

The "Black" Triangle

A General Reader



*The problems of air pollution and some
proposals for abatement strategies
in the so-called Black Triangle region of
East-Central Europe*



The Swedish
NGO Secretariat
on Acid Rain

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Introduction

"Black Triangle" is the name used to describe, in a narrower sense, the region of eastern Europe where Poland, Germany, and the Czech Republic meet. If made to include Upper as well as Lower Silesia in Poland, the region around Ostrava as well as northern Bohemia in the Czech Republic, and the surroundings of Cottbus and Leipzig in East Germany, it may also be called the Sulphur Triangle.

Here there is an extensive mining of hard coal and lignite, mostly by opencast methods, coupled with numerous coal-fired power plants and much heavy industry. But there are also some famous national parks and great forests, which are visited by millions of tourists every year – although much of the area has already been damaged by air pollution.

Substantial aid for cleaning up has already been promised, for the East German part, by the Federal Government, and partially fulfilled. Although other western governments have also held out promise of assistance, especially for Poland and the new Czech Republic, little has so far come of it. There has likewise been little evidence of any result from an agreement concerning the Black Triangle environment that was signed in 1991 by Germany, Poland, and the former Czechoslovakia.

Here are presented proposals for ways of cutting down on the emissions that are causing so much of the pollution in the Sulphur and Black Triangle area, but within a relatively short time. Among them is one by Stefan Björklund, an energy consultant who is closely associated with electricity generating in Sweden and is a frequent visitor to eastern Europe. Another is by Jozef Gega, of the Technical University in Cracow, and also chairman of the Energy Commission of the Polish Ecological Club (PKE). The latter's report was originally made for the Cracow City Council, while Stefan Björklund's, written from the western point of view, was commissioned by the secretariat. There are also statements on various aspects of the matter that have been issued by environmentalist NGOs at recent international conferences.

Our aim with this publication is to provide a basis on which to start discussion of ways of reducing air pollution in the Black Triangle as simply and cost-effectively as possible, as well as giving reasons.

Reinhold Pape

The Swedish NGO Secretariat on Acid Rain

Proposals for a more efficient use of energy to curb air pollution in Poland and the Czech Republic

Stefan Björklund, Energy Consultant

This report has been written from a strictly economic viewpoint, taking into account both pay-off time and the cost benefit. This was deemed necessary because of the run-down state of the countries' economies and a great general need for investment in their infrastructures. In a capitalist economy the pay-off time is of course the most common criterion for the allocation of investments.

In formulating the recommendations of the study, the guiding principles have been:

- A quick implementation of environmental knowhow.
- Low capital intensity, to make up for lack of hard currency.
- Energy prices that are assumed to adjust to world market.
- Local manufacturing bases for environmental equipment.

With many other demands tending to take precedence, progress in environmental improvement has so far been slow. But because of the way energy is being wasted in Central and Eastern Europe, there can in fact be a good correlation between what is good for the economy and for the environment. Since the costs of energy will gradually have to adjust to world prices, saving energy can lead to increased profits, or at least to reduced losses, as well as benefiting the environment.

The most important thing is to get the process of saving started, giving priority at first to the simplest measures. The time for introducing advanced capital-intensive technology will come later, when the economy is improving. It would in any case take several years before large-scale investments could begin to take effect. By then, measures of the simpler type proposed here would already have begun to pay off – both in the economic sense and for the environment.

coal and lignite accounted for no less than 76 per cent of the total energy consumption in Poland and 55 per cent in Czechoslovakia. Some parts of these countries, such as Upper Silesia and northern Bohemia, are the most heavily polluted areas in Central and Eastern Europe.

Coal is mainly used for firing

- Household stoves.
- Small boilers of 0.1-10 MW_{th} supplying heat for buildings and industries.
- Medium-sized water boilers (10-50 MW_{th}) for district heating systems.
- Medium-sized boilers (10-50 MW_{th}) for industry.
- Large boilers (>50 MW_{th}) for power generation.

The most severe effects are often due to the innumerable domestic stoves and small boilers. In almost any town one can see thousands of chimneys and hundreds of short smokestacks pouring out black, evil-smelling smoke. The small boilers and stoves are also the most wasteful of coal.

Better stoking to reduce energy waste

Thousands of small boilers are being stoked by untrained persons, who work for low pay during winter. Their orders are to feed the boiler with a certain amount of coal per hour according to the temperature. A pilot project managed by a Swedish utility, Malmö Energy, showed it to be possible to reduce fuel consumption in small heating boilers by 30 per cent simply by teaching the stokers how to handle and maintain the boiler properly.

Training the stokers and changing their attitude would certainly be the quickest and least expensive way of reducing the emissions from the small boilers by 20-30 per cent. The pay-off on the investment can be estimated in days rather than years. A scratch training program for stokers should be set going as soon as possible. Western utilities and local-government authorities could

In Poland and Czechoslovakia coal burning has been the main cause of air pollution. In 1989 hard

contribute by sending stokers and technicians to share their energy-saving knowhow with the Poles and Bohemians.

Energy conservation by consumers and in the district-heating distribution system

In Central Europe the average energy consumption per square metre of building space is 20-50 per cent higher for a given temperature than it is in Scandinavia. Experience from a pilot project carried out by Malmö Energy in Katowice shows that by installing simple regulating equipment the heat consumption in apartment blocks can well be reduced by 30 per cent without any impairing of comfort.

There is a need to educate consumers and change their attitude to the use of energy. In a market economy with real-cost allocation, there will have to be substantial increases in the cost of heating. This will create an incentive for consumers to save money by conserving energy. The pay-back time for money spent on educating and changing the attitude of consumers can be counted in weeks or months.

There is an opportunity for western makers of heating and piping systems to establish a local manufacturing base for radiator valves and temperature regulators. The pay-off time for the most simple improvements, such as fitting valves, could be a couple of years.

The thermal insulation in housing is generally not very good. A standard for energy saving in new housing must be introduced. In areas with effective CHP the insulation standards should not, for economic reasons, be too strict.

In the Katowice area the energy losses in the district-heating distribution system amount to 40 per cent on account of leaking and uninsulated pipes. Relatively inexpensive maintenance might make it possible to reduce this figure by half.

In areas with district heating, a combination of stoker training and improved care of the boilers with the simple measures outlined above could reduce the specific coal consumption in apartment buildings by 50 per cent. The sulphur and dust emissions to air from small boilers would diminish to the same extent and a substantial improvement of urban air quality would result.

Abatement through improved efficiency

The needs to be met include:

- ☐ Technology transfer by licence.
- ☐ A quick build-up of knowhow in utilities and local equipment for environmental protection.

☐ Higher efficiency as the most realistic strategy to reduce pollution. Environmental investments must be combined with investments to increase efficiency in fuel use so that they will pay for themselves.

☐ Emissions of sulphur and dust are the main problem.

☐ Energy conservation policies to be integrated with modern economic policies with the object of making the economy more efficient and able to compete on the world market.

EXAMPLE: LIME INJECTION IN MEDIUM-SIZED BOILERS.

Medium-sized steam boilers (10-50 MW_{th}) provide steam for industrial purposes and heat for district heating. Some of the larger ones have simple back-pressure turbines for generating electricity. There are also several thousand coal-fired heating boilers. Many of these are very old, some built in the 1940s with still being in use after 300,000 operating hours. Approximately half of them have a remaining useful life of >80,000 hours.

Here again a first step should be to train stokers. There will also have to be reasonable investments in technology to improve fuel utilization and ensure proper maintenance. It may be assumed that in such case the operators will be better skilled in running their equipment, although fuel utilization could certainly be improved by 10-20 per cent through better training of personnel. The pay-back time for money spent would be very short.

With better skilled stokers and maintenance staff it would be worthwhile considering investment in new regulating technology, particularly for those boilers with a remaining life of 80,000 hours or more.

Lime injection in water-tube boilers can reduce the emissions of sulphur by 30-40 per cent. This is worth considering for boilers with an annual operating time in excess of 3000 hours. The investment would be \$ 10-40 kW_{th}. Fitting lime injection to a typical 20 MW boiler costs approx. \$300,000. For a typical base-load boiler with 4000 hours annual operating time, burning 30,000 tons of coal with 1 per cent sulphur, the reduction can be 200 tons of SO₂ a year.

Investment in sulphur-reducing equipment can only be worthwhile if combined with fuel-saving arrangements and training of stokers. Lime injection requires skilled operators to be effective. There have been several cases in Poland where expensive western equipment has performed badly through being improperly operated.

Selecting a few types of boilers, manufactured in fairly large series, would make it possible to



achieve considerable economies of scale and result in a lower cost for installation.

Coal washing

In the Katowice-Gliwice area the coal-mining industry has started to build pilot plants for washing and upgrading coal at the pits. The aim is to get rid both of ballast, up to 30 per cent, and pyrite sulphur. The cleaned coal will be briquetted and used for domestic stoves and very small boilers. Experience from the United States indicates that the sulphur content can be brought down to 0.6-0.8 % S. A great benefit is that with clean coal there is less need to dispose of large amounts of ash. The cost of reducing the sulphur content in this way is estimated to be comparable to that of lime injection.

It has not yet been demonstrated that washing can be feasible for cleaning lignite, and it is not being considered either on the Bohemian or the Polish side.

Expanding combined heat-and-power generation

There is a great potential for an increased use of CHP. Although there are several large condensing power plants around Katowice, for instance, heat for the district system comes from separate boilers without any generation of power. The same situation exists in towns such as Most, Litvinov, and

Teplice in Bohemia. In Poland a few large power plants, such as Dolna Odra and Opole, have recently been equipped with co-generation turbines connected to district heating. Some Polish towns, among them Chorzow and Zabrze, have very old and inefficient plants for co-generation. The large condensing power plants utilize only 30-35 per cent of the primary energy for electricity. The rest is lost in cooling.

In Poland the closing down of many industries had led to a fall-off of 15 per cent in the demand for electricity in 1990-91. Most of the proposed investment in new efficient CHP stations has in any case come to a standstill for lack of funds.

By integrating district-heating networks into larger units and connecting them to large power plants, old and inefficient heat boilers could be shut down. Primary energy can be better utilized by tapping low-pressure steam from the large condensing plants. The installation of more CHP would also enable the total emission of pollutants be reduced, although it should of course be combined with rudimentary investments to reduce waste in the distribution systems. But in a situation where money is hard to come by, energy saving in distribution and housing would not have top priority in CHP-connected systems. Most of the energy that might be saved in the networks would in any case be wasted in cooling towers.

If funds for new construction should become available in the mid-nineties, new CHP plants with high electrical efficiency, and sophisticated desulphurization and denitrification, should have top priority. In most cases it will be convenient to put the new construction on old sites with their existing infrastructure.

Large power stations

POLAND: HARD COAL

Half of the installed electrical capacity is in power plants built before 1975. They will all be over 20 years old before it will be possible to fit any sophisticated equipment for flue-gas desulphurization. With the possible exception of Kozinice, southeast of Warsaw, these plants should be shut down and replaced with new ones if there is still a demand for the power.

When it has been commissioned in the next few years, the new plant in Opole (6x360 MW_e) will have been fitted for 90 per-cent flue-gas desulphurization. The first part of the plant to be built will have a less sophisticated scrubber.

The following plants (7000 MW) are less than sixteen years old. It should be feasible also to

equip them for flue-gas desulphurization, if funds are available within the next few years.

POLAND: LIGNITE

There are two large lignite-fired power stations Belchatow near Lodz and Turow near the Czech and German border. They are supplied from several large opencast mines.

Belchatow is today probably the largest single source of sulphur emissions (500,000 tons SO₂) in Central Europe. This holds true even if the sulphur content of the lignite is only 0.64 % S. Belchatow, built between 1970 and 1990, consists of twelve units, each of 360 MW_e. The emissions of sulphur from this plant are a major problem for whole of Europe. It will cost more than \$600 million to equip it for 90-95 per cent desulphurization of the flue gases. The construction time might be six years or more if the plant is to operate with a reasonable load factor. Belchatow is the mainstay in Poland's national power supply.

Turow (10x200MW_e) consists of three different plants near Bogatynia on the River Neisse. On the other side of the river, in Germany, are two large lignite-fired power stations, Hagenwerder and Hirschfelde, each of 1700 MW capacity. Turow was built in the 1960-70s. It is doubtful whether the whole complex is worth a large investment in flue-gas desulphurization. There are plans to extend its operating life to 2025 by spending \$500 million, in this case it must of course be fitted for 90-per-cent desulphurization.

Two older plants at Adamow and Konin are to be closed down before the turn of the century.

NORTHERN BOHEMIA: LIGNITE

The sulphur content in the lignite from northern Bohemia is considerably higher (1.5%) than in that from Poland. Less than half of the total generating capacity, 3000 MW_e, has been built since 1975. The emissions from the newer plants amount approximately to 600,000 tons of SO₂ a year. It may be worthwhile to consider fitting the following for flue-gas desulphurization.

All the plants are in a run-down condition, the CSFR electricity board having invested mostly in

nuclear power during the eighties. The lignite plants will need refurbishing before any investment in expensive flue-gas desulphurization can be considered. Some older plants may have a potential for lime injection.

New CHP plant in Chorzow, Poland

The Chorzow power station is located in the most polluted part of the Katowice area. Energoprojekt, Katowice, intends to build a new coal-fired CHP plant of 165 MW_e/586 MW_{th} on the site of an old power station, commissioned in 1898 and still in use with equipment from the forties. The new plant will have modern fluidized-bed boilers with 90% S reduction, made in Poland. Estimated cost: \$200,000,000. The project is in an advanced stage of planning, but funds still have to be secured.

Ledvice power station

Situated in northern Bohemia between the cities of Litvinov, Most, and Teplice, this project could be an interesting show piece in the mid-nineties. The present Ledvice condensing plant has a capacity of 640 MW_e. It was built in the sixties and is now due for modernization. The district heating for neighbouring cities is at present supplied by water boilers with no CHP turbines. The total emission of sulphur dioxide in the area is estimated to be approximately 160-200,000 tons a year.

One proposal would be to integrate the cities' district-heating networks and to build a new efficient CHP block at Ledvice, with a capacity of approximately 250MW_e/330 MW_{th}. With 90-per-cent sulphur abatement and 85-per-cent total fuel utilization this new plant could result in a reduction of sulphur emissions by more than 100,000 tons a year and while substantially reducing the use of lignite. The total investment would amount approximately to \$500,000,000. It might eventually be financed by exporting 16 TWh of electricity during the first eight years after commissioning.

Name	Capacity (MW _e)	Built	Load factor (%) 1989	CHP possible
Jaworzno III	1200	1980	56.6	Katowice
Rybnik	1600	1975	69.9	?
Dolna Odra	1600	1977	55.1	Szczecin
Laziska	1040	1980	56.8	Katowice
Polaniec	1600	1982	56.2	no

Data from Coopers & Lybrand Deloitte, January 1991.

Name	Capacity (MW _e)	Commissioned	ton SO ₂	CHP possible
Pocerady 2	400	1977	48,000	no
Tusimice 2	800	1974-76	127,000	no
Prunerov 2	1000	1981-82	185,000	no
Melnik 3	500	1980	43,000	no
Ledvice	660	1967-69	44,000	Most-Teplice

APPENDIX I

Data on some of the large power plants in Poland and northern Bohemia. Compiled from various sources, base year 1989.

