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EUROPEAN VIEWS ON CONTROLLING ACID RAIN

by

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Foreword

The National Governors Association (NGA) will be considering a plan for alleviating acid rain effects by reduction of emissions of sulfur and nitrogen oxides. This plan, in some respects similar to current legislative proposals in Congress, was formulated by the northeastern governors with administrative support from the Commonwealth of Massachusetts. Lt. Governor John Kerry has undertaken to prepare this plan for consideration by the NGA.

In order to provide a better understanding of how other industrialized nations are dealing with the acid rain problem, the office of Lt. Gov. Kerry arranged for a tour of European countries during the week beginning 10 January 1984. Norway, Sweden, the Federal Republic of Germany (FRG), Belgium and the United Kingdom (UK) were visited, as well as the Commission of the European Communities (EEC) in Brussels. Arrangements for these visits were aided by representatives of the respective U.S. Embassies. Expenses of the trip were covered by the M.I.T. Energy Laboratory.

The U.S. participants in the tour were:

Lt. Gov. John Kerry, Commonwealth of Massachusetts
Dr. Anthony Cortese, Commissioner of the Massachusetts Department
of Environmental Quality Engineering
Mary Ann Marsh, Office of the Lt. Governor
Kathleen Anderson, Office of Sen. Edward Kennedy
Dr. James Fay, Energy Laboratory, Massachusetts Institute of
Technology

The following account is reconstructed from notes taken during the tour. For simplicity, the account is divided according to the countries and agencies visited. A list of individuals consulted is appended at the end. No attempt has been made to attribute the views expressed to specific individuals.

Norway

Ministry of Environment

A wealth of studies all show that the major factor in the acidification of lakes and streams in Norway is acid precipitation. Other factors, such as land use, may produce local effects but no other cause than acid rain can explain the widespread regional effects observed. Only the UK still disputes this point. While there is as yet no evidence of forest damage in Norway, there is great concern that it will eventually happen and no proof that it will not happen. This is an area of enlarging research.

Acid deposition in Norway is due in about equal parts to emissions from the UK, other western European nations (including Norway), and eastern Europe. An informal agreement has been reached among eight nations (Norway, Sweden, Finland, Denmark, FRG, France, Austria, and Switzerland) to reduce sulfur emissions by 30% before 1993. The USSR has agreed to reduce the transboundary flow of its sulfur emissions by the same percentage. Of course, this reduction is but the first step and will not solve the problem of acidification.

There are other benefits to reducing sulfur emissions, such as reduced corrosion of metals and damage to stone materials. A recent OECD study showed that the savings from such damage alone would offset the costs of sulfur control, but this is not a major issue in Norway.

Norwegian Institute for Water Research (NIVA)

In southern Norway most lakes have a Ph less than 5.5 (33,000 square km). Fish populations have been declining since 1900 and precipitation acidity has been increasing. Based on prognostic modelling, a reduction of 30, 50 or 70% in deposition would

restore 22, 35, or 49% of the lakes to a viable condition. However, it is not known whether the current situation is truly reversible.

Liming experiments have been conducted and more are being planned at an estimated cost of US\$2 million per year.

Norwegian Institute of Air Research (NILU)

The annual deposition of sulfur in Norway is estimated to be 300,000 tons per year of which 10% is due to Norwegian emissions. It is assumed that deposition will be reduced in proportion to emission reductions, as this matter was settled in an OECD study in the early 70's.

Sweden

National Swedish Environmental Board (SNV)

There has been steady progress in understanding the implications of acid rain since Oden first reported in 1967 on the results of monitoring begun in 1955. An OECD report issued in 1976 established the scientific basis of the long range transport problem. In 1979, 34 countries (including the U.S. and Canada) agreed to the Convention on Long Range Transboundary Air Pollution proposed by the United Nations Economic Commission of Europe (UN ECE). (The Convention was ratified in 1983). A second OECD study (1981) on acid rain showed that the benefits of emission control were comparable to the costs. By the time of the 1982 United Nations Conference on the Human Environment, agreement had been reached on the relation of acid deposition to emissions in Europe.

Current proposals to reduce emissions by 30% - 60% will not solve Sweden's environmental problem; 70%-80% reduction will be necessary to protect the most sensitive areas. Resistance to reducing emissions comes principally from the UK, Italy and

eastern Europe. Emissions from the German Democratic Republic are of concern. So far, there is no interest in the sharing of abatement costs among affected countries as all countries can expect some local benefits.

