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AIR POLLUTION CONTROL POLICY IN THE FEDERAL REPUBLIC OF GERMANY

This article provides an overview of the basic air pollution control strategies and policies in the Federal Republic of Germany. After a brief historical review of air pollution control policies in this country a comprehensive description of the present system and its laws, regulations, standards, and approaches, as well as the organisational structure are given. Based on an investigation of the actual effects of air pollution control policy on emissions and the ambient air quality the achievements and shortcomings are evaluated. The article ends with some recommendations for improving the effectiveness of air pollution control policies.

I. A Brief History of Air Pollution Control Policy in The Federal Republic of Germany

1. The Development of Programmes and Legislation

Air pollution control has been a concern of German governments for a long time (1). As early as the 19th Century, German scientists conducted thorough investigations on the damage caused by smoke pollution. More systematic legislation directed towards air pollution problems caused by industrial establishments started with the "general trade regulation", enacted by the Prussian government in 1845. It established, inter alia, a permit system for designated facilities and authorised the responsible authorities to place conditions on emitting facilities. The basis principles of this law-like regulation were later transferred to the "trade regulation" of the Norddeutscher Bund

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in 1969. Shortly afterwards, it became valid for the Deutsche Reich. A "technical directive for air" was passed in 1895. Both the trade regulation of 1869 and the technical directive of 1895 formed the basis for air pollution control for about 100 years, until 1959 or 1964 respectively. The main objectives and strategies of the trade regulation, in combination with the "civil code" was to protect health and property in the neighbourhoods surrounding such installations. Pollution abatement measures were primarily implemented by the "dillution" of emissions and the building of higher chimneys insofar as gaseous emissions were concerned. With respect to dust filter techniques were developed quite early.

Because of the limited scope of pollution control regulations, the deterioration of the quality of the air continued. A major concern in the 19th Century had been harmful effects to health and damages to property and forests by dark smoke. With rapid increases in industrialization, especially after the Second World War, air pollution problems, as well as the range of harmful substances emitted, increased. But it was not until the mid-1950s that serious air pollution control legislation debates began. The first framework law on air pollution control which the federal government passed was "the law for changing trade regulations and amendment to the civil code" or, as it was usually called, "Clean Air Maintenance Law" of December 1959. In 1964 a "technical instruction for maintaining air purity" was issued by the then responsible Federal Ministry of Health. Compared to the old law, the Clean Air Maintenance Law of 1959 provided for some basic improvements, inter alia, the list of designated facilities requiring a permit was extended, standards for enforcement were made stricter, it strengthened the so-called neighbours rights against damages by air pollution, and it provided the responsible authorities with the administrative instrument of improvement orders. The Technical Instruction Air (TI Air) of 1964 contained, inter alia, the licensing procedure for industrial facilities requiring a permit, ambient air quality standards for five air pollutants, and required that all emitting facilities had to be equipped with the best technical control devices available.

The new federal legislation for air pollution control contained decisive limits for coping with the increasing and more complex air pollution. For example, air pollution by traffic and small facilities was not included, and also no adequate means were provided for controlling pollution under regional aspects. Northrhine-Westphalia, as the most polluted state of the FRG, was also a forerunner in developing new clean air strategies, which later on influenced national legislation considerably (2). Thus, the government of Northrhine-Westphalia was the first among the federal states which enacted an immission protection act in 1962. It contained, in contrast to the national act, requirements for small and domestic emission sources. It was also the government of Northrhine-Westphalia, which enacted the first smog-oriented ordinance (1964), built up a comprehensive monitoring system, and developed the strategy of "clean air plans", which aim at the reduction of pollution loads in heavily polluted areas.

Although some decisive modifications of laws and regulations, compared to the older ones, took place in the late 1950s and the 1960s, the task of air pollution control was primarily to perceived as one to reduce emissions which could be harmful to health to human beings in the vicinity of emitting facilities.

Thus, to a great extent, air pollution policy was just one of many (and often a minor) aspects to be considered by factory inspectorates. Insofar, air pollution control policy, until the end of the 1960s, was more or less an annex to industrial policy. It was not until 1970 that air pollution control policy was conceptualised and than, in 1974, by legislation established as an autonomous policy area.

This "modern phase" of air pollution control policy in the FRG started with two environmental programmes, especially the comprehensive "environmental programme" of the federal government of 1971 issued by the then governing social-liberal coalition covered nearly all environmental areas, and, most important, established the basic objectives and

principles of environmental policy, especially the precautionary, the polluter pays, and the cooperation principles of this environmental programme, and by the already enacted state immission protection acts, whereby that of Northrhine-Westphalia was most influential, the parliament enacted the "Federal Immission Protection Act" (FIPA) in 1974, after the federal government obtained concurrent legislative powers in the area of air pollution in 1972. It covers not only air pollution control, but also noise, vibration and similar phenomena. This law created a completely new legal basis for air pollution control in the FRG. It was, quite rightly, described as one of the most comprehensive and modern laws for the protection of ambient air, especially in conjunction with the new "technical instruction for maintaining air purity", issued as the first general administrative regulation on the basis of FIPA. The TI Air provided details for implementing FIPA and replaced the major tool for the guidance of air pollution control policy implementation. As early as 1971, against powerful and vehement opposition by industrial pressure groups (especially refineries) the "Lead in Petrol Act" was enacted. The law provided for the reduction of the lead content in gasoline-based fuels.

The enactment of FIPA in 1974 provided the basis for many subsequent legislatory activities. After FIPA, until the end of the 1970s, a bulk of ordinances, decrees, guidelines, etc., aiming at air pollution control have been issued (see next chapter below). Thus, the phase from 1974 - 1983 can be characterised as a mixture of legislative and enforcement activities to implement the basic principles of FIPA by instruments and strategies contained in FIPA and related regulations without substantial changes of these objectives and approaches. This picture did not change until 1983, when considerable modifications and amendments to existing regulations took place, stimulated by the dramatic increase in forest damages. This phase, still in progress, can be characterised as being clear cut, problem-oriented air pollution control policy, because the focus of air pollution control regulations was set on major emitting sources, and a comparatively stringent timetable fixing the steps of enforcement was established. Furthermore, the means provided for implementation of the objectives were to a considerable degree more adequate than the former ones. Especially the 1983 enacted ordinance on large firing installations mandates substan-

tial emission reductions in new and existing stationary sources. However, one basic feature of air pollution control policy remained the same, despite some minor modifications: air pollution control is basically a highly formalised, regulatory policy, implemented with traditional bureaucratic means and allowing little flexibility for emitters' efforts to make pollution control requirements less costly. In addition, the existing principle that legally allowed emissions are free of costs was not tackled: despite numerous claims by several groups a charge system was not established.

The current phase of air pollution control policy also highlights the importance of international cooperation. No systematic approach for this area has been established so far, however, certain bilateral negotiations (especially with European countries belonging to the COMECON) have been initiated. The important role played by the European Economic Community at least was made clear when the EEC decided not to take up the stringent standards for automotive emissions proposed by the federal government of the FRG. The importance of the international dimension of air pollution control policy has been known for many years, at least since reports were made on the long-range transport of air pollutants, but until recently no adequate measures have been established by the federal government. The 1982 Stockholm conference on acidification of the environment marked the beginning of a new attitude of the federal government towards international pollution control efforts. Since then, the federal government has been pushing for more vigorous implementation of the 1979 EEC convention on transboundary pollution and for a more aggressive emission abatement directive by the EEC. The 1984 "Multilateral Conference on the Environment" in Munich, initiated and organised by the federal government, might provide the starting point for closer cooperation in air pollution control between western and the other European countries.

2. Social, Economic and Political Development and the Influence on Air Pollution Control Policy

Starting with the beginning of modern air pollution control policy in 1969, the first phase of "policy design" (policy formulation)

was characterised by

- a nearly complete consensus of all relevant parties and actor groups on the need of a comprehensive, "autonomous" environmental policy. It was the then governing social-liberal coalition which took the initiative and established, in a rather short period, a thorough basis (environmental programme of 1971) for environmental legislation. Numerous groups from different societal spheres participated in designing this programme,
- influences of activities of international organisations which discovered the environment as an issue (UNO, NATO; OECD, etc.) and the involvement of the federal government from 1968 onwards in the preparations for the 1972 Stockholm conference on the environment,
- a media boom in the environmental issue reporting since 1969,
- strong efforts of the government to get business interest groups to participate in the programme formulation (this was later emphasized by the so-called cooperation principle as one of the three basic principles of environmental policy). Furthermore, the strong consideration paid to business interests considerably influenced the design of environmental policy, inter alia, the polluter-pays-principle was modified to include criteria of economic feasibility, and strict liabilities were excluded,
- the fragmentation of the general concept according to environmental medias in contrast to an "integrated concept" on the basis of the ecological context, as was claimed by a group of scientists and the Nature Protection Organisation. However, the institutional fragmentation of responsibility at the policy level decisively influenced the fragmentation of the design,
- the almost total lack of citizen groups interested in air pollution control and the almost complete disinterest of the political parties in environmental issues.

The next phase of legislatory activities leading to the enactment of basic air pollution control regulations in 1974 was characterised by:

- **growing public concern on environmental pollution,**

- the almost exclusive participation of members from bureaucracy in drafting the law, and their close cooperation with business interest groups, which decisively influenced FIPA and especially the ordinances enacted after 1974.

The third phase, the "implementation phase", in which the basic air pollution control regulations were implemented by organisational, enforcement, and financial measures began approximately in 1975. It can roughly be characterised by the following items.

- rapid increase in public concern about air pollution problems a corresponding increase of citizens initiatives centering around the issue of environmental pollution. Due to the weak response of so-called traditional interest groups, and the political parties to their claims, the citizens initiatives organized at the communal, state and federal level, participated in political elections, and opposition against emitting sources (especially power plants) as well as against new industrial and other developments was tremendously increasing involving, in single cases tens of thousands of people.

- discussion on the so-called implementation deficit in air pollution control policy for which the weak, inadequate legal instruments and the lacking enforcement activities of the competent authorities were made responsible,

- the successful formation of green parties at the state level and finally at the national level, the "Greens" won considerable votes in elections at all three levels. They placed representatives in the assemblies of several states and gathered enough votes in the national election to displace the Free Democratic Party as the third party in the national assembly, the Bundestag, in 1983,

- growing resistance of business groups and trade unions against air pollution control measures in the wake of the economic recession accelerated by the energy price crisis of 1973. This opposition met favorable response by the federal government, which, after meeting with business interest groups and trade unions im July 1975 at Gymnich, such radically watered down environmental policy and redirected emphasis almost exclusively on pure economic goals. The following increase of environmental action groups and the success of green parties in political elections as well as opinion polls showed

that the general public was dissatisfied with this decision and its consequences,

- the number of court cases and the general involvement of courts in environmental conflicts increased considerably. The courts' decisions (especially those of the lower courts) sometimes favored environmental concerns, but there have also been decisions setting decisive restrictions on enforcement or abatement measures. All in all, although the courts played an important role in environmental conflicts, they have not been able to solve the structural, legal, political and economic problems causing the conflicts,

- the failure of the major parties to integrate the growing concern and public interest on environmental problems into their programmes, as well as in activities,

- a comprehensive coverage of environmental problems by the public media reporting nearly daily on environmental damages,

- the failure of lower tier authorities (at the communal level) to integrate the environmental concerns into their local policies (industrial siting, urban development, energy supply, etc.). In general, local authorities gave priority to attracting industries and avoided even to study environmental problems in their area because they feared economic losses by getting a reputation as being a polluted area,

- small progress in the development of abatement technologies and emphasis on the strategy of building high chimneys to reduce local pollution loads,

- growing concern on harmful effects to human health by air pollution,

- the discovery of extensive forest damages, which had the most decisive impact on the nation's domestic and international environmental policies.

The fourth phase, which is still in progress, of reinforcing air pollution control policy, mainly set in motion by the dramatic public

debate on the negative consequences of air pollution to forests, health and the ecosystem as a whole, began at about the end of 1982. The then governing social-liberal coalition reacted rather suddenly to the broad consensus having emerged throughout the public for support of stricter control of emissions as well as to the growing political importance of the Greens by issuing, in September, 1982, a programme titled "Account and Perspectives of Environmental Policy". This ambitious new programme gave environmental policy an entirely new, extremely important dimension, which it had never had. The most important proposals of the programme dealt with air pollution control measures. New regulations were announced, mandating substantial emissions reductions from the large, older, firing installations by giving the operators the option of either retiring with a certain number of years, or installing purification equipment. In addition, strict emission standards for new emission sources were announced. This environmental programme of the social-liberal coalition was taken over almost unchanged by the new government (conservative-liberal coalition), which took over power some weeks later. The new federal government implemented, in a rather short period, basic elements of the programme by an enactment of the ordinance on large firing installations of 1983, the amendments (revisions) of the TI Air, and by initiating EEC legislation on automotive exhaust standards. Not only did the federal government's attitude to air pollution problems change, but also most state governments subsequently introduced new air pollution control programmes and started implementation activities. Furthermore, local authorities, especially those suffering from a high air pollution load, considerably increased their activities for stricter air pollution control, sometimes even challenging powerful industrial groups, e.g., the power supply industry and the chemical industry. All in all, the influence of business interest groups on environmental policy has diminished, and both public authorities and emitting sources are now being placed under strong pressure by the public to achieve real success in reducing emissions. At present, symbolic environmental policies--enacting ambitious programmes and laws without adequate impacts because of implementation short-falls--do not have good chances of being accepted by the public. What is important, too, is that some of the most powerful trade unions increasingly call for state subsidized employment and investment programmes in the area of energy saving and environmental protection.