The figures relating to Poland are from a report entitled *Government initiative on environment fund*, August 1991. Other sources give much higher figures for sulphur emissions from Polish power plants. It is not possible within the scope of this

brief report to make an analysis of the differences in the emission figures.

The data from northern Bohemia comes from the Czech power board. It also relates to 1989, but seems to be more reliable than the Polish.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1														
2	Poland													
3	Name of plant	Rate	Age	Fuel	Cal val	Consumption	Sulphur	Term input		Elec prod	Emission			
4		MWe	Year	type	GJ/t	Kton/year	%	TJ /Y	TJ/GWh	GWhe /Y	t SO ₂			
5														
6	Lignite													
7	Belchatow	4320	0-7	b	7,47		0,64				112000			
8	Konin	555	30	b										
9	Turow 1-3	2000	20	b	8		0,5				171000			
10	Adamow	600	25	b										
11	Patnow	1645	20	b	7,7		0,88							
12														
13	Katowice area													
14	Rybnik	1720	15	h							70000			
15	Jaworzno	1640	20	h							100000			
16	Laziska	1040	20	h										
17	Lagisza	840	20	h										
18	Siersza	740	20	h							61000			
19	CHP													
20	Skawina	550		h										
21	Blachownia	280	20	h										
22	Bytom	120	5	h										
23	Bielsko Biala	105	25	h										
24	Halemba	100	25	h										
25	Zarbze	25	17	h										
26	Projected													
27	Skawina	400	1996											
28	Katowice	100	1998											
29	Zarbze	100	1998											
30	Bedzin	20	2000											
31		50	1997											

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Name of plant	Rate	Age	Fuel	Cal val	Consumption	Sulphur	Term input		Elec prod	Emission				
2		MWe	Year	type	GJ/t	Kton/year	%	TJ /Y	TJ/GWh	GWhe /Y	t SO ₂				
3															
4	Bohemia/Moravia									65189					
5	Komorany			b	10,6	1574	1,55	16684	12	1390	48794				
6	Opatovice			b	10,6	2160	1,38	22896	12	1908	59616				
7	Chvalovice		77-78	b	10,6	2894	1,04	30676	11,9	2578	60195				
8	Ledvice	640	67-69	b	11,5	2658	0,82	30567	11,8	2590	43591				
9	Pocerady 1	800	70-71	b	10,2	5293	1,03	53989	11,6	4654	109036				
10	Pocerady 2	400	77	b	10,1	2334	1,04	23573	11,6	2032	48547				
11	Tusimice 1		63-64	b	11,1	3254	1,45	36119	12,59	2869	94366				
12	Tusimice 2		74-76	b	10,6	3915	1,63	41499	11,98	3464	127629				
13	Prunero 1	660	67-68	b	10,7	2338	1,65	25017	12,39	2019	77154				
14	Prunero 2	1000	81-82	b	11,1	5990	1,54	66489	11,15	5963	184492				
15	Detmarovice		75-76	h	19,3	1668	0,85	32192	11,5	2799	28356				
16	Oslavany			h	16,1	229	2,79	3687	12	307	12778				
17	Hodonin		54-58	l	8,79	1109	1,27	9748	12	812	28169				
18	Oktovice			b	13,1	412	2,03	5397	12	450	16727				
19	Olomouc			b	11,7	298	2,85	3487	12	291	16986				
20	Melnik 1		60-61	b	10,3	1793	1	18468	12	1539	35860				
21	Melnik 2		70-71	b	10,4	1683	1,04	17503	12,16	1439	35006				
22	Melnik 3	500	80	b	10,3	2106	1,03	21692	11,53	1881	43384				
23	Tisova			b	10,9	2546	1,59	27751			80963				
24								0							
25															
26	Total above					42586		455243		32290	1123293				
27															
28				b = brown coal											
29				l = lignite											
30				h = hard coal											
31				o = heavy oil											

APPENDIX II

Projects to be promoted by environmentalist organizations

Education and build-up of competence is needed in the local practical field of designing, building, maintenance and operating of environmental technology in a commercial world. Better training of machine operators and technicians could give a substantial improvement of economy. At present many experienced technicians, between 50-60 years of age, are now being made redundant through rationalization. These are people with a lot of experience from western utilities and industries. It might be of interest for some of them to be employed as technical advisers in Central and Eastern Europe. In Germany and Denmark there are for instance many individuals with experience of boiler maintenance. In Sweden there are also many with experience of district heating and water distribution. The Swedes have also been pioneers in sewage treatment.

Because many of these have a pension from their employers, some might be interested in working as advisers for a modest fee. This might be arranged as a program by twinning towns and other areas of local government.

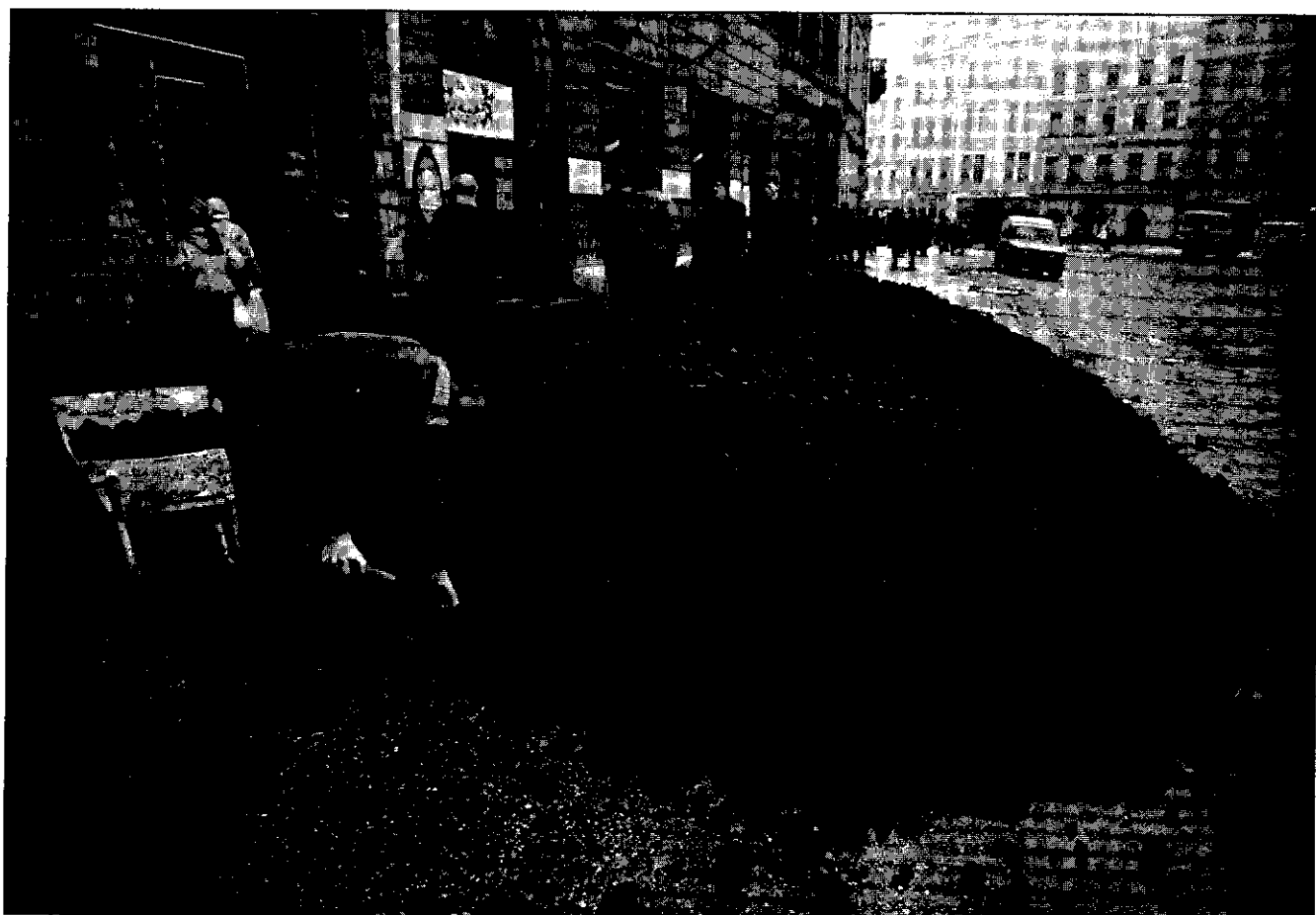
Four plants for heat and power should be presented in detail as a model for a campaign. They should be located in the most heavily polluted areas. To be able to present a credible assessment of the cost of rehabilitation, further information will be needed about the cost of manufacturing the equipment by local industry.

Cooperation should be arranged without delay between western utilities and Poland and the Czech Republic to improve plant management, as should

☐ Work for energy saving in district-heating systems.

☐ Start of two lime-injection projects for medium boilers.

To be able to present credible projects for the last, which could be implemented quickly, data is needed, in particular for medium-sized boilers with a capacity of 20-50 MW_{th}, built in the 1960s and 70s with a remaining life of not less than 100,000 hours. One should be situated in North Bohemia and another in Silesia.



ANDRÉ MANIENNIKOV

Ways toward an efficient heating system for Cracow

Józef Gega, University of Mining and Metallurgy, Cracow

At present hard coal in various forms is the basic source of energy for the heating system in Cracow – natural gas, electricity, and fuel oil only being used to a marginal extent. The main sources of heat are a plant for the combined generation of heat and power, various industrial and district heating installations, and domestic stoves.

Being almost entirely coal fired, heat and power production accounts for about 35 per cent of the air pollution in Cracow, in the form of particulates, sulphur dioxide, nitrogen oxides, hydrocarbons, and carbon dioxide. Most of these come from some 1360 small boiler plants and about 200,000 domestic stoves. Most of the small boilers, which provide more than 30 per cent of all the heat, are concentrated in the historic parts of the city.

Because of the environmental situation, the entire heating system in Cracow needs to be re-engineered. The use of coal will have to be restricted and the heat-producing sources changed, together with the distribution networks for electricity, district heating, and gas. City development, as well as the need to phase out local boiler houses and home stoves, will require an extension of centralized heating. In this way greater efficiency can be achieved in the conversion of energy, together with a reduction of the effects of burning solid fuels.

Centralized heat production and distribution

The following plants for the production and distribution of centralized heat are operating within the present system.

LEG COMBINED HEAT-AND-POWER PLANT

Construction begun in 1970 (first boiler WP-70). Present peak capacities: Hot water 1540 MW_{th} (available capacity 1320 MW_{th}). Steam 120 MW_{th}. Combined 1540 MW_{th}.

To complete this base for the city heating system will require investments in WP-120 boiler No.7

(top boiler) and the thermal unit BC-100 No.5 (5th construction stage) to allow the Leg plant to reach a design capacity of 1670 MW_{th} for hot water and 120 MW_{th} for steam. The increment in thermal capacity would then be 160 MW_{th} for WP-120 and 179 MW_{th} for BC-100, or altogether 349 MW_{th}.

No especial time schedule is proposed, but considering the possibilities of utilizing the waste energy from the production of electricity, it would be advantageous to concentrate first on the thermal unit, and let the top boiler follow. Among the other investments that are necessary for the reliable and efficient functioning of the whole thermal system are:

- New technical solutions to allow continuous regulation of the circulating pumps. This is essential for the automation of the network and the introduction of heat metering at the consumer end.
- Enlargement of the capacity of a water-softening plant from 360 Mg/hr to 500 Mg/hr, and enlargement of the retention capacity from 2000 Mg to 5000 Mg, in order to improve the reliability of the system, especially when starting up and in case of a breakdown in the network.
- Creation of a dispatch room together with a partial rebuilding of the distribution network.
- Measures to restrict the emissions of NO_x and arrange the desulphurization of the flue gases.

SKAWINA HEAT-AND-POWER GENERATING PLANT

The disposable power achieved after the first stage of rebuilding in 1990 is 220 MW_{th}. The disposable thermal power drawn from this is 100 MW_{th}. Heat is primarily supplied to the city of Skawina, but any surplus can be used for Cracow. With the intermediate pumping station that is planned, it will be possible to supply more to Cracow even with the existing source power of 220 MW_{th}. As more turbines become modernized, the design capacity can be raised first to 380 MW_{th} and then to 440 MW_{th}. By 1997-98 the final design capacity of the Skawina plant will give a disposable power of 600 MW_{th}. By the year 2000 the total additions of thermal power will have amounted

to 500 MW_{th} if all the planned expansion comes about.

The extra heat will be used for a city district that is at present supplied from the Leg plant. The resulting surplus will provide for the needs of new consumers, as well as making for the elimination of low-level emissions.

COMBINED PLANT AT HUTA SENDZIMIRA STEELWORKS

This CHP plant started supplying heat (85 MW_{th}) to the Nowa Huta district in 1960, and an increase in capacity to 173 MW_{th} in 1965 enabled further small boiler installations to be closed down. The supply subsequently dropped, (being made up for by Leg) to 70 MW_{th} in 1977, until it finally stopped when the plant broke down. When put back in service in 1987 it could supply 39 MW_{th}.

KRAKOWSKIE ZAKLADY SODOWE SODIUM PLANT

Heat began to be supplied from here in 1974 after the addition of a thermal unit financed by the city of Cracow. The capacity is now 18.6 MW_{th}, with the possibility of a temporary increase to 23.2 MW_{th}. Since the sodium plant is to be sold off, however, heat will have to come from the Leg plant instead.

Almost half of the city's needs for heat are provided through the district-heating system, with a total pipeline length of 630 kilometres. The pipelines radiate out from the generators, without any cross-connections between them. This situation needs remedying, not least to increase the reliability, which is at present inadequate. Later developments of the system should include new heat sources (for instance burning liquid fuel) placed well away from the present ones.

Coal and the alternatives

The burning of practically nothing else but coal is the main cause of the excessive air pollution in Cracow, especially in the historic centre. The pollution comes mainly from the numerous small boilers (some of which may burn coke) and the domestic stoves. It tends to hang only a few metres above ground level, and on the frequently windless days with temperature inversions can constitute a serious danger to health and the environment.

There is a tendency all over the world today to switch from solid fuels to natural gas as a source of energy. For Poland, too, the forecasts indicate a decline in hard-coal and lignite mining after the year 2000. The drawdown is likely to be due mainly to the increased expense of mining and processing as well as to probable environmental charges. This trend is in fact already evident, as

Table 1. Information about some fuels and electricity.

Fuel, electric energy	Unit	Heating value (MJ)	Sulphur contam. (%)	Ash contam. (%)	Unit price (zł)
Large coal I (Wujek mine)	kg	31	0.5-0.6	5-8	890
Nut coal II	kg	30	0.5-0.7	5-9	860
Nut coal II (Mysłowice mine)	kg	23	>1.0	8-12	760
Pea coal (Sierza mine)	kg	21	1.2-2.0	10-12	500
Natural gas	m ³	34.3	-	-	1940
Fuel oil	dm ³	41	-	-	3300
Electric energy	kWh	3.6	-	-	638
Ditto, tariff II	kWh	3.6	-	-	319

the price of Polish coal has already risen above world prices, and if account is also taken of efficiency in heat production, natural gas will be found to be relatively cheaper. See Table 1.

The sector in which energy saving can particularly pay off is the space-heating system. From an economic point of view, the right choice of fuel for small boilers and domestic stoves can be highly important.

