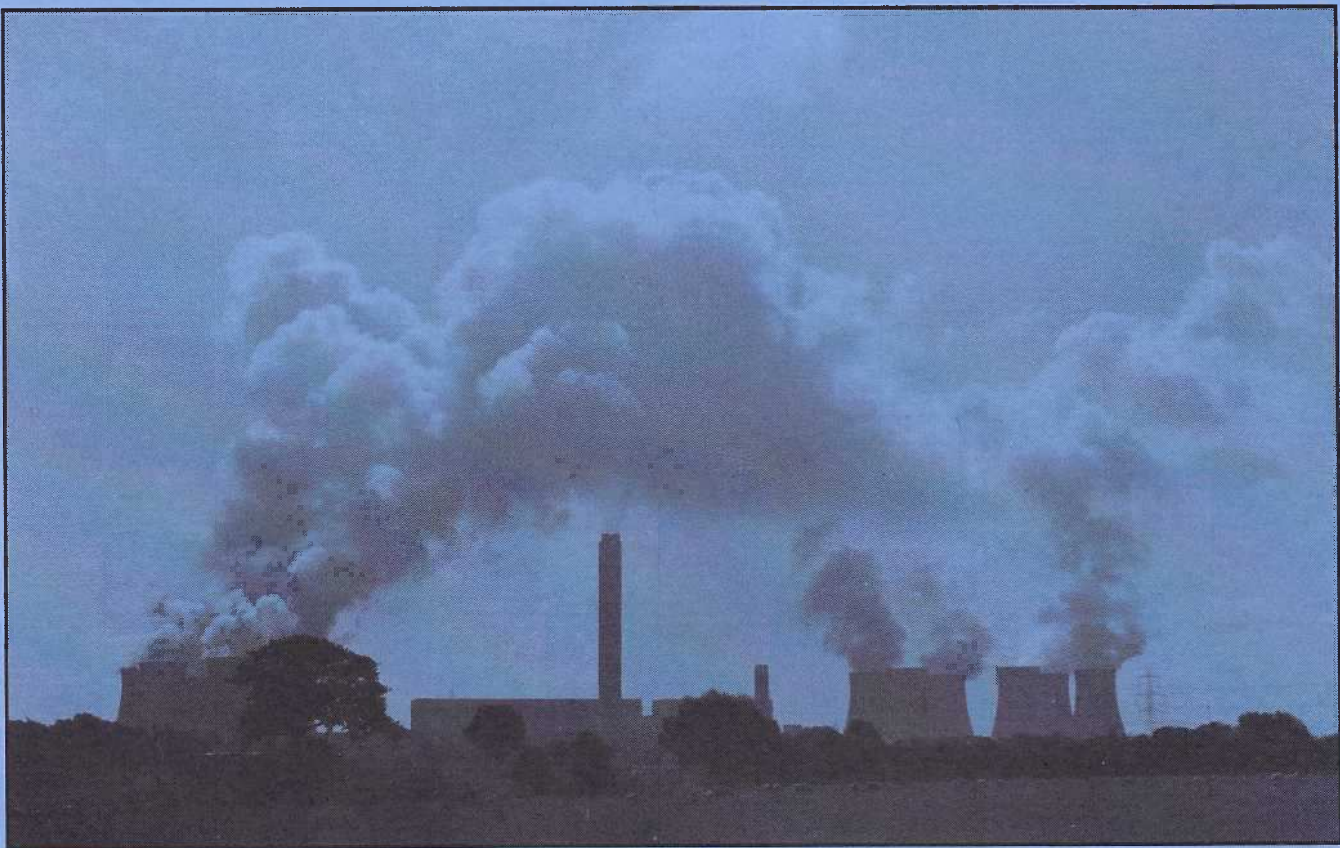
AIR POLLUTION AND CLIMATE SERIES

6

Doing more than required

Plants that are showing the way



Some utilities are already achieving lower emission levels than envisaged even for future standards

STOP ACID RAIN

The Swedish
NGO Secretariat
on Acid Rain

The Swedish NGO Secretariat on Acid Rain

The Swedish NGO Secretariat on Acid Rain was formed in 1982 with a board now comprising one representative from each of the following organizations: Freinds of the Earth Sweden, 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 Baltic States, Russia, and the Czech Republic, and on the other towards members of the European Union, 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.

