NO.4, December 1990

Acid News

A Newsletter from the Swedish and Norwegian NGO Secretariats on Acid Rain

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EUROPE'S FORESTS

Harvest losses revealed

EVERY YEAR airborne pollutants reduce the potential yield of timber from European forests by 118 million cubic metres. In terms of 1987 US dollars this amounts to a loss of up to $30 billion. Such are the conclusions of Professors Sten Nilsson, Ola Sallnäs, and Peter Duinker as set forth in reports on the effects of air pollutants on European forests from the International Institute for Applied Systems Analysis* in Austria. The authors affirm that the only way to restore forest health lies in a drastic reduction of the emissions of acidifying substances to the air.

By using computer models, the IIASA scientists have calculated the effects of air pollution on forest conditions and growth. Applying the concept of critical loads, they have classified Europe's forest areas according to their sensitivity to depositions of sulphur and nitrogen, after which they calculated the extent of forest area that is exposed to depositions in excess of chosen target loads. It appears that about 80 per cent of the coniferous forests and 40 per cent of the broadleaved are receiving loads of pollutants that are altogether too high.

The pollutant load is a contributory, and in some regions the direct

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The Swedish NGO Secretariat on Acid Rain
Box 245
S-401 24 Göteborg, Sweden
Phone: +46-31-15 39 55

The Norwegian Clean Air Campaign
Postbox 94
N-1364 Hvalstad, Norway
Phone: +47-2-78 38 60

Acid News

A newsletter from the Swedish and Norwegian Secretariats on acid rain.

ACID NEWS is a joint publication of the two secretariats, whose aim is to provide information on the subjects of acid rain and the acidification of the environment.

Anyone interested in these problems is invited to contact the secretariats at either of the addresses below. All requests for information or material will be dealt with to the best of our ability.

In order to fullfill the purpose of Acid News, we need information from everywhere – so if you have read or heard about something that might be of general interest, please write or send a copy to:

The Swedish NGO Secretariat on Acid Rain
Box 245
S-401 24 Göteborg, Sweden
Telephone: 031-15 39 55
Telefax: 031-15 09 33

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THE SECRETARIATS

The Swedish NGO Secretariat on Acid Rain is supported by the following environmental organizations:

- The Environmental Federation (Miljöförbundet)
- The Swedish Anglers' National Association (Sportfiskarna)
- The Swedish Society for the Conservation of Nature (Naturskyddsföreningen)
- The Swedish Youth Association for Environmental Studies and Conservation (Fältbiologerna)

Address and telephone: see above.

The Norwegian Secretariat, "The Norwegian Clean Air Campaign," is organized by five non-governmental organizations concerned with the environment:

- Nature and Youth (Natur og Ungdom)
- The Norwegian Forestry Society (Det Norske Skogselskap)
- The Norwegian Association of Anglers and Hunters (Norges Jeger- og Fiskeförbund)
- The Norwegian Society for Conservation of Nature (Norges Naturvernforbund)
- The Norwegian Mountain Touring Association (Den Norske Turistforening)

The Norwegian Clean Air Campaign
Postbox 94
N-1364 Hvalstad, Norway
Telephone: 02-78 38 60
Telefax: 02-90 15 87

EDITORIAL

Unacceptable kms

ON FEBRUARY 14, 1991, a protocol will enter into force concerning the "control of emissions of nitrogen oxides or their transboundary fluxes." Signed at the Bulgarian capital of Sofia in November 1988, this protocol involves in essence a freezing of NOx emissions at 1987 levels. As from 1995 those levels may not be exceeded.

Of the twenty-six nations that signed the protocol, sixteen have now ratified it, thus enabling it to come into force. It also includes clauses to the effect that as a second step measures shall be taken to bring about an actual reduction of emissions. Here the "critical loads" approach is to be applied, and negotiations to this end are to start no later than six months after the protocol's coming into force.

This is the second protocol issuing under the UN ECE Convention on Long Range Transboundary Air Pollution, the first having concerned emissions of sulphur dioxide. Whereas the emissions of this last pollutant have steadily diminished during the last decade — falling by more than 20 per cent from 1980 to 1989 — those of NOx have on the contrary increased. Since at least half of the nitrogen-oxide emissions come from road traffic, measures to control car, truck, and bus exhausts will be of utmost importance if the trend is to be reversed.

Among European countries Austria, Switzerland, Sweden, Norway, and Finland have now set emission standards which mean in effect that all new petrol-driven cars have to be equipped with three-way catalyzers. Although similar requirements have been in force in Japan and the United States for about ten years, they are only expected to be applicable for new cars in the whole of the European Community from 1993. Whether eastern European countries will introduce them, or when, is still a matter of speculation.

Heavy diesel-driven trucks and buses account for a large part of the emissions of NOx from road traffic, and the requirements for such vehicles have already been tightened up in a few European countries. But there is as yet no agreement on new standards within the Community, and eastern Europe appears hardly even to have thought about it.

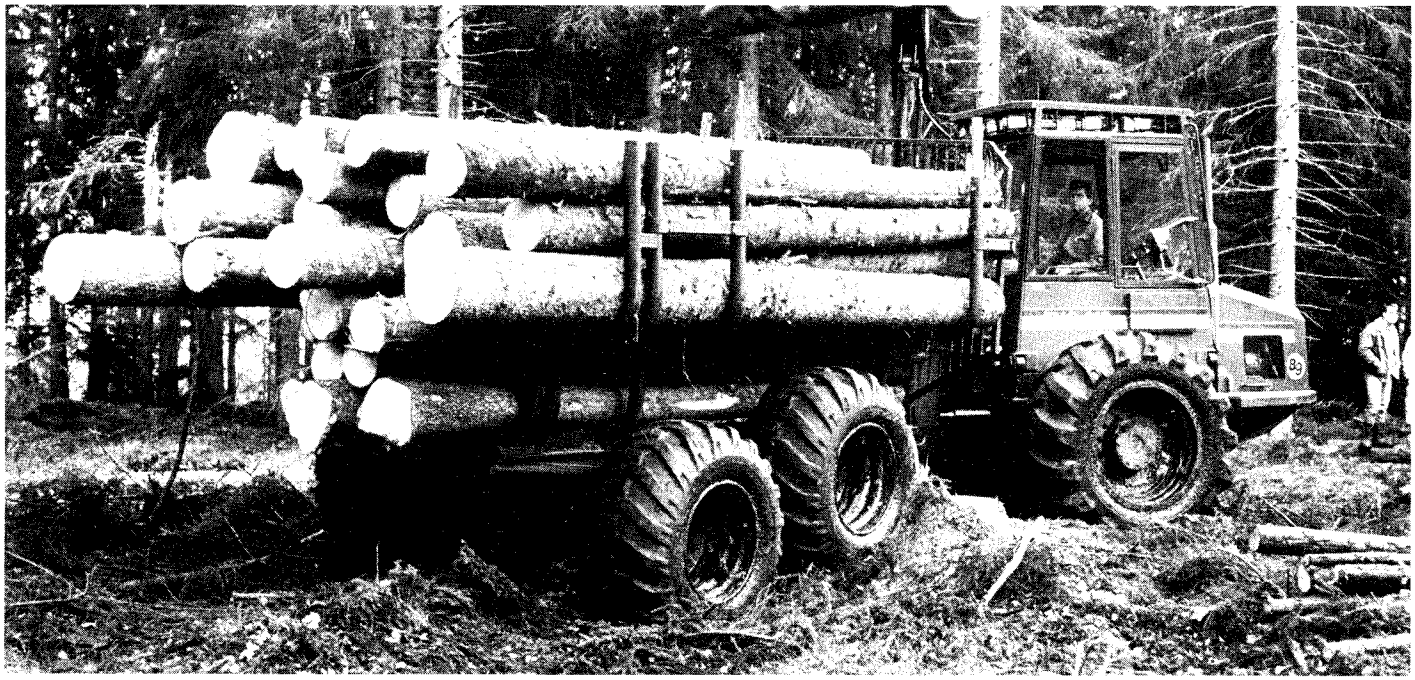
While catalyzers are expected to reduce the emissions of NOx from any one vehicle by more than 80 per cent, in the case of heavy diesels the proposed requirements are calculated to lower them only by something like half. It will also take time for the effects to show up in the whole fleet, since vehicles of this type will often go on running for 10-15 years. The emissions total is likely to be affected even more by the fact that the total transport milage is steadily increasing, together with the total number of vehicles. Part of the reduction resulting from cleaner vehicles will thus be offset by the increase in traffic.