II. Present Air Pollution Control System: Laws, Regulations, Standards, Approaches and Organisation

1. Introduction

The Federal Republic of Germany (FRG) is a federal state with a written constitution (Grundgesetz), providing the eleven German states (Laender) with strong legislative and executive powers (3). Environmental protection responsibilities and functions must be organised according to the requirements of the constitutional order. In general, the constitution divides powers between the federal government, the states and the local authorities (Gemeinden). In the arena of air pollution control, the latter only play an indirect role, e.g., in development planning, as so-called third parties, submitting opinions in permit procedures, responsibilities for road construction, traffic control, energy supply and tasks delegated to them by state authorities.

The constitution divides legislative authority between the federal government and the state in three ways. In some areas, the federal government has exclusive jurisdiction (Article 73 of the Constitution). Specific environmental matters are not covered herewith. Only the areas of federal railways and air traffic have an indirect relation to environmental protection, also the Environmental Statistics Act of 1974 is based on this provision. The federal government and the state have concurrent jurisdiction in the areas of noise abatement, exploitation of nuclear energy and radiation protection, waste disposal, and, what is of importance here, air pollution control (Article 74 of the Constitution). Concurrent (competing) jurisdiction means that the state may only pass laws in these areas if the federal government has not done so. Accordingly, federal law may replace already existing laws at the state level. In 1974, the federal government had used these powers to enact the Federal Immission Protection Act, the basic law for air pollution control. In the third area of framework jurisdiction, such as nature protection, regional planning, water supply (including water protection), etc., the federal government is only authorized to pass broad framework laws, which must be implemented by the individual states by own detailed laws adapted to the specific conditions of their administration area.

Finally, it is important to note, that the federal constitution does not make particular reference to environmental protection; its amendment by a basic provision for a safe or healthy environment is still discussed. Therefore, the most important sources for environmental legislation are the laws passed by federal or state parliaments. In the case of air pollution control policy, the central law is the Federal Immission Protection Act.

2. Responsibilities and Organisational Structure

As was noted in the introductory section above, not only legislative powers but also their execution are divided between the federal government and the state governments. The federal government did not acquire full legislative competence for air pollution control matters until a constitutional amendment in 1972 gave the federal level concurrent legislative powers with the states in this area. Prior to this, the federal government had the power only to promulgate framework laws which the states "filled-in". This situation changed fundamentally with the enactment of the Federal Immission Protection Act (Bundes-Immissionsschutzgesetz; in the following cited as FIPA). Under this law, the federal executive is authorized to issue ordinances (the function like a law) and administrative rules (Verwaltungsvorschriften), serving as a binding guideline only for public authorities and not for the general public or the emitters. However, they actually affect these groups, too. In both cases of statutory and administrative regulations the federal executive needs the consent of the State Chamber (Bundesrat), which represents the state governments. This requirement for consent is extremely important for it serves as an effective means for the states to participate in and to influence the basic requirements, standards and approaches of air pollution control policy. Thus, federal government has only limited actual power to independently develop and enforce a national air pollution control policy.

Apart from this limited (actual) legislative power, its power to control the implementation and enforcement activities of the state authorities is even more restricted. Implementation and enforcement of FIPA

is a state matter. The states, through their administrative agencies, are primarily responsible for enforcing the law. They also have the power to organise their implementation systems as they deem appropriate. Accordingly, they organise themselves the structure of the authorities, the administrative procedures (if not stipulated by administrative regulations by federal government), as well as the appropriation of financial and personal resources. Furthermore, there is no strong formal control provision at hand for the federal executive to force the states to perform their implementation and enforcement duties. In implementing FIPA and its supplementing regulations and guidelines established by the federal executive, the states are only subject to control over the correct legal application. However, some influence on performance of state authorities is ensured by legal rights of the regulatory, third parties and the public, who can take legal action primarily on the basis of the Civil Code (BGB), administrative law and other dispute resolving procedures. Courts can review both lawfullness and appropriateness of the activities.

As a result of the constitutional requirements for a power division between federal government and the states, the air pollution control system in the FRG is exceeding complex. In the following, a rough overview of the administrative set-up of air pollution control and on other relevant institutions will be given.

2.1 Federal level

Federal laws on air pollution control must be passed by both the federal parliament (Lower House = Bundestag) and the state chamber (Upper House = Bundesrat). Also, regulations and administrative rules, made under delegated power by the federal executive (Bundesregierung) or federal ministries need, as a rule, the consent of the state chamber.

There are several federal ministries involved in air pollution control policy but, in general, and for the most important cases, the responsible ministry is the Ministry of the Interior (Bundes-Innenministerium). It coordinates the environmental policies of the federal government, including environmental planning, reactor safety, radiation

protection, waste and water management, international cooperation in environmental matters, etc., and air pollution abatement. It is responsible for issuing statutory and administrative regulations on the basis of FIPA. According to its range of tasks in environmental protection matters, it can be considered as the Ministry of the Environment. Within the ministry, environmental protection matters are the responsibility of the "Division of Environmental Protection" (Umweltabteilung), which is divided into three sub-divisions, which are further sub-divided into units responsible for particular aspects of the respective areas of concern. Sub-division UI handles general environmental affairs (like planning, coordination, international affairs, economics, etc.); sub-division UII is responsible for water resource management; and sub-division UIII is in charge of noise abatement and air quality conservation.

Related to the Ministry of the Interior is the Federal Environment Agency (Umweltbundesamt), established by law in 1974 (approx. 450 employees). It functions mainly as a research and advisory body. Central responsibilities cover, for example, the development of an environmental information planning system, research on technological and scientific data to support development and implementation of environmental policies, providing scientific assistance to the federal government in matters of air quality control, and in particular, for the preparation of statutory and administrative regulations, information for the public on environmental matters, etc. The agency also manages a special monitoring network for monitoring air quality in so-called rural areas for providing information on background pollution. In accordance with the legal division of functions between the federal government and the states, the agency cannot issue any regulation or perform control functions. Since its establishment in 1974, the agency has tremendously gained importance as an information center for government and private organisations, as well as individuals and the public. Some of its reports on pollutants have deeply influenced the public discussion and implementation of counter-measures.

The Institute for Water, Soil and Air Hygiene, also subordinated to the federal ministry, is mainly concerned with research in the fields of human ecology, water, soil and air hygiene, etc.

Coordination of federal environmental programmes is conducted by the

Cabinet Committee for Environmental Questions, chaired by the Prime Minister (Bundeskanzler), with members from all federal ministries involved in environmental protection. The "permanent board of the heads of divisions for environmental matters" coordinates environmental policy and implementation in the federal government and between the states and the federal government. The "conference of ministers for the environment" of the states (including the Federal Ministry of the Interior) is the major committee for coordination of state and federal environmental policy and information exchange. Furthermore, a special joint federal-state committee on air pollution and noise does similar work with a stronger focus on air pollution.

As mentioned above, the Ministry of the Interior can be considered as the Ministry of the Environment; but other federal ministries are also involved in air pollution protection matters and policies. So, for example, for energy policy and the economic implications of environmental protection policies, the Federal Ministry of Economics; for landuse policy and regional planning, the Ministry for Town and Regional Planning; for nature conservation, pollution of water, air and soil by agriculture and forestry, the Federal Ministry of Food, Agriculture and Forestry; for transportation and the environment, the Federal Ministry of Transport; and responsible for coordinating research and for development of air, water, soil, etc., pollution controls, low-pollution technologies, etc., the Federal Ministry for Research and Technology, to name just the most important ones.

Although there are special forums and committees for coordination and information exchange between the several ministries at federal level, the fragmentation of responsibilities and powers often leads to coordination problems and conflicts between the departments involved, which makes it difficult to develop a comprehensive and consistent air pollution control strategy (conflicts and coordination-problems are primarily a result of different views on policy priorities by the ministries, whereby especially the Ministry of Economics, in most cases, is in strong opposition against air pollution control regulations for its "clientele".)

In order to overcome these problems unfavourable for a rational and efficient environmental policy, suggestions have been made to estab-

lish an environmental "super-ministry", taking over all environment related responsibilities, however, there seem to be no prospects in the near future to have such an institutional re-arrangement (which also would be highly questionable from the viewpoint of the theory of bureaucracy).

2.2 State level

The state governments are not only responsible for implementation and enforcement of FIPA, they also can state laws and regulations as well as issue directives concerning air pollution control. The state governments have quite a large room for discretion in air pollution control policy decisions, especially concerning the selection of approaches and strategies offered by the federal law and in setting their own priorities in air quality management. For example, they organise their own systems for air pollution alerts (like smog-situations), establishment of monitoring networks and the development and implementation of "clean air plants". Thus, the real authority for air pollution control in the FRG rests with the eleven states.

To administer the responsibilities under environmental legislation states governments have designated the authorities responsible for implementation and supervision of air pollution control policies. Since the responsibility for organising enforcement generally rests with the eleven states, no uniform pattern for the implementation systems exists. Some states have a special ministry of the environment, while others have divided the responsibilities among several departments. In general, responsibilities in the area of air pollution control are divided between the general administration (ministries, district administrations, county administrations) and the technical agencies (factory inspectorates = Gewerbeaufsichtsämter), but some states have organised administrative and technical tasks in one department. All systems have advantages and disadvantages. For example, where responsibilities are divided, the general administration is highly dependent on information from technical agencies and can thus be "manipulated" by those agencies, which sometimes have deep-rooted relationships to the emitting sources concerned. Departments of the general administration, as a rule, are better able to coordinate the efforts of several

agencies, but less technically competent. Technical agencies are characterised by a high level of expertise, and, at the same time, a high dependency on cooperation with industry. The result is that most permit procedures are determined by close cooperation between industry and the responsible agency, resembling a bargaining situation. Negotiations between the ministry and the agency begin long before an application for a permit is filed. Since pre-negotiations are conducted internally, no public participation is possible at this stage. Thus, the essential decisions are made without participation of neighbours and the general public. In the formal permit procedure, afterwards, when citizens are allowed to participate and to submit their concerns or interests, it is, in most cases, too late to influence the design of the proposal reached during the informal pre-negotiation stage.

To sum it up: The organisational structure (state implementation systems) for air pollution control vary considerably between the eleven states, both for the verticle division of functions (between ministries and lower tier authorities) and the horizontal division of functions (between ministries, agencies and authorities at the same hierarchical level).

2.3 Local level

As mentioned above, the influence of lower tier authorities (local authorities) as well as their general responsibilities in air pollution control policies are rather limited. Most of their competences are delegated to them by state authorities, accordingly, their activities are closely supervised and controlled. Thus, they play only a minor role in implementation and enforcement of air pollution control legislation. Finally, it should be mentioned, that the role of local government in air pollution control varies greatly between the states.

2.4 Other institutions

The "Council of Environmental Advisors" (Sachverständigenrat für Umweltfragen) is an independent committee of experts which advises the Minister of the Interior on environmental issues. It periodically issues special reports on major issues of environmental policy, and, so

far, it has published two comprehensive reports on the state of the environment (Umweltgutachten).

Environmental policy-making is also supported by close cooperation between governmental agencies and several private, professional organisations, which provide (mostly technical) standards and guidelines. Among these the Association of German Engineers (VDI) with its Clean Air Commission plays the most important part. So far, more than 200 guidelines have been published. They do not have legal force, but in practice, they are often used as references for defining what is technically possible. The Clean Air Commission is not open to public participation; therefore critics indicate that their standard setting process and its outcome is strongly influenced by experts from private industry.

2.5 Courts

Courts play an important role in implementation and enforcement of air pollution control legislation. This is particularly true for the "administrative courts" (Verwaltungsgerichte), which decide cases involving public law. They hear cases brought by private persons to prevent, control or repeal action by a government agency or private organisation carrying out public functions. Also emitters quite often take legal action on the basis of administrative law. Taking legal action is only possible if the infured party's rights have been (unlegally) harmed by an administrative activity (or non-activity: Verpflichtungsklage). There are three levels of administrative jurisdiction: administrative court. Possibilities for taking legal action against air pollution and the damages therefrom also follow from the civil code; these cases have to be brought before the regular courts (four-level hierarchy). The criminal law plays a very minor role in the area of air pollution as well as in environmental protection matters in general. It has been decisions of the administrative courts which have, in some cases, decisively influenced air pollution legislation and policy.

3. Laws and Regulations

Compared to other European countries, the laws and regulations for air pollution control in the FRG are the most comprehensive and detailed ones (4). Since the beginning of the seventies, federal and state legislatures and governments have enacted numerous laws, regulations, guidelines, technical instructions and other directives covering the whole area of air pollution control, including standards, substantial policy matters, legal provisions for third parties and the public, technical matters as monitoring and sampling devices, etc., and procedural rules. There is a strong tendency, rooting in the specific politico-administrative culture of the FRG, to strive for an almost loop-hole-free system of legal regulations for all aspects of programme formulation, implementation and enforcement in the area of air pollution control. Existing laws and regulations have been repeatedly amended and made more detailed. As a result of all these legislative and norm-setting activities, air pollution control policy in the FRG is based on a "full national programme" (5), which means all dimensions of this policy area are covered by formal rules (the programme dimensions making up a full national programme are: administrative instruments and procedures, organisation, financing, emission-product- and process standards, monitoring and reporting, ambient air quality standards and goals). Thus, the present air pollution control system in the FRG not only is characterised by its highly complex organisational structure, but also by its tremendously complex and detailed legal and other requirements. The relevant paragraphs to be taken into consideration in air pollution control policy cover hundreds of pages and even legal and administrative experts admit that it is extremely difficult for them to get a full understanding of the total system.

The following section will provide an overview of the most important federal laws and regulations for air pollution control and air quality management (6). Regulations by the states and local authorities (Satzungen) as well as those laws from other policy subjects, which exert indirect influence on air quality management (e.g., landuse planning, energy supply) are excluded here for practical reasons; they can be easily drawn from the numerous comprehensive handbooks and legal digests covering the whole area of environmental protection.

3.1 Overview

The Federal Immission Protection Act of 1974 (complete title "law for the prevention of harmful effects on the environment caused by air pollution, noise, vibration and similar phenomena").