AIR POLLUTION AND CLIMATE SERIES

6

Doing more than required

The "top ten" combustion plants owned by European utilities revealed in a survey by

Anna-Karin Hjalmarsson
ÅF-ENERGIKONSULT STOCKHOLM AB

THE SWEDISH NGO SECRETARIAT ON ACID RAIN

Previous reports in the series:
No. 1 The Eastern Atmosphere (1993)
No. 2 The "Black" Triangle – a General Reader (1993)
No. 3 Sulphur emissions from large point sources in Europe (1995)
No. 4 To clear the air over Europe (1995)
No. 5 Large combustion plants. Revision of the 1988 EC directive (1995)

AIR POLLUTION AND CLIMATE SERIES
Doing more than required. Plants that are showing the way.
Author: Anna-Karin Hjalmarsson, ÅF-Energikonsult Stockholm AB.

ISBN: 91 558 3618-6
ISSN: 1400-4909
Printed by Williamssons Offset AB, Stockholm, Sweden, 1996.
Published by The Swedish NGO Secretariat on Acid Rain, Box 7005,
S-402 31 Göteborg, Sweden. Phone: +46-31-10 55 90. Fax: +46-31-711 46 20.
Further copies can be obtained free of charge from the publisher,
at the above address.

Preface

According to the EC directive of 1988 concerning emissions of air pollutants from large combustion plants, the European Commission was to put forward a proposal for revision at the latest by July 1995. But no such proposal has been forthcoming. Early last April the Commission did however call a meeting of member states and NGOs to discuss the revision. It was then said that no final draft could be expected before the autumn of this year.

The directive sets limits to the emissions of sulphur dioxide and nitrogen oxides from large plants. In 1990 such plants were responsible for 63 and 21 per cent of the emissions of these pollutants within the union.

It has emerged from the study here presented that there are already a number of plants in operation which are meeting with a good margin even the so-called BAT requirements (Best Available Technology) that the Commission intends to include in the revised directive, so as to be applicable to new plants around the end of the nineties.

The fact that so many existing plants, of various sizes and fired with various fuels, can achieve levels of emissions that are already markedly lower than those envisaged for plants that are yet to be built, shows clearly that the Commission's proposals are far too lenient, failing to follow even the current best technology.

A description and analysis of the existing directive have been given in a previous report in the Secretariat's APC series,* where various proposals were also made for its revision, including the requirements that were needed if it really were to reflect the possibilities of the best available technology.

By decision of the Council of Environment Ministers in December 1995, the Commission is to work out a comprehensive strategy for dealing with the problems of acidification. This was to show how the target was to be attained of pressing acidifying depositions down to levels below the critical loads. For the achievement of that target the emissions from large combustion plants will obviously themselves be critical.

There is by now widespread agreement that emissions in general will have to be drastically reduced, and quickly. We are now presenting this study as a means of stimulating discussion as to how, and by how much, the emissions of acidifying pollutants can and should be cut back – by showing what can be done even now.

Göteborg, May 1995

Håkan Carlstrand
Chairman, The Swedish NGO Secretariat on Acid Rain

* Lundberg, F. & Ågren, C. (1995) *Large Combustion Plants: The EC Directive. Comments on the present directive and proposals for revision.* No. 5 in the Air Pollution and Climate Series published by The Swedish NGO Secretariat on Acid Rain, Göteborg, Sweden.