According to a forecast presented at an international conference on transportation and the environment that was held in Gothenburg, Sweden, this last November, the global motor vehicle population is expected to double over the next forty years, rising to about one billion. At present about half of the new cars worldwide are equipped with catalyzers, and it is expected that three-quarters will be after 1993. *If* the best available technology were to be applied in *all* vehicles, by 2010 there could be a reduction of NOx emissions. But after that the increases in vehicle milage would cause them to rise again.

Bringing about any satisfactory reduction of NOx emissions, and keeping them there, will require a combination of still cleaner vehicles with limitations of transport mileage. It will be vital to reduce transport mileage if we are also to markedly bring down, within a reasonable time, the amounts of carbon dioxide emitted from road vehicles. Measures to this end should moreover be coupled to others aimed at improving energy efficiency and stimulating a switch to non-fossil fuels.

In short, it may be said that even with the application of the present most rigorous emission standards, any uncontrolled increase in vehicle mileage would be altogether unacceptable from the point of view of the environment.

Christer Ågren



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Continued from page 1

cause of forest damage, often appearing as needle and leaf loss. Diminished growth has been found to accompany defoliation, and to occur in conifers when needle loss exceeds 25 per cent.

The researchers state openly that their approach is decidedly simplified, taking no account for instance of altitude, land exposure, and other ecological conditions. But they also point out that their calculations are in all probability too conservative, since they have only considered the effects of sulphur, and so far left out those of other pollutants.

Using a combination of data on depositions, critical loads, forest resources, and effects on growth in a computer model, the IIASA scientists have made forecasts, under various scenarios, of the development of timber resources in Europe over the next 100 years.

The figures concerning the reduced harvest potentials are presented as yearly averages for that period. They show eastern Europe, including the European part of the Soviet Union, to be the worst affected. There the annual harvest loss is found to be 70 million cubic metres, as against 48 million in the rest of Europe. This amounts to an overall loss for Europe of almost one-fifth.

In terms of money, these losses amount to between $6 and $30 billion (US) per annum over the next hundred years. The lower figure refers to the price of timber as delivered to the mill, at 1987 cost level, the higher to an aggregation comprising the mill price of roundwood, the value added through industrial processing (as in pulp and paper making), and the social welfare value, such as that provided by forests in the way of recreation.

Economic losses in European forest production due to air pollutants. The lower figures represent the value per average cubic metre of roundwood at mill site, the higher ones also taking into account the simplest value added by industrial processes and the value of non-wood benefits (recreation, conservation. Expressed as US dollars in 1987 value.

Area	Billion dollars/year
Western Europe	2.9-14.5
Eastern Europe	1.9-8.5
European USSR	1.5-7.4
Total Europe	6.3-30.4

The authors of the study dwell on the fact that air pollution affects other values besides timber production. A damaged forest has less value for instance for recreation, as protection against soil erosion, for maintaining the quality of water, and as habitat for wildlife. Estimates of non-timber values indicate that these can add up to many times the market value of the timber.

It is thus evident that the emissions of acidifying and damaging pollutants will have to be rapidly and drastically reduced. The costs can be kept down through so-called target reductions – that is, by applying measures precisely where they will be the most cost-effective. Improved and more careful management of forest resources will also be necessary, according to the IIASA researchers, and European foresters have to adopt the kind of silvicultural practices that can help mitigate the damaging effects of air pollutants.

Christer Ågren

***IIASA**, A-2361 Laxenburg, Austria.
Phone +43-2236-71520.

On the following pages

ECE SURVEY

Forest decline continues

FROM THE RESULTS OF the 1989 Forest Damage Survey in Europe it appears that in some regions, especially in Eastern Europe, damage has increased. In forests at higher elevations, and those that are more than sixty years old, there has been much heavier defoliation than in younger stands and at lower elevations. In the mountainous regions of Germany (both former East and West), Czechoslovakia, and Poland, the trees on several thousand of hectares are either seriously damaged or dying.

From Bulgaria now comes a report that the trees in 25,000 hectares of silver fir forest, out of a total of 35,000 hectares, are severely damaged or dying. Moreover the Scots and Austrian pine and Douglas fir on 20,000 hectares are dying or dead.

This last UN ECE (United Nations Economic Commission for Europe) forest damage survey covered 116 million hectares in twenty-six countries, or two-thirds of the entire forest area in Europe. Twenty-two countries (see table) made nationwide surveys, while four confined themselves to selected regional areas. Data is included for the first time on damage in the western parts of the Soviet Union: the Ukrainian and Byelorussian SSRs and the Kaliningrad region. Areas not yet entirely covered by the survey are some parts of broadleaved forest, mostly in Scandinavia, the forests of Turkey, and major portions of the forests in Byelorussia and the Ukraine.

The same method has been followed as in the four previous years, the trees on sample plots being assessed for damage in accordance with a five-class system, with 0-10-per-cent defoliation placed in Class 0, 11-25 per cent in Class 1, 26-60 per cent in Class 2, more than 60 per cent in Class 3, and dead trees in 4. The defoliation rating is shown for different species and age groups of coniferous and broadleaved trees.

In most countries damage to Norway spruce *(Picea abies)* is shown to have remained stable or even decreased slightly. Notable deterioration was recorded however in Czechoslovakia, Poland, and Lithuania. While the condition of Scots pine *(Pinus sylvestris)* remained generally unchanged, in some countries (Bulgaria, Lithuania, Hungary, Portugal, the Netherlands, East Germany, and Switzerland) the older trees showed a negative trend.

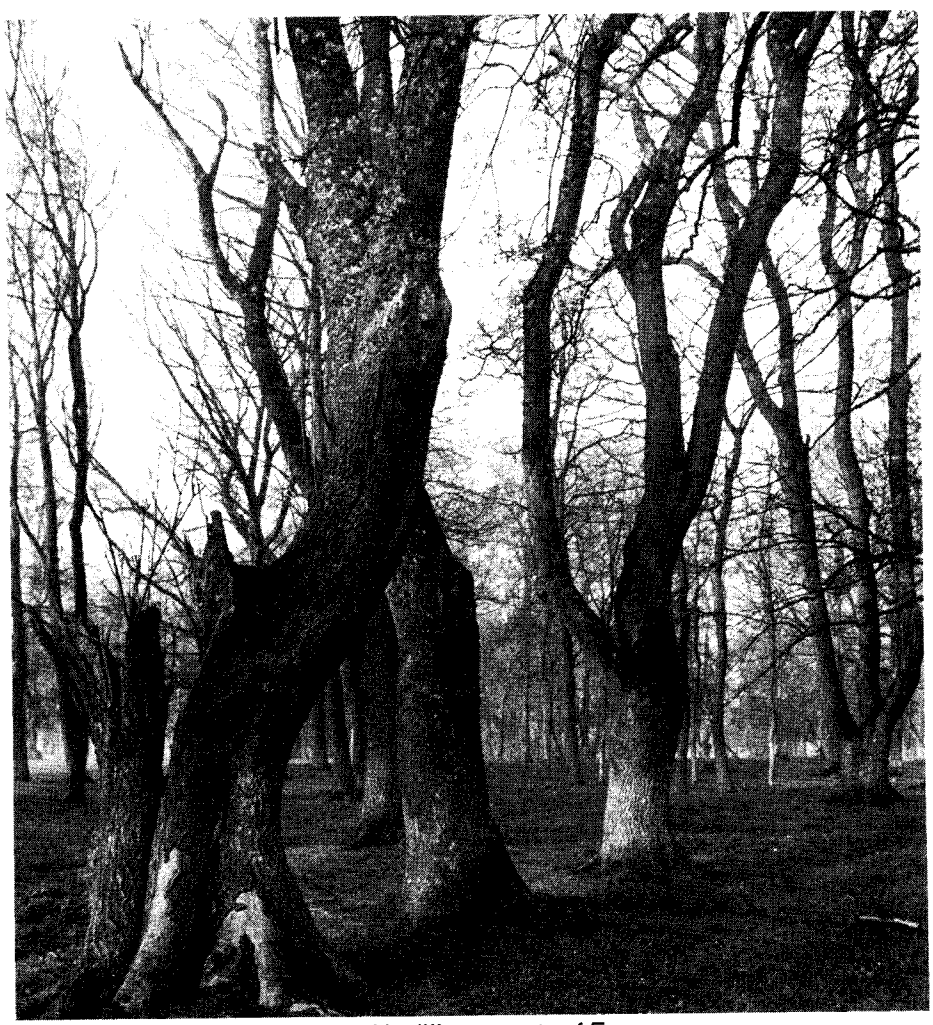
The situation is still critical for Silver fir *(Abies alba)*. Although of relatively minor economic importance, its ecological value is undisputed. In West Germany 60 per cent of the trees over 60 years of age were found to be moderately to severely damaged (in Classes 2-4).