Sweden is increasing its control of sulfur emissions, ultimately hoping to reduce them by a factor of three below 1980 levels. It provides subsidies of 75% of the cost of scrubbers where required. Sweden expects coal will replace oil as the fossil fuel of the future for stationary sources.

Soil acidification is being closely monitored. Gradual reduction in Ph has been observed and Mg, K and Cd have been decreasing since 1963 in the south. In large areas of the south magnesium concentrations are close to the critical level needed to maintain healthy forest growth. Changes in the north are less.

There are some large areas of reduced forest growth in the south. It is not known whether this is the result of soil changes, acid precipitation, drought or ozone damage. On a wider scale, there is no measurable productivity decline. Liming of soils increases the Ph but sometimes reduces productivity in the near term (ten years).

Surface waters, especially in the south and west, are increasingly acidic. The area of rainfall with Ph less than 4.3 has been increasing with time. About 18,000 lakes show evidence of acidification, 9,000 of them having damaged fish stocks. Liming of 3,000 lakes is now underway in the most acidified and unbuffered areas at a cost of US\$20 million. Fish populations are increasing in these lakes but there are some deleterious side effects. It would require about US\$30-40 million per year to lime all the lakes that now need it.

There is some acidification of groundwater affecting about 400,000 people.

In all countries the support of public opinion is needed before governments will begin to reduce emissions. Evidence of acid deposition damage within the emitting country helps to galvanize such public opinion.

Belgium

Office of Secretary of State for Public Health and Environment

Belgium is seeking to reduce sulfur emissions by 30% below the 1980 level of 800,000 metric tonnes per year. It is expected that coal will replace oil as the fuel for stationary sources. This change will result in some sulfur reduction since many current sources now use 3.5% sulfur oil. The goal is 0.7% sulfur equivalent in coal. Emission standards are not used, but emission agreements are negotiated with fuel users.

It is estimated that the export of sulfur across Belgium's national boundaries is no greater than the imports. Sulfur control in the future will have to take into account the transboundary effects.

There is some tree damage in the east (not forest) but none in the west. There is some evidence of surface water acidification. Surface waters supply one third of the population.

Environmental groups claim that there is damage which is being overlooked: tree and soil damage, especially due to heavy metals, which may be related to acid deposition.

Future reductions will follow the polluter-pays principle. There is no sentiment for sharing costs within the common market countries. Pressure from environmental groups is needed to achieve reduction goals.

Commission of the European Communities

Ministry for the Environment

Following a meeting last June of the heads of state of the European Economic Community at which the problems of acid rain and airborne lead were raised, the Commission prepared a draft directive for its Council of Ministers on the limiting of emissions of sulfur, nitrogen oxides and particulates from large combustion plants. This draft has not yet been discussed or adopted. The proposal is quite similar to that in force in FRG (see below). It would require each country to reduce total sulfur emissions by 60% and nitrogen oxides and particulates by 40% (below 1980 levels) before 1995. In addition, emission standards would be established for new facilities. (The Commission document lists estimates of costs and benefits of this proposal).

There is strong support for this proposal, especially from the FRG. It is in accord with the UN ECE Convention on Long Range Transboundary Air Pollution. If the U.S. were to adopt a similar program, it would help the approval of this proposal by the EEC. The proposed ministerial meeting in Munich this summer will provide opportunity for the other European nations, especially those of eastern Europe, to discuss their plans for pollution control.

The Commission will propose standards for lead in motor vehicle fuel in May.

The Federal Republic of Germany (FRG)

Ministry of Interior

Effective last July, new standards for control of sulfur and nitrogen oxides are now in force. The effect of these standards will be to reduce sulfur emissions by 60% and nitrogen oxide

emissions by 40% by 1993. The principal purpose of this program is to reduce the damage to trees in the Black Forest, but auxiliary benefits of reduced damage to structures and materials and improvement in public health are also acknowledged.

A sulfur emission standard of 400 mg SO₂ per cubic meter is required of all new plants over 300 MWt, and the same or a less stringent standard is required for smaller or existing plants, depending upon size and the amount of remaining useful life. To achieve these standards, flue gas scrubbers will have to be installed on all large plants, which use coal having 1.1-1.3% sulfur after cleaning. (Gypsum will be produced in the desulfurization process, thereby alleviating the sludge disposal problem). About 40,000 MW of plants will be fitted with scrubbers, 75% of which will be retrofitted. A 50% reduction below present emissions of 3.3 Mt/yr is estimated for 1988. The total capital cost is estimated at US\$4 billion, and consumer prices will be raised by 10-15% to cover the total costs.