Summary

The aim of this study, which has been carried out by Anna-Karin Hjalmarsson of ÅF-Energikonsult Stockholm AB at the instance of the Secretariat, was to identify some of the large European combustion plants that were best from the point of view of the environment. The ranking has been based on their emissions of sulphur and nitrogen oxides. Data came both from power plants and plants for combined heat and power. Although most of the plants are burning coal, either lignite or bituminous, there are some fired with oil, natural gas, and biofuels. No claim is made to have covered the whole field, but simply to present examples of different types of plant from a limited number of countries.

Emissions have been evaluated according to the concentrations of pollutants in the flue gases, not by total annual volume, and because of the importance of using energy efficiently, they are shown in relation both to fuel input (the usual form of measurement) and output of useful energy in the form of electricity and/or heat.

It comes out that many plant owners have made efforts to bring emissions down to levels below those prescribed in current legislation. The emissions from the ten best plants in the study, expressed as the sum of sulphur and nitrogen oxides, range from 32 to 66 mg/MJ of fuel input (equivalent to 85-175 mg (SO_2+NO_2)/Nm^3 dry gas at 6 per cent O_2), and from 36 to 119 mg/MJ of energy output. By either reckoning the same plant came out best.

The study shows it to be quite possible, even with conventional technology, to attain emission levels that are considerably lower than required either in the directive or in national regulations.

Contents

1. Background to the study

As is well known, a great part of the emissions of acidifying substances in Europe comes from large combustion plants. A number of plants have previously been identified as large emitters and ranked according to their annual emissions, primarily of sulphur. Many plant owners have however taken steps to reduce their emissions and there are now plants with considerably lower concentrations of pollutants in their flue gases than either the EU directive (see below) or national regulations require.

In general, though, reductions have come about primarily through authorizations for individual plants. There have also been local or regional tendences to make the conditions for permits stricter than those set down in the EU directive or national legislation. In some countries economic instruments have provided the impetus to reduce emissions. Sweden is an example of a country where such instruments, in the form of a tax on sulphur emissions and a charge for nitrogen oxides, have led to reductions.

In this study the plants have been evaluated by their concentrations of pollutants, not their annual emissions. Emissions are shown on the one hand in relation to fuel input, and on the other to the output of useful energy in the form of electricity and district heat. Because of the need to ensure an effective use of energy, emissions should be related to plants' efficiency. The efficient use of energy will mean burning less fuel and so conserving natural resources and holding down emissions of carbon dioxide. Efficient plants that produce both electricity and heat are those that use energy to the best effect. In plants producing electricity only, often more than half of the energy content of the fuel is cooled away to no good.

In order to restrict acidifying emissions from new plants, the EU directive 88/609/EEC, *The limitation of emissions of certain pollution into the air from large combustion plants*, set limits for plants of more than 50 MW capacity. The directive also sets national ceilings for member states. Each country is still at liberty however to impose stricter requirements than those included in the directive. Such requirements may be incorporated in general rulings, national or regional, or be set for individual plants after scrutiny. There are also examples of other control measures, such as the tax on sulphur emissions and the charge on nitrogen oxides, which have been used in Sweden for several years and found to be effective means of curbing emissions.

The large combustion plants directive is now being revised and a new draft version may be expected before the end of the year (1996). The present study shows it to be practically possible to achieve plant emission levels that are distinctly lower than required in the EU directive or most national regulations. It also reveals that quite a few plant owners have already managed to go beyond the requirements of the directive.

2. Gathering information

The information necessary for the study has been obtained by circulating a questionnaire (Appendix 1) to appropriate authorities as well as plant owners – primarily in Germany, the Netherlands, Denmark, Sweden, and Austria, countries that were chosen as having the strictest requirements in regard to emissions from large combustion plants.

Information was not always easily forthcoming. One reason was that in most countries plant owners are required each year to report to the authorities essentially the same information as that asked for in the questionnaire. They therefore tended to assume that it would be publicly available, but in several countries it is regarded as confidential.

There may, too, have been some remaining unwillingness on the part of plant owners to admit the possibility of achieving much lower

Table 3.1. Plant data. Fuels and installed capacities.