Because of their low sulphur content, the first three sorts of coal listed in the table are acceptable for use in Cracow. Because of their effects on the environment, on the other hand, the cheaper sorts from mines such as the Sierza, with a high sulphur and ash content, should not be used.

It should be noted that the listed prices do not include the cost of any intra-urban transport, local storage, or the removal of ash and slag. Nor do they include the cost of effects on the environment.

In calculating the price per unit of thermal energy produced by the various fuels, the following thermal efficiencies have been used:

$n = 40\%$ for small boilers

$n = 25\%$ for domestic stoves

The equivalents for natural gas and heating oil are 75% and 92%, which shows their relative advantage.

It will be evident from Table 2 that the greatest benefit can be obtained by the use of natural gas and even electricity instead of coal in domestic stoves. The price would be halved and the environmental effects minimized. The price of thermal energy from gas in small boilers appears comparable to that from the use of coal only because some of the costs of the latter – local transport, ash removal, environmental damage – are not included. Substituting gas for coal would thus be fully motivated in this case too. If priced on the 2nd-rate tariff, electricity could be used in places not reached by the piped heating system. Apart

Table 2. Prices per unit of fuels' heat energy and useful consumer energy.

Fuel, electricity generation	Inherent heating-unit price	Useful heating unit price from	
		small boiler	domestic stove
Large coal (Wujek mine)	28.70	71.75	114.80
Nut coal II	28.60	71.50	114.40
Nut coal II (Mysłowice mine)	33.00	82.50	132.00
		Unit price at n=75%	Unit price at n=92%
Natural gas	56.56	76.40	61.48
Fuel oil	80.50	107.31	87.50
Electric energy (tariff II)	88.61	—	88.61

from its being good for the environment, this solution has the advantage of requiring only low investments for connecting up.

The coal used for district heating is not considered here because there are no economic substitutes – the prices being negotiated with the mines on long-term contracts.

To show what can be gained from energy saving, the relative costs of heating one square metre in a private apartment in Cracow and Helsinki are shown in Table 3. One of the main reasons for energy saving being so effective in Finland is that people have been able to see the benefits accruing from their own efforts.

If energy saving is to be made possible and worthwhile in Cracow, metering and regulating devices will have to be installed in all apartment buildings connected to the district-heating system's local boiler plants. Insulation and advisory services will also be required if heat losses are to be reduced.

Nearly 60 per cent of the natural-gas market in Poland rests on supplies from the former Soviet Union at a price of US \$0.10/m³, the rest being supplied from much cheaper Polish sources. The price of electricity from Polish power and CHP plants ranges from 190 to 300 zł/kWh. The figure given in Table 4 is explainable by differences in

Table 3. Amount of energy required to heat 1 m³ of a 50-square-metre apartment in Poland and Finland.

	Heating average demand (MJ/m ³ -year) for	
	Poland	Helsinki (Finland)
Present value ¹	350	149
Planning value ²	320	124
Planning value ³	285	—

¹ Poland's heating demand 2.35 times higher.

² Poland's planned demand 2.6 times higher.

³ Poland's planned heating demand in 2015 ca. 2.3 times higher.

the quality of the generating equipment and in the price of the coal that is used.

Although the price of heat has been doubled, it is still being subsidized, with consequent market distortion. This also intensifies the problem of pollution, since all the power-generating and CHP plants burn either hard coal or lignite.

The district-heating system in Cracow, with its extended distribution lines, is very inflexible, allowing little possibility of reacting to temperature changes. Its efficiency is very low, and the heat losses in distribution are considerable.

Modern power and CHP systems are now tending worldwide to the use of natural gas. Gas-fired energy production is steadily on the increase, and may already constitute between 20 and 60 per cent of any country's output (the 60 per cent is in Japan). Given therefore the current market situation, with growing supplies and attractive prices for natural gas, and also promising forecasts of new finds and the increasing cost of solid fuels, the heating system in Cracow should develop in the direction of using less coal. Coal should in fact be used only at the big heat-and-power generating plants at Skawina and Leg.

The aim for the big centralized heating plants should, besides cutting back on the use of coal, be to bring about greater flexibility and efficiency, as

Table 4. Average cost of heating an average apartment with various fuels and an energy consumption of 350 MJ/m³ per year. All costs in million zlotys per year.

Fuel	Heat cost at n=100%	Heat cost	Heat cost	Cost from district heating system or local boiler
		with boiler at n=40%	with stoves at n=25%	
Large coal I ¹ (Wujek mine)	1.26	3.15	5.00	—
Nut coal II ² (Mysłowice mine)	1.45	3.62	5.80	—
		Unit price at n=75%	Unit price at n=92%	
Natural gas	2.48	3.30	2.68	—
Fuel oil	3.52	4.10	3.88	—
Electric energy	3.86	—	3.86	—
District heating				
—subsidized*	—	—	—	2.49
—without subsidy**	—	—	—	6.00

* Unit price at current 4150 zł/m³ a month.

** Unit price at real cost of 10,000 zł/m³ a month.

As will be seen from the table, the costs of using coal or gas for firing small boilers are about equal (provided only the contract price for coal is considered), and only half as much when using gas or electricity instead of coal in domestic stoves.

New attitudes on the part of consumers and producers to the use of energy will be necessary in view of the changed market situation in Poland, with new prices for gas, electricity, and heat. The new prices for natural gas (1940 zł/m³) and electricity can now be regarded as comparable to those prevailing outside Poland.

well as to enhance environmental safety. This rather than increasing their capacity. Effort should focus on improving the efficiency of plants presently in operation, as well as on closing down the smaller local boiler installations. The development of future heating systems should be based on analyses of the comparative costs of using coal and natural gas. For Cracow however the heating system should in any case rest on the use of natural gas or electricity for every kind of installation except the big centralized plants.

Because of the drawdown in steel output at Huta Sendzimir, the use of natural gas there has been cut from about 700 million Nm³ per year to about 450 million. There is thus a good possibility of using the steelwork's plant (reducing stations, storage tanks) for a district-heating system.

Because of the complicated nature of a change-over from coal to natural gas and electricity, especially in the densely populated city centre of Cracow, the phasing-out of coal cannot be rapid, but will have to be carried out gradually up to the year 2000.

At the consumer end

As already mentioned, about 84 per cent of the non-industrial heat supply in Cracow is provided by the centralized heating system.

Residential premises have cast-iron or sheet-steel radiators with a surface area dimensioned according to the space that has to be heated. The heat is intended to be regulated by control valves on the radiators, but with age the valves begin to leak and become ineffective, so the indoor temperature can only be regulated by opening windows. Effective control valves usually have auto-regulating devices which ensure maintenance of a constant indoor temperature and eliminate the need for continual readjustment leading to leaks.

It would seem necessary to make metering and regulating equipment mandatory for such premises. In this way a great amount of energy could be saved. There are many kinds of device on the market, and fitting them would pay for itself in a very short time. Since even minor adjustments of temperature are impossible in the centralized system, this is the only reasonable solution.

Those dwellings not connected to the district heating system, amounting to about 16 per cent of the total, are heated by some 200,000 coal-fired stoves. Most of them are tile stoves, and some are

very old. They are inefficient, partly because the coal is not completely burned – unburned hydrocarbons and gases absorb heat and are released into the atmosphere. Some heat is also lost because it is absorbed by the ash which results from the incomplete combustion of the coal. The efficiency value is $\eta=25\%$, only 25 per cent of the heat value of the fuel being utilized.

Priority should be given to phasing out these stoves and replacing them with high-efficiency types using gas or electricity. High-efficient gas systems are well understood and widely available, and should be preferred. There are various kinds of electric heating already in use, but more extensive use of electric heating will require new cable networks and transformer stations.

Ways to achievement

To ensure proper development of the Cracow heating system it will be necessary to bring the Leg power plant into municipal ownership, and arrange local management for all the production and distribution of heat. The present situation, with Leg in state ownership and the distribution network in the hands of local government, does not allow for any real improvement. Centralized management is needed to avoid the inertia and arbitrariness of the present system.

Models for further changes in statutory regulations and management policies should be based on analyses and evaluations of the steps so far taken. Current operations should be evaluated and improved as new knowledge is acquired.

Appropriate financial measures will also be required for a proper development of the system. Financial incentives should be provided to encourage and support the development of better, more efficient solutions. It will be important to encourage energy saving among consumers, which means that energy or heat meters would have to be widely installed.

A network of consultants should also be set up to advise consumers about the means for saving energy. They could among other things show them the advantages of energy saving.

Financial incentives should be complemented by a flexible system of discounts and fines, administered by the municipality.

And all along ways should be sought for enabling the city to discontinue the use of the cheaper sorts of coal with their high sulphur and ash contents.

Opportunities for saving

THE RESTRUCTURING of industry in eastern Europe offers great possibilities of energy saving, enabling the emissions of air pollutants such as sulphur and carbon dioxide to be cost-effectively reduced. Investments leading to improved efficiency in the use of energy in eastern Europe would be a means of lessening the pollution load both there and in the West. In other words, it should be in the interest of the western European countries to support the process of economic restructuring in the East.

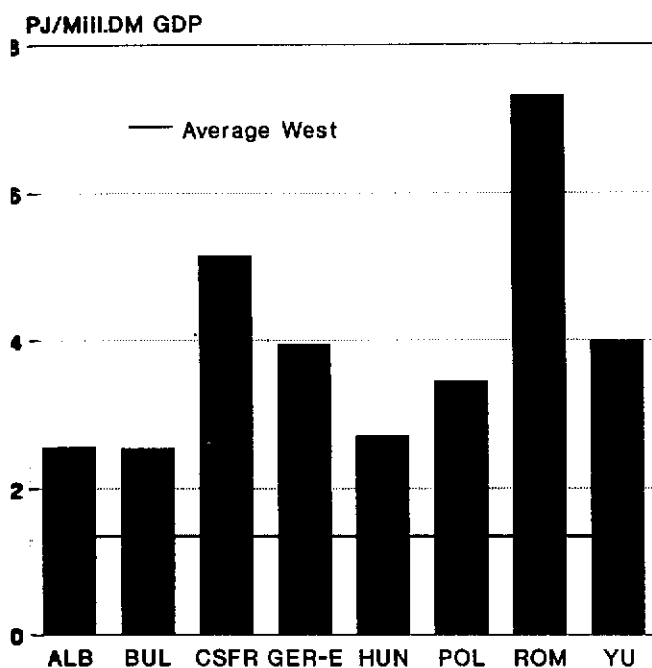
An analysis of the way changes in the economic and energy systems of eastern European countries can affect general policies for the reduction of acid rain has recently appeared in a report* from IIASA, the International Institute for Applied Systems Analysis based in Austria.

For the purposes of the analysis IIASA has employed two scenarios, the one for reference, representing the latest available governmental energy projections for the year 2000, and the other anticipating a transition from centrally planned to market economies. The projections in the first, which date back several years and therefore mostly reflect the expectations of former governments, presuppose an increase in total primary energy demand in eastern Europe of almost 30 per cent between 1985 and 2000.

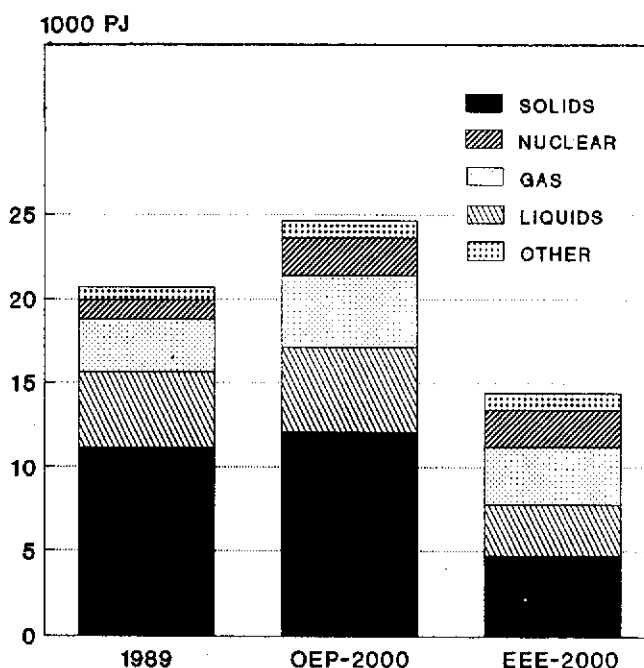
According to that scenario, energy intensity in industry would increase by an average of 8 per cent, from 4.5 to 4.86 petajoules per million DM of gross domestic product. In comparison, the level in western Europe in 1985 was 1.25 petajoule. This enormous difference is due to the poor performance of the existing technical equipment in eastern Europe, with its low energy efficiency, combined with a high share of energy-intensive heavy industry.

The energy consumption of the transport sector in the East, in terms of petajoule/DM1m of gross domestic product, was about 10 per cent higher (in 1985) than in western Europe, and is expected to increase by 10 per cent by the year 2000. In 1985 the consumption of energy for domestic use was about equal in East and West, or 34 terajoules per capita per annum. An increase of 10 per cent by 2000 was forecast for eastern Europe.

The second scenario assumes the transformation of industry towards more advanced production processes and less energy-intensive activities, resulting in a gradual approach to the average western European levels of 1985 in the overall energy intensities in the East. In the case of industry, it is assumed that only about half the changes that will be necessary for reaching the 1985 levels of western Europe will have been



Industrial energy intensities in eastern Europe, 1985.



Eastern energy use according to the scenarios.

Sulphur emissions (in kt SO₂) for countries of eastern Europe for 1985, and for two energy scenarios.

	1985	OEP Scenario ¹		EEE Scenario ²	
		I	II	I	II
Albania	121	167	41	78	38
Bulgaria	1070	1555	236	152	11
Czechoslovakia	3150	2513	708	1743	114
Germany (East)	5360	5048	1158	3892	431
Hungary	1404	1529	580	1018	128
Poland	4300	4165	749	3427	425
Romania	1800	3261	313	2544	232
Yugoslavia	1500	2393	321	1093	124
SUM	18705	20631	4106	13947	1503
Change	-	+10%	-78%	-25%	-93%

¹ Official Energy Pathway
² Energy Efficiency in Eastern Europe

implemented by the year 2000.

The sulphur emissions that result from the application of the two scenarios are shown in the table. Under each of the scenarios two levels of emissions are shown. The first represents the "no control" case, with no measures for the reduction of emissions applied at the sources of fuel combustion, indicating the upper range of emissions. The second shows the emissions that would remain after the application of all the control technologies that are now commercially available.

Instead of increasing by 10 per cent, as in the OEP scenario, the emissions would be reduced by about 25 per cent with the EEE scenario. The maximum achievable reduction would be 93 instead of 78 per cent. Similarly, improvements in energy efficiency would have a positive effect on the emissions of CO₂. Instead of a 17-per-cent increase by 2000, as in OEP, with the EEE scenario the eastern European emissions of CO₂ would decline by 23 per cent, as compared with 1985.

During the last year maps were published showing the critical loads for acid deposition over Europe. The achievement of the low deposition levels that will be required if the critical loads are not to be exceeded would call for a marked reduction of emissions in a great part of Europe – and in some countries almost zero emissions. Consequently these loads are not considered when setting short-term policy targets in international negotiations. In the negotiations for the next sulphur protocol under the UN ECE Convention on Long Range Transboundary Air Pollution, interim target loads will be used instead.