To achieve nitrogen oxide control, the best available technology will be required on large stationary sources and three-way catalytic converters on motor vehicles. The latter will be introduced beginning with 1986 models in Germany. Also, current US export models will be made available immediately for domestic sales. The FRG hopes to obtain the agreement of other European auto manufacturers (notably the Italian and French) to introduce catalytic converters, but this may not happen until 1990. To do so requires a supply of unleaded fuel and the conversion of the auto/fuel system to one resembling that in the U.S. and Japan. There is no current agreement among European nations on this point.

About 40% of the airborne sulfur levels in FRG are due to domestic emissions. Of the domestic emissions, about 50% are deposited within the FRG. Nevertheless, it is felt that transboundary pollution, especially from eastern Europe, must be

reduced before the problem can be solved.

The acute damage to trees in the Black Forest is described in a recent report (March 1983) by the Council of Environmental Advisors. The damage is characterized by loss of foliage of coniferous and deciduous trees (principally Norway spruce, silver fir and beech species) which progresses quite rapidly, resulting in death within a few years of the onset of the first symptoms. The pathological conditions are unlike damage normally observed from SO₂ (there is some damage of this type near the Bavarian border due to large sulfur sources in Czechoslovakia). Damage is most often observed at an elevation of 600-800 m and on slopes facing the prevailing wind direction. The current consensus is that the damage is related to airborne secondary pollutants, including wet and dry acidic material, oxidants (especially ozone), and heavy metals. The damage may be caused directly to the foliage or the soil/root system, or may result from a viral infection or other unknown causes. A common opinion is that the airborne material has, over a period of years, stressed the trees beyond what has historically been encountered from natural causes, resulting in the observed irreversible damage leading to death. In support of this diagnosis, it has been observed that forest productivity in the Black Forest has been declining since the mid 50's. Also, nitrogen oxide emissions have doubled in the last ten years, leading to a rapid increase in oxidant levels. Thus the effects are thought to be cumulative.

The sudden acceleration of tree damage in the last few years has created an awareness on the part of the public of this new environmental problem. The current emission control program reflects the great public interest in mitigating the damage to the Black Forest, which is considered a prime environmental (if not cultural) resource in the FRG. It is expected that government aid to repair the forest damage will be increased.

Ministry of Research and Technology

New technology is being developed to aid in emissions reduction. Several small fluidized bed reactors (up to 200 MW) have been tested. A demonstration plant will be ready in 1985. Also, limestone injection is being tested on a 50 MW power plant. This will be helpful for lignite-fueled plants which can't use scrubbers. They have had no experience with NOx controls, and need them for retrofitting power plants.

Association of German Industry

Although it has doubts about the necessity of the emissions control program described above, German industry has agreed to conform to its goals. The cost of the program is estimated to be US\$4-6 billion. Some industries, such as aluminum, will experience more than a small cost increase. Of the sulfur reduction goal of 1.3 Mt/yr, the industry estimates it will reach 1.2 by 1988 and 1.6 by 1993; i.e., by the target date of 1993 it will exceed the goal by 25%. Rapid depreciation of abatement equipment in 4-5 years will help in financing, but abatement costs will be passed on to the consumer.

Black Forest (Baden-Wurttemberg)

We visited a section of the Black Forest located about halfway between Karlsruhe and Stuttgart. The average age of the trees in the stand we inspected was about 70 years. We saw evidence of crown dieback in both mature and young trees. Discoloration of foliage was easily observable. Dead trees had been removed. In this section of the forest, a survey of last summer showed that 31% of the trees were lightly damaged, 18% were moderately damaged and 0.6% were heavily damaged (i.e., over 60% loss of foliage).

United Kingdom (UK)

Ministry of Environment

While there is some evidence of lake and stream acidification in Scotland, there is no evidence of forest damage. A recent, but incomplete survey, shows there is acid deposition, especially in the north and west where the rainfall is greater. While the OECD study on long range transport is accepted, the effects of deposition on ecosystems is disputed. A collaborative study of soil and lake acidification, financed by the CEEB and the National Coal Board and carried out by the Royal Society and the Norwegian government is just beginning.

The costs of scrubbers would be enormously high, increasing electric rates 4-10%. Only if new plants were built would sulfur controls be used, and then only if better technology were available. No new fossil fuel plants will be needed within ten years. Current sulfur control technology is not considered to be cost-effective.