Plant designation. Owner	Fuel	Installed capacity MW_{input}	MW_{el}	MW_{heat}
Danmark				
Avedøre Power Station. Sjællandske Kraftværker	Coal	595	250	330
Netherlands				
Amercentrale 9. EPZ Eindhoven NL	Coal	1743	600	350
Eemshaven, EC-3/4/5. EPON	Natural gas	1900	1050	0
Hemweg, unit 8. UNA	Coal	1496	630	0
Sweden				
Värtaverket, PFBC (two units). Stockholms Energi AB	Coal	440	140	224
Västerås 1-2. Västerås Stads Kraftvärmeverk	Coal	300	70	200
Västerås 3. Västerås Stads Kraftvärmeverk	Oil	640	220	365
Västerås 4. Västerås Stads Kraftvärmeverk	Coal	450	155	250
Händelöverket, P13. Norrköpings Energi AB	Biofuel	140	40	85
Idbäcksverket. Nyköpings Energi AB	Biofuel, coal	105	35	58
Germany				
Altbach/Deizisau. Neckarwerke	Coal	1090	423/379	280
Gersteinwerke, Emsland, B/C, F/G/H/I. VEW	Natural gas	5670	2370	0
Westfalen, Block C. VEW	Coal	705	284	0
Werne, Block K. VEW	Natural gas, coal	420/1374	700	0
Jänschwalde. VEAG	Lignite	8*/762	4*/500	348
Boxberg III, N and P. VEAG	Lignite	4*/762	2*/500	0
Aschaffenburg, unit 21. Bayernwerk	Coal	395	143	0
Aschaffenburg, unit 31. Bayernwerk	Coal	378	143	0
Ingolstadt, unit 3. Bayernwerk	Oil	1007	370	0
Ingolstadt, unit 4. Bayernwerk	Oil	1007	370	0
Schwandorf B. Bayernwerk	Lignite	297	90	0
Schwandorf C. Bayernwerk	Lignite	297	94	0
Schwandorf D. Bayernwerk	Lignite	803	270	0
Neurath D. RWE	Lignite	1634	570	7
Niederaussem G. RWE	Lignite	1711	597	7
Rostock. Kraftwerks- und Netzgesellschaft	Coal	1370	509	150
Austria				
Voitsberg 3. Draukraft	Lignite	792	250	0
Mellach. STEWAG	Coal	543	N/A	N/A
Korneuburg, Block 2. Verbundkraft	Natural gas	685	283	2
Durnrohr, Block 1. Verbundkraft	Coal	924	387	0

* Number of units, each with same capacity.

emissions than are prescribed in the regulations. Yet many owners seemed to be exceedingly proud of their ability to hold down emissions and were glad of the prospect of appearing among the "top ten."

3. Plant data

Replies were received from seventeen plant owners. In some cases the information concerned a whole utility – that is, it took in more than one boiler or unit – while in others separate information was given for each unit, so that data can be presented for altogether thirty units.

In Table 3.1 the plants are listed under country, with the type of fuel and the installed capacity, expressed as fuel input as well as net electricity and heat output. The unit sizes range from about 100 to 1700 MW capacity. Table 3.2 shows the specific emissions of sulphur

Tabell 3.2. Specific emissions of sulphur and nitrogen oxides.