By last autumn, when the present IIASA report was being produced, target loads, in some cases preliminary, had been specified by ten European

countries. Using the RAINS model, the reductions of emissions have been spread over the various countries so as to permit achievement in the most cost-effective manner. The model shows that attainment of the target loads that have so far been specified will entail a general reduction of emissions in Europe by a good 70 per cent. As a result of decisions so far taken, the reduction is likely to be less than 30 per cent.

For most eastern European countries the EEE scenario implies a considerable reduction of emissions. This in turn means that some western countries will not need to reduce to the same extent. For the whole of Europe the overall cost of reducing emissions would be 44 per cent lower in the EEE case than in the OEP scenario, or DM34 billion per annum instead of 61 billion. The report also gives the abatement costs for each country according to each scenario, both in money and as a per cent of their gross domestic product.

As demonstrated by the model, improvements in efficiency would not only lead to lower abatement costs within any country applying measures to that effect.

As shown by the international optimization model approach that is used in the RAINS model, such measures might also have a benefit elsewhere by lowering the requirements on other countries.

In other words, the improvement of energy efficiency in eastern Europe could permit a considerable decrease in abatement efforts in the West. It should thus be a matter of vital self-interest for the West to ensure the success of the East's restructuring process. The considerable cost savings might in fact provide the motivation for western countries to engage in that process. They could at least use the difference in abatement costs between the two scenarios as a base for financial support to eastern Europe, and still retain a cost saving as compared with the "no control" case.

In both cases the efficient control of emissions from large combustion plants is an absolute necessity. Increased energy efficiency will on the other hand mean that fewer large power plants will be needed, and thus there would be a lower amount of emissions to be abated.

CHRISTER ÅGREN

*** Economic Restructuring in Eastern Europe and Acid Rain Strategies.** By M Amann et al. Available from the publisher, IIASA, A-2361 Laxenburg, Austria.

The analysis was carried out with the RAINS computer model developed by the Institute (Regional Acidification Information and Simulation).

From Acid News 1/92.

Ecological problems in Cracow and their health consequences

AFTER THE SECOND WORLD WAR, Polish industry was rebuilt – under Soviet direction – with a one-side emphasis on extremely intensive coal mining together with the heavy industry sector, requiring a lot of energy. In addition, coal is also used as the only energy source for domestic stoves. To cover all energy needs almost 200 million tons of hard coal and 70 million tons of brown coal were produced every year. Part of the hard coal was converted to coke for the Cracow and Katowice steelworks.

According to the official statistics, Poland emitted in 1989 ca. 10 million tons of toxic gases and ca. 4 million tons of dust in which there are numerous compounds, such as heavy metals and especially lead and cadmium salts and also carcinogenic hydrocarbons.

Therefore, already in 1982, 27 areas of ecological hazard were recognized in Poland. These areas included 11.3 per cent of the country's surface with approximately 13 million people, or 35 per cent of the total population. One in three Poles lives in an area designated as ecologically hazardous, because of contaminated air or water. Five such areas are already in a state of ecological disaster because of dramatic damage to forests, crops, buildings, and human health.

The situation is especially bad in the region near the border with Czecho-Slovakia and East Germany which is called "the black triangle of pollution" (or "death triangle"). In that area large parts of forest are completely dead. Acid rain has

a negative effect on soil and water. In addition to acid rain, the falling dust contaminates the soil with heavy metals and other chemicals. The problem is especially bad in the south of Poland in the region of Katowice (Upper Silesian industrial district) and in Cracow.

Cracow is a magnificent medieval city, the previous capital of Poland, with many monuments and relics of history, architecture, and art. It is on the UNESCO zero-class world heritage list. However, after the Second World War, Cracow has changed into an industrial city. In its neighbourhood, in 1950, were located an aluminium smelter and the Lenin steel mill, with more than 700 chimneys. Toxic compounds from the factories hang for days over the city in the Vistula river valley because of frequent temperature inversions. The lack of ventilation causes the worst ecological situation in the country. Toxic gases from the industry mix together with smoke from local coal-power plants and domestic stoves, mainly in winter. The most disturbing damage has been recorded in the central, ancient part of the city. We can see destroyed monuments, ornaments and stonework. Damage is spreading more quickly than it can be repaired.

Material and methods

The environment of Cracow was studied by a special commission of the Polish Academy of Sciences. The commission completed a list of the

Table 1. Toxic compounds in the region of Cracow.

	Year/selected			MAC*/annual/	
	1981	1986	1988	protected area	specially protected area
<i>Immissions ($\mu\text{g}/\text{m}^3$)</i>					
Sulphur dioxide	103	104	91	64	11
Fluorides (F/HF)	4.8	1.7	1.8	1.6	0.4
Nitrogen oxides	54	45	—	32	8
SPM**	93	116	61	22	11
Lead	—	0.35	0.39	0.20	0.10
<i>Emissions (1000 ton/y:</i>					
Sulphur dioxide	114.7	106.2	93.8		
F, NOx etc.	74.9	82.3	80.3		
Carbon monoxide	544.3	419.5	378.4		
Dust	118.5	128.7	101.4		

*=Maximum allowable concentration **=Suspended particulate matter.

Source: Department of Environmental Protection, 1988.

most toxic compounds present in the environment of Cracow.

The same pollutants that are toppling trees, soiling crops, and eating away buildings are toxic for human health. The emitted pollutants are the main risk factor for public health. Millions of people in Cracow or in Upper Silesia live in conditions that are a daily hazard. In relation to health we usually know effects of particular pollutants, but the situation is more complicated if they make a combination of compounds with synergistic action.

Merely to breath is the great hazard. In the ambient air there are various irritant gases: sulphur dioxide, hydrogen fluoride (especially at the time when aluminium was produced from cryolite), nitrogen oxides, and suspended particulate matter (Table 1). The noxious gas molecules attach themselves to tiny particles from industry, as well as from car exhaust gases, enter deep into the lungs where they irritate epithelial cells of the airways, leaving the lungs vulnerable to the attack of viruses, bacteria or allergens, and also do their damage by impairing the body's immune system.

Results

In the Cracow region it was possible to observe a direct reaction from the respiratory system one or two days after a peak of imission. For smokers living in the polluted area, the problems can be even worse (Table 2), since their lungs are already damaged by tobacco smoke.

During several years of observation it was possible to see an evident increase in chronic bronchitis and asthmatic reactions. Especially sensitive are children from non-polluted towns.

The prolonged respiratory diseases lead to respiratory insufficiency and an increase in cardiovascular diseases. One of the risk factors for the cardiovascular system is also the huge amount of carbon monoxide, about 1000 tons per day,

emitted from the steel works. It is difficult to evaluate how much it could be from all sources (including traffic and domestic heating). Carbon monoxide has a very negative effect on human health. It blocks oxygen transport by blood and causes tissue hypoxia. Hypoxia and various stresses result in consequence in compensatory hypertension which was found in about 25 per cent of Cracow residents (Table 3). This is related to an increased frequency of myocardial infarcts, ischemic heart disease, and stroke. Cardiovascular mortality represents around 50 per cent of total mortality.

Most typical, however, for the Cracow region are the consequences of prolonged exposure of residents to air contaminated by hydrogen fluoride from the aluminium plant. The emissions were stopped after the electrolysis division was closed in 1982, but the negative health effects are still present. Independently of the local irritant effect of hydrogen fluoride on airways, fluorides penetrate easily into blood and the cells, where they inhibit many cellular processes, especially those connected with cell energy formation in the form of ATP molecules, which are chemical energy carriers, converted in the organism into all other types of energy.

Fluorides thus diminish somatic strength and muscular activity, as well as the formation of bioelectric energy, especially in the nervous cells. Part of this effect is abolished by supplementations of magnesium which neutralize some fluoride effects. Finally, fluorides accumulate in bones. Depending on the age, 60-90 per cent of the residents in the vicinity of the aluminium plant suffered from bone pains and spine stiffness.

This was a symptom of skeletal fluorosis. Fluorides made the bones more brittle, so the fractures take longer to heal. Although emissions of fluorides diminished after the most dangerous department of this factory was closed, the amount of degenerative diseases of the spine

Table 2. Chronic bronchitis in residents of Cracow.

	Control rural area (%)	Cracow (%)
Non-smokers		
- men	4.1	6.8
- women	1.8	3.8
Smokers		
- men	14.5	29.6
- women	8.2	16.4

Source: Nikodemowicz, 1982/83.

Table 3. Cardiovascular diseases in residents of Cracow.

Diseases	Control area (%)	Cracow (%)
Hypertension	5.3	24.3
(over 180/95 mm Hg)		
Ischemic heart disease	5.4	11.0
Myocardial infarction	9.6	15.3

Source: Król, 1983.

Table 4. Lung cancer mortality in man (index per 100,000).

Residents of:	1975	1985
Katowice/Upper Silesian Ind. District	68.7	70.6
Cracow	44.5	64.6
Biala Podlaska (East of Poland)	38.9	45.8
Total cancer mortality in Poland	164.0	195.3

continued to increase as a late effect of exposure to fluorides.

Pollution also contributes to a range of mental illnesses, especially related to the negative effects of carbon monoxide, hydrogen fluoride, organic solvents, and lead ions on nervous cells and the brain. Petrol in Poland still contains a high concentration of lead, which is already forbidden in many countries, since numerous studies have shown that lead causes brain damage and mental retardation, especially in children. Lead salts present in polluted air and absorbed from the lungs to the bloodstream reach the brain cells, where they damage many enzymatic reactions. Therefore lead can impair learning in children and promote their hyperactivity. Children express more aggressiveness and irritability. A report of the Polish Academy of Sciences from 1985 pointed to increased indices of mental retardation among school children.

All toxic compounds mentioned above can accumulate in the placenta of pregnant women, leading to a degeneration seen in morphological and histoenzymatic studies. This has a negative influence on the development of the foetus. In addition to increased numbers of spontaneous abortions, 45 per cent of pregnant women develop complications and 30 per cent of children are born with health problems – prematurity or low birth-weight. Infant mortality at 18 per 1000 is still very high, four times higher than in the Western countries. Many congenital malformations are also reported, especially heart defects which may be related to exposure to various genotoxic compounds.

In the ambient air of Cracow there were also mutagenic compounds, such as polycyclic aromatic hydrocarbons emitted during coke production and chlorinated hydrocarbons emitted from a chemical factory which caused mutations and malformations in plants. Mutagenic compounds are also carcinogenic and increase cancer mortality. Standardized indices of cancer mortality are still lower in Cracow than in Silesia or in some western countries, but they are increasing over time (Table 4).

Exposure to carcinogenic compounds from industry started later, and since several years are needed between exposure and the appearance of tumors, an increase in cancer mortality can be expected in the future. Cancer statistics may also be modified by the reduction of life expectancy by six to eight years (68 for men and 75 for

women), since cancer mortality rapidly increases with age.

In demographic studies a peculiar effect was also found in the countries of the previous eastern block – a surplus mortality among men of working age. This was also found in Cracow, but not in small villages of the region, so it may be related to the polluted environment of the town.

Discussion

The price paid by society for air pollution and degradation of the natural environment is enormous. It includes not only economic loss but is an important factor in the radical worsening of people's health and quality of life. Independent of the threat to future generations, pollution reduces somatic strength and mental ability by diminishing biological energy. Air pollution is one of the major risk factors producing tens of thousands of cases of respiratory and hearth ailments, birth defects, aborted pregnancies, and mental retardation. All these effects can be seen in Poland because levels of air pollution are a hundred times higher than those experienced in western Europe. Since the risk factors are great, there is every reason to blame pollution for the decline in public health.

The only preventive solution is the elimination of exposure to toxic compounds in the environment. It is a moral problem, because human beings have the right to safe conditions of life and development.

Great social and political changes in central and eastern Europe have created conditions for such a reorganization of industry and energy as to make for a safer environment. But this cannot be done on the local level. It requires action on a global scale, in order to save "our common future." The new idea of "sustainable development" which joins development with homeostasis requires a respect for many barriers and limits. Its realization must be one of the most important aims for the protection of coming generations.

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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.
 - Demonopolization of industrial structures and resource management.
- New energy strategies based on energy saving and efficiency, the potential for decentralized 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 decisionmaking.
- 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 strategy.
- 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.

NGO statement on energy policy in CEE

We call upon the governments of East and West to seize the opportunity for innovation in energy policy development offered by the period of transition in economic and political systems in Central and Eastern Europe. Such innovation would address the serious economic, environmental and social problems in this region, avoid the mistakes of other industrialized countries, and contribute to global sustainable development.

Detailed analysis of energy policies by environmental organizations from Central and Eastern Europe has established that:

- ☐ The highly inefficient production and use of energy in this region imposes unnecessary costs on the economy and adds to the significant damage and risks to the environment and human resources such as: acid rain, the accumulation of dangerous wastes, the risk of nuclear accident and the threat of global warming.

- ☐ Through innovation in the development of energy policy, the demand for energy services can be met while cutting energy sector costs, improving social conditions, and reducing the production of energy-related environmental pollutants.

- ☐ Improvements in the efficiency of end-use, distribution and supply of energy represent the most appropriate policy options for our countries. These options are found to be substantially cheaper and cleaner than the provision of more energy supply.

- ☐ The hidden long-term economic costs of environmental damage from the use of fossil fuels and nuclear power highlight the need to develop the use of renewable energy sources.

- ☐ Decentralized energy planning involving public interest groups and non-governmental organizations offers the most appropriate mechanism for energy policy development.

- ☐ Such energy policies can also increase the energy security of our countries by reducing reliance on important fuels and electricity. In addition, the establishment of national production capacity for energy efficient and renewable energy technologies can offer long-term economic and social stability.

We conclude from this analysis that:

A. Governments and utilities in Central and Eastern Europe should:

- ☐ develop and implement economic concepts that favour environmentally sound forms of production that minimize use of energy;

- ☐ recognize the merits of broad public participation in energy debates and the potential of environmental groups in bringing forward constructive solutions;

- ☐ recognize that apart from the direct environmental effects in their own region, the wasteful energy sector in this region is a major contributor to the problem of climate change;

- ☐ examine both supply-side and demand-side options for meeting demand for energy services and introduce policies to favour those options which offer the lowest environmental and economic cost;

- ☐ recognize the unacceptable costs and dangers imposed by nuclear power, the negative experience to date of most countries with nuclear power programs and the significant costs of clean up to be met in the future and start closing down nuclear reactors immediately;

- ☐ encourage the use of renewable energy sources and development of new energy efficiency possibilities;

- ☐ actively seek cooperation with other governments to exchange information about successful strategies, to solve energy problems with an international dimension in an environmentally sound way and to have more strength in negotiations with western governments, institutions and companies that want to push the region in an opposite way.

Through the actions outlined here, the countries of Eastern and Central Europe could set a leading example for the rest of the world in the necessary transition towards an environmentally sustainable future.

B. The governments of the OECD-countries, the international financial institutions (EBRD, World Bank, IMF), and the European Commission (e.g. PHARE and TACIS programs) should:

- ☐ give priority to projects which focus on improving energy efficiency within both the energy and industrial sectors and undertake consultation with NGOs of the region to establish environmental priorities;

- ☐ make assessments of the energetical and environmental implications of aid, investments and support to activities of the private sector in this region obligatory and positive results as a prerequisite for approval;

- ☐ actively support with grants and technical assistance rapid closing down decisions of eastern governments;

- ☐ contribute to a 10 billion dollar soft loans program to accelerate increase of energy efficiency and introduction of clean energy production.

