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SWEDISH POLICIES AND RESEARCH PROGRAMMES

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Emission Status and Trends

The Swedish emissions of sulphur dioxide reached their peak value in the early 70s. Since then the emissions have decreased substantially and further reductions will be implemented (Table 1.1). The aim of the Swedish government is to reduce sulphur emissions by at least 65 % between the years 1980 and 1995.

The energy sector accounts for about two thirds of the total sulphur emissions. The development of the energy sector is therefore of decisive importance. In the Swedish strategy to combat acidification great attention is given to the coordination of energy and environmental policies in order to minimize the effect of electricity and heat production on the environment. The current energy policy targets imply that the energy system should be based to the greatest possible extent on enduring, preferable renewable and indigenous, energy sources. Efficient energy use and stringent emission control requirements are encouraged.

The reduction of the sulphur content of fuel oil - the only fossil fuel of importance in Sweden - has been carried through according to a plan adopted by the Parliament in 1976. As from October 1, 1984, the sulphur content of heavy fuel oil is restricted to max 1 % nationally. This corresponds to 0.24 g of sulphur per megajoule fuel. The sulphur content of light fuel oil is limited to 0.3 % as from October 1, 1980, and a new limit in the range 0.15-0.2% is planned.

The reduction of the sulphur emissions from industrial processes is being achieved by the stipulation of gradually more rigid emission standards in the permits granted under the Environmental Protection Act.

The emission standard in the permits given for new coal-fired plants with an annual total emission in excess of 400 tonnes of sulphur, is normally 0.1 g of sulphur per megajoule fuel.

The Swedish emissions of nitrogen oxides increased heavily during the 50s and 60s. The steep increase in these decades follows mainly the expansion of the total number of cars. In the 70s emissions increased only slightly and since 1980 they have decreased.

Motor traffic accounts for about 70 % of total nitrogen oxides emissions. Stationary combustion sources contribute with about 20 % and industrial processes with about 10 % (Table 1.1).

The motor vehicle exhaust standards from the 1976 year models entailed a reduction of nitrogen oxides from passenger cars by about 10 % between 1975 and 1980. During the same period, however, the emissions from diesel vehicles increased by the same amount.

The aim of the Swedish government is to reduce nitrogen oxides emissions by 30 % between 1980 and 1985. Emission standards for passenger cars equivalent to those now in effect in the U S have been introduced on a voluntary basis for the 1987 and 1988 car models and compulsory for the 1989 models. To encourage the purchase of "clean" vehicles the sales tax on the 1987 and 1988 car models confirming to the new standards is reduced by SEK 5200. To stimulate the use of lead-free gasoline the tax is reduced by SEK 0.16 per litre compared to the premium grade containing 0.15 lead per litre.

Further measures to reduce emissions of nitrogen oxides are being explored. These include new emission standards for diesel vehicles and stricter emission requirements on stationary sources.

The Swedish emissions of non-methane hydrocarbons for 1980 and a prognosis for 1995 are given in Table 1.1. The estimates are considerably more uncertain than for sulphur dioxide and nitrogen oxides.

Motor vehicles accounted for about 60 % of the emissions of hydrocarbons in 1980.

Emissions are expected to decrease by about 30 % between 1980 and 1995. All sources are projected to decrease their emissions. The largest decrease is expected from motor vehicles due to the new emission standards for passenger cars.

The Swedish emissions of ammonia are very uncertain. The annual emissions from agricultural activities are estimated at 40 000 tonnes. Manure is the main source and steps are taken to reduce emissions.

Effects

In Sweden about 18 000 lakes and 90 000 kilometres of running water are affected by acidification. The damages are most severe in non-calcareous areas in the western and southern part of the country. Only a small corner in the north is not affected.

The connection between deposition of sulphur and acidification of surface water is generally accepted. To avoid large scale acidification of sensitive lakes and streams the deposition of sulphur should not exceed 0.5 g $S/m^2 \cdot y$. The present level of deposition in the western and southern part of the country is 2 g $S/m^2 \cdot y$.

New research results have shown a strong soil acidification during the last decades in southern Sweden. The acidification has a severe impact on the soil processes and leads to increased leaching of magnesium and other essential nutrients and to elevated levels of aluminium and heavy metals in ground and surface water. Increased corrosion on underground constructions have been reported.

Acid groundwater is a problem in many parts of Sweden. To what extent the acidity is caused by acid deposition is not yet quite clear. 400 000 permanent residents and 650 000 recreation houses are dependent on water supply from small private groundwater wells. The annual indoor damages due to corrosion have been estimated to SEK 150 millions.