Plant designation. Owner	Emissions mg S/MJ_{fuel}	Emissions mg NO_2/MJ_{fuel}
Danmark		
Avedøre Power Station. Sjællandske Kraftværker	49	64
Netherlands		
Amercentrale 9. EPZ Eindhoven NL	24	111
Eemshaven, EC-3/4/5. EPON	0	45
Hemweg, unit 8. UNA	24	91
Sweden		
Värtaverket, PFBC (two units). Stockholms Energi AB	15	37
Västerås 1-2. Västerås Stads Kraftvärmeverk	6	35
Västerås 3. Västerås Stads Kraftvärmeverk	69	45
Västerås 4. Västerås Stads Kraftvärmeverk	3	26
Händelöverket, P13. Norrköpings Energi AB	3	43
Idbäcksverket. Nyköpings Energi AB	19	28
Germany		
Altbach/Deizisau. Neckarwerke	22	70
Gersteinwerke, Emsland, B/C, F/G/H/I. VEW	0	35
Westfalen, Block C. VEW	27	66
Werne, Block K. VEW	17	57
Jänschwalde. VEAG	8	71
Boxberg III, N and P. VEAG	30	75
Aschaffenburg, unit 21. Bayernwerk	19	58
Aschaffenburg, unit 31. Bayernwerk	20	60
Ingolstadt, unit 3. Bayernwerk	10	22
Ingolstadt, unit 4. Bayernwerk	16	18
Schwandorf, B. Bayernwerk	20	57
Schwandorf, C. Bayernwerk	17	55
Schwandorf, D. Bayernwerk	17	54
Neurath, D. RWE	13	71
Niederaussem, G. RWE	18	70
Rostock. Kraftwerks- und Netzgesellschaft	9	61
Austria		
Voitsberg 3. Draukraft	43	51
Mellach. STEWAG	3	58
Korneuburg, Block 2. Verbundkraft	0	41
Dürnrohr, Block 1. Verbundkraft	13	47

and nitrogen oxides in relation to fuel energy content (calculated from the lower effective heat value). Nitrogen oxides are given as the sum of NO and NO_2, expressed as NO_2. Factors for conversion from mg S/MJ and mg NO_2/MJ of fuel input to mg SO_2/Nm^3 and mg NO_2/Nm^3 can be seen in Appendix 2. The unit mg/Nm^3 is that used in the EU directive.

Included in the study are plants fired with all the main types of fuel, from lignite, bituminous coal, oil, and natural gas to biofuels. Most of the plants are purely steam plants, although there are some equipped with both steam and gas turbines, in which case the amount of electricity obtained is always greater, relatively, than with a steam turbine alone. About half are condensing plants where all surplus heat is cooled way. In a few cases a small quantity of heat is produced for district heating. Otherwise they are exclusively plants for combined heat-and-power.

4. Acidifying emissions from different fuels

The emissions of acidifying substances are listed according to fuel and the type of plant, whether condensing or combined heat-and-power. Plants that produce only very small amounts of useful heat are classified as condensing plants. The acidifying emissions have been calculated as the sum of sulphur dioxide and nitrogen oxides. Emission values are shown both as mg per MJ fuel input (for conversion factors see Appendix 2) and mg per MJ useful energy – the latter being given as the sum of the net electricity output and the heat for district heating.

4.1. Bituminous coal

All the coal-fired plants here listed are equipped for flue-gas desulphurization, either by wet scrubbers or spray dry scrubbers, as well

Table 4.1. Emissions of acidifying substances from coal-fired plants.

Plant	Country	mg (SO_2+NO_2)/MJ energy input	mg (SO_2+NO_2)/MJ useful energy[1]
Condensing plants			
Dürnrohr 1. Verbundkraft	Austria	73	154
Werne K. VEW	Germany	91	227
Aschaffenburg 21. Bayernwerk	Germany	96	259
Aschaffenburg 31. Bayernwerk	Germany	101	272
Altbach. Neckarwerke	Germany	114	273
Westfalen C. VEW	Germany	121	331
Combined heat-and-power			
Västerås 4. Västerås Stads Kraftvärmeverk	Sweden	32	36
Västerås 1-2. Västerås Stads Kraftvärmeverk	Sweden	46	53
PFBC, Värtaverket. Stockholm Energi AB	Sweden	67	80
Mellach. STEWAG	Austria	64	119
Rostock. Kraftwerks- und Netzgesellschaft	Germany	78	196
Avedøre. Sjællandske Kraftværker	Danmark	161	215
Hemweg 8. UNA	Netherlands	140	332
Amercentrale 9. EPZ Eindhoven	Netherlands	160	333

[1] Useful energy is the sum of the net electricity output and the heat for district heating.

as selective catalytic reduction (SCR) for reducing the emissions of nitrogen oxides. The emissions of acidifying substances range from 32-160 mg/MJ_{fuel} and from 36-333 mg/$MJ_{useful\ energy}$.