Specific energy policy recommendations

The following elements should feature in the energy policies of all countries, though country-specific details will alter the priorities and emphasis given to each.

GENERAL RECOMMENDATIONS

- ☐ Decentralization of the energy industry, which will lead towards decentralized energy planning;

- ☐ All new investments should be based on least-cost planning techniques.

ENERGY EFFICIENCY

Governments should establish the fiscal, institutional and legislative framework to encourage energy efficiency and discourage energy wastage. Such a comprehensive framework would include:

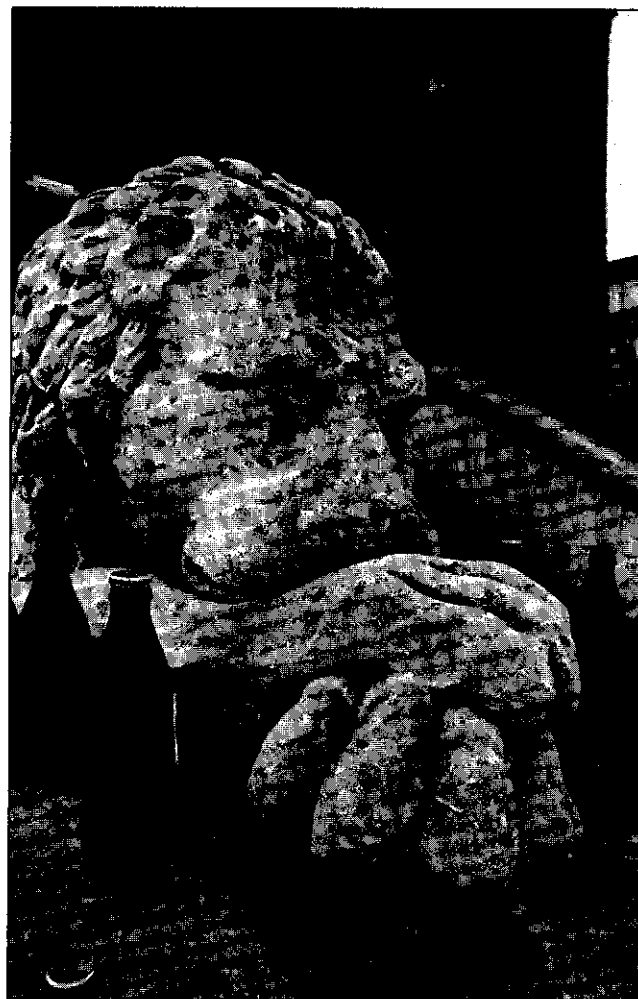
- ☐ the provision of financial incentives for energy efficiency measures;
- ☐ the introduction of energy utility regulations to promote energy efficiency ahead of energy supply;
- ☐ the setting of rigorous energy efficiency standards for buildings, vehicles, appliances, lighting, and industrial processes and the introduction of regulation for labelling to inform the public;
- ☐ the development of energy pricing policies to encourage energy efficiency and reflect environmental costs of energy sources, taking into consideration the socio-economic impacts;
- ☐ the establishment of public education programs on energy efficiency and specialized education and training programs for industry and utility staff;
- ☐ the encouragement of technical innovation and demonstration through government support and procurement policies;
- ☐ the encouragement of co-generation and other more efficient energy supply-side technologies when replacing or reconstructing energy supply systems;
- ☐ a move towards decentralized energy planning.

RENEWABLES

- ☐ Governments should assess the renewable energy potential for our countries, taking into account the distinct environmental advantages offered by decentralized renewable energy technologies over fossil fuel and nuclear power technologies.
- ☐ They should support research and demonstration projects for renewables as a long term strategy.
- ☐ And establish appropriate regulation and incentives for the development of renewable energy sources.

NUCLEAR POWER

- ☐ A moratorium should be imposed on the construction of nuclear power stations.
- ☐ A comprehensive program should be urgently developed for the decommissioning of existing nuclear power plants and clean up of nuclear sites (including radioactive waste dumps, reprocessing facilities, test sites and uranium mines).
- ☐ All existing nuclear power plants in Central and Eastern Europe should be closed, starting with the most dangerous types immediately:
 - All 15 RMBK reactors in CIS and Lithuania
 - All 10 VVER 440/230 reactors in the Commonwealth of Independent States.
 - Kosloduy 1, 2, 3 and 4 (Bulgaria)
 - All nuclear reactors in CSFR
 - Paks 1 and 2 in Hungary and the remaining reactors within two years.
- ☐ The costs of any improvements in nuclear reactor safety should be compared with the cost of displacing the need for the reactor through improved energy effi-



ANDRÉ MASLENNIKOV

ciency and the development of renewable energy sources.

- ☐ The conclusions of the report of the International Atomic Agency on the Chernobyl Project should be questioned and fully independent long-term studies of the health effects of low level radiation exposure be established.

INVOLVEMENT & ACCESS TO INFORMATION

- ☐ Accurate data on the costs, safety and environmental impacts of energy production and the potential for energy efficiency improvements and renewable energy sources should be accessible to the public.
- ☐ The development of energy policies should involve public interest groups and non-governmental organizations at local, regional and national levels.

To reflect the need for better co-operation, information and skills exchange on energy issues at governmental and non-governmental levels in Central and Eastern Europe, NGOs of the region have agreed to establish a formal energy policy network as a part of Greenway.

This statement was first prepared by the Greenway/Friends of the Earth Energy Conference in Celakovice, Czechoslovakia in June 1991 and updated at the Vienna Conference in October 1992. It is supported by a broad coalition of environmental NGOs in Central and Eastern Europe.

Critical loads for air pollutants

*Statement from the third international NGO seminar on strategy,
April 10-12, 1992, Torrekulla, Sweden*

AIR POLLUTANTS from combustion plants, transport, industrial and agricultural sources all contribute to the heavy environmental stress affecting human health, ecosystems and materials throughout Europe. For example, it is estimated that acid, resulting from emissions of acidifying air pollutants, is being deposited in amounts that are damaging to the environment over three-quarters of Europe. As a result, forests, soils, ground and surface waters will inevitably be affected.

Therefore, drastic reductions in emissions of air pollutants are urgently needed if sensitive elements of the environment are not to be further damaged. In order to stop the ongoing deterioration of the environment, concentrations and depositions of air pollutants must be reduced to below the critical loads.

Critical loads can be defined as a quantitative estimate of an exposure to one or more pollutants above which adverse effects on receptors, such as plants, ecosystems or materials, may occur. To express it more simply, critical loads are the maximum amount of pollutants that ecosystems can tolerate without being changed or damaged.

REQUIRED REDUCTIONS

Based on up-to-date and internationally agreed scientific data on critical loads, we have jointly decided on the following objectives concerning total European emissions of air pollutants:

- ☐ at least a 90 per cent reduction in emissions of sulphur dioxide (SO₂);
- ☐ at least a 90 per cent reduction in emissions of nitrogen oxides (NO_x);
- ☐ at least a 75 per cent reduction in emissions of volatile organic compounds (VOCs);
- ☐ at least a 75 per cent reduction in emissions of ammonia (NH₃);
- ☐ at least a 75 per cent reduction in concentrations of tropospheric ozone, which is to be achieved by meeting the objectives for NO_x and VOCs, as above.

The reductions are based on the emission levels in the early 1980s and refer to western and eastern Europe, including the European part of Russia.

These are minimum demands, but they do not necessarily imply that every country or region must achieve equal reductions. In areas with very high emissions, greater reductions will be necessary, while in some other areas needed reductions may be lower.

Furthermore, as a result of improved methods of scientific research and increased knowledge, the data on critical loads is likely to be continuously reviewed

and revised. Following such revisions, also the objectives for emission reductions should be reconsidered.

The critical loads concept must not be used to determine the amounts by which concentrations and depositions of pollutants can be allowed to increase in areas currently receiving pollutants below the present critical loads.

TIMEFRAME

The response of governments to the damage caused by air pollutants has so far been totally inadequate, although progress has been made in some countries primarily in reducing sulphur emissions. As a result of this, and international agreements such as the 1985 Sulphur Protocol to the UN ECE Convention on Long Range Transboundary Air Pollution (CLRTAP), reductions of 23 per cent in European sulphur-dioxide emissions were achieved between 1980 and 1989.

The emissions of nitrogen oxides, volatile organic compounds and ammonia, on the other hand, still constitute a growing problem. Despite this, only limited commitments have been made to control emissions of these pollutants.

Nevertheless, scientific evidence confirms that drastic reductions are required in order to safeguard forests and other sensitive ecosystems over large areas of eastern and western Europe. As regards acid deposition, it is estimated that critical loads are exceeded over three-quarters of Europe. In some central and northwestern parts of the continent the depositions are twenty times higher, if not more, than the critical loads.

As critical loads are widely exceeded, and have been so for several decades, the need for action to curb emissions is consequently increasingly urgent. From an environmental point of view, the above reductions are required immediately.

ACHIEVING REDUCTIONS

Bilateral, multilateral, and international agreements and arrangements should be used to achieve reductions as a matter of urgency. Nations should act unilaterally, however, to make faster progress than international measures require.

Priority must be given to preventing pollution at source, by establishing this as a central criterion in both energy planning and economic development.

It should be noted that the strategy we propose for reducing emissions of sulphur dioxide, nitrogen oxides and volatile organic compounds (including methane), has significant implications for energy use, and thus

will also lower atmospheric concentrations of ozone, carbon monoxide, and carbon dioxide, which are some of the main pollutants contributing to global warming.

The urgency of meeting the reduction targets demands that a range of measures be adopted, including:

- ☐ using renewable energy sources;
- ☐ increasing the conservation of energy;
- ☐ increasing the efficiency of energy production, transmission, and use;
- ☐ switching to less polluting fuels;
- ☐ applying best available techniques in the energy, transport, industry, and agriculture sectors.

The price of fuel and electricity should more readily reflect the real cost to society of the social and environmental impacts of air pollution and the inefficient use of energy and other resources.

The European countries and the European Community should base their transport policies primarily on environmental criteria. Priority should be given to the development of modes of transport with the least environmental impact.

Measures to reduce air pollutants from the transport sector include:

- ☐ the implementation of volume control, including for example that no new major roads should be built, investment in public transport and railway freight systems should be increased;
- ☐ the adoption of plans and timetables to *reduce significantly* the total European volume of road and air traffic;
- ☐ the adoption of standards for increasing the fuel efficiency of all new motor vehicles, including aeroplanes and ships;
- ☐ the adoption of properly regulated emission standards for all new motor vehicles, including off-road vehicles, aeroplanes and ships;
- ☐ the adoption of speed limits for road traffic at a maximum of 100 kph.

Progressive environmental standards should not be regarded as trade barriers. Any harmonization that affects environmental standards should be at the most stringent current level.

Financial incentives and disincentives, such as levies on petrol, diesel and kerosene, can be useful tools in reducing air pollution. Income from environmental levies should be used to finance measures for pollution prevention, including investments in public transport, as well as to restore damage caused by pollution.

RELATIONS BETWEEN WEST AND EAST

It is particularly important that eastern countries avoid duplicating the western countries' wasteful pattern as regards especially energy use, transport and consumerism. The transition in economic and political systems in Central and East Europe now offers a historic opportunity for innovation towards sustainable energy and transport systems.

Western European countries should undertake, bilaterally or jointly, concrete projects to assist eastern European countries in their implementation of pollution prevention programs.

Priority should be given to projects which discourage energy wastage and instead focus on improving energy efficiency within the energy and industrial sectors. Renewable energy sources have a particularly important role to play, bearing in mind their advantages over nuclear and fossil-fuel-based technologies. Projects could include:

- ☐ development of domestic pollution control and energy-saving industries through joint-venture schemes, for both domestic and export applications;
- ☐ transfer of know-how in pollution prevention techniques, effective resource management, environmental monitoring and energy planning policy;

It should be ensured that the development of new pollution control activities does not create new environmental hazards in solving old problems or involve the transfer of undesirable technology from the West.

In the development of such projects, full consultation should take place with both the public and non-governmental organizations, ensuring the need for proper environmental impact assessment (EIA).

ACCESS TO INFORMATION

All data held by authorities in European states as well as by the European Commission concerning the emission, transport, concentration, and deposition of pollutants should be made publicly available.

PARTICIPANTS

The meeting was organized by the Swedish NGO Secretariat on Acid Rain and attended by representatives from twenty-two non-governmental environmentalist organizations from fifteen countries in Europe.

INTERNATIONAL ORGANIZATIONS:

- European Environmental Bureau
- Greenway Central and East European Network

NATIONAL ORGANIZATIONS:

- Bond Beter Leefmilieu, Belgium
- The Danish Society for Nature Conservation
- Clean Air Action Group, Hungary
- Community Atgaja, Lithuania
- Earthwatch, Ireland
- Ecological Projects Centre, Russia
- The Environmental Federation in Sweden
- Estonian Green Movement/FoE
- The Finnish Society for Nature and Environment
- Friends of the Earth UK
- Global 2000, Austria
- Green House Litvinov, Czechoslovakia
- Greenpeace Czechoslovakia
- Lithuanian Green Movement
- The Netherlands Society for Nature and Environment
- The Norwegian Clean Air Campaign
- Polish Ecological Club
- Slunicko Foundation, Czechoslovakia
- Socio-Ecological Union, Russia
- The Swedish NGO Secretariat on Acid Rain

THE STATEMENT IS ALSO SUPPORTED BY:

- Greenpeace International
- Friends of the Earth International

"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 Conven-

tion, 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 to make some general statements concerning the policy that the local environmental movements would like to see adopted as soon as possible (see page 18). Some representatives from Upper Silesia said the immediate priorities in their case did not concern SO₂, NO_x 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, proposals 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' priorities 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 presented at a meeting of the environmental ministers from eastern and western Europe which will probably take place 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.

REINHOLD PAPE

Article published in Acid News No. 4/1990.

Preparing for clean-up

FOLLOWING THE political changes that took place in Czechoslovakia in the autumn of 1989, several environmental programs and resolutions have been put forward by the governments of the two republics. The federal minister for the environment, Jozef Vavrousek, has endeavoured to make environmental protection a central element in the reforms for creating a market economy – with “eco-taxes” and financial incentives playing a major role.

Three federal laws have been up for enactment this year: a general environmental protection act, a clean air act, and a waste disposal act. The Clean Air Act, which will allow penalties to be imposed on polluters, was approved by the federal parliament in July. This will enable the authorities to impose fines up to the equivalent of US\$200,000, with the possibility of a doubling for second offenders. In certain circumstances the inspectors will have a mandate to close down a polluting plant.

One of the aims of this federal law is to ensure that the emissions from existing stationary sources of pollution will comply with EC standards within five years.

While the law sets the general framework for a nationwide policy in regard to air pollution, its specific application will remain under the jurisdiction of parliaments of the Czech and Slovak republics. Both the construction of new plant and the modernization of old will be subject to each separate republic's legislation. It is expected however that the parliaments in each case will require compliance with EC standards from the start.

The commentary to the Clean Air Act states that the pollution of the atmosphere in the Czech republic places it among the most polluted territories in Europe. The quality of the air in northwestern Bohemia is coming close to constituting an ecological catastrophe, and the situation is not much better in a number of other industrial and residential agglomerations, such as Prague, Ostrava and smaller urban areas.