The following ordinances (Rechtsverordnung) are based on the Federal Immission Protection Act:

- first ordinance for implementation of the FIPA (Ordinance on Dry-Cleaning Facilities) of 1974,
- second ordinance for implementation of the FIPA (Ordinance on Dry-Cleaning Facilities) of 1974,
- third ordinance for implementation of the FIPA (Ordinance on the Sulphur content in Light Fuel Oil and Diesel Oil) of 1975,
- fourth ordinance for implementation of the FIPA (Ordinance on Facilities Subject to Licensing) of 1975,
- fifth ordinance for implementation of the FIPA (Ordinance on Immission Protection Experts) of 1975,
- sixth ordinance for implementation of the FIPA (Ordinance on Professional Knowledge and Reliability of Immission Protection Experts) of 1975,
- ninth ordinance for implementation of the FIPA (Ordinance on Principles for Licensing Procedures) of 1977,
- tenth ordinance for implementation of the FIPA (Ordinance on the Emission Inventory Declaration) of 1978,
- twelfth ordinance for implementation of the FIPA (ordinance on Hazardous Incidents) of 1980, and
- thirteenth ordinance for implementation of the FIPA (Ordinance on Large Firing Installations) of 1983.

Based on the Federal Immission Protection Act and its Ordinances, numerous administrative guidelines and circulars specifying various aspects for the law and the regulations have been passed in order to guarantee a common implementation practice in all federal states. The most important are

- first general administrative regulation under the FIPA (Technical Instruction for Maintaining Air Purity) of 1974,

- fourth general administrative regulation under the FIPA (Monitoring of Ambient Air Quality in Designated Areas) of 1975,
- fifth general administrative regulation under the FIPA (Emission Inventories in Designated Areas) of 1979.

Finally, the following laws deal with specific matters of air pollution control:

- the Law on Environmental Statistics of 1974
- the law on reduction of air pollution caused by lead compounds in fuels for motor vehicles (Petrol Lead Law) of 1971.

As a member of the European Economic Community (EEC) environmental regulations and directives of this supra-national institution are also of importance to air pollution control policy in the FRG. On the basis of the EEC treaty, the Council and the Commission of the European Community can influence air pollution control policies: Regulations and directives of the EEC can replace national air pollution control regulations or have to be implemented like national regulations. Among the more than 40 environmental directives enacted by the EEC are several directives important for air pollution control policies in the member states:

- directive on motor vehicle immissions of 1970,
- directive on the sulphur content of fuel of 1975,
- directive on lead in petrol of 1978,
- directive on ambient air quality standards vor SO_2 and suspended particulates of 1980,
- directive on ambient air quality standards for lead of 1982,
- directive for combatting air pollution caused by industrial plants of 1984,
- directive on the limitation of emissions from large firing installations,
- directive on environmental impact assessment of 1985,
- directive on ambient air quality standards for nitrogen dioxide.

With respect to international treaties and agreements the government of the FRG belongs to the signatories of the Geneva Convention on Long-Range Transboundary Air Pollution (enforced in 1983) and to the so-called 30%-Club, the members of which have committed themselves, in 1984, to reduce their annual sulphur emissions by at least 30%, as soon as possible, at by 1993 at the latest.

3.2 Basic standards, regulations and approaches for air pollution control

Based on the legal material listed in section 3.1, this section will provide an overview of the substantial contents of the laws and regulations and the fundamental approaches for air pollution control in the FRG.

The overall objective of environmental policy in the FRG is expressed in the government's 1971 "Environment Programme" (7). According to this programme, the environmental policy of the government of the FRG is based on three basic principles:

- Precautionary Principle: Environmental policy is not limited to preventing immediate threats and removing damage that has already been caused, but demands that considerable efforts have to be made in order to prevent environmental damage from occurring in the future.

- Polluter Pays Principle: Costs incurred in preventing or offsetting environmental impacts are to be paid by the polluter.

- Cooperation Principle: Environmental policy shall be developed in close cooperation between all relevant parties. In concreto this principle requires that in the process of preparing regulations and administrative orders a hearing should be held, which shall include all parties concerned; these parties usually are: representatives of federal, state and local administration, of signs, economics (e.g., emitters and their federations) and citizens' organisations.

The above-mentioned basic principles have been substantiated before air pollution control policy by FIPA and the pertinent regulations. The primary objective of FIPA and air pollution control policy in general is to protect human beings as well as animals, plants and other objects from harmful effects on the environment and, insofar as facilities subject to licensing are concerned, from dangers, considerable nuisances caused in other ways, and to prevent such harmful effects on the environment.

In order to make these ambitious but rather vague general objectives

"manageable" with regard to maintaining and improving the quality of the air FIPA includes the following strategies combined with standards:

- Ambient air quality standards: By setting ambient air quality standards it shall be avoided that tolerable concentrations of pollutants in air quality are exceeded by the establishment of new emitting facilities or by expansion or considerable modifications of existing facilities.

- Emission standards: According to the principle of precaution, emissions of pollutants have to be controlled in a way that the application of all possible emission reduction measures--taking into account the best available control technology as well as its economic feasibility--is assured in every single case regardless of the ambient air quality situation in the area. Thus the prevention principle is also applied in areas with relatively good air quality. The concretisation of emission limits possible by the application of the best available control technology has been done in many cases by the establishment of emission standards. So far, emission standards for maximum concentrations for about 170 air pollutants (specified for over 40 types of facilities) are established.

At present only 8 ambient air quality standards for the protection against health hazards, and 5 for the protection against considerable disadvantages and substantial impairments are established, as the following table shows.
Numerous highly technical and complex paragraphs in the technical instruction for maintaining air purity (TI Air) contain requirements for how to monitor and assess these standards. It should be mentioned that the establishment of ambient air quality standards by general administrative decree (TI Air) and not by statutory regulation (Rechtsverordnung of Gesetz) gives them a somewhat cloudy legal status because the TI Air is only binding to the administration but not to the

Table 1: Old (1974) and new (1983) Ambient Air Quality Standards

Substances	TI Air 1974		TI Air 1983			
IW 1: long-term standard IW 2: short-term standard	IW 1	IW 2	Health IW 1	 IW 2	Impairment etc. IW 1	 IW 2
SPM (without materials, incl.) mg	0.10[1] 0.20[2]	0.20[1] 0.40[2]	0.15	0.30		
Lead, inorganic compounds in SPM - Pb - g/m^3	-	-	2.0	-		
Cadmium, inorganic Cd-compounds in SPM - Cd - g/m^3	-	-	0.04	-		
Chlorine mg/m^3	0.10	0.30	0.10	0.30		
Hydrochloric acid - Cl - mg/m^3	0.10	0.20[3]	0.10	0.20[3]		
CO mg/m^3	10.0	30.0	10	30		
SO_2 mg/m_3	0.140	0.40	0.14	0.40		
NO_2 mg/m_3	0.10	0.30	0.08	0.30		
Dust fall (non-hazard.) g/(m^{2}d)	0.35	0.65			0.35	0.65
Lead, inorganic lead in dust fall - Pb - mg/(m^{2}d)	-	-			0.25	-
Cadmium, inorganic Cd-compounds in dust fall g/(m^{2}d)	-	-			5	-
Thallium, inorgan. TI-Compounds in dust fall g/(^{2}d)	-	-			10	-
Hydrofluoric acid, inorg. gaseous fluorine comp. g/m3	2.0	4.0			1.0	3.0
Hydrogen sulfide mg/m3	0.0050	0.010				
NO mg/m3	0.20	0.60				

1) Particles below 10 m
2) Particles above 10 m
3) As long as hydrochloric acid cannot be measured clearly separated from chlorides, IW2 shall be 0.30 mg/m^3

Source: S. Kalmbach, 1983 and TI Air 1983

courts. Therefore, in conflict cases, the ambient air quality standards are principally open for courts' interpretation whether or not they fulfill the principle requirements of FIPA. However, a court case which was finally decided by the (highest) Federal Administrative Court (the so-called Voerde Decision) held that the ambient air quality standards can also be considered by courts as the state of the art of present scientific knowledge on harmful effects of the respective pollutants (8). Correspondingly, the ambient air quality standards are also, to a high degree, binding for the courts and only open to interpretation for them if certain substantial reconditions are not fulfilled (e.g., if the court can show that the pollution limit value was not based on existing scientific knowledge or scientific progress requires a revision).

With the exception of the aforementioned "conflict cases" the ambient air quality standards serve as basic measuring points against which the FIPA's general directives regarding the avoidance of harmful or detrimental effects can be judged. In general, it depends on them, whether a new emitting source above a certain size can obtain the required license, existing emitting sources have to be ordered or encouraged to adopt stricter pollution abatement measures and whether the responsible authorities have to set up a so-called Air Quality Maintenance Plan to assure attainment of the ambient standards.

The basic objectives of FIPA as operationalised by ambient air quality standards and the precautionary principle to reduce emissions independently from the existing ambient air quality according to the best available control technology, are implemented by several more or less-inter-related approaches established by the laws and regulations and listed in section 3.1. above. The following basic approaches can be found:

- facility-related measures
- area-related measures
- product-related measures

- mobile sources-related measures
- general supplementing and supporting measures.

3.2.1 Facility-related measures

Industrial and trade facilities potentially harmful to the environment to a certain extent may not be operated without a license. Approximately 100 facilities subject to licensing are fundamental principles of the licensing procedure have been set down by the ninth ordinance for implementation of FIPA. Without a license, the construction and operation of these listed types of industrial plants is not permitted. Not only new developments of plants are subject to approval, but also large-scale alterations of existing ones.

With regard to providing a uniform practice and interpreting and applying the FIPA, the Technical Instruction for Maintaining Air Purity (TI Air) has been enacted in 1974. It includes inter alia the following instructions for licensing:

- ambient air quality standards for key pollutants,
- emission standards for more than 170 air pollutants combined with the general requirement to apply the best available pollution control technology,
- specification of methods and instruments for determination, assessment and evaluation of ambient air quality and emissions and for calculation of dispersion of emissions into the atmosphere (stake height formula).

The most rigorous control requirements apply to new emitting sources (those approved since 1974), regarded as heavily polluting. They have to obtain, under a highly complex and usually time-consuming procedure, a license by the responsible state authorities. During the licensing procedure the responsible authority has to investigate whether the requirements of FIPA are fulfilled. In order to make sure that the requirements are fulfilled, the responsible authority can grant a license subject to conditions and restrictions or, if fulfillment cannot be ensured, the license will not be issued.

The normal licensing procedure is open to public participation. The application for a license and associated documents are publicly displayed for two months, but not documents containing business secrets. During this period, anyone can place objections against the development with the responsible authority. After the license is granted, only those with a direct interest are allowed to initiate court procedures. Also, the applicant (emitter)--if not satisfied with the decisions of the authority--can apply four a court decision. The involvement of administrative courts in conflicts with license-granting processes is quite a common feature.

The responsible licensing authority shall also obtain the opinion of any other authority whose area of competence is affected by the project. After the expiry of the period specified for objection, the licensing authority must discuss the objections to the project with the applicant and with those who have lodged the objections (a process rather similar to a public hearing). The decision on the application for a license shall be issued and the grounds stated in writing; it shall be served upon the applicant and the person having lodged the objections. If there are more than 500 persons involved, such service may be replaced by public notice.

For installations of a certain type or size (specified in the fourth ordinance) licenses may be issued by a facilitated procedure. Under the facilitated procedure, the application and the relevant documents are not open to the public. Thus, no formal objections can be raised. Only injured parties can make complaints against the license on the grounds of both civil and public law.

For small and medium installations, no formal licensing requirements exist. But there is a general legal provision that such installations have to avoid harmful environmental effects according to the latest state of technology or that harmful environmental effects which cannot be avoided are reduced to a minimum. Even if installations do not require licensing, their construction and operation is subject to certain regulations (such as the first ordinance for implementation of FIPA, which regulates the design, installation, and operation of furnaces using solid or liquid fuels) and also to requirements by general

laws and regulations, especially, the building law.

Older, already existing emitting facilities or those having received a license under the FIPA are treated in quite a different way than new sources. Only if the existing facility is significantly modified almost the same formal requirements as for new installations take place. For all other cases of large emitting sources Article 17 of FIPA establishes that in cases where the general public or the vicinity are not adequately protected from harmful effects on the environment or other dangers, considerable disadvantages or considerable nuisances, the responsible authority shall give subsequent directions (so-called abatement or clean-up orders). But these additional requirements cannot be enforces if any investigation of the case shows that such measures would not be economically justifiable for the owner (economic feasibility) or cannot be carried out according to the latest state of pollution abatement technology. In practice, these restrictions have almost excluded existing pollution sources from additional requirements; therefore, one of the most important legal provisions for cleaning up polluted areas was in practice until recently almost meaningless. This situation changed with the enactment of the thirteenth ordinance for implementation of FIPA, the ordinance on Large Firing Installations of 1983, which imposes stricter emission reduction requirements on installations with a capacity of more than 50 MW (th).

The main elements of this ordinance are: emission standards for large firing installations of more than 300 MW(th) are now 400 mg/m^3 in the case of SO_2 and considerably less than 800 mg/m^3 in the case of nitrogen oxides; plants with a capacity of over 300 MW(th) also have to attain a degree of separation of at least 85% for SO_2; emission standards for nitrogen oxides are dynamic: apart from observing emission standards, use must be made of any possibilities for further reduction of emissions through furnace improvements or other technical measures corresponding the state of the art of technology; the conference of the federal and state ministers responsible for the environment took a basic policy decision on April 5, 1984, according to which firing installations with a capacity of more than 300 MW(th) will only be licensed if their nitrogen oxide emissions, in terms of NO_2, do not exceed 200 mg/m^3 in case of coal firing, 150 mg/m^3 in the case of liquid firing, and 100 mg/m^3 in the case of gas firing (in principle the same values should also be complied with by old plants at the earliest pos-

sible date if the operation is to be continued for an unlimited period).