The deposited nitrogen contributes to acidification of surface and groundwater if it is not consumed by vegetation. During snow-melt nitric acid may contribute to the acidification of running water by 20-30 per cent. Such acid surges with extremely low pH-values are very detrimental to fish-life.

Nitrogen has so far been a limiting factor in most terrestrial ecosystems and the deposition of nitrogen has had a favourable effect on forest growth. There are, however, indications that forest ecosystems in southern Sweden are approaching a stage of nitrogen saturation. This means that primary production will not be further increased by increased nitrogen supply. Such systems may leach considerable amounts of nitrate.

The target levels for deposition to avoid negative effects of nitrogen saturation of forest soil have been estimated to 1-2 g $N/m^2 \cdot y$ expressed as total deposition of oxidized and reduced nitrogen compounds. The present deposition in southern Sweden exceeds 2 g $N/m^2 \cdot y$.

Nitrogen is the nutrient that generally limits growth in the marine environment. In the Baltic Sea the contribution of nitrogen from atmospheric deposition amounts to about one third of the total load. The eutrophication of the Baltic Sea is a matter of great concern.

In the beginning of the 80s increased forest damages were reported also in Sweden. Needle losses in about 30 % of older spruce stands in the southern and southwestern parts of the country are attributed to the combined effects of soil acidification, direct effects of air pollutants (particularly ozone) and extreme climatic conditions.

As a defense against acidification and to restore valuable lakes and streams a liming programme is in operation. 4 000 lakes have been treated so far. The money available from the Government for the year 1986/87 is SEK 110 millions corresponding to 85 per cent of the total cost. The effects of lake liming are positive. Streams, however, are much more difficult to handle as the water-flow varies by two orders of magnitude and because the metal-rich leachates from acidified soils remain toxic even if pH is brought back to normal values. The general experience is that countermeasures in the environment are no acceptable substitutes to control measures at the source.

Important Issues in Future Policy-Making

The large-scale acidification and forest damages in Europe today demonstrate that the tolerance limits of nature are exceeded. Future international co-operation within the framework of the Convention must provide answers to the following questions:

- What are the target levels of deposition and air quality to safeguard a long-term healthy environment?

- What do these levels mean in the form of necessary emission reductions in different areas?

- What are the least-cost solutions to achieve the emission reductions and how are they to be implemented?

In most countries national energy and transportation policies have been developed with little or no care of the environment. In the future these policies and the environmental policy will have to be closely coordinated.

Priorities in Swedish Acidification Research

Deposition. Quantification of dry deposited nitrogen substances, especially of gaseous nitric acid, and its variation with topography, distance from forest edges, type of vegetation, etc.

Forest damages. Effects of soil acidification in combination with extreme climate conditions (drought periods).

Direct effects of ozone and nitric acid - studies in open top chambers.

Effects of nitrogen saturation on different physiological processes, e.g. frost sensitivity and accumulation of various organic substances, and on the flow of nitrate and cations.

Groundwater. Development of models of groundwater acidification and chemistry over time as a function of geology and levels of deposition.

Surface water. Development of models of mercury content in fish as a function of acidification and characteristics of the drainage area and the aquatic ecosystem.

Corrosion. Effects of soil acidification on underground constructions.

Countermeasures in the environment. Effects of liming of surface water. Development of methods to restore acid groundwater and to neutralize forest soil and improve forest vitality.

International Research Evaluation Mechanisms

A growing number of countries are establishing acidification research and monitoring programmes which means that more and more data will be available. Results from individual research projects and short-term monitoring programmes are often of limited value in the process of decision making. However, if the critical questions are formulated, data from different countries can be assessed and either provide the answers or identify the important gaps for further research and monitoring.

It is essential that in each national acidification research and monitoring programme resources are allocated for assessment of existing data outside the own programme. Within the Convention such assessments could be made by small groups of countries and the results discussed by experts from all interested parties.

Evaluation of research results relevant to the problem discussed within the Convention should be an important part of the work plan of the Executive Body.

TABLE 1.1

Emission trends in Sweden (1000 tonnes)

Source	1980			1984			1990			1995		
	SO_2	NO_x	CH	SO_2	NO_x	CH	SO_2	NO_x	CH	SO_2	NO_x	CH
Stationary combustion sources	252	67	4	106	46		89	53		80	52	3
Industrial non-combustion sources	150	34	70	98	19		70	19		50	19	55
Non-industrial and domestic activities	63	28	95	40	19		18	13		14	12	85
Mobile sources	18	199	258	20	205		16	181		12	157	152
Total	483	328	427	264	289		193	266		156	240	295
Index	100	100	100							32	73	69