The defoliation of oak *(Quercus robur)* has become significantly more serious. In Czechoslovakia and the Kaliningrad region more than 60 per cent of the older oaks were moderately to severely damaged. Recoveries were on the other hand reported from Greece, the Netherlands, and the United Kingdom. A general improvement for common beech *(Fagus sylvatica)* is attributed in some cases to recovery from earlier insect attacks.

Damage by way of loss of needles or leaves has been observed in all twenty-six countries of the survey. In eight countries air pollution is considered to be the essential destabilizing factor for the health of the forests. In a majority of the others it is regarded as a factor contributing to a weakening of forest health.

In submitting its survey to the ECE Working Group on Effects, the Programme Task Force of ICP Forests expressed concern over the continuing decline of the forests and the acidification of forest soils in Europe, while emphasizing the need for further action to reduce air pollution.

Christer Ågren



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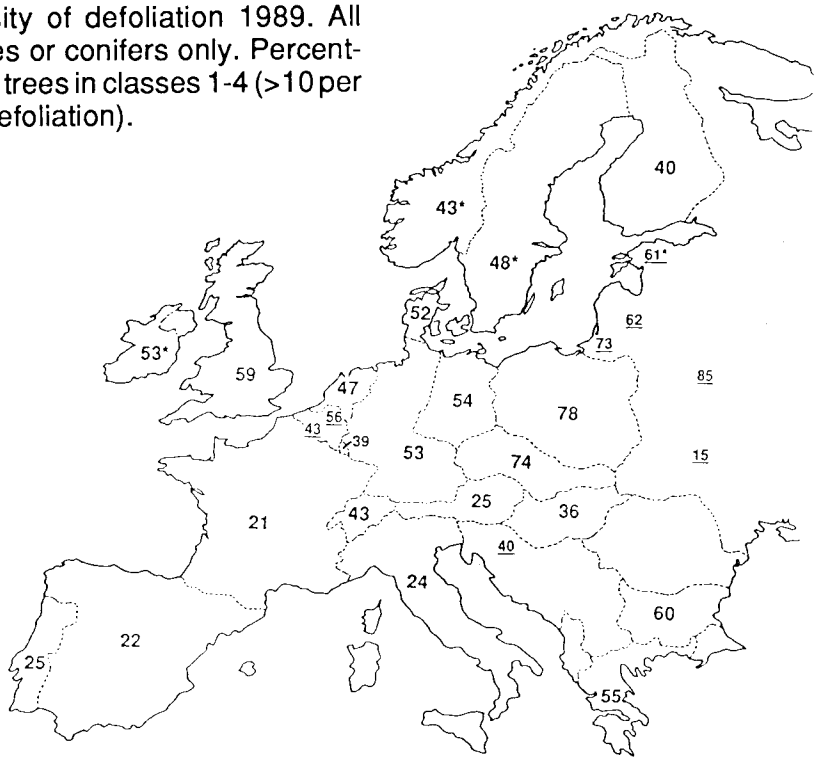
Oaks have been variously affected in different parts of Europe

Intensity of defoliation 1989. All species or conifers only. Percentage of trees in classes 1-4 (>10 per cent defoliation).



Except when underlined (regional) the figures represent nationwide surveys. *=conifers only. Source: United Nations ECE, ICP Forests (International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests).

Intensity of defoliation in 1989, in per cent of trees affected. For all tree species, unless marked * for conifers only. Based on nationwide (N) or regional (R) surveys.

Country	Moderate to severe (Classes 2-4)	Slight to severe (Classes 1-4)	No defoliation (Class 0)
USSR-Byelorussia (R)	76.2	85.0	15.0
USSR-Kaliningrad (R)	35.0	73.1	26.9
Czechoslovakia (N)	33.0	74.0	26.0
Poland (N)	31.9	78.0	22.0
USSR-Estonia (R)	28.5	61.2	38.8
United Kingdom (N)	28.0	59.0	41.0
Denmark (N)	26.0	52.0	48.0
Bulgaria (N)	24.9	59.5	40.5
Yugoslavia-Slovenia (R)	22.6	39.7	60.3
USSR-Lithuania (R)	21.5	62.4	37.6
Finland (N)	18.0	39.9	60.1
German Dem. Rep. (N)	16.4	54.3	45.7
Belgium-Wallonia (R)	16.4	42.8	57.2
Netherlands (N)	16.1	47.4	52.6
German Fed. Rep. (N)	15.9	52.9	47.1
Norway* (N)	14.8	43.0	57.0
Ireland* (N)	13.2	52.8	47.2
Sweden* (N)	12.9	48.1	51.9
Hungary (N)	12.7	36.4	63.6
Luxembourg (N)	12.3	39.1	60.9
Greece (N)	12.0	54.6	45.4
Switzerland (N)	12.0	43.0	57.0
Belgium-Flanders (R)	11.6	55.8	44.2
Portugal (N)	9.1	24.9	75.1
Italy (N)	9.1	24.2	75.8
France (N)	5.6	20.7	79.3
Austria (N)	4.4	25.4	74.6
Spain (N)	3.3	22.0	78.0
USSR-Ukaraine (R)	1.4	14.6	85.4

Recent publications

Control Strategies for Photochemical Oxidants Across Europe (1990)
Report from the OECD describing the emissions of air pollutants that give rise to photochemical oxidants, and analyzing the possible technologies for emission control as well as their costs. 116pp. Price FF 125. OECD, 2 rue André Pascal, 75775 Paris cedex 16, France.

Palaelimnology and Lake Acidification (1990)
The book contains scientific papers on palaelimnological research on the evidence for lake acidification based on the chemical and biological record preserved in the lake sediments. The clear conclusion is that the dominant cause of surface water acidification is acid rain. 205 pp. Price £40. Obtainable from the publisher: The Royal Society, 6 Carlton House Terrace, London, England SW1Y 5AG.

The role of Nitrogen in the Acidification of Soils and Surface Waters (1989)
Report (Miljörapport 1989:10) from a scientific workshop organized by the Nordic Council of Ministers and the US Environmental Protection Agency in October 1988. Available from Nordisk Ministerråd, Store Strandstraede 18, 1255 Kobenhavn K, Denmark.

Marine Pollution '90 (1990)
Report by the Swedish Environmental Protection Agency presenting its new program for action on marine pollution. Gives a review of the efforts that have been made to improve the situation, describes the pollution of the seas surrounding Sweden, states environmental goals, and puts forward proposals for continued action. 165 pp. Price SEK 190. Available from the publisher: The Swedish Environmental Protection Agency, Information Department, 171 85 Solna, Sweden.

Air Pollution '90 (1990)
Report setting forth the Swedish Environmental Protection Agency's new program on air pollution. Among others it deals with pollutants such as sulphur and nitrogen oxides, VOCs, ammonia, ozone, CFCs, mercury and carbon dioxide. In general it follows on the same lines as the report on marine pollution. 67 pp. Price SEK 90 (address from the Agency above).

With aim on ozone

IF ALL GOES WELL, this next year the countries of Europe and North America will be signing an agreement to limit their emissions of volatile organic compounds (VOCs). The aim is, chiefly, to lessen the formation of photochemical oxidants, and of ozone in particular. In low concentrations at ground level, ozone can do harm to trees, crops, structural materials, and human health. When present at low levels, ozone is also a greenhouse gas.

Negotiations for a protocol on VOCs have been going on for almost two years, and it had been expected to have one ready for signing in time for the November meeting of the Executive Body of the UN ECE Convention on Long Range Transboundary Air Pollution. There are already two protocols under this convention: one for reducing the emissions of sulphur dioxide, dating from 1985, the other for nitrogen oxides (1988).

A number of countries, and in particular some West European ones, have been striving for a VOC protocol that would involve tangible reductions. The Netherlands, Sweden, and France have for instance proposed reductions of at least 30 per cent by 1998-2000 – either from the levels of 1987 or from those of any other year that individual countries might care to specify. The hope is that by permitting flexibility in the choice of base year, the adhesion will be gained of as many countries as possible, and especially of the United States.

Another group, led by Czechoslovakia, is urging that the emission of VOCs should simply be frozen at 1990 levels after the year 2000. This proposal is thought to be supported by several East European countries.

The United States has put forward an alternative which amounts in essence to limiting emissions "in order to achieve national tropospheric ozone standards determined by each member country." This would be done by applying national emission standards to emission sources, in accordance with a technical appendix to the protocol.