4.2. Lignite

All the plants burning lignite are equipped for flue-gas desulphurization and SCR. The emissions of acidifying substances range from 87-138 mg/MJ_{fuel} and from 264-415 mg/$MJ_{useful\ energy}$.

Table 4.2. Emissions of acidifying substances from lignite-fired plants.

Plant	Country	mg (SO_2+NO_2)/MJ energy input	mg (SO_2+NO_2)/MJ useful energy[1]
Condensing plants			
Schwandorf D. Bayernwerk	Germany	88	264
Jänschwalde. VEAG	Germany	87	267
Neurath D. RWE	Germany	96	271
Schwandorf C. Bayernwerk	Germany	89	285
Schwandorf B. Bayernwerk	Germany	97	308
Niederaussem G. RWE	Germany	106	310
Voitsberg 3. Draukraft	Austria	138	381
Boxberg III, N och P. VEAG	Germany	135	415

[1] Useful energy is the sum of the net electricity output and the heat for district heating.

4.3. Oil

Both the German plants here listed burn high-sulphur oil, but being equipped for flue-gas desulphurization (wet method) and SCR they can get very low emission levels. The Västerås unit, which is fired with low-sulphur oil (0.3 per cent S) has no flue-gas desulphurization but is equipped with SCR to reduce the emissions of nitrogen oxides. The emissions of acidifying substances range from 41-184 mg/MJ_{fuel} and from 117-245 mg/$MJ_{useful\ energy}$.

Table 4.3. Emissions of acidifying substances from oil-fired plants.

Plant	Country	mg (SO_2+NO_2)/MJ energy input	mg (SO_2+NO_2)/MJ useful energy[1]
Condensing plants			
Ingolstadt 3. Bayernwerk	Germany	41	117
Ingolstadt 4. Bayernwerk	Germany	50	138
Combined heat-and-power			
Västerås 3. Västerås Stads Kraftvärmeverk	Sweden	184	245

[1] Useful energy is the sum of the net electricity output and the heat for district heating.

4.4. Natural gas

All the plants fired with natural gas are of the combi-cycle type, meaning they have both steam and gas turbines for the production of electricity. Since natural gas has a very low sulphur content, the only emissions of acidifying substances are nitrogen oxides. The emissions range from 35-45 mg/MJ_{fuel} and from 69-92 mg/$MJ_{useful\ energy}$.

Table 4.4. Emissions of acidifying substances from plants fired with natural gas.

Plant	Country	mg (SO_2+NO_2)/MJ energy input	mg (SO_2+NO_2)/MJ useful energy[1]
Condensing plants			
Korneuburg 2. Verbundkraft	Austria	41	69
Eemshaven, EC-3/4/5. EPON	Netherlands	45[2]	81[2]
Gersteinwerke B/C, F/G/H/I. VEW	Germany	35	92

[1] Useful energy is the sum of the net electricity output and the heat for district heating.

[2] Estimate of the Netherlands EPA.

4.5. Biofuels

The two biofuel-burning plants included in the study are both equipped with SCR to reduce the emissions of nitrogen oxides, and are the first such plants to be so equipped. Because of the low sulphur content of these fuels (about 10 mg S/MJ_{fuel}) desulphurization has not been used. The emissions of acidifying substances range from 50-66 mg/MJ_{fuel} and from 57-72 mg/$MJ_{useful\ energy}$.

Table 4.5. Emissions of acidifying substances from plants burning biofuels.

Plant	Country	mg (SO_2+NO_2)/MJ energy input	mg (SO_2+NO_2)/MJ useful energy[1]
Combined heat-and-power			
Händelöverket P13. Norrköpings Energi AB	Sweden	50	57
Idbäcksverket. Nyköpings Energi AB	Sweden	66	72

[1] Useful energy is the sum of the net electricity output and the heat for district heating.