The ordinance also covers old plants mandating substantial SO_2-emissions reductions on a temporal basis. Operators are hereby forced to refit their installations within certain transitional periods to reduce their SO_2-emissions within ten years, or to close them down within five years. About 1,500 existing large-firing installations are covered by this obligation. Of these, the larger plants have to be fitted with flue gas desulphurisation facilities if the operator decides to continue to run them for an unrestricted period. The considerably smaller installations have to change to low-sulphur fuels instead.

Since enforcement of the ordinance, all new large firing installations have had to install flue gas desulphurisation units. Smaller plants are only allowed to use-low-sulphur fuels. According to official statements the ordinance will lead to a cut of the annual SO_2-emissions in the FRG by 50%, from 3.2 mio. tons in 1980 to approx. 1.6 mio. tons in 1993. Total investment costs for aiming at this goal are estimated to be about 10 billion DM or more. The Federal Environment Agency estimates that by implementation of the ordinance the emissions of nitrogene oxide of large firing installations (presently about 1 mio. k/a) will also be cut by about 70% anually by 1993.

In 1983 the Technical Instruction for Maintaining Air Purity (TI Air) of 1974 was substantially amended. Especially the ambient air quality provisions underwent significant changes. For the first time, ambient air quality standards for lead, cadmium and thallium were established, also emission standards for carcinogenic substances were made stricter. In comparison, the ambient air quality standards for SO_2 were not revised. Modifications of the basic principles and requirements for licensing facilities and for monitoring and assessment of ambient air quality also took place. Furthermore, the maximum allowable stack height was fixed at 250 meters. The amendment of the TI Air in 1983 was a first step; drafts of further amendments are presently being discussed. Those further amendments aim at tightening emission standards in accordance with the advanced state of the art. This amendment will cover almost all areas of industry, in particular, blast fur-

naces, steel works, lead smelters, coke ovens, cement works, chemical plants, oil refineries, firing installations with a capacity of less than 50 MW(th) which are not covered by the ordinance on large firing installations, etc. In addition, the requirements for enforcing clean-up abatement measures in existing emitting sources shall be improved. A further reduction in annual SO_2 emissions, in addition to those initiated by the ordinance on large firing installations, is expected by these measures.

In addition to the pending amendments to the TI Air, there are drafts for an amendment of the Federal Immission Protection Act (FIPA). They also aim at improving the provisions for reducing immissions from existing facilities, which are not in line with the state of technology for pollution abatement. Especially the existing, restrictive requirement that clean-up orders have to consider the economic feasibility is intended to be changed towards principles more favourable to environmental protection.

Finally, there are draft regulations and discussions on the introduction of economic incentives or more flexible instruments to supplement existing air pollution control regulations, whereby, obviously, offset and bubble models are preferred to emission charges or emission certificates. In this connection, it should be mentioned that the proposed bubble and offset policies are already contained, in a certain respect, in the existing TI Air.

In order to enforce the requirements stipulated by air pollution control regulations, the responsible authorities are provided with special legal devices to safeguard the environment and to ensure compliance with the law, such as monitoring, inspections, injunctions, fines, penal sanctions, to stop production temporarily or to relocate the license. For these purposes, representatives of responsible authorities must be given access to the premises of the factory, they are allowed to take samples and to carry out measurements. However, the operators of facilities can appeal in most cases against such decisions of an authority or file an action at the administrative court. Furthermore, as the real authority for enforcement of pollution control regulations rest with the states, the enforcement behavior of public authorities varies according to different strategies and pre-

conditions (e.g., emitter structure, general economic situation) to be found in the eleven states.

3.2.2 Area-related measures

The area-related measures aim at the maintenance of a certain air quality in low polluted areas and at an improvement of the air quality in heavily polluted areas. For maintaining air quality, state governments are authorised by FIPA to stipulate by ordinance that in special, designated areas, which require special protection from harmful effects on the environment as a result of air pollution, certain installations may not be established or only operated at specific times, or must satisfy specific technical requirements, etc.

The following measures, inter alia, apply to heavily polluted areas, that is regions where air pollution is heavy enough that it causes, or could be expected to cause, environmental harm: designation of heavily polluted areas by the responsible state authorities; systematic and continuous monitoring of emissions and ambient air quality; and, finally, the establishment of so-called Clean Air Planes.

According to official announcements and in taking into consideration their central position in the air pollution control law of the FRG, as well as the comprehensive and detailed legal provisions for them, Clean Air Plans are a basic administrative instrument in air pollution control policy. Constituents of the clean air plans are the emission, ambient air quality, and effect inventories; further, an assessment of the situation, emissions and ambient air quality forecasts and an action plan containing several measures to improve the air quality.

The establishment of a source and emission inventory is to be considered as a core element of the clean air plan. Herewith the main emitters of air pollutants are identified and the quantities of these emissions. The fifth ordinance for implementation of FIPA stipulates detailed requirements for such inventories. The final step of a clean air plan, the action plan to improve the air quality is the outcome of all information provided by the previous steps and should enlist measures for remedial and precautionary actions to reduce the air pollution. However, these actions plans (or clean air plans) themselves do

not have the force of law, thus being enforceable only on the basic of the existing "normal" legal provisions for pollution abatement measures or where the state government has adopted specific requirements under separate authority. Therefore, in practice, clean air plans primarily function as an information gathering, dissemination and planning tool (for a comprehensive discussion of clean air plans see the contribution by H.Schreiber).

In contrast to clean air plans which aim at improving air quality, the smog alarm system, as a further important area-related measure provided for by FIPA aims at information and warning of the public when weather conditions cause, or are expected to cause poor air circulation which can lead to a threat of peoples' health by a dangerous increase in air pollution. FIPA authorizes state governments to determine by ordinance areas in which, when air circulation is poor, a considerable increase in the harmful impacts on the environment by air pollution is to be feared. For these (potential) smog areas, the responsible authorities can prescribe special measures, such as restrictions on fuels, operating hours of emitting facilities and traffic. Until now, only six states have enacted smog-ordinances: Baden-Wuerttemberg, Berlin, Northrhine-Westphalia, Saarland, Hesse and Rhineland-Palatinate. The content of these smog-ordinances is almost similar, as they are based on a design developed by the state committee for air quality protection. When poor air-exchange conditions occur, the responsible authorities issue alarm warnings at three levels, depending on the severity of pollution.

The established thresholds for issuing alarm are rather high; thus, despite many high pollution episodes in some areas, smog alarms rarely have been issued. This obvious weakness of the smog ordinances led, in 1984, to a revision of the reference model. The new formula set stricter thresholds, and shortly after enforcement, the new regulation led to smog-alarms (in January 1984) in four states: Northrhine-Westphalia, Hesse, Hamburg and Bavaria. Although the smog regulation has been improved, it only takes effect when high pollution loads already exist, a warning function was not included (for a comprehensive discussion of the smog alarm system see the contribution by V. Prittwitz).

FIPA also authorises state governments to designate areas that require special protection (e.g. spas, recreation area, areas around hospitals) where stricter, preventative regulations for stationary emitting sources can be enforced. No state government has passed ordinances for special protection areas so far.

3.2.3 Product-related measures

Product-related measures come very close to a preventative approach of air pollution control policy. In contrast to other, rather dominant, strategies they generally exclude follow-up problems caused by dillution/diffusion and/or of pipe treatment. Furthermore, compared to other approaches used in the FRG's clean air policy, product-related measures have proved to be effective and efficient.

FIPA provides that the federal government can legislate fuel standards in order to protect the environment from harmful effects of air pollution. On that basis, the federal government issued the ordinance on sulphur content of light fuel oil and diesel fuel. Since 1979, the maximum level of sulphur compounds--calculated as sulphur--in light fuel oil (primarily used for domestic heating) and diesel oil may not exceed 0.3% by weight. The reduction of sulphur content was achieved in three steps:

- May, 1975: 0.55%
- May, 1976: 0.50%
- January, 1979: 0.30%.

It can be said that the sulphur content regulation was one of the most effective in reducing SO_2-emissions and in improving ambient air quality, especially in agglomerations with many single heating furnaces. It is estimated, that as a result of the third step of the sulphur content regulation annual emissions of between 150,000 and 200,000 tons of SO_2 have been avoided. The federal Minister for the Environment (Bundesinnenminister) recently announced the intention to investigate the possibility of a further reduction in sulphur content to 0.15 % by weight. This reduction would cut SO_2 emissions by 140,000 tons.

The Lead in Petrol Act was passed in 1971 to reduce the concentration of lead compounds in petrol. The lead content of petrol fuels was reduced in two stages by this act to 0.15g per liter with effect from January 1976. As unleaded petrol is the basic requirement for the introduction of the three-way converter for especially reducing nitrogen oxides from motor vehicles, the federal government decided, in 1983, to prepare the legal basis for the introduction of unleaded petrol with effect from January, 1986. In January, 1984 the mineral oil industry in the FRG announced its readiness to supply unleaded regular petrol before 1986 in line with the trend in demand and unleaded premium petrol from January, 1986 onwards.

As product standards are also a matter for decision by the EEC, also the competent institutions at this level had been involved. The decisions by the EEC set some restrictions on the plans of the federal government as was the case for initiatives to strengthen exhaust standards of motor vehicles, too.

FIPA authorises the federal government to prescribe by ordinance that certain substances or products liable to cause harmful effects by air pollution can be limited or prohibited. On the basis of this provision, the tenth ordinance for implementation of FIPA was enacted in 1978 to restrict the marketing and use of products containing PCBs, PCTs and vinyl chloride aerosols. The reason for this regulation was to avoid air pollution problems resulting from incineration of products containing those substances.

3.2.4. Mobile sources-related measures

FIPA in connection with the Road Traffic Act authorises the federal government to regulate the design, equipment, operation and testing of motor vehicles by ordinances. Several measures have been taken by reduce motor vehicle emissions by amendments to the Road Traffic Licensing Order and by adopting guidelines of the EEC! However, all these measures failed, to a large extent, to meet the objective of the Federal Environmental Programme of 1971 to reduce motor vehicle emissions stepwise to 1/10th of the average of the 1969 level. In order to reduce the increasing emissions from motor vehicles in a more effective way, the federal government decided in 1983 to adopt the

exhaust standards valid in the U.S.A. from the beginning of 1986 onwards and, correspondingly, requested the EEC to take similar action.

After heated discussions, the EEC finally decided not to follow the request of the federal government and proposed exhaust standards and time limits for their implementation much weaker than the proposal of the government of the FRG. The EEC also raised concern about paying subsidies to car owners who install catalytic converters, but no final decision on this point has been made yet. It can be said that the EEC which has the authority by the Treaty of Rome to set, inter alia, product and car exhaust standards binding for all member countries, has hindered, in a massive way, the FRG's efforts to reduce air pollution.

Presently, investigations initiated by the federal government are being made to determine the effects on air pollution reduction by introducing a general tempo limit on motorways. The results of this study will be available in the fall of 1985.

3.2.5 General supplementing and supporting measures

Manifold provisions for financial support and other incentives for promoting research and development as well as pollution abatement technologies and other related measures to reduce emissions and improve air quality or methods for identifying damages and their causes, etc., are made by the federal government, the states, local authorities and other institutions (9).

Since 1975, tax depreciation provisions allow for faster depreciation rates for pollution abatement investments than for normal production facilities. The "European Recovery Programme" provides low interest credits for construction or expansion of air pollution control investments. Further credits and bonds for air pollution control measures are granted by the states and by a special credit institute (Kreditanstalt für Wiederaufbau). In 1979, the federal government initiated a programme for the modernisation of old emitting plants (Altanlagensanierungsprogramm) providing financial support for the exemplary improvement of existing emitting facilities (10). The programme covers a

total volume of 560 million DM and runs until 1987. To get financial support, plant operators must demonstrate that they are contributing towards reducing the amount of gaseous or dust emissions. More than a quarter of the total amount of financial support is connected directly or indirectly with the measures for reducing SO_2 emissions. A related objective of this programme is to gather information on technical possibilities for abatement measures in existing sources and for setting emission standards. Until 1983, 171 projects were supported with a total sum of 398 million DM.

Since the beginning of 1982, about 75 research projects have been commissioned by several federal ministries for studying the problem of "dying forests" (Waldsterben) (the official term for the popular term dying forests is "new type of forest damage"). In total, about 70 million DM have been made available by the federal government, the states and other institutions for this research.

Several energy-related measures for directly or indirectly reducing emissions have also been introduced or supported by the federal and state governments. The federal government enacted legislation for energy saving and rational use of energy combined with financial support: for example, the revision of the 1977 ordinance on thermal insulation in 1982 successively introduced new requirements for thermal insulation of new buildings, the Modernisation and Energy Saving Act provided subsidies for energy saving measures in housing construction between 1978 and 1982; since 1983, special depreciation rates for solar heating units, heat recycling systems, wind power and biogas units, etc. are available. Programmes of the federal government and the states support the development of district heating systems. The introduction of financial support for retrofitting old cars or buying new cars with catalytic converters has already been mentioned in section 3.2.4.

The last point to be mentioned in this section is the promotion of international cooperation on research and the exchange of information

about air pollution problems. This is done for several subjects and in cooperation with numerous states and organisations (e.g., ECE, EEC, OECD, UN, WHO). Also, the exchange of scientific, technical and other information relevant for air pollution problems with European countries belonging to the COMECON has been broadened in recent years. The FRG has quite a relevant "exchange" of air pollutants with some of these European states (long-range transport); they were participants at the "Multi-lateral Conference on the Environment" held in Munich, June, 1984, focussed on air pollution problems and possible measures to combat air pollution (11).