The reason for this American attitude is that it is felt the United States has already gone far toward reducing emissions, and would therefore favour a general application of commonly agreed "best available technologies."

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From the United Kingdom comes a proposal for the insertation of a special paragraph by which measures to limit emissons should first be applied to those sources that send out VOCs with the highest photochemical ozone creation potentials (POCBs). The idea is to reduce concentrations as cost effectively as possible. On account of differing chemical structures, different types of VOC contribute in varying degree to the formation of ozone. They are either of varying reactivity – taking longer or shorter time to react chemically – or give rise to differing numbers of ozone molecules.

From a study of 69 different compounds that has been made in the UK, to determine how much ozone is formed per kilogram of emitted VOC, it appears that alkenes, aromatic compounds, and aldehydes generate the most ozone. The chief emission sources for these VOCs in Britain are road vehicles and solvents. That just these sources should predominate is due on the one hand to the fact that they produce relatively highly reactive VOCs, and on the other that they constitute a large proportion of the total emissions.

This British study involved tracing the transport and conversion of pollutants over a period of up to five days. In the course of a longer period, however, some of the less reactive substances will probably give rise to still more ozone.

In Europe the amounts of ozone formed in any region will depend both on VOCs and NOx – the ozone in and around built-up areas coming mostly from VOCs, and from NOx in the open countryside.

From calculations using computer models it can be seen that the concentrations both of VOCs and NOx will have to be halved if the criticial hourly values for ozone (120-150 $\mu g/m^3$) are to be attained. Still greater reductions will be required if one is to get down to the critical concentrations for longer periods – for an 8-hour average and a growing-season average. In that case it would be more effective to reduce the emissions of NOx rather than those of VOCs.

A study carried out within the Dutch-German Phoxa project seems to indicate a need to reduce the emissions both of NOx and VOCs by more than 75 per cent in order to attain the short-time values for ozone, and still more for the long-time ones.

It should also be borne in mind that a number of VOCs can be direct-

ly harmful both to humans and vegetation. The effects of air pollutants on health are especially prominent in urban areas. In such surroundings, according to Swedish estimates, up to 800 annual cases of cancer can be traced to air pollutants, and of these some 300 are the result of exposure to certain definite VOCs (in a population of little more than eight and a half million). Here again, motor vehicles are the predominant urban source.

Both the ECE convention itself and the proposed protocol on VOCs are however primarily directed at air pollutants that sweep across borders and are carried over long distances by the winds, not at local problems of pollution. The following are therefore likely to be main provisions of the protocol:

Either a freezing or a 30-per-cent reduction of emissions to be the basic requirement. (If however the proposal to allow a free choice of base year should be accepted, the measures required to achieve a 30-per-cent reduction will vary widely from country to country.)

Priorities for certain emissions in accordance with the POCP principle.

Each country to make inventories of VOC emissions in accordance with common guidelines.

Each country to set national emission standards, within two years of the protocol coming into force, for new stationary and mobile sources. The standards must accord with the requirements of a technical annex to the protocol. (There may be a demand at a later stage for measures applying to existing sources.)

As a second step, negotiations of further reductions based on the critical-loads approach.

There is already a plethora of scientific evidence of the direct and indirect effects of VOC emissions, with reliable model computations showing that reductions of at least 50 per cent are needed. In view of the danger of ozone formation alone, it will probably be necessary to consider reductions of at least 75 per cent. Nevertheless there are some countries that prefer to turn a blind eye to the facts, and are urging a wait of ten years before starting to reduce emissions at all.

In a common plan for dealing with air pollutants, which was adopted earlier this year, the Scandinavian countries have agreed to aim at a reduction of VOC emissions by 50 per cent from 1988 to 2005. The Netherlands for their part have decided to try and bring down emissions by almost 60 per cent, as from 1981 to the year 2000.

Although such aims are clearly inadequate from the general viewpoint of environmental protection, they probably give a good indication of what is politically and practically possible today. But for surer protection of ourselves and the environment against the effects of VOCs and ozone, the long-term aim must be a 75-per-cent reduction of the emissions of VOCs.

Christer Ågren

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Damage to crops

The losses to Swedish agriculture caused by high concentrations of ozone in the atmosphere amount to billions of kronor anually, according to recent research. It is estimated that about 10 per cent of the total harvest is lost in account of ozone. In terms of money this means between 1 and 3 billion kronor a year. In the view of the researchers the most likely figure would be 1.4 billion.

The study on which these figures are based was carried out by scientists from Sweden's University of Agriculture and IVL (the Swedish Environmental Research Institute). It covered autumn and spring wheat, autumn rye, barley, oats, potatoes, turnips, and sugar beet. Almost 90 per cent of the country's arable land is used for growing these crops. Actually leguminous plants, such as peas, were found to have suffered worst, but potatoes, wheat, and barley were also badly affected.

Christer Ågen

UNITED STATES

Acid rain report is finally presented

This last September the National Acid Percipitation Assessment Program presented a draft version of its final report. This report was commissioned by Congress in 1980 as a means of sorting out the scientific uncertainties about the causes and effects of acid rain. It was intended to help officials develop policies on air pollution.

By continually refering to this research project, the Reagan administration was able to put off taking measures to curb emissions all through the eighties. President Bush, on the other hand, put forward proposals for action as early as in the summer of 1989 - more than a year before the report of the Program was finally presented.

Oddly, the economic cost of the damage ascribable to acid rain is one of the important matters that the report fails to deal with. This seems all the more odd in view of the fact that the project itself, with the research it entailed, is said to have cost $537 million.

Controlling emissions

ACTIVITY FOR THE CONTROL of nitrogen oxide emissions has been considerable during the last few years. In order to meet new emission standards, most of the large coal-fired power plants in the former Federal Republic of Germany have for instance been retrofitted both for combustion modification and post-combustion treatment.

More than ten countries now have national limits on emissions of nitrogen oxides from coal combustion. These national standards vary from country to country, mainly on account of differences in typical boiler sizes, firing systems, and the type of coal that is being used, but also according to whether the boilers are new or old. The table shows the emission standards that are either currently in force or about to be implemented, in terms of milligrams of NO_2 per cubic metre (mg/m^3) of flue gas.

The nitrogen oxides formed during combustion consist mainly of nitrogen monoxide (NO), with a small part – on an average less than 10 per cent – of nitrogen dioxide (NO_2). The amounts formed depend principally on the nitrogen content of the coal, the combustion temperature, and the level of excess air. Measures are usually taken at the combustion stage as a first step towards reducing emissions, but where the limits cannot be met by combustion control alone, flue-gas treatment has to be applied as well.

Combustion modifications

Measures of this kind were first introduced in the seventies, and mainly in Japan, the United States, and West Germany. The technologies that were subsequently developed led to a new generation of low-NOx systems, which have now been applied in other countries as well, including Austria, Canada, Denmark, Finland, Italy, the Netherlands, Sweden, and the United Kingdom. By now different types of combustion measures are used at a total installed capacity of over 150,000 megawatts of electric capacity.

First as a means of reducing emissions come operational measures, such as fine tuning, balanced fuel-to-air ratios at each burner, and the reduction of excess air. Among further steps are air staging (for example over fire air) and low-NOx burners. Fuel staging (reburning) is used to reduce the NOx that has already been formed back to nitrogen, while flue-gas recirculation lowers the level of available oxygen through dilution and so the flame temperature.

The different methods of combustion modification yield differing results. Reductions of 25 to 40 per cent have been attained in West Germany through the use of low-NOx burners in combination with air staging. The advanced low-NOx burners that have recently been installed at some plants give a reduction of more than 50 per cent. From Japan come reports of emissions within a range of 300-600 mg NO_2/m^3 being achieved through a combination of combustion measures.