It says that the main cause of this state of affairs is the inordinate de-



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mand for energy, which is relatively far greater than that in any normally developed country. Moreover the leading source of energy is low-grade brown coal, with a high content of sulphur. The greatest demands for energy come from heating, the generation of electricity, and the metallurgical and chemical industries.

The Czech parliament has therefore adopted an energy-saving program which includes setting up of information centres for energy saving throughout the country and the possibility of financial support for energy-saving measures in private and public buildings.

Mobile sources also contribute considerably to air pollution, the most prominent being road traffic. A feature of the Czech republic is the old age of the vehicles. Already in a poor technical state, they suffer

from low servicing standards and a general lack of spare parts. The rate of renewal is also slow. While the domestic automobile industry is belatedly adjusting to western European emission standards, the emissions from the older vehicles remain among the continent's worst.

Czechoslovakia has however now begun to develop a program for reducing emissions of sulphur dioxide and nitrogen oxides. The Minister for the Environment estimates that 30 per cent of the sulphur dioxide emissions can be eliminated by installing scrubbers and filters, at a cost equal to about £400 million. Last January an agreement was signed with the European Community which makes available to the CSFR a sum of 30 million ecus for seventeen environmental projects, including one for cleaning up the

country's largest power station. Installations that exceed the new emission limits, and are too old to be cleaned up, will be shut down.

In an interview with the New Scientist, the minister said there is not enough money in Czechoslovakia for cleaning up the pollution. "We are prepared to use any equipment we can get," he said. "I know scrubbers with 95 per cent efficiency are available, but it is better to have scrubbers that work at 60 per cent than to have nothing at all."

With almost 8000 square kilometres, Northern Bohemia has 6 per cent of the total area of the CSFR and 7.6 per cent of its population. Its output of products for industry accounts for 10.6 per cent, that of consumer goods for 15 per cent, and of electric power for as much as 32.6 per cent of the whole country's production, as well as 69 per cent of the brown-coal mining.

The economy of the region, characterized by a high proportion of power resources, shows up in annual emis-

Not enough money in Czechoslovakia for cleaning up

sions of almost one million tons of SO₂, 330,000 tons of nitrogen oxides, and 212,000 tons of solids.

Faced with this situation, in November 1990 the Czech republic passed a resolution for an Environment-depolluting Program of the North Bohemian Region for 1991-95 with a Prospect until the year 2000. The proposed investments include construction for a total of nearly 20.5 billion CSFR crowns, with 13.3 billion crowns earmarked for desulphurization.

The resolution calls for the establishment of regional funds for the depollution of the environment, to be administered by the Association of Towns and Communities of the North Bohemian Region, with contributions from the state budgets of the republic and the federation.

Since the whole package of measures was regarded as a matter for the entire nation, and not only the Czech republic, the resolution was submitted to the federal parliament for adoption, so far without result.

REINHOLD PAPE

As it is now

In 1990 the Czechoslovakian Federal Committee for the Environment published a study* on the state of the country's environment. This was intended as a basis for the development of a new environmental policy in Czechoslovakia. Here follow some of the main features of the study.

The existing data on emissions of air pollutants in Czechoslovakia consist mainly of calculated estimates. Only to a limited extent are they based on direct measurements. It is however clear that there has been a substantial increase in emissions over the last few decades.

It appears that from 1959 to 1970 the emissions of sulphur dioxide increased from 900,000 to 2,450,000 tons, and then to 3,100,000 tons in 1980 and 3,150,000 tons in 1985. Subsequently, due to milder winters with a lower consumption of coal, as well as an increased use of nuclear energy, the emissions have been relatively stable. They are now estimated to amount to 102 kilograms per capita and 12.3 tons per square kilometre.

By far the greater part of the emissions of SO₂, 79 per cent, emanates from power generators and heating plants. Industrial processes account for 11 per cent, domestic heating for 7 per cent, and diesel-driven vehicles for 3 per cent.

The total emissions of nitrogen oxides, expressed as NO₂, are estimated to be about 1,200,000 tons, or 57 kilograms per capita. The power generating and industrial sectors together contribute 71 per cent, transportation 22 per cent, and all types of heating 7 per cent.

Emissions of hydrocarbons (volatile organic compounds, VOCs) are put at 150-200,000 tons, the sources being industry (about 50 per cent), transport (30 per cent), and domestic heating (17 per cent). With a growing use of natural gas, these emissions are increasing.

About 60.4 million tons of the greenhouse gas carbon dioxide (expressed as carbon) are emitted in a year. This is the equivalent of 4.1 tons per capita. Carbon monoxide emissions are 1.5 million tons, transport being responsible for 45 per cent.

The emissions of solid particulates, especially fly ash, and aerosols have increased from 800,000 tons in 1950 to 2,800,000 tons in 1985. They continue to grow gradually as a result of the deterioration and hence reduced efficiency of the electrostatic separators installed 10-15 years ago.

The fly ash from the burning of brown coal in Czechoslovakia contains many hazardous substances: arsenic, beryllium, cobalt, nickel, selenium, and bismuth, as well as radioactive elements such as uranium and thorium. Even on an annual average, the concentrations of particulates in the air exceed by far the permissible levels in Czechoslovakia.

The atmospheric haze due to air pollutants cause a decrease in the hours of sunshine as well as in its intensity. In winter Prague, for instance, gets two hours less of sunshine daily, and the intensity may be reduced by as much as 40 per cent.

The concentrations of air pollutants have also increased in areas far distant from the main sources of emission. The average annual levels of SO₂ in such areas have, for instance, risen from 2-5 micrograms per cubic metre to 10-20 µg/m³. Ground-level ozone resulting from chemical reactions involving NO_x and VOCs has also shown a considerable increase. It is now almost impossible to find any part of Czechoslovakia where there is not an excess of harmful substances in the atmosphere.

From the point of view of the direct effects on human health, the peak concentrations of airborne pollutants – lasting for several minutes, hours or even days – are especially serious. In Prague, during the inversions of January 1982 and February 1987, the twenty-four-hour concentrations of SO₂ exceeded 3,000 µg/m³. The highest permissible limit is 150 µg/m³. In the town of Chomutov that limit is exceeded on an average during 117 days of the year.

About half of the population of the Czech republic, and a third of the Slovakian, are living in areas with notably low air quality.

***The Environment in Czechoslovakia (1990).** Report of the Federal Committee for the Environment. Published by the Department of the Environment, Slezská 9, 120 29 Prague 2, Czechoslovakia.

Average annual concentrations of SO₂ in Czechoslovakia (mg/m³)

	1970	1975	1980	1985
Chomutov region	53	71	94	126
Most region	57	80	102	132
Teplice region	51	77	93	110
Ostrava region	36	36	46	55
Prague (Karlov)	100	100	128	155
Bratislava	49	67	55	60

Bohemian problem bared

FROM A CORNER OF northern Bohemia, known as the Basin, with no more than 2 per cent of the country's area, the yearly emissions of sulphur dioxide amount to more than 750,000 tons. This part of Czechoslovakia, with an area of 2500 sq kilometres, is the home of half a million people, yet its emissions of sulphur equal the combined total of all those from Sweden, Norway, Finland, and Denmark.

Northern Bohemia as a whole, with an area of 7800 sq kilometres, covers six per cent of the country. Here three-quarters of Czechoslovakia's brown coal is mined, over 90 per cent by opencast methods. More than half of the total is also burned in northern Bohemia, where a good third of the country's electricity is generated, and almost a third of the gas. Here, too, is ten per cent of the country's industrial capacity, and more than half of the uranium is mined.

Within the Basin, which fills 32 per cent of the area of northern Bohemia, are parts of the following districts: Usti n.L., Teplice, Most, and Chomutov. For decades the Basin has been important for its brown coal, although the kind mined here is of poor quality, with a regular ash content of 25-30 per cent, and sometimes up to 45 per cent. The sulphur content is usually between two and three per cent, but may be

as much as five per cent. The increased demand for energy in the fifties led to an expansion of brown-coal mining in the Basin, and heavy industry became concentrated to a large extent just here.

According to the reigning ideology, industrialization was the basis of all development, with a top priority for heavy industry. Despite its lack of acceptable energy sources, the country was ordered, in 1948, to develop a heavy industry requiring large amounts of energy as well as raw materials.

In the Basin, the state of the environment can only be described as catastrophic. Mining, almost entirely by the opencast method, has ravaged a greater part of the area. Before any coal can be extracted, a 100-metre-thick layer of soil has to be dug away. Streams must be diverted, whole villages moved, and a new road network laid down.

One of the worst problems is however air pollution. That in the Basin has been described as the worst in Czechoslovakia, and perhaps the worst anywhere in Europe. The country's emissions of sulphur dioxide amount altogether to almost three million tons. Of this total, the twenty-five largest sources account for 1.6 million, with almost half coming from the Basin (Table 1). Then, too, are the emissions from smaller industries and domestic boilers.

Various toxic, mu-tagenic and carcinogenic substances also get out into the atmosphere, further aggravating matters.

Predominant winds from the southwest and west help spread air pollutants over the whole Basin. Because the area is shaped like a valley, inversions often occur, and then, instead of being swept away by the winds, the pollution accumulates for several days. In consequence there are periods, especially in winter, from October to March, with very high concentrations. Consequently, too, the trees on the north side of the Basin are either dead or dying.

In Teplice, the concentrations of sulphur dioxide, nitrogen oxides, and carbon monoxide have been recorded for several years. There the monthly averages for sulphur dioxide have regularly exceeded 200 micrograms per cubic metre ($\mu\text{g}/\text{m}^3$) during winter, and have often been 40-60 $\mu\text{g}/\text{m}^3$ even in summer, and peak (half-hour) levels of 2000 micrograms have been recorded.

These figures may be compared with the highest permitted for sulphur dioxide in Czechoslovakia, which are: yearly average 60 $\mu\text{g}/\text{m}^3$, 24-hour average 150 $\mu\text{g}/\text{m}^3$ and half-hour average 500 $\mu\text{g}/\text{m}^3$.

Considerable additions to the pollution come from the brown-coal mining operations themselves. The slag often catches fire or simply goes

Table 1. The 12 largest emission sources for SO₂ in Czechoslovakia (more than 50,000 tons per annum, 1987). With the exception of Utvínov all are power stations.

	SO ₂ (tons/yr)	Solid particles (tons/yr)	NO _x (tons/yr)
Prunérov II	202,000	10,700	55,500
Pocerady	123,500	13,900	53,700
Nováky	123,200	55,900	34,800
Melník	114,500		53,400
Tusimice I	102,300	11,300	32,700
Tusimice II	97,600	9,300	27,700
Prunérov I	93,500	24,300	26,400
Utvínov	93,500	17,200	28,500
Tisova	89,700	23,800	27,400
Chvaletice	74,400	7,900	27,100
Komorany	69,300	43,300	15,100
Vojany	56,400	32,500	24,100

Source: Ecoforum, 1990.

Table 2. Child health

	All Czechoslovakia	Bohemian Basin
Infant mortality	12.4/1000	17.6/1000
Disorders among newborn at maternity clinic	9.48%	17.8%
Chronically ill and children with defects		
- Preschool	12.4%	17%
- School age	24.2%	27.6%
Teenagers in good health	58.7%	45.7%
Teenagers with health threatened	6.8%	17.4%

Source: Ecoforum, 1990.

on smouldering. In 1988 samples were taken of three carcinogens in the village of Roudniky, four kilometres from Teplice. The concentrations were found to be 500-800 times the permissible levels.

There must be similar concentrations in other parts of the Basin as well. The smouldering slag probably emits a number of carcinogenic substances. Workers in the opencast mines will therefore be especially at risk.

As regards the nation's health, between 1945 and 1960 the Czechoslovakian record was among the best in Europe. But from 1960 onwards the situation got steadily worse, and the Basin was one of the worst affected areas. Among the chief causes are

Life expectancy is among lowest in the industrialized world

the high levels of air pollution. Among the problems troubling the inhabitants of the Basin is diminished immuno defence. Continued exposure of mucous and other tissues to harmful substances in the air opens the way to respiratory infections, of which there has been a great increase, especially among children (Table 2).

From blood tests it has been seen that children in the Basin have a deficiency of red blood cells. Staying for a fairly long time in a cleaner atmosphere leads to improvement, only to be followed by a relapse a few weeks after returning home.

While the average life expectancy in Czechoslovakia is in any case among the lowest in the industrialized world, in the Teplice district it is 1-3 years shorter than in the rest of the country. The mortality rate from cancer (of the respiratory tract, large intestine, and stomach) is also higher in the Basin than the national average. Since cancer often takes a long time to develop, these effects may be said to reflect the environmental situation as it was twenty years ago. Given the present situation, health will continue to be affected and victims claimed during decades to come.

IRENA KLASTERSKA

UPPER SILESIA

In need of aid

ALREADY IN THE early 1980s twenty-seven parts of Poland had been officially classified as areas at ecological risk. Areas so defined were those in which the standards of pollution were exceeded in at least two respects. Today, according to official estimates, such areas constitute 11 per cent of the country's total area, and include 34 per cent of the population.

The regions of Upper Silesia and Cracow represent only 2.2 per cent of Poland's territory, but have about 5 million inhabitants, or 12.7 per cent of its population. These two industrial regions in southern Poland use an extremely high share of the country's natural resources, and are also responsible for large amounts of environmental pollution – including 30 per cent of the national emissions of dust, 28 per cent of the sulphur dioxide, and 53 per cent of industrial wastes.

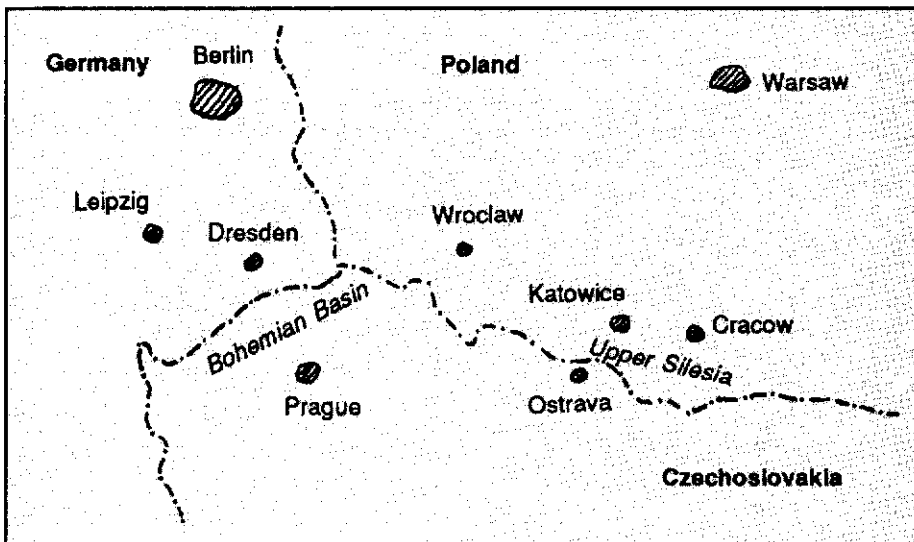
The concentrations of great amounts of air and water pollution as well as industrial wastes in such a relatively small area, with a high population density, gives rise to health as well as ecological hazards. Most important of them are the large emissions of SO₂, affecting primarily the local inhabitants, but also, through long-range transport, people and environments in distant parts of Poland and other European countries. Both Upper Silesia and the Cracow region are also relative-

ly more affected by water pollution than other areas of Poland.