As already mentioned, the governments of the federal states have the implementation and enforcement power for most air pollution control matters. As a result, state governments set different degrees of priority in selecting air pollution problems to be combatted and on the approaches available to them. Therefore, we find a variety of combinations of approaches in the individual federal states. Besides these approaches and combinations thereof, based on national legislation or state legislation derived therefrom, there also exist a variety of instruments and approaches not based on legislation. In most cases this means special measures and programmes, sometimes combined with financial support, which have been developed in order to prevent a further increase of air pollutants harmful to forests. For example, the governments of Northrhine-Westphalia, Bavaria and Baden-Wuerttemberg have made what can be called "pollution control agreements" with power plant operators to reduce SO_2, partly also NO_2 within a certain time period and, to a certain effect, stricter than statutory regulations. It was only recently that also local authorities, especially larger municipalities, started to develop their own strategies to improve air pollution control measures by public and private firms. However, as their competences in air pollution control are rather limited by relevant law, they are almost confined to strategies of mobilising general political influence or to use their legal powers under other laws (primarily landuse and building laws). Until the present, no general statement on the influence and general importance of these developments can be made because a more active and positive involvement in air pollution control by local authorities started only recently (12).

III. Air Pollution Problems: Development and Principle Features

1. General Indicators

This sub-section shall briefly provide central statistics and information on the Federal Republic of Germany and its international setting, for a better understanding and assessment of air pollution problems facing this country (13).

1.1 General national indicators

With about 62 million inhabitants and a total area of approximately 250,000 square kilometers, the FRG has an average population density of 248/sq.km. Compared to the other member countries of the EEC, the FRG ranks third (after the Netherlands and Belgium) with its population density. An intra-national comparison among the eleven federal states shows large differences in population density, urban agglomeration of industry and population exists in the states of Northrhine-Westphalia and Berlin, which are, at the same time, the states with high air pollution loads. in general, and compared to international standards, the FRG belongs to the densely populated and highly industrialised countries.

Because most of the air pollution problems in the FRG are the result of combustion processes, the development of energy trends and changes in energy structure are of interest. The energy supply pattern in the FRG is characterised by the high percentage of mineral oil (ranking first) and coal (ranking second). Compared to other countries coal (which involves more technical problems for pollution abatement measures) has a very strong "political position" because of the political influence of the coal mining industry and coal miners unions on energy policy decisions. This lead in 1980 to a so-called century treaty between the power generating industry and the coal mining companies to increase the percentage of coal used for energy production until 1995. Since 1970, there have been significant shifts in energy consumption patterns resulting in an increase of natural gas and nuclear energy. Further, the growth rates in energy consumption levelled off. In 1974 energy consumption, as well as the final energy demand, decreased for the first time. For the latter, this trend remained continuous. The

highest energy saving rates have been achieved by industry whereas the energy consumption in the traffic sector increased. In the household sector (including small business) the trend remained about the same. Although the proportion of nuclear energy in energy production increased (presently it accounts for about 17% of electricity production), it is not to be expected that the rather small growth rates of nuclear energy will significantly contribute to a decline in emissions of air pollutants because of the long planning, authorisation and construction time for new nuclear power plants due to public opposition.

Major factors contributing to these changes in energy supply and demand patterns include higher energy prices, technological changes, changes in consumer habits, promotion of energy saving measures and economic recession. The latter affected the emission of air pollutants in general. Especially "high pollution industries" like the iron and steel industry suffered from economic recession and declining demands. This led to a decrease of particulate and gaseous discharges. The overall positive effects of ecnonomic recession on discharges of air pollutants have to be considered when evaluating environmental policy impacts because they cannot be accounted for as a success of environmental policies. On the other hand, the economic recession, especially since the oil price crisis of 1973, has hampered the development of needed environmental programmes and the enforcement of existing ones: environmental policy increasingly came under pressure by massive reproaches to be responsible for contributing to inflation, unemployment, declining economic growth and preventing technological progress. These challenges in fact slowed down the progress in air pollution control policy until recently, although no reliable data were provided to support the arguments that the air pollution control programmes led to such unfavourable macro-economic impacts.

The climatic conditions in the FRG are of a moderate continental type with relatively warm summers and rather cold winters. Correspondingly, air pollution problems increase in the winter (heating periods). Furthermore, there are quite often critical weather situations in which the horizontal and vertical exchange of air is reduced to such a degree that harmful concentrations of pollutants arise (London type smog). Ecidence is also increasing that photochemical smog situations (Los Angeles type smog) are possible in certain regions despite mode-

rate temperatures in the summer.

Emissions of air pollutants by car exhaust have increased over the past decade. This upward trend is due to the weak control requirements for motor vehicles which have not kept pace with increases in the number and use of vehicles. Since 1950 the number of vehicles has increased more than tenfold: from 2 million in 1950 to 27 million in 1980.

1.2 International Features

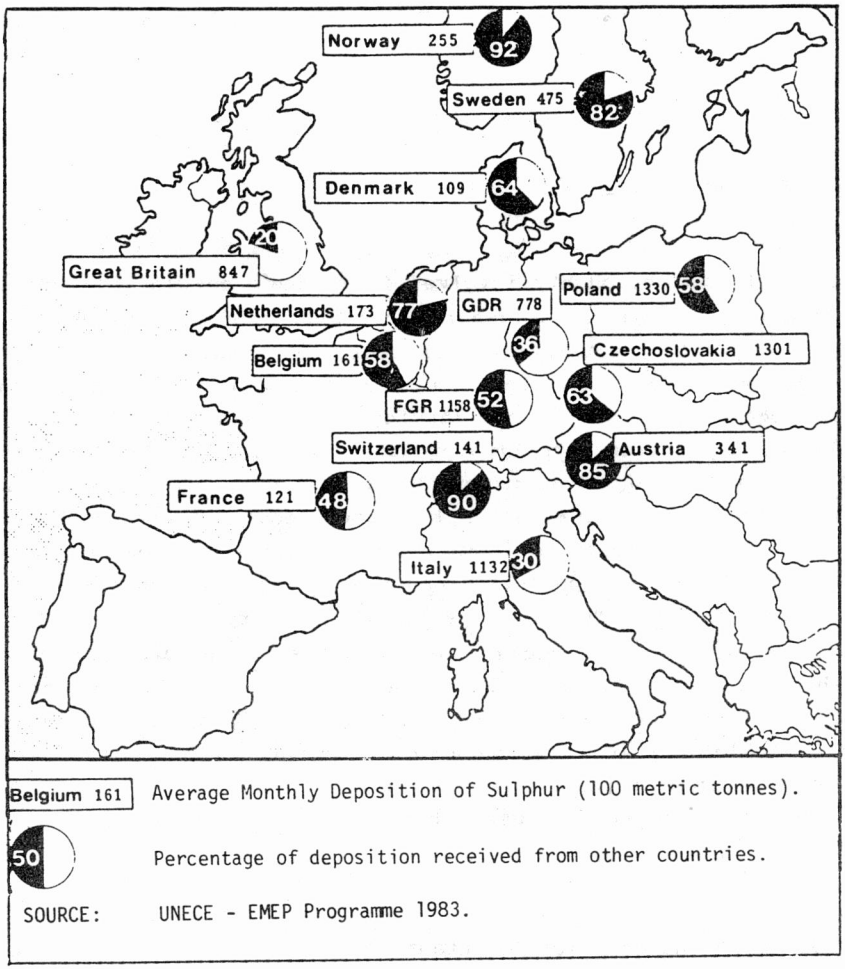
The FRG is thoroughly involved in Europe's complex air pollution problems (14). It is not only a major exporter of air pollutants, but also a recipient of substantial quantities of imported pollution. Particularly significant is the long-range transport of sulphur dioxide and nitrogen oxides which are transformed through oxidaton in the atmosphere and the transformation products of which are the main causes of acidic deposition. The other transformation products are ozon and photochemical oxidents. Almost all European countries are considerably affected by air pollutants from other countries. Correspondingly, an effective national air pollution control policy also requires international cooperation. This is especially necessary for combatting SO_2. The FRG belongs to the largest SO_2 producers in western Europe. About one-half of the FRG's sulphur emissions are transported to Scandinavia, eastern Europe, and other countries. A similar amount of foreign pollution, originating mainly in France, the United Kingdom, the German Democratic Republic and Belgium is deposited within the FRG's borders according to estimations.

2. Emissions of Major Pollutants (15)

In general, the total amount of emissions of air pollutants is indentified by calculations, not by direct monitoring at the source. Only in rare cases, primarily large-firing installations, direct and

Figure 1:

Sources of 1980 Deposition of Sulphur in Europe



Source: Environmental Resources Ltd. 1983

continuous monitoring of few air pollutants (SO_2, NO_x, dust) takes place. In alle the other cases, emission inventories result from calculations based on energy, raw material and production data, which are related to so-called emission factors. Thus a certain range of uncertainty is involved in the calculation of these figures. The range of uncertainty is lower for major air pollutants than for the (in quantities) minor, however, in most cases, more harmful air pollutants. It is generally agreed, that emission monitoring should be improved for reliable and valid data on the amounts of emissions and their trends are preconditions for a rational air pollution control policy.

2.1 Emission Source Inventory

The following table 2 (see next page) shows the development of major air pollutants and the raltive contribution by major emitting sources. The figures show, for the period of 1966 to 1982, that the total amount of SO_2 emissions has remained nearly stable, whereas the emissions of NO_x and hydrocarbons (CH) have dropped. The relative (and partly also the absolute) contribution of power plants to SO_2 emissions and of traffic to NO_x and dust emissions has increased.

In contrast to the major (conventional) air pollutants, which are rather few in number and relatively well-documented, the "unconventional" trace pollutants are numerous and not controlled systematically although many have been the subject of controversies about their environmental and health impacts. Of prime concern are substances known or suspected to cause cronic defects such as cancer, genetic changes and deformities at birth. The following substances are included in these unconventional pollutants. Inorganic arsenic, asbestos, benzin, mercury, vinyl chloride, cadmium, halogens, and their organic compunds, lead, benzo (a)pyrene, chloroflouoro carbons, dioxins, ethylene, formaldehyds, vinyl chloride and PCBs, to name just a few. There is still considerable uncertainty about the amount of emissions of these pollutants and their effects. There are only more or less rough estimates about the amount of emissions of halogene, some organic compounds which are known to be especially toxic, and for emssions of toxic metals and other tocix trace elements such as lead, mercury, cadmium,

Table 2: Total Emissions of SO_2, NO_2, Dust, CO and CH in the F.R. of Germany by Sources, 1966-1982

	1966	1970	1974	1978	1982
			SO_2		
% Mt/a*	3.2	3.6	3.6	3.4	3.0
1) Kraftwerke/Fernheizwerke	41.3	45.9	51.3	55.1	62.1
2) Industrie	35.7	32.3	30.0	27.8	25.2
3) Haush. u. Kleinverbr.	19.9	18.6	15.3	13.4	9.3
4) Verkehr	3.1	3.2	3.4	3.7	3.4
			NO_X als NO_2		
% MT/a	2.0	2.4	2.7	3.1	3.1
1) Kraftwerke/Fernheizwerke	23.6	26.5	30.0	27.8	27.7
2) Industrie	30.6	25.5	21.0	16.7	14.0
3) Haush. u. Kleinverbr.	5.8	6.0	5.0	4.5	3.7
4) Verkehr	40.0	42.0	44.0	51.0	54.6
			Dust		
% Mt/a	1.8	1.3	0.97	0.75	0.7
1) Kraftwerke/Fernheizwerke	25.2	21.8	19.6	22.7	21.7
2) Industrie	58.5	57.8	60.8	61.4	59.7
3) Haush. u. Kleinverbr.	13.7	15.8	13.4	8.0	9.2
4) Verkehr	2.6	4.5	6.2	7.9	9.4
			CO		
% Mt/a	12.5	13.0	11.2	9.1	8.2
1) Kraftwerke/Fernheizwerke	0.2	0.2	0.3	0.3	0.4
2) Industrie	13.8	13.7	16.7	14.9	13.6
3) Haush. u. Kleinverbr.	52.0	41.7	27.8	18.8	21.0
4) Verkehr	34.0	44.4	55.2	66.0	65.0
			CH		
% Mt/a	1.4	1.7	1.8	1.8	1.6
1) Kraftwerke/Fernzeizwerke	0.5	0.5	0.5	0.5	0.6
2) Industrie	25.0	26.5	27.0	27.0	28.0
3) Haush. u. Kleinverbr.	46.0	42.0	40.0	35.5	32.4
4) Verkehr	28.5	31.0	32.5	37.0	39.0

*Mt/a = Million t/a
1) power plants
2) industry
3) domestic heating. and other small sources
4) traffic
Source: Umweltbundesamt 1984

arsenic, berylliom, which have been in the focus of studies with respect to their effects to human health. Many of them are emitted by mobile souces, power plants, industry and, especially waste incineration plants.

The relative contribution of the several emissions sources to air pollution in terms of concentration values and to detrimental and harmful effects for the environemnet and human health is not aonly, or completely a result of their emission amount. In most cases, it is also a function of geographical conditions and the height of the emission outlet. Although, for example, conventional power plants are the main contributors bo SO_2 emissions, their contribution to air pollution (immission effect) in residential agglomerations is less than from domestic heating furnaces due to the tall chimenys in power plants. On the other hand, power plants and industry, because of their tall chimneys, are major contributors to long-range transport of air pollutants, and, therefore, primarily responsible for the problems indicated by the term "acid rain". Traffic is not only a major source of air pollution in cities, but also in less densely populated and rural areas, due to the dense road network in the FRG. Finally, it is to be mentioned that there is a large inter-regional variety in emitter-structure (i.e., the relative contribution of groups of emission sources to total emission) and as a result of that, a corresponding inter-regional variety in the relative contribution to air pollution by different emission sources. Thus, air pollution control legislation should be flexible enough to provide instruments and provisions suited to these different conditions.

3. Ambient Air Quality (Immissions) (16)

3.1 Monitoring Network

For monitoring ambient air quality two monitoring networks exist in the FRG. The first, more comprehensive, one is run by the state authorities, the second, smaller, one is run by the Federal Envrionment Agency.

