a group of nations, imposes a unilateral tax there is the risk that it will make its

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[75] Project 88 -- Round II, Incentives for Action: Designing Market-Based Environmental Strategies.

[76] 14 Int'l Env't Rep., No. 18 (Sept. 11, 1990).

[77] Id. at No. 11 (June 5, 1991).

[78] Id.

[79] IPPC First Assessment Report, Vol. I, at 31.

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industries less competitive in the world market. Second, even if all nations imposed such a tax, the uneven use of fossil-fuels means that some nations will be better off competitively. Third, graduated fuel taxes strike particularly hard at coal rich nations. Fourth, carbon taxes tend to encourage the development of nuclear power plants, which obviously have their own set of opponents. Fifth, alternatives in the form of conservation or fuel switching may be so expensive that the tax does not drive power plants away from the use of fossil fuels like coal. Finally, absent compelling evidence of need, developing nations may be particularly loathe to add to the cost of electricity -- the basic input to virtually all other products.

III. CONCLUSION

As the result of ever closer scrutiny, coal-fired power plants are being asked to install new technology requirements, pay higher penalties and/or participate in newly created markets. Under any of these approaches, there are a number of facts that coal-fired power producers are confronting. First, more regulation of a greater number of pollutants is likely. Second, transboundary cooperation, particularly in Europe, is becoming the norm in most air pollution control efforts. Third, in developing and politically reforming countries, the high cost of technological, lack of energy research and development capability, and the difficulties in maintaining and monitoring compliance will demand international attention and assistance. Finally, the "reverse" externalities of pollution control -- socio-economic impacts on coal suppliers and the creation of pollution in controlling pollution (e.g., scrubber sludge or the capture of metals) -- may prove an intractable problem for coal producing nations. In the end, no form of regulation -- whether markets, taxes or standards

-- can disguise the fact that those who benefit from coal-fired generation will have to pay more and do more in the coming years in order to utilize the world's supply of coal.