The degradation of the natural environment constitutes a substantial threat to human life and health, with a resulting decrease in average life expectancy, as may be deduced from the table. Such data does not however only relate to the state of the environment. Life expectancy is also strongly affected by the general deterioration of living conditions which has lately taken place in Poland. It is however generally acknowledged that environmental hazards are important contributors to this alarming tendency.

The situation in the Upper Silesia and Cracow regions is in large extent due to the high concentration of heavy industries, in particular steel and nonferrous metallurgy, as well as chemical industries. Their negative impact on the environment has in many cases been intensified by the continued use of obsolete technology. For example until late in the 1980s some coking plants had been using equipment dating from 1916. Also adding to health risks are the dangerous locations both of old and new plants, as for instance the old smelting plants in the centres of some Silesian cities and the Lenin (now Sedzimir) steelworks which was built in the 1950s, for political reasons, in the suburbs of Cracow.

In the official list of the fifty-two largest industrial sources of air pol-



The so-called Black Triangle region of coal mining and heavy industry at the junction of Germany, Czechoslovakia, and Poland.



Inhabitants of Bytom, near Katowice, demonstrating on Earth Day 1990.

lution, eighteen are in the Upper Silesian and Cracow regions. These account for 23 per cent of the total emissions from large sources. Of the fifty-seven largest sources of untreated sewage in Poland, eighteen are mines and industrial plants in these two regions, which "produce" more than one-third of the total of untreated sewage.

The dramatic environmental situation of the traditional industrial regions of southern Poland calls for urgent changes in regional environmental policy. However the effectiveness of any appropriate policy can be considered only in the context of national environmental policy, or of the economic and social changes now taking place in Poland.

In the medium and long term the environmental situation in these regions will be mostly affected by the extent of implementation of the Na-

tional Program for Environmental Protection that is now being debated. The general aim of this program is to reverse existing degradation trends in the natural environment. In regard to air pollution the program proposes an initial 30-per cent reduction of SO₂ emissions and a stabilization of NO_x emissions.

For protecting waters the program envisages among other things a 50 per cent reduction of untreated sewage discharged to rivers by the year 2000.

Despite the poor situation in the country itself, and its effect on the environment in neighbouring countries, Poland will not be able to improve matters only through the use of its own internal resources. In the first place, the size of the expenditures that Poland could embark on for environmental protection, without conflicting with other economic

and social goals, is determined by the income level per capita (US \$2070 in 1989). In the years 1975-1985 Poland spent 0.5 per cent of its GDP on environmental protection. In 1980-1982 that indicator actually dropped to 0.25 per cent, and it was only in 1988 that it rose to 0.8 per cent. According to OECD estimates, as much as 2 per cent of national income should be spent merely for maintaining the environment in its existing state.

Environmental degradation also causes substantial economic losses. At the turn of 1970 they were estimated to be 10 per cent of the Polish GDP. The last estimates made in 1986 put the losses at 1000 billion zlotys, of which 40 per cent was related to SO₂ emissions.

The implementation of radical environmental programs in Poland is also hampered by the size of the foreign debt, amounting in 1989 to US\$41.4 billion. Since huge amounts of hard-currency earnings have to be earmarked for debt service, the ability to use hard currency for environmental protection is limited.

There are some cases of foreign aid being offered for restoration of the environment in Upper Silesia and the Cracow region. The most important would seem to be a project financed by the World Bank. The US\$15 million loan offered to Poland by this institution will be used for financing the upgrading of environmental policy and regulation, assessment of capabilities for the reduction of industrial emissions, setting up a system for air-quality management in the Upper Silesia and Cracow regions, and one for water-management in the upper Vistula basin.

Besides the World Bank project, some countries are engaged in individual environmental projects in South Poland. The United States has for example offered US \$7 million for environmental protection in the Cracow region, Germany is giving DM 50 million for the construction of a district heating system in Gliwice (Upper Silesia), and the Nordrhein-Westfalen government US \$5 million for environmental monitoring in the Katowice area.

The above article is based on a report by Professor Adam Budnikowski at the Central School of Planning and Statistics, Warsaw.

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Selected health indicators for Poland and the Katowice district 1984.

Disorders	Poland	Katowice district
Per 10,000 of population		
Pregnancy complications	123.8	143.1
Natural abortions	41.8	66.7
Cancer	71.2	75.5
Diseases of the digestive system	135.9	157.0
Injuries, intoxication	108.7	114.7
Infant mortality (per 1000 of births)		
Total	19.1	20.5
Urban population	18.8	20.7
Rural population	19.5	18.5

Source: B. Stephien et al., *Eko* 1989, No. 2.

Projecting car emissions

IN THE COMING decade, the emissions of nitrogen oxides from private cars in Poland may almost double, and those of carbon dioxide increase by about 70 per cent. These are among the conclusions of a study* carried out by Earth Resources Research on behalf of WWF International.

The ERR institute has developed a computer model for projecting future emissions of air pollutants from road vehicles. Among the factors taken into account are for instance:

- Vehicle technologies in use, taking into account fuel types, vehicle efficiencies, and abatement technologies.
- The mix of vehicles in the total stock, and the rate of change of mix as determined by vehicle operating lives, rate of purchase, and stock growth.
- Road network conditions, including average speeds and degree of traffic congestion.
- Total demand for travel in motor vehicles.

In the specific case study of Poland it was assumed that the average annual distance travelled by each car will rise from 7,000 to 10,000 kilometres between 1990 and 2010. In the same time period the total number of cars in the country is projected to double, from five to ten million cars. This will then be equal to around 250 cars per thou-

sand people, which will still be less than current ownership levels in western Europe, where they are typically between 300 and 400 cars per thousand and are still rising.

In projecting future emissions of nitrogen oxides three scenarios have been developed with different rates of introduction for new vehicles entering the Polish car stock, including the proportions of new vehicles meeting differing emission standards in each year.

It is assumed in Case A that sales of catalyzer-equipped cars (meeting the EC standards for 1993 year models) will start around the middle of the nineties, and that by the year 2000 they will amount to about 70 per cent of new-car sales.

In Case C, representing the most optimistic of the three scenarios, it is assumed that the sales of catalyzer vehicles will have already started this year, and that from 1996 all the new cars will be equipped with catalytic converters. The assumptions for the B scenario lie about halfway between those of Cases A and C. The results of the various scenarios for NO_x emissions are illustrated in Figure 1.

Three scenarios have likewise been developed to project future fuel consumption in private cars. Case A represents a business-as-usual scenario, reflecting current European averages and trends in fuel econ-

omy. Cases B and C are increasingly optimistic in regard to the proportion of new cars entering the stock and to the average efficiency of those vehicles. The last would imply a continuing high fuel-cost regime, probably coupled with fiscal incentives to the takeup of fuel efficient cars, and with stringent fuel-use standards.

The resultant fuel consumption as projected by the ERR model may be seen from Figure 2. In this, the weight of fuel is presented as petroleum equivalent, so the growth rate presented will be closely representative of the increase in the expected emissions of carbon dioxide. As can be seen from the figure, car fuel use is predicted to at least treble over the next thirty years.

The conclusion from this study is that a package of measures aimed at the transport system as a whole will be necessary if the environmental effects of road transport are to be limited. Any policy that concentrates solely on the application of "clean" technologies to new vehicles will be environmentally insufficient.

CHRISTER ÅGREN

*Factors influencing NO_x and CO₂ emissions from road traffic in Central and East Europe, by Malcolm Fergusson, Earth Resources Research, 258 Pentonville Road, London, England N1 9JY.

Figure 1. Projected NO_x emissions (thousand tons/year) from cars in Poland.

Case A — Case B + Case C ◇

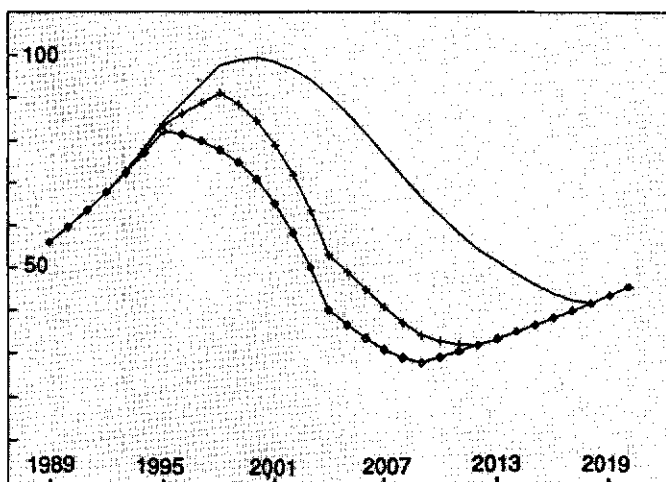
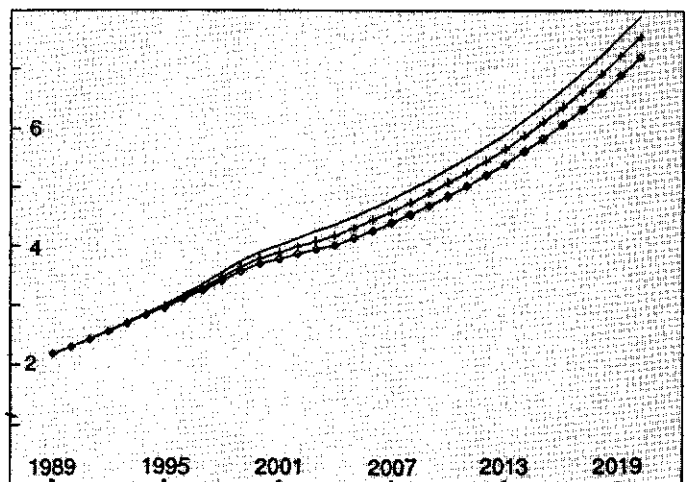


Figure 2. Projected fuel use (million tons/year) in cars in Poland.

Case A — Case B + Case C ◇



Environmental fund

THE POLISH government has lately been making preparations for setting up a fund to forward the development of environmental projects, no matter whether the ultimate financing comes from abroad or from domestic sources. The intention is that it should also be an instrument in the Debt for Environment Swap Program, by which part of the country's \$20 billion foreign debt would be exchanged for investments in environmental projects with an effect extending beyond Poland's borders.

The aim is however to provide additional resources for the protection of the environment in Poland too, and not merely to divert funds from local projects to others that happen to be of greater international interest.

The Polish government decided that in order to make the idea convincing to foreign governments, it would have to put forward a proposal for an institution that would ensure the implementation of environmental projects. A feasibility study was therefore carried out this last summer in consultation with various governmental departments, scientists, politicians, and NGOs.

The outcome was a proposal to establish such a fund as an independent foundation, secured by statute and with the Minister of the Environment as its legal trustee. It would be governed by a supervisory board, comprising seven Polish representatives and five from creditor countries, which would in turn be advised by a small group of independent international experts, who would review the fund's strategy and performance on an annual basis.

Priority, it is suggested, should be given to investments in four main areas:

1. Transboundary flows of sulphur dioxide and nitrogen oxides.
2. Pollution of the Baltic Sea.
3. Emissions of greenhouse gases.
4. Nature conservation and biodiversity

The first two would mean attending to the improvement of efficiency, flue-gas desulphurization, and the installation of low-NO_x burners at

large heating and power plants. The fines from mines with high-sulphur coal would also need cleaning, and the gas supply should be extended to various end-use markets as well as to the repowering of existing electricity plants.

Measures to promote energy effi-

Projects proposed for diminishing transboundary pollution

ciency will be necessary in all end-use sectors. This will require such things as demonstration projects, programs for energy saving by local authorities in their buildings and plants, the replacement and upgrading of small and medium-size boilers, improvements in process integration at industrial plants, better insulation and more modern coal-burning equipment in urban hous-

ing, and a renewal of public transportation.

Along with a general modernization of the gas-supply systems, methane could be extracted from coal mines and waste dumps and put to use.

Detailed proposals for projects in all four areas were also included in the feasibility report. These are based on previous research carried out by the Ministry of Environment and advice from the local vojvods. Besides giving technical data, they assess the environmental benefits as well as estimating the costs.

It is proposed, for instance, that in order to diminish transboundary flows of SO₂ and NO_x, ten specified coal-fired power stations should be equipped for desulphurization and part-denitrification. Coal cleaning at hard-coal mines in Upper-Silesia would add two more projects to the list. The total cost for the twelve is estimated to be \$1842 million, of which \$953 million should come from the proposed environmental fund.

REINHOLD PAPE



© WALDEMAR KOMPALA

Power clean-up envisaged

SPEAKING AT A SEMINAR in Serock, Poland, last October, the then Under Minister for Environment, Maciej Nowicki, claimed that his country's emissions of sulphur dioxide could be reduced by 30 per cent by 1995 and 40-50 per cent by the year 2000.

Here is a somewhat shortened version of Mr Nowicki's address.

Contemporary Poland has fifty-four generating and heat-and-power plants in operation. Their total capacity amounts to 28,900 MW electricity. In 1989 they burnt approximately 57 million tons of anthracite and 70.5 million tons of brown coal. In addition there are various industrial enterprises with 230 small plants for generating electricity and heat, with a total capacity of 3,150 MWe. There are also 119 hydro-electric plants which provide approximately 2,000 MWe. These plants produced altogether 145.5 TWh (terawatt hours) of electrical energy and 512 PJ (petajoule) of thermal energy in 1989.

The emission of dust from power generating is estimated to total 1.0-1.2 million tons per annum, which means 30-35 per cent of the nation's emissions of particulate matter. The emissions of sulphur dioxide (SO₂) from fuel-burning power processes amounted to 2.8-3.0 million tons in 1989 (approximately 70 per cent of the country's total). The figures for nitrogen oxides (NO_x) are 0.6-0.65 million tons (40-45 per cent of national emissions). In addition to this, power plants produced 35.8 million tons of wastes (slag and soot), of which only 43 per cent were re-utilized. The remainder – about 20 million tons – was added to the enormous landfills which already contain about 250 million tons of such waste. In addition to the pollution resulting from the burning process itself, there is also the damage from mining of anthracite (devastation of the Silesian environment) and lignite (removal of huge quantities of soil, subsidence, etc.).

Seventy-five per cent of all Poland's forests are endangered, 60 per cent of the soil is suffering from acidity, and the tangible losses re-

sulting from air pollution account for several percentage points of the GNP. Any increase of pollution, or even maintaining the emissions of dust, SO₂ and NO_x at present levels in the years to come, would greatly add to the destruction now being witnessed. Every effort must therefore be made to quickly reduce the pollution from power generating, while at the same time increasing the output potential.

It will be necessary to pursue eco-development with the aim of promoting human health and a clean natural environment. In any program the saving of raw materials and energy will occupy a prime place. The countries of western Europe have, over the past fifteen years, proven that rapid economic development is possible with a stable, or even falling, use of energy. In Poland the potentials are particularly great in both the industrial and construction as well as the transport sectors.

The implementation of a nationwide program aimed at the rational use of energy in all its forms should be a top priority for the government, industry and every citizen. It would be possible to save 30-40 per cent of the energy now being used while at the same time greatly decreasing environmental pollution, raising the quality of products manufactured by Polish industry, and raising the standard of living of the citizen.