The Federal Environment Agency, which reports to the Federal Minister of the Interior, is responsible for analysing the causes of environ-

mental damage and assessing long-range-transboundary air pollution, particularly the deposition of air pollutants. The agency operates a measuring network of 15 stations throughout the FRG and there are plans to extend this monitoring network to a grid with sections of 100 x 100 kilometres. In the final state of development, the agency will operate 25 monitoring stations. The substances presently measured by the agency's monitoring stations and sample-taking places are SO_2, NO_X, CO, 03, suspended particulate matters (including Pb, Cd), deposition (includiing dust, PCB, CD, pH, anions) and meteorological parameters. One of the main objectives of the agency's monitoring network is to provide information about so-called background pollution, i.e., representative figures on the development of ambient air pollution in rural areas.

Monitoring of ambient air quality in general is the responsibility of the federal states. The Federal Immission Protection Act, as well as ordinances and decrees by federal government, establish basic requirements for size and density of monitoring networks, pollutants to be measured, measurement equipment and the kind of analysis. According to FIPA, the states have to establis a monitoring network in designated (heavily polluted) areas. In these areas, as a rule, the following pollutants are to be monitored continuously: SO_2, NO_X, CO, SPM, CH, ozon. In general, the states operate networks with sections (grades) ranging from roughly 4 x 4 km. Amount and density of monitoring stations vary from state to state, also the substances measured show a high variety. In addition to the requirements of FIPA some states operate monitoring stations in areas which are not designated as heavily or have established additional monitoring stations in designated areas. In total, the states have established monitoring networks with more than 200 stationary and mobile measurement stations, which continuously monitor the concentrations of major air pollutants in ambient air. Additionally, they operate monitoring stations for taking samples in longer time periods (Stichprobenmessungen).

3.2 Reporting on Monitoring Results

The practise of reporting on monitoring results varies from state to state. In general, there are monthly and annual reports available

to the public. Data are usually given for short-term and long-term concentrations. Some states have introduced, for certain areas, a continuously working information system by providing daily concentration values to the public media. A national overview on the development of ambient air quality is provided by reports of the Federal Environment Agency and so-called "immission protection reports" of the federal government required by FIPA. However, both reports provide date in a highly aggregated way and with a considerable time lag. Thus, the data privided by the latest available comprehensive report by the Federal Environment Agency (Daten zur Umwelt), published in 1985, end with figures for 1982. As a result of severe criticism on the bad state of environmental reporting in the FRG activities have recently been started to improve the situation.

3.3 Monitoring Results

Based on the available information on ambient air quality development during the last decade, the following general conclusions can be drawn for major pollutants.

1) sulphur dioxide: SO_2 concentrations dropped considerably during the 60s in many polluted areas, however, this trend levelled off during the 70s. At present, the majority of monitoring stations show a divergent picture. However, despite these differnces, there are quite clear indications for a long-term stagnation of concentrations in a range of 70-140 mg/m^3. This levelling off of improvement rates (stagnation) in the late 70s and the early 80s is especially prominent in densely populated and highly industrialised regions. In contrast, in some rural areas, a slight increase in pollution was monitored. However, in general, the long-term ambient air quality standard (140 mg/m^3) is now complied with by all monitoring stations, whereas the short-term standard (400 mg/m^3) is still exceeded at some monitoring stations in urban areas. Especially during the winter months very high peak concentrations are reported not only from stations in metropolitan areas, but also in rather rural areas. There are many claims by the public and scientists that peak concentrations (not only for SO_2 but also for other pollutants) are not sufficiently considered in air pollution control strategies.

2) Nitrogen oxides: NO_2 concentrations show an overall increase. The highest concentration values are reported from stations close to roads. The annual concentration levels lie in a range of about 50 - 100 mg/m^3 in agglomertions and in a range of 10 - 20 mg/m^3 in rural areas.

3) Carbon monoxide: no improvement in urban areas, especially monitoring stations at roadsides report high concentration levels.

4) Particulates: the improvement rate in dust deposition levelled off in the late 70s. Since then, the situation remained nearly the same (stagnation) in agglomeration areas. In some industrial areas the standards are still exceeded. Also for suspended particulate matters (SPM) an ambivalent trend exists: SPM concentrations showed a slight decrease in heavily polluted areas, however, in "normal" areas the situation remained nearly the same.

5) Other pollutants: the standards for some heavy metals (lead, cadmium) are still exceeded in some industrial areas, however, a slightly improving trend is reported for cadmium and in an increased sense for lead. The latter trend is especially due to the lead in petrol act which considerably reduced the allowable lead content in petrol. For organic compounds, which constitute a class of pollutants exhibiting intrinsic health and ecological effects, the situation in general remained bad. The federal government admitted that a strong need exists for extending and improving monitoring of these compounds. Photochemical oxidents such as ozon, hydrogen peroxide, etc., have undergone systematic investigations only recently. Available data indicate that high concentrations arise in some regions in the summer. It is assumed that concentrations of ozon show an increasing trend because of increasing NO_2 emissions.

3.4 Special Features of Air Pollution Problems

Available data on emissions and concentration levelsi ndicate that until the beginning of the 80s only rare improvements for both

major and specific pollutants have been achieved (17). With the exception of dust, a large part of the improvements in agglomeration areas have been achieved by the strategy of "problem dislocation" (tall chimeneys). The area of mobile sources, with the exception of lead, no improvements have been achieved. Furthermore, relatively weak control of the drastically growing number of chemicals have generated or increased the problems with numerous "new pollutants". Taking all this into consideration, the special features of air pollution problems in the FRG are made up for

- emissions of major air pollutants by power plants and other large firing installations, especially contributing to the long-range transport of pollutants;
- emissions by mobile sources, especially nitrogen oxides and hydrocarbons, cotributing in a massive way to air pollution in cities, to the formation of photochemical oxidents and, also, to long-range transport of pollutants;
- increasing concern, hints and varifications that industry and especially waste incineration plants emit a large variety of harmful or toxic substances, at present not sufficiently controlled or even monitored.

Given these features of air pollution problems, the following general characterisation can be made: most of the emissions of major air pollutants are a result of combustion processes in stationary and mobile sources, whereas the emissions of new, more complex, pollutants are mainly a result of not sysematically controlled inputs (raw materials) in industrial processes or the final treatment of industrial outputs after use (waste incineration).

Finally, in a densely populated and highly industrialized country such as the FRG the emissions of air pollutants contribute significantly to soil pollution, especially be toxic and accumulating substances. Having ignored the relationship between emissions of air pollutants and soil pollution for a long time, the federal government recently issued a comprehensive proposal for a soil protection programme (Bodenschutzkonzept) and announced future legislationon this subject.

4. Future Trends of Air Pollution Problems

4.1 Emission Trends form Stationary Sources

Recent amendments to FIPA and the technical instruction for maintaining air purity (TI Air) expected to be enacted at the end of 1985 or the beginning of 1986 provide stricter and improved instruments and requirements for cleaning up existing sources, or enforcing stricter emission limits for new sources. The amendments also increase the incentives, and by this the flexibility for emitters for introducing abatement measures. The TI Air amendment of 1985, officially deemed the core of the second extrapolation of the action programme "save the forest", establishes, inter alia, new requirements for nearly all industrial emitting sources, especially for smaller firing installations not regualted under the ordinance for large firing installations. It also establishes stricter emission limits, especially for carcinogenous substances and special harmful heavy metals; for example, bensol (old standard: 20 mg/m^3, new standard: $5mg/m^3$), arsen (old standard 20 mg/m^3, new standard: 1 mg/m^3), and cadmium (old standard: 20 mg/m^3, new standard: 0.2 mg/m^3). In addition, it provides clearer and more systematic requirements for improving (cleaning up) existing (old) sources by setting time periods for implementation. The new provisions have to be implemented as a rule within five years, or three respectively ten years, in special cases. Official estimations are based on the following effects by these new requirement:

- dust: a reduction from, at present, 400,000 tons/a (1982) to 160,000 tons/a (a reduction of 40%). Together with new requirements established by other legislation, primarily by the ordinance for large firing installations, dust emissions will be reduced,in the long term from 700,000 tons/a (1982) to 450,000 tons/a;
- sulphur dioxide: a reduction from 540,000 tons/a (1982) by nearly one-third. All measures combined (including those under the odinance for large firing istallations) are estimated to reduce the total amount of SO_2 emissions from 3 mio. tons/a (1982) by 1,9 mio. tons/a in the long term.
- nitrogen oxides: the total amount of 270,000 tons/a (1982) emitted by facilities regulated under TI Air, is expected to drop by 100,000 tons to 170,000 tons/a. All new requirements combined are expected to lead to a reduction of total emissions from 1,3 mio

tons (1982) to 0,8 mio. tons/a in the long term.

According to a recently published study by the Federal Environment Agency on the long-term effects of the ordinance for large firing installations, the following estimates can be made on the basic of the legally required declarations of operators of large firing installations:

- the annual SO_2 emissions from large firing installations will decrease from more than 2,0 mio. tons/a (1982) to 0,8 mio. tons/a by 1988 (a reduction of 1,2 mio. tons). By 1983 the total amount will drop to 0,5 mio. tons/a, i.e., a reduction rate of 75% from 1982 to 1993.
- nitrogen oxides: according to the estimates, the total amount from large firing installations will decrease from 1,0 mio. tons/a, at present, to 0,3 mio. tons/a in the early 90s (a reduction rate of about 70%).

Based on these official estimates, rather large reductions of emissions from old and new, lar[illegible], medium and small facilities are to be expected by the mid 1990s. Critics declare that these are optimistic estimates, based on the expectation of a full and strict enforcement of the new regulations by state authorities. They also point critically to the fact that most of the expected effects in emission reduction will take place after a rather lengthly time period, whereas faster measures are needed to save the forests. This criticism is directed especially at recently enacted requirements for exhaust control of automobiles.

4.2 Mobile Sources

In 1985, the EEC member countries agreed on new exhaust standards for new automobiles, which clearly appeared to be less strict than initially proposed by the federal government of the FRG. Due to the weak requirements of the ECE directive estimates based on prognosis on future trends in traffic increase came to the conclusion that until 1993, NO_X emissions by automobiles will increase (19). Thus, a remarkable reduction of NO_X emissions will take place only if a general tempo limit of 100 km per hour on motorways and 80 km/h for federal high-

ways (Bundesstraßen) is set. Taking into account these estimates, the NO_X concentrations in ambient air will remain nearly stable in general areas until about the early 1990s, whereas for urban areas, an increase is to be expected.

5. Damages by Air Pollution/Damage Costs (20)

Although the exact nature and extent of damage by all air pollutants evidently require further study, it is not disputed that previous and existing air pollution levels have caused, in some cases massive damages to human health, materials, plant life, rivers and lakes, and soil. In the FRG only a few comprehensive and systematic empirical studies on damages by air pollution have been made so far. Their main focus was damage to forests and materials, only to a lesser extent on health effects. Recently, growing concern with air pollution effects on rivers, lakes and soil has led to a promotion of studies in these problem areas. Especially for investigations into the health effects of air pollution, there is a strong demand by both the public and scientists alike to increase toxicological and epidemiological research. What has been said about the state of damage research also applies for research on benefits of air pollution control, although the general statement is not disputed, that even in economic terms expenditures on pollution abatement are, in the long term, more favourable than during damages.

5.1 Public Health (21)

Compared to other industrialised countries which have been challenged by high air pollution loads surprisingly few studies have been devoted to health effects of air pollution in the FRG. This is not only indicated by the weak position of epidemiological research in public and private institutions, buat also by figures on the development of expenditures by the federal government for R&D (Research and Development) in the area of air pollution: in the period 1976 - 1980, the federal and state governments spent a total sum of 816 mio. DM, of which only 28 mio. DM was used for studies on the effects of air pollution in general, and only 8 mio. DM thereof was allotted for studies on effects to human beings. Recently, some state governments have increased their funding, especially for epidemiological studies, due to the growing public concern on harmful effects of air pollution to human health and well-being.

Despite the lack of comprehensive and commonly agreed data, there is evidence for significant adverse health effects resulting from both high and low concentrations of several air pollutants. As early as 1962 an investigation revealed that a smog catastrophe in the Ruhr Valley area in December 1962 led to an increase in the mortality rate (156 more persons died than in the same period of the previous year). Several other studies and information show that mortality and human health, especially of the young and elderly is effected in smog episodes. A recent study, performed in West Berlin, identified that the mortality rate of the elderly is about 15% higher after winter days with a high air pollution load (parameter: SO_2) than in times with low level pollution. In heavily polluted areas (i.e., Duisburg), more than twice as many people suffer from bronchial diseases than those in rural areas. It is generally acknowledged that in areas with a high air pollution load a significantly higher rate of respiratory diseases (especially with so-called risk gropus: children, elderly persons) exist. According to an official statement of the Federal ministry of the Interior in 1983, for the past decade, not only have diseases of the respiratory tract increased in areas with high air pollution, but also suspectibility to infections. There is also growing concern by pediatricians and parents about the increase of allergies with children as well as pseudo-coup and sudden infant death syndrom which they assume to be (partially) caused by air pollution. Despite contradictory results of scientific studies and statements of public officials and politicians responsible for envorinmental protection, there has been a growing belief throughout the general public, since 1983, that air pollution contributes to illnesses in a much stronger way than was previously believed. At present, medical doctors who take the effects of air pollution into consideraton in research or practise are still in the minority. However, there are clear indications of growing interest in this issue.

Not only is concern about detrimental health effects of tradtional (major) air pollutions growing, but also on the effects of a large variety of toxic substances and gases, due to the increasing production and emission of new and complex chemicals. There are assumptions that they have contributed to the increase of cancer and, in certain cases, to deformities (dioxin). Furthermore, area studies conducted in the vicinity of chemical industry, glass an zinc production plants, revealed high heavy metal concentrations in the blood level of child-

ren. Reports of the Federal Environment Agency provided evidence that asbestos, lead, cadmium, etc., have led to harmful health effects in a sgnificant way.
Finally, it should be noted, that the lack of comprehensive and reliable data on health effects of air pollution, as well as the small amount of research in this area, sharply contrasts to the public concern and interest in information about this subject.