New combustion technologies

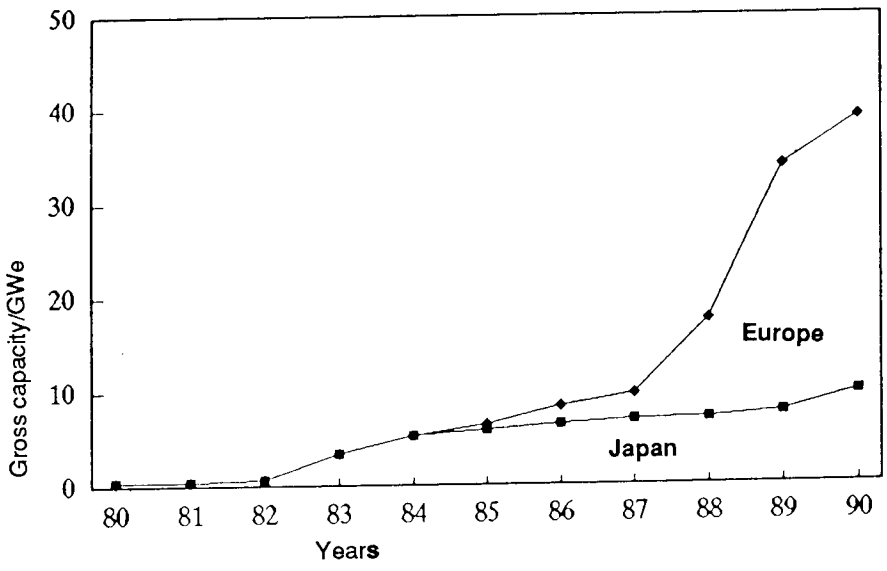
In some new technologies emission control is an integral part of the process. Among them is atmospheric fluidized-bed combustion (AFBC), which is being employed in an increasing number of plants. Here the combustion conditions, such as low combustion temperature, are conductive to low NOx formation. Similar conditions are found also in PFBC, pressurized fluidized-bed combustion. Three demonstration plants are now either under construction or starting up in Sweden, Spain, and the United States. Emission levels of 135 and 250 mg/m^3 are guaranteed in two of them, although to meet the lower limit measures such as the addition of ammonia may be required.

Another new technology, which is still at demonstration scale, is integrated coal gasification/combined cycle (IGCC). The reducing atmosphere existing during gasification means that most of the fuel-bound nitrogen is converted to nitrogen gas, although a small fraction may form ammonia. The most important source for NOx formation is the combustion chamber of the gas turbine. Here the conditions – intensive combustion, high excess air, and high temperature – favour the formation of NOx, the emissions of which can however be reduced by up to 80 per cent by using water or steam injec-

National NOx emission standards, currently in force or planned for implementation.

Country	New plants mg NO_2/m^3	Existing plants mg NO_2/m^3
Austria	200-400	200-400
Belgium	200-800	–
Denmark	650[1]	[1]
EC	650-1300	–
Finland[2]	200-400	400-620
Germany (incl. former GDR)	200-500	200-1300
Italy	200-650	200-650
Japan	410-510	620-720
The Netherlands	400-800	1100
Sweden[2]	140	140-560
Switzerland	200-500	200-500
Taiwan	600-850	600-850
United Kingdom	650	–
USA	615-980	–

[1] in addition to "bubble principle" for utilities
[2] conversion used: 1 mg NO_2/MJ = 2,7 mg NO_2/m^3



Total installed capacity with SCR in Japan and Europe (IEA Coal Research NOx Installations Data Base 1990)

tion. Among the effects of injection may on the other hand be lower combustion efficiency.

Flue-gas treatment

The methods that are now used for reducing NOx in flue gases are primarily selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR), as well as combined processes for the simultaneous reduction both of sulphur and nitrogen oxides. By the end of 1990 coal-fired plants with a total capacity of about 40,000 MWe will be fitted with equipment for flue-gas cleaning.

The clearly predominant method so far has been selective catalytic reduction. It involves the injection of ammonia into the flue gas in the presence of a catalyst (usually titanium-oxide based) to reduce NO and NO_2 to nitrogen gas and water. The catalyst can be put at different places in the flue-gas flow, the important factor being that it should be where the conditions such as flue-gas temperature are right, which usually means between 300 and 400 °C. Commonest is the so called "high dust" position between the economizer and the air preheater, where untreated flue gas containing SO_2 and particulates passes through the catalyst.

The SCR technology was developed in Japan, where the first installation at a coal-fired power plant came into operation in 1980. The first installation to start working in Europe was in West Germany, in 1985. Now plants fitted with SCR are in operation also in Austria and the Netherlands, while Denmark, Finland, Italy and Sweden are planning to install SCR units. In most cases, to meet an emission limit of 200 mg/m^3, the equipment is designed for a 70-80 per cent reduction. At a few plants, where the NOx concentrations in the flue gas are particularly high, a 90-per-cent reduction is aimed at.

The SNCR method is attractive because it requires no costly catalyst. Emissions of NOx can be controlled by using appropriate reducing chemicals, such as ammonia or urea. The reaction usually occurs at temperatures of 900-1100 °C. It can however be made to take place at lower temperatures if urea is used with additives.

The SNCR method results in lesser reductions of NOx than SCR, despite the higher consumption of chemicals it requires. The expected reduction is 35-50 per cent, but reductions up to 80 per cent are supposed to be attainable under favourable conditions.

There are now eight commercial installations (1700 MWe) in operation in western Germany and Austria.

Combined processes

Numerous processes have been developed for the combined desulphurization and denitrification of flue gases. Most of them are still on a laboratory scale, with only a few operating on a full commercial scale. Combined processes are moreover considered to be unduly complex and expensive. As more stringent standards become introduced both for SO_2 and NOx emissions, together with restrictions on residue disposal, opinion may however change.

What the West Germans are doing

The aim in the former West German republic has been to reduce the emissions of nitrogen oxides from power plants by 74 per cent by 1993 (counting from 1983). In other words, from almost one million to 250,000 tons (expressed as NO_2). Concurrently the emissions of sulphur dioxide from power plants are to be brought down by 80 per cent, from 2 million to 400,000 tons. In fact, reductions of 38 and 65 per cent had already been achieved by 1988.

Selective catalytic reduction is to be applied in power plants with a capacity of altogether 33,000 MWe, at an estimated capital cost of DM 7 billion. The corresponding cost for desulphurization, affecting 43,000 MW of electric capacity, is put at DM 14 billion. By 1988 there were 165 desulphurization plants in operation, or ready for it, at 72 of the West German power stations.

The additional cost per kilowatt-hour for applying both desulphurization and denitrification varies, but usually lies between DM 0.015 and 0.035, the average being 0.025 DM/kWh. Since only half of the total electricity demand is however generated in power plants equipped for desulphurization and/or denitrification, the average increase in electricity prices is likely to be no more than DM 0.013.

Danes to save and gain

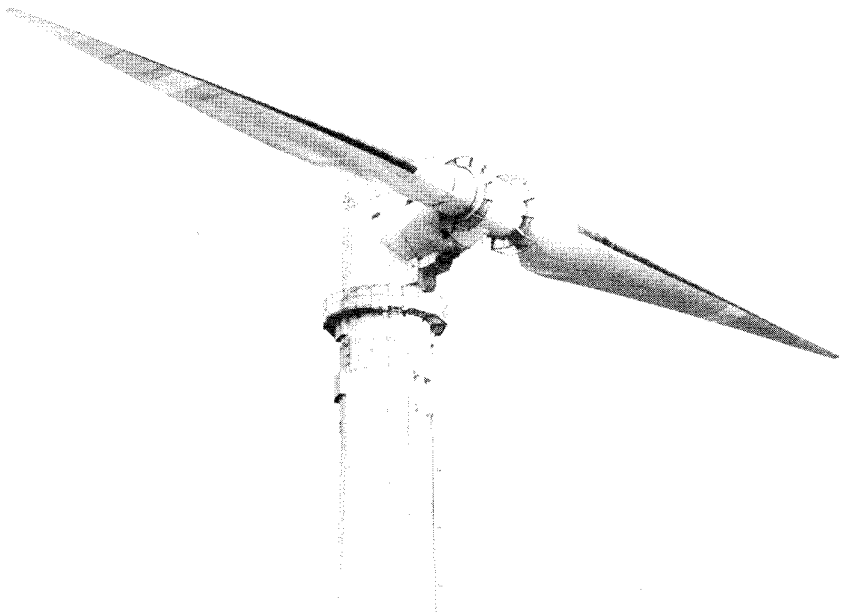
THERE IS a proposal in Denmark to reduce energy use by 15 per cent in as many years, and to halve it in fifty years. The ambition of the Ministry of Energy in putting forward its plan *Energi 2000* is to show how Denmark might lead the way among nations in fulfilling the recommendations of the Brundtland commission. A halving of the use of energy by the industrialized world within that period was precisely what this UN commission, the World Commission on Environment and Development under the chairmanship of the Norwegian Prime Minister Gro Harlem Brundtland, had called for.

The Danish plan proposes a broad decentralization of power production, from large coal-fired plants to small gas-fired ones, together with altered tariffs for power and heat, and greatly increased use of wind power, solar and geothermal energy, and biofuels.

It is further assumed that energy charges will be levied on industry. To avoid hampering export trade, however, the income so generated would be channelled back to manufacturers in the form of subsidies for energy-saving investments. Just how such a system would work has however not been made clear.

The following are among the means put forward for bringing about a more efficient use of energy.