Air quality has been improving since the 19th century and there is no new perception of deterioration as in Norway. No health effects have been identified with acid rain. It is unlikely that a cost-benefit study would show favorable results in the UK, although the opposite may be true for Europe as a whole. If the 1980 level of sulfur emissions (4.3 Mt/yr) were halved, the environmental effects in the UK would be imperceptible. If this were done throughout Europe it would take decades to see an improvement.

If the U.S. were to undertake a control program, the UK would certainly review its present policy.

Dept. of Energy

Current lake and soil acidification in Norway is not

necessarily due primarily to acid deposition. Diatom residues in lakes do not support current views on the contribution of acid rain.

It is not known what level of abatement costs would be cost-effective. The CEGB believes that abatement costs of 1-2% of power plant costs would be acceptable. Non-scrubber technologies are 20-30 years away from full implementation.

The EEC proposal will be thoroughly reviewed to be sure that the costs will be worth the benefits. If the proposal were implemented in the UK, only 13 of the largest stations (50 generating units) would have to be retrofitted with scrubbers to achieve the 60% sulfur reduction required. This would require at least ten years because of scheduling limitations.

Friends of the Earth

FOE is just starting a campaign to inform the public about the acid rain problem. There has been little press attention and very little public awareness. They believe it will be necessary to show that there is damage in the UK if the public is to support controls.

Conclusions

There is general agreement that acid precipitation is caused by the long range transport of sulfate and nitrate across international boundaries and that the amounts of deposition are fairly allocated as to source by the current meteorological models.

In Scandinavia, acidification of lakes and streams , and to a lesser extent soils, is the primary effect of acid deposition. To prevent further acidification there, substantial reduction of acid precursor emissions throughout Europe will be necessary.

Rapidly spreading forest damage in West Germany has added a note of urgency to the discussions within the EEC on transboundary air pollution control. Also, the need to reduce NO_x emissions so as to limit oxidant levels (thought to be an ingredient in forest damage) as well as nitric acid deposition has enlarged the scope of current and proposed programs for control of long range pollutants.

Reduction in damage to public health, materials and structures, as well as acidification of water supplies, are seen as benefits of prospective control programs which will more than balance the costs when aggregated throughout Europe as a whole. Nevertheless, easily documentable environmental damage (e.g., lake acidification or forest damage) within each nation greatly helps to engender political support for abatement action.

The EEC proposed goal of equal percentage of reduction of emissions below a base year level, irrespective of those levels (as measured by per capita emissions, for example) seems to be accepted as equitable. Each nation is expected to pay for its own emissions reduction. Costs are expected to be passed on to the consumers of energy and products.

The achievement of a 60% reduction in sulfur oxide emissions within a ten year period is possible through use of current technology, principally scrubbers. High sulfur residual oil will be replaced by coal in large sources. The reduction of NO_x emissions within the same period will require some controls on stationary sources but more importantly it will necessitate a switch to catalytic converters and lead-free fuel for automobiles.

The reduction of transboundary air pollution is seen as an international problem affecting all industrial nations, as evidenced by the agreement of 34 nations, including the U.S. and

Canada, to the UN ECE Convention. The European nations regard U.S. participation in transboundary pollution control as essential to the reaching of an agreement in Europe since it would signal the internalizing of control costs in one of the largest world trading partners.

List of Persons Interviewed

Norway

Ministry of Environment

Erik Lykke

NIVA

Lars Overrein

Arne Hendriksen

Kjell Baalsrud

Merete Johannessen

NILU

Harold Dovland

Sweden

SNV

Valfrid Paulsson

Goran Person

Jan Nilsson

Thomas Levander

William Dickson

Bertil Hagerhill

Belgium

Office of Secretary of State for Public Health and Environment

Henri Renson

J. Huylebroeck

J. Mulkens

Commission of European Communities

Ministry for Environment

Heinrich von Moltke

H. P. Stief-Tauch

A. J. Fairclough

Domenico Milano

Federal Republic of Germany

Ministry of Interior

W. Goerke

Dr. Lohmeyer

Dr. Schuler

Dr. Heiman

Ministry of Research and Technology

Dr. Bauer

Association of German Industry (BDI)

Dr. Eberhard Meller

Gunter Hill

Black Forest

Dr. Hans G. Enghardt

United Kingdom

Department of Environment

Dr. Martin Holdgate

Fiora McConnell

Department of Energy

Mr. Agrell

Dr. John Clark (CEGB)

Friends of the Earth

Claire Holinan

Chris Rose