Achievement of this will involve restructuring industry by on the one

hand replacing old, energy intensive technologies with newer, energy efficient ones, and on the other reducing the proportion of heavy industry in favour of high-technology industries requiring many times less energy in relation to the value of the product.

The most important and simplest method of reducing the emissions of SO₂ resulting from the burning of anthracite coal over the next 3-5 years would undoubtedly be to implement the fuel-enriching and desulphurization program.

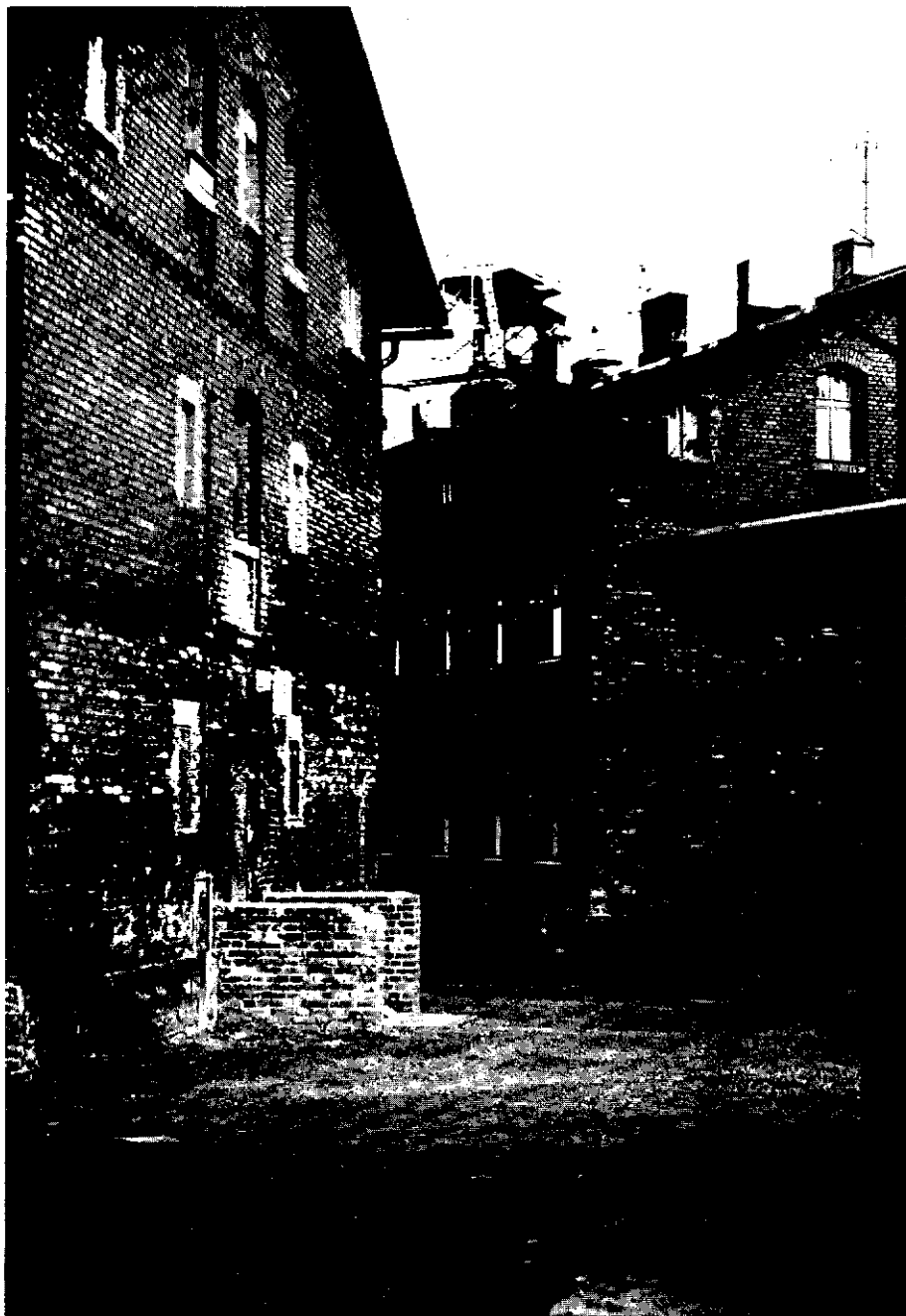
It should be noted that today, no generating plant receives coal with the specifications for which the plant was designed. The plants have to take delivery of coal with a low heat value (18.3 megajoule/kg on the average), with a large ash content (average 28.5 per cent) and a sulphur content in the order of 0.6-3.5 per cent (1.14 per cent average). Because the coal that is being burned is of low quality, 1,000 to 1,200 MWe is being "frozen" in existing plants, electro-filters are overburdened by dust, and excess emissions of SO₂ amount to about 400,000 tons yearly, while about 5 million tons of rock are needlessly being hauled around the country.

By using simple flotation methods, long known in Poland, it is possible to eliminate most of the rock found in coal as well as so-called pyritic sulphur (which accounts for 30-50 per cent of the sulphur content of anthracite coal).

Poland's ten largest SO₂ emission sources 1988. With the exception of Dolna Odra all are coal-fired power stations.

	District	SO ₂ (tons/year)
1. Belchatow	Piotrkowskie	341,600
2. Turow	Jeleniogonskie	205,400
3. Polaniec	Farnobrzskie	149,800
4. Jaworzno III	Katowickie	123,400
5. Rybnik	Katowickie	123,200
6. Kozienice	Radomskie	116,100
7. Siersza	Katowickie	111,500
8. Konin	Konin-Goslauice	84,000
9. Dolna Odra (oil fired)	Szezecinskie	78,300
10. Laziska	Katowickie	77,600

Source: Statistical Yearbook Poland 1989.



Tradition for dwellings to huddle around industrial plants in sothern Poland.

During the next two years concentration facilities are expected to be built at the four mines producing 10 million tons of coal with the greatest sulphur content. All the remaining mines that supply coal for energy production should have such facilities within three years. The cost is estimated to be 2 trillion zlotys (approximately US \$200 million).

In contrast to anthracite, brown coal has its entire sulphur content in organic form, and thus it cannot be separated from the coal prior to the burning process. The only way to reduce SO₂ emissions from the large power plants using lignite (Belchatow, Turow and Patnow) will be to install equipment for desulphurizing the flue gases. It is entirely with-

in reason to expect at least the Belchatow and Turow plants to be so equipped within five years. This will make it possible to limit SO₂ emissions by about 500,000 tons per year, at a cost of approximately 5-6 trillion zlotys (US \$500-600 million). Similar facilities must be installed simultaneously at the power plants in Upper Silesia on account of the need to concentrate effort on cleaning up this, the most polluted region of Poland, as quickly as possible.

It may thus be assumed that Poland's emissions of SO₂ can be reduced by at least 30 per cent within five years. The cost will, however, amount to one billion dollars.

It should be added, that only one new large-capacity power plant will

be commissioned during this period (Opole 3,200 MW). It will be equipped for highly efficient flue-gas desulphurization. The electricity potential of the Polish power industry can increase by 4,200-4,500 MW within five years.

In the medium term, within 10-15 years, the main task will be the introduction of new, more effective coal-burning technologies through the manufacture, in Poland, of FBC (fluidized bed combustion) boilers. This technology will make possible not only savings in coal, but also greatly decreased emissions of SO₂ and NO_x (by 60-80 per cent), without any need for special cleaning equipment. Such boilers will steadily replace the old conventional types. The Polish factories at Raciborz, Sosnowiec, and Sedziszow are now phasing out the old types and starting the manufacture of FBC boilers.

Another major problem, power blackouts during evening peak hours, makes it necessary to build peak-load plants, fuelled by gas. An increased import of natural gas is planned through a pipeline from the North Sea, as well as increased domestic production. Gas-fired plants emit no SO₂ or dust, while NO_x emissions are many times lower than for coal-burning plants.

A middle-term step is the development of district heating systems, to replace the inefficient individual furnaces used for residential heating. The improved efficiency can result in savings of several million tons of coal annually. Modernization and expansion of the heating network of the industrial generating plants could further add to this potential. The implementation of any program such as the above will not, however, be possible prior to the total reform of fuel and energy prices (bringing them in line with world prices) coupled with the introduction of tax breaks and other economic instruments for those who undertake tangible pro-environment action.

The end result of all this could be an increase of 10,000-12,000 MW in Poland's potential capacity by the year 2000, accompanied by a reduction in SO₂ emissions by 40-50 per cent, compared with today's figures.

Maciej Nowicki is now Minister for the Environment in Poland.

Lakes and forests in Sweden

BECAUSE OF AIR POLLUTION, close on 14,000 lakes are now distinctly acidified in Sweden – and about 4000 of them very badly so. And rapid further deterioration will ensue if acid deposition continues at the same rate as today – it being estimated that after only a few decades the number of acidified lakes will have risen to 34,000. In total, the country has something like 85,000 lakes with a surface area of more than one hectare.

Acidification has extensive biological effects in lakes. For one thing the diversity and number of aquatic species diminishes, resulting in a greatly changed ecosystem. Such effects occur already when the pH-level of the water drops below 6. Among the sensitive animal species are snails, mussels, crustaceans, and certain species of insects and fish.

As regards the effects on forest soils, the pH value of the soil on some 650,000 hectares of forest land in South Sweden is now under 4.4, which is thought to be a critical level at which release of potentially toxic metals to the soil water will start. On a further 700,000 hectares in that part of the country the pH values ranges between 4.4 and 4.7, and unless there is a dramatic reduction of the acid deposition, the acidification of these soils too will go below the critical level within a couple of decades.

One effect of acidification is the greatly increased leaching of plant nutrients from the soil. Since 1950, in some areas more than half of the available magnesium, potassium, and calcium has become lost in this way.

National inventories of the scale and distribution of forest damage have been carried out since the mid 1980s. In 1991 twelve per cent of the trees were classed as moderately to severely damaged, i.e. they had lost more than a quarter of their foliage.

Other negative effects caused by the sulphur and nitrogen pollution are changes in the flora and fauna, acidification of the groundwater, reduced crop yields, damage to materials and cultural monuments, and direct impact on human health.

The cause of acidification is to be found in man-made emissions to the atmosphere, primarily of sulphur dioxide and nitrogen compounds. As

shown by data from the European monitoring program, between 80 and 90 per cent of the sulphur and oxidized nitrogen compounds that are deposited over Sweden comes from abroad, the countries contributing the most being Germany, Britain, and Poland.

The discovery of the acidification problem in Sweden, in the mid-1960s, led to the adoption of measures to reduce the emissions of sulphur dioxide, starting in 1969. In 1970 Swedish emissions of

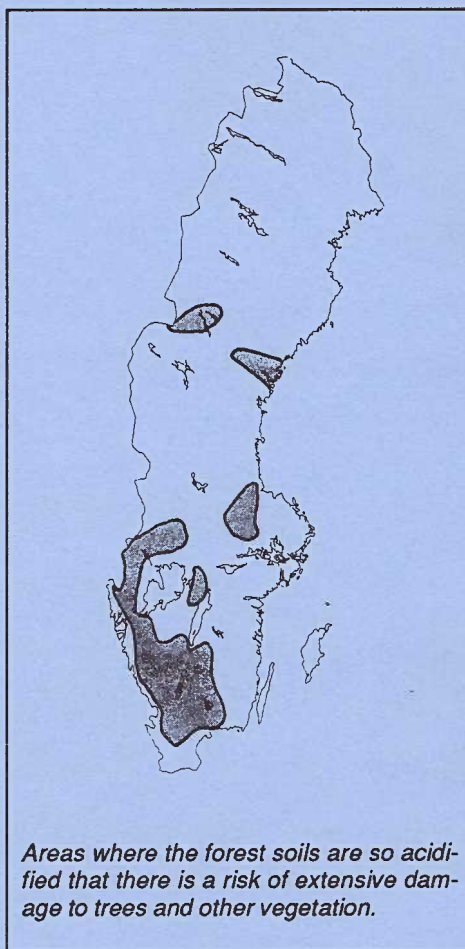
sulphur dioxide amounted to about 900,000 tons. By 1980 they had been nearly halved, and by 1991 they had fallen to 107,000 tons – a reduction of 79 per cent as compared to the level of 1980. Parliament has decided that the aim will be to reduce emissions by 80 per cent between 1980 and 2000.

Swedish emissions of nitrogen oxides amounted in 1980 to 424,000 tons, and by 1991 they had been reduced by 8 per cent, to 388,000 tons. The target for reductions as decided by the Swedish parliament is to reach a 30-per-cent reduction by 1995. According to estimates by the Swedish Environment Protection Agency, this target is however not likely to be attained until 1998.

The amount of acid deposition that various types of soil will manage to neutralize in the long run – the so-called critical load – will depend primarily on the mineral weathering rate. The critical load may be defined as the greatest superaddition of a certain pollutant an ecosystem

can support without suffering damage in the long term. The additions of acid substances should therefore not take place at a rate exceeding that required for enabling soil weathering to neutralize them.

In Scandinavia, the critical loads for acid deposition are being exceeded on 80 per cent of the forest area. According to recent calculations done by the Swedish Environment Protection Agency, for Sweden the deposition will have to be reduced by at least 70 per cent between 1990 and 2010 if the acidification of the soil is not to go on increasing. To reverse acidification will naturally require still greater reductions. And the quicker the desired rate of recovery, the faster and greater they must be.



Areas where the forest soils are so acidified that there is a risk of extensive damage to trees and other vegetation.



The Swedish
NGO Secretariat
on Acid Rain

About the Secretariat

The Swedish NGO Secretariat on Acid Rain was formed in 1982 with a board now comprising one representative from each of the following organizations: The Environmental Federation, the Swedish Anglers' National Association, the Swedish Society for Nature Conservation, the Swedish Youth Association for Environmental Studies and Conservation, and the World Wide Fund for Nature Sweden.

The essential aim of the secretariat is to promote awareness of the problems associated with air pollution, and thus, in part as a result of public pressure, to bring about the required reduction of the emissions of air pollutants. The eventual aim is to have those emissions brought down to levels – the so-called critical loads – that the environment can tolerate without suffering damage.

In furtherance of these aims, the secretariat operates as follows, by

- ☐ Keeping under observation political trends and scientific developments.
- ☐ Acting as an information centre, primarily for European environmentalist organizations, but also for the media, authorities, and researchers.
- ☐ Publishing a magazine, Acid News, which is issued five times a year and is distributed free of charge to some 5000 selected recipients.
- ☐ Producing and distributing information material.

- ☐ Supporting environmentalist bodies in other countries by various means, both financial and other, in their work towards common ends.

- ☐ Acting as coordinator of the international activities, including lobbying, of European environmentalist organizations, as for instance in connection with the meetings of the bodies responsible for international conventions, such as the United Nations Convention on Long Range Transboundary Air Pollution.

- ☐ Acting as an observer at the proceedings involving international agreements for reducing the emissions of greenhouse gases.

The work of the secretariat is largely directed on the one hand towards eastern Europe, especially Poland, the former Czechoslovakia, and the Baltic States, and on the other towards members of the European Community, in particular Great Britain. By emitting large amounts of sulphur and nitrogen oxides, all these countries add significantly to acid depositions over Sweden.

As regards the eastern European countries, activity mostly takes the form of supporting and cooperating with the local environmentalist movements. Since 1988, for instance, financial support has been given towards maintaining information centres on energy, transport, and air pollution. All are or will be run by local environmentalist organizations.