- Energy consumption standards for refrigerators, freezers, and office equipment.
- Household appliances to be marked for energy consumption.
- Lower fixed charges in electricity and heating tariffs, together with higher charges for consumption, in order to encourage economizing.
- The government to set an example by applying, within three years, a sophisticated system for the analysis and control of energy consumption in its own buildings.



© KJELL-ARNE LARSSON

Danish plan includes greatly increased use of wind power.

If the plan is carried out, the energy sector's emissions of carbon dioxide are calculated to come down by almost 30 per cent, those of nitrogen oxides by 50, and of sulphur dioxide by 60 per cent – all between 1988 and 2005. The capital investments envisaged for the energy sector during this period would amount to 29 billion Danish crowns, while there would be a saving of 58 billion as a result of reduced energy use and lower cost for energy.

The plan has already been adopted by the Danish parliament. It is uncertain, on the other hand, how the EC commission will take it. In Denmark itself, scepticism has been shown mostly on the industrial side. Environmental concern has however already led to succesful export business, as in the case for instance of wind turbines and systems for flue-gas cleaning. There is also a complement to *Energi 2000* in the form of a plan for the transport sector.

Per Elvingson

Energi 2000 can be obtained from Statens Informationstjenste, Postboks 1103, 1009 Kobenhavn K, Denmark, at a price of DKK 60.

Many of the combined methods yield a refined by-product, such as sulphur or sulphuric acid.

The activated-coke process is one of those that have come furthest on a commercial scale, and there are now two installations in operation in western Germany, and one in Japan. Catalytic conversion both of SO_2 and NOx represents another combined approach, two processes being used – designated SNOX and DESONOX. Pilot and demonstration plants have been operating in Denmark and West Germany, and one is planned for the United States. The first full-scale installation has been ordered in Denmark and will start operating in 1991.

Among the other processes currently being planned for pilot operation are the irradation process, the copper-oxide, the NOXSO, and the SOxNOxROxBOx.

The results obtained for the reduction of NOx from coal-fired power stations are good. The tight emission standards of some European countries are already being met, and the abatement technologies have been well adapted and applied.

Anna-Karin Hjalmarsson

IEA Coal Research, London. Author of the report **NOx control technologies for coal combustion** (1900). Available from the publisher; IEA Coal Research, Gemini House, 10-18 Putney Hill, London, England SW15 6AA, at a cost of £180.

Acidification charted

ONE GREAT PROBLEM resulting from air pollution, which has received comparatively little attention, is the acidification of lakes and streams. When surface water becomes acidified, a marked impoverishment of biological life follows. Fishes, mayflies, molluscs, and plant plankton are among the most affected groups of organisms.

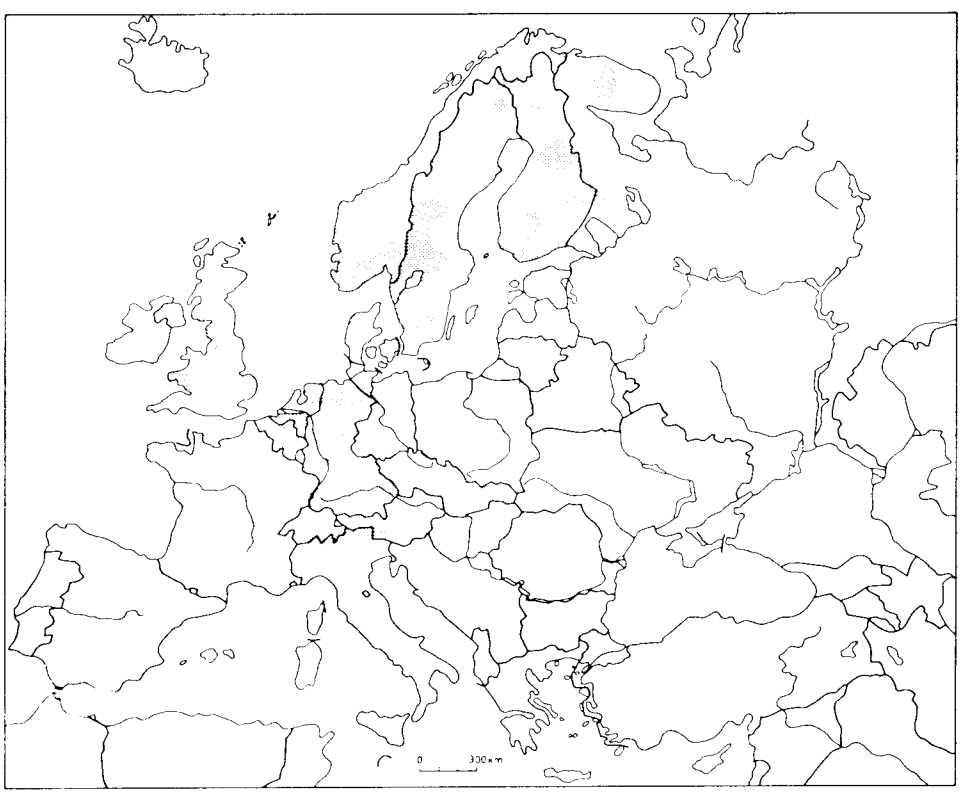
Most of the reports on the chemical and ecological effects of acidification have come from Scandinavia and North America. That the problem has wider significance appears however from a report* issued by the Nordic Council of Ministers.

The study comes in two parts, based on the one hand on computer models to determine where in Europe acidified surface waters can be expected, and on the other on a literature review and the answers to a questionnaire circulated to ECE countries. For the purposes of the study, acidification was defined as the continuing loss of natural acid-neutralizing capacity. This process is manifested as increasing hydrogen ion concentration (acidity) and/or declining alkalinity.

By computer processing a number of variables, such as the base cation content of the soil, its depth and texture, and the neutralizing capacity of the bedrock, a map was produced where Europe is divided into squares according to four degrees of sensitivity (from low to very high).

The next step was to combine the sensitivity with data on depositions of sulphur (from 1980). The result was a map showing areas with potential risk of surface water acidification. Where high sensitivity and high sulphur depositions coincide, the risk for surface water acidification is greatest.

Most of the areas with a very high risk of acidification proved to be in central Europe, but there were also others in the northwest of Spain, in the Alps, the Pyrenees, Romania, Hungary, Poland, northeastern and southeastern Finland, the southernmost parts of Norway and Sweden, parts of the west coast of Italy and the United Kingdom. Areas with a high risk appear, too, in Scandinavia, Poland, the USSR, and Hungary. A region that is in itself sensitive, but on account of low depositions of sulphur is not at risk, lies in the mountain border between northern Sweden and Norway.



Areas in Europe reported to have surface waters affected by acidification.

Only fifteen of the more than thirty ECE countries replied to the questionnaire. The replies and the information from the literature review have been put together country by country, and the maps show where in Europe and North America the surface waters are reported to be affected by acidfication.

It would appear from the computer calculations that the problem is more widespread in Europe than the map shows. The discrepancy is probably ascribable to the fact that in many parts the surface waters have been insufficiently investigated.

Per Elvingson

***Surface water acidification in the ECE region.** Nordic Council of Ministers. Miljörapport 1988:14 (with summary in English).

Country feeling its way

ENVIRONMENTALISTS played a considerable part in giving impetus to the revolt against Communist rule in Czechoslovakia. Their alarming reports on the state of the environment, coming on top of a growing awareness of the situation, were among the elements that aroused public anger.

Following the revolution, a new Czech Ministry of the Environment was quickly set up, with the greatly respected Bedrich Moldan as minister. When appointing staff, Mr Moldan selected many leading environmental activists, from former illegal as well as legal groups, and the same pattern was followed by Josef Vavrousek half a year later when creating a federal department of the environment.

The environmentalists' situation also changed in other ways. Activists continue to work for their various groups, but cannot afford to do this to the same extent as before. Groups that were legal under the old regime usually received government subsidies, or enjoyed other advantages such as cheap accommodation and mail charges, and even payment for some of their working time. Since this no longer applies, all groups are in difficulty for funds, office space and supplies. Landlords find it more advantageous to let property to Czechoslovak-American joint ventures than to impoverished NGOs.

There is also a drain of activists to other fields such as politics or business. Previously group activities had given young people opportunities for legal opposition and travel, but that is no longer the case.

New opportunities for environmental activity have on the other hand now arisen. Groups that used to be illegal have now become legal, among them the Ecological Society and the Ecological Bulletin. Other groups that have now appeared include Prague Mothers, Children of the Earth, The Ark, Rainbow Movement, and Ecoforum.