5.2 Forests and Plants (22)

The recent forect damages have been recorded particularly thoroughly in the FRG. After an alarming increase on damages in areas remote from industry, an assessment of damages was carried out in the autumn of 1982, identifying 8% of the forested area as being injured. Repeated assessments with unified criteria of evaluation during 1983 showed that 34% of the total forested area was injured, centering on the Bavarain Forest, Fichtegebierge, Frankenwald, Harz and the Black Forest. Damages have also been observed in the Alps and other areas which were not afflicted before. The third assessment in 1984 showed that the total proportion of trees affected rose from 34% in 1983 to 50% in 1984 (see table 3 next page).

Table 3: Survey of Forest Damage in the FR of Germany

Species of tree	Degree 0 no signs of damage		Degree 1 stlightly damaged		Degree 2 moderate damage		Degrees 3 and 4 very sick and dead		Total degrees 1+2+3+4	
	1983	1984	1983	1984	1983	1984	1983	1984	1983	1984
	as % of area covered by species									
Spruce	59	49	30	31	10	19	1.1	1.6	41	51
Pine	56	41	32	38	10	20	1.4	1.3	44	59
Fir	25	13	27	29	41	45	7.8	12.8	75	87
Beech	74	50	22	39	4	11	0.4	0.8	26	50
Oak	85	57	13	35	2	9	0.2	0.4	15	43
Other species	83	69	9	24	8	7	0.4	1.0	17	31
Total	66	50	25	33	9	16	1.0	1.5	34	50

Survey: Forest damage 1983 and 1984 by species and degree of damage. In the Federal Republic the annual damage is put at DM 1,400 million.
Source: Federal Ministry for Agriculture, Europe Environment No. 227/March 1985.

The 1984 survey also showed that deciduous trees suffered heavy damage. During the second and third survey there was a rapid increase in damage among beeches and oaks than among the conifers, so that the differences in the degrees of damage among the various types of trees have narrowed.

Despite the present lack of final scientific evidence, most experts believe that air pollutants play a crucial part in causing and determining the extent of the damage, either alone, or in combination with other air pollutants and factors. In March, 1983, the "Council of Environmental Advisors" issued a special report entitled "Forest Damage and Air Pollution" (Waldschäden und Luftverunreinigungen). They acknowledged that all serious attempts to explain the problems came to the result that air pollutants play a decisive part in causing damages to forests and among them sulphur dioxide and nitrogen oxide, and their transformation products, are the most important ones. Initially, acidic precipitation (acid rain) was seen as the main cause of damage, recent opinion, however, has tended towards the idea that photochemical oxidents developed from nitrogen oxides under the impact of sunlight, and particularly ozon, also play a significant part. Therefore, present knowledge seems to confirm that, without air pollutants, the problem of dying forests would not occur.

The problem of massive damages caused to forests by air pollution is not a new phenomenon of the 80s. Since the early 1970s, and with a considerable increase in 1976, there have been reports on massive damages of a new form caused to first in the south of the FRG. About the same time, damages were reported on spruce trees. Damage to forests occured initially among older populations in higher mountainous areas, however, later on, younger trees and forests in lower regions were increasingly affected. According to estimates of the "union of german forest owners' associations" the losses, as a result of damage to forests, amount to about 1 bio. DM per annum. New estimates, on the basis of the third survey, put the annual damage at 1,4 bio. DM. There are assumptions that an economic loss of numerous billion DM per annum will result if the damage rate continues to increase.

It is not only the economic loss of the forest owners which makes the problem of dying forests a national issue, and a challenge for air pollution control policy, but also other functions the forest provides. It serves, inter alia, to protect property against pollution,

as well as it protects soil, and climate. Should these functions be heavily impaired, then a general deterioration of ambient air quality, drinking water quality, the climate, the living conditions of animals, etc., will deteriorate. Furthermore, soil erosion, landslides, rockslides, avalanches, will increase. Finally, without having figured out all the problems and damages protentially resulting from dying forests, the recreational and esthetic function, as well as its income function for many persons who derive their livelihood from tourism, will be (and partly already is) heavily impaired.

The costs to society caused by forest damages include also the so-called avoidance and abatement costs. So far, a great deal has been spent on fertilization, liming, etc., measures, e.g., the federal and state governments have made appropriations in 1984 of about 33 mio. DM to subsidize fertilization or replanting of damaged forests, etc. The related budget for R&D has been considerably increased, too. Finally, it is to be pointed out that figures and estimates on damage costs concentrate on those effects that are physically measureable and which can be transformed into economic terms. In addition to such effects, and this is especially true for the immaterial value that forests are given by Germans in general, there are those which cannot be physically measured ore expressed in economic terms but nevertheless generate massive mobilisation of the general public and challenges to politicians and industrial emitters never before seen in the history of the FRG.

Damages to plants have been repeatedly reported, in many cases, as the result of specific pollutants, like, inter alia, cadmium, lead, and fluor. The so-called "red list" for endangered plants, which was updated in 1984, showed an increasing threat to the flora. Sufficient data on the magnitude of effects due to exposure to air pollution are not available. But damage to plants within and without forest ecosystems has been increasingly reported. Thus, the federal government admitted, in 1984, that the assumption that damaged forests is only one sign of a more comprehensive threat to other vegetaton, and thus, to the environment as a whole, must be taken seriously. Environmental movement groups have included human beings into this perspective, as can be learned from one of tho most popular slogans: "first the forest dies, then human beings" (erst stirbt der Wald, dann stirbt der Mensch).

5.3 Rivers and Lakes, Soil

Recent investigations have shown that the unpolluted upper parts of rivers and streams with low lime content have been significantly acidified. High concentrations of sulphate and aluminium, by far exceeding the standard for protecting fish, have also been monitored. Preliminary reports on lakes have shown that acidification mainly appears in areas where forests are also damaged. Acidification has an important side-effect as it contributes to the release of heavy metals, which then can damage the quality of the ground water. Available data do not allow an estimate of economic losses due to water pollution by air pollutants. The federal government reported in 1984 that the causes of acidification and the input of phosphates to lakes and rivers primarily result from the combustion of fossil fuels.

Most air pollutants, once emitted into the air, will deposit on the soil (23). Although the soil is for many air pollutants a "final target" where accumulation of air pollutants can reach critical values, even if the concentrations in ambient air are minor, the relationship between air and soil pollution was not investigated or made a political issue until recently. Thus, national data on damages and damage costs are not available. But it is generally acknowledged that air pollution is one of the major causes of soil pollution. Since 1982, the federal government has promoted the devlopment of a comprehensive soil protection concept, which was approved by the government in 1985. At present, this concept is still on the political agenda. Legislation on this subject is probably not to be expected before 1987. Some groups are critical about the long period of time until legislation and implementation, but many groups admit that the concept as such is well-established and very fastidious.

5.4 Materials (24)

For many years damages to materials by atompsheric pollution have been determined. Serious damage is caused not only to all types of buildings and materials, but in particular, valuable architectural monuments and historically valuable buildings, memorials and medieval stained-glass windows. One worldwide known case in the cathedral of Cologne (KölnerDom), the sandstone of which shows signs of serious decay. Similar alarming syptoms are found at numerous other famous buildings. As these buildings, etc., represent irreplaceable values, the damage costs (cost occurring for renovation, preservation, etc.) show only a small fraction of the total loss.

IV Enterprises' Response: Development of Air Pollution Abatement Technology and Expenditures

The environmental programmes and public pressure mainly resulting from the problems of dying forests and health problems due to air pollution have influenced business decisions in a number of other ways. In some cases, they appear to have stimulated industrial innovations. In other cases, because of legal requirements to take the best available technology and the costs involved in this, they have discouraged innovation and retrofitting of old facilities. Due to weak supra-national legislation (by the EEC) the construction of low-polluting cars has been decisively impeded. Thus expenditures for research and development and for investments in new product lines for low-pollution cars in the automobile industry started only recently.

In the area of stationary sources, investments in air pollution control have a much longer history. As most of the emissions from stationary sources are emitted by combustion processes, the following review of abatement technologies will focus on this (26).

Because combustion of fuels for energy production is the cause of the major air pollution problems, energy saving measures are of interest. In industry, by improving processes, introducing power-heat cutting and the use of waste heat, as well as recycling of waste material, etc., the final energy consumption was lowered from 48% in 1960 to about 34% in 1980. The specific industrial fuel consumption related to the net production was halved within this period.

The discharge of pollutants such as carbon monoxide, unburned hydro carbons, and soot can be considerably reduced by improving combustion processes. For these pollutants, efficient techniques with low CO, CH and soot emissions have been developed, mainly because this also contributes to an efficient use of energy (money-saving aspect). For nitrogen oxides (NO_X) development and introduction of low NO_X combustion methods has been rather slow. Also fluidised bed furnaces, a special method in combustion processes to achieve low NO_X emission levels, exist, at present, only in small figures. However, the introduction of this technique shows a progressive tendency. Flue-gas denitrification facilities are presently not in use in the FRG. However, as a result of the ordinance on large firing installations of 1983 and of special

programmes of several state governments, this abatement technique (mainly the selective catalytic reduction method) has to be installed in new and old larger firing installations, especially power plants, in the coming years. The first selective catalytic reduction equipment will start operation at the end of 1985 or the beginning of 1986 in a coal-fired power plant of 460 MWel. It is expected that the retrofitting of large firing installations with flue-gas denitrification facilities will be completed by 1990. According to an estimation of the Federal Environment Agency, the NO_x emissions from power plants will be reduced in the time period 1980 - 1985 from 1 mio. tons to 0.3 mi. tons.

Desulphurisation of flue-gas is an effective means of reducing SO_2 emissions; desulphurisation rates up to approx. 95% are possible with the present available technologies. At the end of 1983, ten power stations in the FRG were fitted with flue-gas desulphurisation installations with a total capacity of 3,400 MWel. The investment costs for this technology for coal-fired power plants with a capacity of 150MWel to the extent of approx. 40 mio. DM, in the case of a capacity of 750MWel: about 125 mio. DM (flue-gas denitrification facilities are cheaper, the costs are, in general, less than 50% of the costs for flue-gas desulphurisation). The ordinance on large firing installations of 1983 and special programmes of several state governments, a large increase of flue-gas desulphurisation facilities in old and new large firing installations are expected until 1993. According to official estimations, the total SO_2 emissions in the FRG will then be reduced by 50% compared to 1980. The total desulphurisation capacity will then amount to more than 50,000 MWel.

Statistics on environmental protection expenditures in industry show a small increase in investments for all areas since 1980, from 3.5% to 4.6% (relative to total investments) in 1982. About 50% of total pollution control investments are spent on air pollution control facilities. According to experience, the operating costs per annum amount to about one-third of the investment costs during the depreciation period of the facility. About two-thirds of the total investment for air pollution control took place in four sectors: electricity generating industry, mineral oil industry, iron and steel industry and chemical industry.

Finally, the increasing importance of the so-called eco-industry (production of pollution control equipment, monitoring appliances, etc.) for employment and general economy is to be mentioned. This business sector is one of the rare sectors with rather high growth rates. The turnover in this sector was recently estimated to amount to about 16 billion DM per annum. Furthermore, the federal government introduced in 1979 a special job-creation programme with explicit environmental measures. The state of Hesse started such a programme in 1983. Both programmes have only minor relations to air pollution control (e.g., traffic improvement, energy-saving measures).

Table 4: Total Investments, Environmental Protection Investments, a Air Pollution Abatement Investments in Industry, 1979-1981

	Total Investment Bio. DM (1)	Investem. Env.Prot. Bio.DM (2)	Investm. Air Poll. Bio.DM (3)	Percentages (3) of(1)	(3)of(
1979	66.9	2.10	0.96	1.4	45.7
1980	76.8	2.67	1.29	1.7	48.3
1981	75.5	2.95	1.53	2.0	51.9

Source: 3.Immissionsschutzbericht der Bundesregierung 1984

Table 5: Pollution Control Investments in Mio DM, 1975-81 by Sources and means

Year	WATER	EOP 1)	I 2)	PR 3)	AIR	EOP 1)	I 2)	PR 3)	WASTE	EOP 1)	I 2)	PR 3)	NOISE	EOP 1)	I 2)	PR 3)
1975	911	727	180	5	1213	764	205	244	178	146	30	1.7	210	134	71	5
1976	821	673	140	7	1154	858	240	56	199	171	27	1	223	144	69	10
1977	749	595	144	10	1120	771	210	140	203	146	52	5	207	138	61	8
1978	686	534	141	9	1129	725	223	180	172	139	32	1.6	201	129	62	10
1979	773	678	85	10	965	686	231	47	160	136	22	1	201	123	68	10
1980	915	770	138	6	1292	873	385	34	220	186	33	2	247	152	80	16
1981	951	817	124	10	1531	1127	351	53	256	217	35	4	210	131	73	5

1) End of pipe
2) Integrated
3) Product related

Source: K. Zimmermann 1985 (IIUG dp 85-8).