5. The ten best plants

Below are listed the ten best plants from the environmental point of view, placed according to their emissions in relation, 5.1, to energy input, and 5.2 to production of useful energy. The emissions of acidifying substances from these ten plants, calculated as the sum of sulphur dioxide and nitrogen oxides, range from 32 to 66 mg/MJ fuel input – corresponding approximately to 85-175 mg $(SO_2+NO_2)/Nm^3$ of dry gas with 6 per cent O_2. Calculated in relation to useful energy, the emissions range from 36 to 119 mg/MJ.

It is remarkable that both lists are headed by coal-fired plants, instead of plants fired with natural gas or biofuels, as might perhaps have been expected. The leading unit in both cases is Västerås 4, which was put into operation in 1973 and was originally intended for oil firing. In 1983 it was altered so as to be able to burn pulverized coal as well. It has subsequently been fitted for flue-gas desulphurization (1986) and selective catalytic reduction (1992). The main inducement for achieving these very low emissions at Västerås has been the tax on emissions of sulphur and a charge for NO_x emissions.

Table 5.1. Emissions in relation to energy input.

	Plant	Type[1]	Fuel	Country	mg (SO_2+NO_2)/MJ energy input
1.	Västerås 4. Västerås Stads Kraftvärmeverk	CHP	Coal	Sweden	32
2.	Gersteinwerke B/C, F/G/H/I. VEW	P	Natural gas	Germany	35
3.	Ingolstadt 3. Bayernwerk	P	Oil	Germany	41
3.	Korneuburg 2. Verbundkraft	P	Natural gas	Austria	41
5.	Eemshaven, EC-3/4/5. EPON	P	Natural gas	Netherlands	45
6.	Västerås 1-2. Västerås Stads Kraftvärmeverk	CHP	Coal	Sweden	46
7.	Ingolstadt 4. Bayernwerk	P	Oil	Germany	50
7.	Händelöverket P13. Norrköpings Energi AB	CHP	Biofuel	Sweden	50
9.	Mellach. STEWAG	CHP	Coal	Austria	64
10.	Idbäcksverket. Nyköpings Energi AB	CHP	Biofuel	Sweden	66

[1] P = Power station. CHP = Combined heat-and-power.

Table 5.2. Emissions in relation to output of useful energy.

	Plant	Type[1]	Fuel	Country	mg (SO_2+NO_2)/MJ useful energy[2]
1.	Västerås 4. Västerås Stads Kraftvärmeverk	CHP	Coal	Sweden	36
2.	Västerås 1-2. Västerås Stads Kraftvärmeverk	CHP	Coal	Sweden	53
3.	Händelöverket P13. Norrköpings Energi AB	CHP	Biofuel	Sweden	57
4.	Korneuburg, Block 2. Verbundkraft	P	Natural gas	Austria	69
5.	Idbäcksverket. Nyköpings Energi AB	CHP	Biofuel	Sweden	72
6.	PFBC, Värtaverket. Stockholm Energi AB	CHP	Coal	Sweden	80
7.	Eemshaven, EC-3/4/5. EPON	P	Natural gas	Netherlands	81
8.	Gersteinwerke B/C, F/G/H/I. VEW	P	Natural gas	Germany	92
9.	Ingolstadt, 3. Bayernwerk	P	Oil	Germany	117
10.	Mellach. STEWAG	CHP	Coal	Austria	119

[1] P = Power station. CHP = Combined heat-and-power.

[2] Useful energy is the sum of the net electricity output and the heat for district heating.