With the return of freedom, activists from all over the country quickly created the Green Circle, an umbrella organization that is open to groups and individuals alike, with the aim of coordinating activities and spreading information. It has run into practical difficulties, such as finding suitable office accommodation, as well as trouble due to disagreements over such things as to whether groups that were legal during the Communist period should be allowed to continue. Cooperation is however much easier at the local level.

The new era has produced not only new NGOs but also a Green political party. The latter had a chaotic start, since there were several such parties, some of which were accused of being provocateurs set up by the secret police and former communists. In the elections for the Federal and Czech parliaments, the Green Party failed to gain a necessary 5 per cent of the votes, although in the preceding opinion polls it had made a much better showing. Riding on 4 per cent of the votes, Green Party candidates gained seats on the other hand in the Slovakian parliament, where the threshold is only 3 per cent. There are also environmentalists among MPs representing the Civic Forum party, as well as its Slovakian twin, The Public Against Violence – but again mostly in Slovakia. For the coming local elections the Greens have entered into coalitions with other parties.

The environmentalist groups' lack of a joint policy on which to lobby is doubly unfortunate in view of the fact that the government has no clear environmental policy either. The new ministries are in any case unable to exert much influence, and the environment is not

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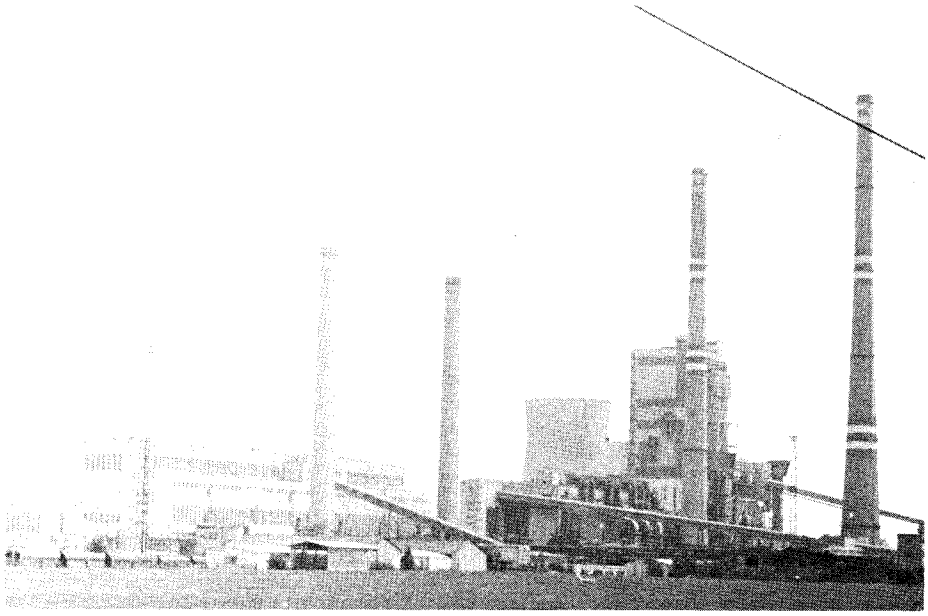

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regarded as particularly important by economists. Mr Kraus, who led the way to economic reform, and is strongly wedded to the idea of a free economy as the sole guarantee of any general improvement, was recently elected chairman of Civic Forum – which may be taken as indicative of the direction that this leading political constellation is now taking. In contrast, Vaclav Havel and his followers, with their emphasis on moral and human values, seem to be losing ground. There is no longer any discussion of a third way, either, such as there was ten months ago.

There is probably a common view throughout eastern and central Europe in regard to conservation and environmental friendliness generally. This mostly involves a lower level of consumption, with fewer throwaway products and less packaging, and also relatively cheap public transportation and less tourism. Threats now coming up include the chemicalization of agriculture and the possibility of environmentally unsound businesses moving in from the West. There is as yet no system of monitoring or legislation to cope with these.

Environmentalist attention is now tending to centre not so much on specific projects as on general government strategy. The government is inclined to phase out big coal-fired power stations in northern Bohemia, only to replace them with nuclear plants – despite opposition both from abroad and from within the country. Neither energy efficiency nor a reduction of consumption are matters of debate. International cooperation within the central European region seems definitely to be called for.

Government intentions are still not clear in regard to the much criticized Gabcikoyo-Nagymaros hydroelectric project on the Danube, although its completion may be expected. There are also other controversial projects such as the Danube-Ostrava canal and a proposal for mining gold with the use of cyanide to the south of Prague. It is greatly to be hoped that the urgency of Czechoslovakia's environmental problems, in combination with the global ones, will force this nation to find its way towards international cooperation.

Zdenek Dolezal

Solar heating

EVEN ON Sweden's northern latitudes, where the sun is low on the horizon for many months of the year, solar heating is now a practical alternative, according to the State Council for Building Research. It can best be applied for heating tap water as well as for space heating, especially in apartment blocks and one-family houses that are connected to some kind of district heating system.

Solar collectors can be placed on the ground, seprate from the buildings, as a complement to the district heating arrangements. In such case the capital cost is now about 5 kronor per annual kilowatt-hour, which spread over a 20-year period gives a solar heating cost of 0.4-0.5 kronor per kilowatt-hour, depending on the available financing facilities.

If solar heating is included in the design of a small housing project from the start, the collectors can be installed on roofs with a southern aspect. Solar equipment designed to provide a good part of the annual heat requirement will then account for less than 7 per cent of the total building costs.

Collectors with areas totalling altogether 80,000 m^2 are now being tried out at experimental stations in Sweden, and their effectiveness is being assessed by Chalmers University of Technology in Gothenburg.

During the last ten years great progress has been made in the design of highly efficient collectors, heat accumulators, and system technology. It has been demonstrated that large collectors in combination with heat accumulators can supply more than 60 per cent of the heating for a housing group. Installations with large collector surfaces (on a 12-sq-m module) can be built for about 1600 kronor per sq metre, and provide between 300 and 400 kWh/m^2 per annum.

According to a Chalmers study, solar energy can still not compete in cost with that from plants fired with fossil fuels. But the report also says that with mass production the collector cost can be brought down to about 700 kronor per sq metre. This should make solar heating fully competitive within a decade.

In a matter of years only, solar energy is expected to provide about 10 per cent of the country's heating requirements.

Reinhold Pape

Further information on solar heating projects in Sweden, as well as video films on the subject, can be obtained from **Jan-Olof Dalenback, Energiteknisk analys, Stiftelsen Chalmers Industriteknik**, Aschebergsgatan 55, S-411 33 Göteborg, Sweden.

"BLACK TRIANGLE"

Aiming at betterment

OCTOBER SAW THE SIGNING of a first tripartite agreement between environmental organizations in Poland, Czechoslovakia, and the former East Germany. This concerned the priorities for environmental action in the so-called Black Triangle.

During the last few years alarming reports had been coming out regarding the degradation of the environment in this border region where Czechoslovakia, Poland, and Germany meet. Here the effects of heavy pollution are evident not only in the destruction of forests and whole landscapes, but also in effects on human health. In some parts of the region life expectancy is four to five years lower than the average in these countries, and many think the causes lie in the polluted environment.

The name Black Triangle stems from the fact that energy production is largely based on coal which is mined here and burned in large power stations, in heavy industry and district heating plants, without any cleaning of the emissions, either of gases or dust.

Typical for the region are its ancient and energy-wasting industrial installations, and almost total lack of measures for environmental protection, with severe local results. Soil, vegetation, and food are contaminated.

Lately hundreds of delegations from western governments, aid agencies, and environmental groups have been visiting eastern Europe, but according to Polish sources only in 5-10 per cent of the cases has actual aid resulted. Big in promise, but little in fact. This was one of the reasons for arranging a seminar on transboundary air pollution in the Black Triangle last October, with the Polish Ecological Club in Katowice acting as host organization. Among those attending, besides forty or so participants from environmental groups in the three countries primarily concerned, were observers from western European and international NGOs.

The program included presentations of the emissions and effects of air pollutants in the three Triangle countries, as well as lectures on international strategies for abatement covering such things as the IIASA RAINS model, the ECE Convention, energy conservation and efficiency, the economics of nuclear power, and the possibilities of financial aid from the West.

From working groups where environmental priorities for the region were discussed there emerged the feeling that it was important of make some general statements concerning the policy that the local environmental movements would like to see adopted as soon as possible (see box). Some representatives from Upper Silesia said the immediate priorities in their case did not concern SO_2, NOx and ozone, but rather the contamination from heavy metals and waste. This was the most pressing problem, needing to be solved in order to improve the situation as regards human health. Some from Czechoslovakia on the other hand were afraid of the negative effects that might result from a continual black painting of the situation, affecting tourism and making the achievement of clean industry more difficult.

Working groups also dealt with energy policy, the problems of traffic and transportation, and the setting up of networks among environmental groups in the region. In one, pro-

Black Triangle Declaration on NGO Strategy for Transboundary Air Pollution within CSFR, Germany and Poland

Priorities for Action

- Decentralisation of decision-making processes for environmental legislation.
- De-monopolization of industrial structrures and resource management.
- New energy strategies based on energy saving and efficiency, the potential for de-centralized energy production and renewable energy sources, recognizing that nuclear power is not an appropriate alternative.
- Incorporation of environmental policy into all aspects of energy policy and industrial policy at national, regional, and local levels.
- Implementation of comprehensive environmental education programs to include decisionmakers, the public, teachers, students, and children.
- Participation of NGOs in decision-making.
- Free access to information on environmental, economic, and social issues.
- An immediate clean-up of environmentally damaging industries and the development of an energy efficiency stategy.
- A long term strategy for sustainable development.

Recommendations for National and International Policy

- "Special focus" strategies by national governments to provide information, resources, and management to solve environmental problems.
- Full discussion of the role of coal in the region including economic, environmental, social, and institutional aspects, paying particular attention to implementation of new clean-coal technologies.
- Emission standards for all new industry and for motor vehicles.
- Limits on road transport, to give priority to public transport.
- Formation of an international "league of friendship" between local governments in areas of environmental degradation throughout Europe.
- Renegotiation and strengthening of the existing tripartite agreement on transboundary air pollution between CSFR, Germany and Poland.

Issued by the Polish Ecological Club (Poland); Grüne Liga (Germany); Arche Netzwerk (Germany); Children of the Earth (CSFR); Brontosaurus (CSFR); Green Circle (CSFR); Ecoforum (CSFR). October 1990.

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posals were put forward for an international campaign on behalf of the Triangle. This would need a detailed strategy, with a list of concrete projects which should be developed within the next few months. It should show the environmental movements' prorities in regard to energy efficiency and alternative energy sources, as well as indicating which industrial and power plants should either be shut down or cleaned up. It is hoped that such a list could be presentd at a meeting of the environmental ministers from eastern and western Europe which will probably take palce next April in the Czechoslovakian capital of Prague.

This campaign will also be specially directed towards the World Bank, the Bank for European Reconstruction and Development (BERD), and western aid agencies generally. The participants of the working group felt it would be a waste of time to work for a European environmental fund, because of the lengthy international negotiations it would involve.

It is proposed to hold regular meetings of environmentalists from the Black Triangle. The next seminar, to be hold in northern Bohemia early in 1991, will deal especially with energy-saving stategies. There will also be bilateral seminars on potentially harmful border projects, such as the Stonova coking plant near Bratislava.

Reinhold Pape

A more detailed report on the Katowice seminar will follow in the next number of Acid News. Further information can also be obtained from Polish Ecological Club, Information Centre for Air Protection (ICAP), ul. Armii Czerwonej 2/220, 40-960 Katowice, Poland.

GREENWAY

Facing a new situation

GREENWAY, the eastern European Environmental NGO Network which was founded in 1985, is to continue its work with an improved organization. This was essentially what came out of its annual meeting on October 26-28 in Riga, the Latvian capital.

Attending the meeting were eighty representatives from the main environmental NGOs in eastern Europe. Particularly discussed was the risk of environmentally harmful industries from the West moving into eastern Europe – the existing east-west trade in hazardous waste being held up as a warning.

Another matter of discussion was the new political situation in eastern Europe. Although environmentalists undoubtedly played an important part in helping to bring about the changes last year, they are now clearly in danger of losing the struggle for environmentally sound development in those parts.

Just before the Greenway meeting the 5th East-West Cosultation took place, also in Riga. These consultations are arranged by the Dutch East-West Foundation. The possiblities, as well as the importance, of adopting EC environmental standards and legislation in eastern Europe were the main subject of discussion at this meeting.

Greenway is now to have a permanent office in Bratislava, and will be an officially registered organization in Czechoslovakia. Among sources of financial support will be CEAT, the continental European branch of Friends of the Earth. CEAT itself is running an East-West project under the name of *New Environment*, with two officers, one in Bratislava and the other in Brussels. Recently it held a workshop in Brussels, extending over ten days, to which fifty-five representatives of environmental groups from eastern Europe had been invited, on the subject of environmental legislation and institutions in the European Community.

Reinhold Pape

Questions concerning the above meetings, as well as subscriptions to Greenway's newsletter, should be addressed to Greenway, c/o SZOPK, Gorkeho 6, CS-81101 Bratislava, CSFR. Phone: +42-7-45264

Curb long-distance trucking!

ON NOVEMBER 15 environmental groups from all over Europe staged a common demonstration, coordinated by he European Youth Forest Action, against the threatening growth of truck transport. Road blocking and other forms of protest took place in Austria, Germany, the Netherlands, France, Denmark, Norway, Finland, Sweden, Poland, and Hungary.

The long-distance haulage of freight by road is fast increasing in Europe, and threathens to continue at an accelerated rate. According to an EEC Task Force Report on the environment and the internal market of November 1989, the opening of the market in 1992 will of itself lead to an increase in transborder traffic of 30-50 per cent. Extension to eastern Europe will be likely to double it by 2010.

More than 25 million trucks are already causing tremendous damage in Europe. Every year more than 10,000 persons are killed and hundreds of thousands injured in accidents involving trucks. Trucks' diesel engines also emit cancer-causing compounds, nitrogen oxides that give rise to acidification and ozone, as well as the major greenhouse gas, carbon dioxide. And millions of Europeans are being disturbed by the noise from trucks.

The EYFA group is urging the movement of long-distance freight by rail or in ships properly equipped for exhaust cleaning. As a means of financing this development, which would require huge investments, it proposes diverting the money that would otherwise be put into new road schemes, such as are favoured by the Round Table of European Industrialists. Big highway projects, it says, only generate more traffic.

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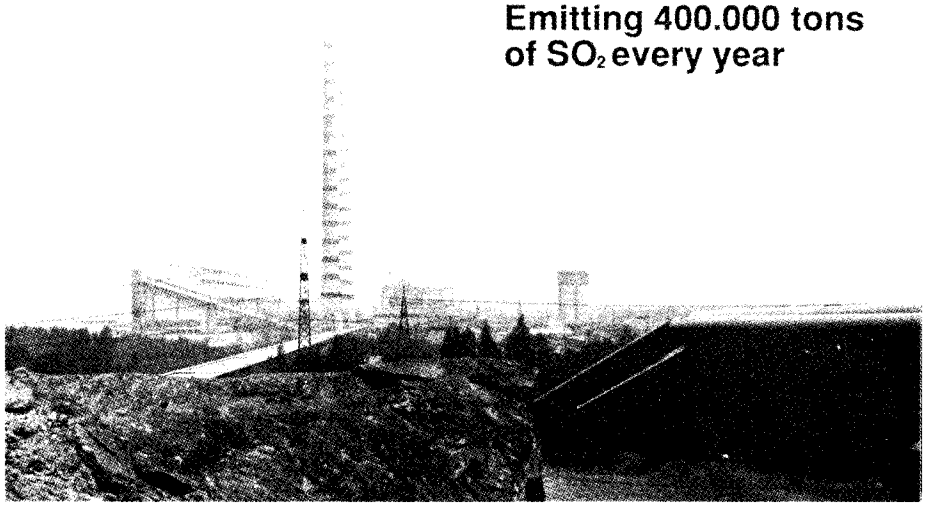
Among the demands in the EYFA action:

- Not one metre more of motorway.
- Extra taxes and restrictions on long-distance trucking.
- Financial support for railways and shipping equipped for exhaust cleaning.
- No acceptance of European Market as planned for 1992, since it is bound to lead to an increase in road traffic.
- More international cooperation for the protection of the environment and cultural exchanges rather than for unnecessary transportation.

The **address** of EYFA's international office is:
Postbus 56
NL-6131 AN Sittard
The Netherlands

Baltic emissions protest



THIS YEAR A POSTCARD campaign has been started by Swedish environmentalists in protest at the pollution from the Balti/Esti power plants in Estonia. Here some 23 million tons of oil-bearing shale with a sulphur content of 1.9 per cent are burnt every year. The annual emissions of SO_2 amount, according to the Estonian Green Movement, to nearly 400,000 tons. This puts Balti/Esti among the ten largest polluters in Europe. The postcards bear a printed text urging the Estonian Council of Ministers to modernize the plants without delay and install desulphurization equipment.