APPENDIX 1

Questionnaire

TOP TEN PLANTS IN EUROPE

Plant name:
Unit:
Utility/owner:
Fuel type:
Boiler type:
Unit capacity, Fuel input, MW:
Net electricity output, MW:
District heating, MW:

Emissions and production in 1995 or (1994)

Emissions	*tonne/year*	*concentration (mg/m^3 norm.)*[1)]
Sulpur dioxide, SO_2 NO_x (as NO_2) Particulates		

[1)] specified at.........% O_2, dry gas

Production	*GWh/year*
Energy input in fuel Energy output, net electricity Energy output, district heating	

Plant specific emission standards

	Unit	*Value*	*Time base*
Sulpur dioxide, SO_2			
NO_x (as NO_2)			
Particulates			

APPENDIX 2

Conversion factors

	Fuel	Factor
mg S/MJfuel	Coal	5.4 mg SO_2/Nm^3 1)
	Oil	7.1 mg SO_2/Nm^3 2)
	Natural gas	7.4 mg SO_2/Nm^3 2)
	Biofuels	5.3 mg SO_2/Nm^3 1)
mg NO_2/MJfuel	Coal	2.7 mg NO_2/Nm^3 1)
	Oil	3.6 mg NO_2/Nm^3 2)
	Natural gas	3.7 mg NO_2/Nm^3 2)
	Biofuels	2.6 mg NO_2/Nm^3 1)

1) 6 per cent O_2 dry gas at normal temperature and pressure.
2) 3 per cent O_2 dry gas at normal temperature and pressure.

Note. A full account of the emission requirements set forth in the EU Directive 88/609/EEC will be found in *Large combustion plants – Revision of the 1988 EC directive*, No. 5 in the APC series published by the Swedish NGO Secretariat on Acid Rain.

APPENDIX 3

Replying to the questionnaire

Avedørevækrket, i/s Sjællandske Kraftværker, Denmark
RWE Energie AG, Essen, Germany
Ministry of Housing, Physical Planning and Environment, the Netherlands
Bayernwerk AG, München, Germany
Norrköpings Energi AB, Norrköping, Sweden
Nyköpings Energi AB, Nyköping, Sweden
N.V. EPZ, Geertruidenberg, the Netherlands
Neckarwerke Electrizitätsversorgungs AG, Esslingen, Germany
VEAG, Berlin, Germany
VEW, Dortmund, Germany
Umweltbundesamt, Austria
Stockholm Energi AB, Sweden
Västerås Stads Kraftvärmeverk AB, Västerås, Sweden
NV Energieproduktiebedrijf UNA, Amsterdam, the Netherlands

Other sources of information

Verband Deutscher Maschinen- und Anlägenbau, Frankfurt, Germany
Technische Vereinigung der Grosskraftweksbetreiber, Essen, Germany
VEBA Kraftwerke Ruhr AG, Gelsenkirchen, Germany
VDEW, Germany
Umweltbundesamt, Berlin, Germany
IEA Coal Research, London, England
Stadtwerke Frankfurt am Main GmbH, Frankfurt am Main, Germany

Sweden's lakes and forests

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 range 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.

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

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 1993 eleven per cent of the trees were classed as moderately to severely damaged, i.e. they had lost more than a quarter of their foliation.

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 1993 thay had fallen to 101,000 tons – a reduction of 80 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 454,000 tons, and by 1993 they had been reduced by 12 per cent, to 399,000 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 around 2000.

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

The European Commission is just now working on a revision of the directive for the regulation of acidifying emissions from large combustion plants – plants which in 1990 were responsible for two-thirds of the sulphur dioxide emitted to the air over Europe from the member countries, and a fifth of the nitrogen oxides. It is now a matter of the limits that are to be set for the emissions from new as well as existing plants.

DOING MORE THAN REQUIRED reveals that there are already large plants in operation that are not only meeting the requirements of the present directive by a broad margin, but have even brought their emissions down to levels below those now proposed by the Commission to accord with the Best Available Technology.

DOING MORE THAN REQUIRED has been commissioned by the Swedish NGO Secretariat on Acid Rain as a contribution to the debate on the revision of the EU directive. The study has been carried out by Anna-Karin Hjalmarsson of the Swedish consultancy ÅF-Energikonsult Stockholm AB, among whose merits are several years of experience with IEA Coal Research in England.

STOP ACID RAIN

The Swedish
NGO Secretariat
on Acid Rain