Figure 2: Total investments and Pollution Abatements Investments in Industry, 1975-1982

Bio. DM

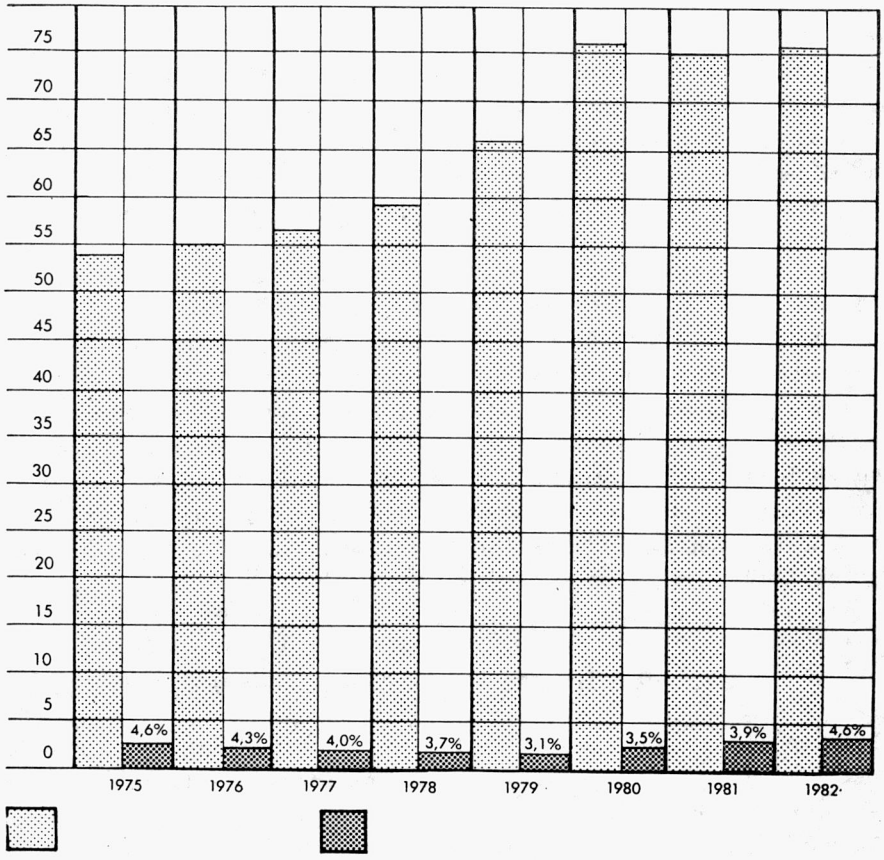


Figure 2 and tables 4 and 5 provide an overview on expenditures for environmental protection measures in industry.

V Evaluations of the existing Air Pollution control Strategies and Instruments

In recent years the discussion on alternative approaches to air pollution control increased tremendously in the FRG due to the apparent deficits of policies to date and the need for quickly effective measures because of the problem of dying forests. One of the most intensively discussed proposals is the approach to adopt market-type economic incentives as part of the environmental control programmes (27). The proponents of such a scheme claim that it will improve both the effectiveness and the efficiency of air pollution control policy. But until the present only minor elements of such alternative strategies have been built in into the existing regulatory approach only recently. Therefore instead of evaluating alternative strategies available to date, a brief overview of the basic explanations for the shortcomings of West German's clean air policy up to its fundamental changes in 1983 will be given. In this overview, only the most important factors are reviewed, primarily based on findings of empirical research on implementation of air pollution control policy. Most of the explanations are drawn from an international comparative study on air pollution control policies with stationary sources conducted by the International Institute for Environment and Society of the Science Center Berlin (28).

1. Explanations for the Shortcomings of Clean Air Policy

Although the legal framework of air pollution control is one of the most comprehensive according to international standards, it contains certain major gaps and shortcomings which are responsible for the implementation shortcomings leading to the above mentioned damages and conflicts.

1) The objectives of air pollution control policy are not clearly stated. The ambient air policy standards are of limited use for a strategy which aims at prevention of further deterioration of environmental quality and for cleaning up polluted areas, because their enforceability is mainly restricted to cases where permits are granted to large new installations. The ambient air quality

standards, especially the standard for SO_2, are rather lax, compared to the state of scientific knowledge and to proposals made by the World Health Organisation. Furthermore, the standard formulation process is not a pure scientific process, but heavily influenced by industrial and other interest groups, whereas environmental interest groups are almost excluded, and by way of selecting information and structuring the procedure of standard formulation processes. As a result, standards become a politically influenced convention, but not a purely scientific result. In addition, the factual meaning of standards heavily depends on supplementary monitoring requirements. Studies reveal that the control function of an ambient air quality standard for enforcement practice is considerably influenced by requirements for measuring systems, monitoring areas, methods of analysis, time periods and statistical methods to be applied. It became evident that by these, an ambient standard "surrounding" means a standard could be lowered or tightened. There are many more opportunities for industry-related groups and experts to change these requirements according to their interests, whereas the public has very limited provisions to assess the importance of such highly technical and complex regulations. Similar patterns appear in the process of formulation emission standards serving as a concretisation of the "state of technology". Investigations supported the assumptions that "programme deficits" which pulled out the teeth of enforcement instruments of the programme, in many cases, were the result of the influence of industrial-related parties. As this standard formulation process usually is organised as a relatively closed "bureaucratic-industrial" cooperation and negotiation process, from which representatives of environmental organisations are excluded, it is hard for pro-environmental groups to influence or even to evaluate the outcome of this process. Because of the increasing tendency of air pollution control policy. In the FRG to become more complex and detailed in legal and technical terms, the substantial meaning of air pollution control regulations is increasingly harder to assess and the whole policy area becomes more unclear to the public.

2) The implementation of a comprehensive air pollution control policy is a relatively new task compared to other policy areas such as energy, industrial an agricultural policy. Air pollution control authorities and the respective departments at governmental level

usually lack a comparable power structure, which the older policy sectors have . As air pollution control measures usually interfere with objectives and interests of the other policy sectors, conflicts between them arise rather frequently. According to the existing power structure, environmental concerns usually tend to be weakened. The existing traditional power structure also largely prevents an effective administrative link between the causal, interrelated policy areas, which would be highly necessary for an effective and rational air pollution control policy. As things stood until recently, for example, energy policy could be pursued almost independently on the basis of its own premises, with little thought to its impacts on environmental objectives. When considering new approaches to air pollution control, it is most important to consider these political restrictions in order to achieve realistic strategies.

3) Installations licensed before 1974 are responsible for most of the emissions of major pollutants. An effect-oriented control policy should have concentrated at these sources. However, the legal provisions have not led to the establishment of demanding control requirements. The clause in FIPA (Article 17) that abatement orders are only justified if the authority can demonstrate the availability of abatement technologies and the economic feasibility almost completely prevented improvement orders. Furthermore, regarding technological and economic possibilities, agencies in charge of pollution control often lack sufficient information. But that is not the only reason that doomed the legal provision for abatement orders to failure. Especially the economists pointed at the structural deficiency of the system. The lack of an incentive for emitters to reduce their emissions. Given the case that an emitter voluntarily increases the standard of anti-pollution technology, there are no rewards for him, however, there are sometimes disadvantages, because through his activity the state of technology is advanced, which then is binding to all other comparable plants. If one owner runs several plants, it can then occur that he will be forced by the authorities to also equip the other plants with the latest technology. An economist (H.Siebert) described this structural deficit of air pollution control policy as follows: The roles of environmental protection agencies and the business sector have

been irrationally reversed. The agency has to promote technological progress, whereas under existing conditions it is rational for the business sector to aim at no technological progress in air pollution control.

4) One of the basic objectives of air pollution control regulations and programmes, the precautionary principle, i.e., preventing emissions harmful to human beings and the environment has evidently not been successfully implemented. The main reason for this failure was the inability of federal and state governments to enforce a comprehensive energy saving policy, and to strengthen emission standards and exhaust limits for stationary and mobile sources, and the preference for the so-called strategy of high chimneys. In general, the responsible authorities relied much more on strategies for dispersion of pollutants than on enforcing pollution abatement equipment.

5) Tremendous amounts of money have been spent on monitoring equipment, however, reliable and comprehensive data on damages, emissions and the ambient air quality situation are lacking. Reliable and valid monitoring data are not only a precondition for development of rational pollution control programmes but also an important means for the general public to evaluate the achievements in air pollution control of responsible authorities. In general, the means for keeping the public informed about environmental issues and programmes are still in their infancy. In addition, even the public authorities responsible for developing air pollution control programmes or implementing them lack fundamental data on industrial emissions. If data were available, it was often the case that they were exclusively used by certain authorities without making them accessible to other authorities. There are only rare cases where large emitters continuously monitor their emissions, and there is no provision for a direct and continuous transfer of such emission data (telemeter system).

6) Beginning in the 1970s not only a growing awareness about air pollution problems, but also a tremendously increasing knowledge of technical, legal, economic, and ecological preconditions--even if it were very complex and detailed ones--of air pollution control

within citizen initiatives and the public in general could be found in the FRG. However, although ' is provided a basic precondition for responsible participation of these groups in environmental policy decisions, only a rather limited involvement was permitted. Both the policy formulation and the implementation processes provide rather limited access for environmental protection groups. In cases where an institutionalised inclusion of members of the affected public or environmental interest groups has been established (especially in the area of permit issuing to designated facilities), it often became evident that no substantial participation of these groups took place because of the close cooperative and informal relationships between the responsible agency and the emitters outside of the formal decision process. Thus, the preconditions for emitters' interests for influencing air pollution control policy are much better than those of the affected public and environmental interest groups. This biased participation structure, in fact, not only led to poor decisions on air pollution control, but also stimulated (and, in a certain respect, justified) the opposition of formally correct established decisions by other means (e.g., blockades, demonstrations). In general, substantial cooperation (or even a certain kind of coalition) of public authorities with concerned citizens or environmental interest groups was a rare feature until recently.

7) Opportunities for affected citizens and environmental interest groups to influence government policy and emitters' behavior or to seek remedies for damages by air pollution through court action are very limited. The strict standing requirements and restrictive legal requirements often preclude court action by concerned citizens or environmental organisations. In cases of actual or potential damages, those who are concerned have the burden of proof to show not only the cause and effect relationship but also the single pollution source responsible for this. In complex situations like damages by air pollution, it is almost impossible to fulfill these requirements. Thus, even in the present situation where forest owners suffer tremendous economic losses by air pollution, the prospects for getting compensation by court actions are very limited. It is not an exaggeration to say that the existing legal and dogmatic principles much more favour those polluting the air than those suffering damages from air pollution.

VI Recommendations

The following recommendations are mainly based on the findings of the international comparative study on air pollution control policies in selected European countries co-directed by the author (29).

Comparatively little has been done to investigate the relationship between air pollution and health problems. There is also a substantial need for more research and monitoring to allow more efficient responses to problem situations caused by air pollution and to allow for better anticipation of emerging problems. In a more substantial sense, there is a need for research on theory and methods of a preventive environmental policy, i.e., the basic conditions for a departure from the present react and cure approach to anticipatory action. This is a very broad area for further research, and even summarising the several aspects to be dealt with by such research would go far beyond the scope of this article. However, although in relations with this research arena, it should be pointed towards the importance of research on strategies to implement and enforce new approaches under present political, social and administrative conditions. In many cases, it has proved to be a weakness of studies on new approaches to air pollution control that they have excluded the basic question: How would the existing system react? Correspondingly, in conjunction with air pollution problems there is a basic need for more research on the role played by the energy supply industry in formulating and implementing air pollution control policy, and also much more research is needed on preconditions and restrictions of an international cooperation in air pollution control.

Finally, basic research is needed on a very specific subject that has to date been hardly discussed. As mentioned in the above section, much research has been done on the issue of how to create more incentives for emitters to do more in air pollution control than the law demands, but this question should also be directed to administrators. There are clear indications that they have not used all the opportunities provided them by the law, and other more politically based powers, to reduce air pollution.

The reasons for the prevailing regulatory approach in West Germany's air pollution control policy have something to do with the politico-administrative culture in this country: administrators (and also technical experts) at the factory inspectorates, which are in many cases also the authorities responsible for air pollution control are used to applying standards and regulations rather to manage economic transfers. Although notoriously complaining about strangling bureaucratic regulations, firms and business federations actually also show a preference for the status quo to a solution involving payments. Furthermore, the public and especially environmental protection groups, are rather reluctant to accept the idea of introducing more economic and flexible instruments because they fear that the tendency towards selling pollution rights will become too strong. Despite the objections and misgivings against economic or more flexible instruments, there is a rather broad bases consensus that the existing air pollution control policy should be made more efficient and attractive to emitters by a "mixture of instruments", a combination of regulatory and economic instruments (30). Thus, research is needed on incentives which increase the activities of administrators in reducing and preventing air pollution problems (31).

According to official statements of West Germany's politicians responsible for the nation's air pollution control policy, this policy is the most progressive, modern and successful in Europe. This favourable self-assessment is, as the preceding sections try to demonstrate, primarily based on a rather formal focus on the quantity of laws, regulations and administrative resources directed to air pollutions problems. Indeed, the number of laws and regulations for air pollution control is impressive. And, a rather formal analysis must admit that no other country--with the exception of the U.S.A.--has established such a comprehensive, detailed and complex system of legal and administrative regulations for air pollution control. However, when the actual performance of this regulatory system is taken into consideration, the achievements seem to be highly questionable. The emissions of major air pollutants have increased or only small reduction rates have been achieved. New pollutants, of a more complex and toxic nature, raise growing concern. Improvements in the ambient air quality of urban and industrial agglomerations have been, for a large part,

the result of the high chimney strategy, contributing decisively to the deterioration of rural areas. Not only the public has for many years been worrying about slow progress or deterioration, but also economic groups point at severe deficiencies of the approaches used. Last, but not least, the dramatic increase of damages to forests, growing concern with acute and chronic injuries to health by air pollutants, and indications of massive and partly irreversible damages to materials, buildings, monuments, etc., and detrimental effects to other environmental areas (nature, water, soil, etc.) and the very slow and limited reactions of the responsible authorities and politicians to these problems, support the conclusion that West Germany's air pollution control policy not only has failed to prevent harm and damages by air pollution, but also failed to a large extent to react in an appropriate way. Thus, until recently, the country's air pollution control policy could not be considered as a shining example for other countries. However, other countries can learn from the mistakes and causes underlying, in order to avoid similar experiences (see chapter V above).

As mentioned, the unfavourable assessment of West Germany's performance in air pollution control holds true until recently. Triggered by the dramatic increase in the damages to forests, an ambitious new programme for reducing emissions from automobiles and large firing installations was developed. It is still to early to assess the achievements of this programme, because implementation did not occur until recently. However, already at this stage, it can be learned that environmental consciousness, massive political actions against polluters and insensitive authorities by citizens groups provide a basic precondition for stimulating a remarkable success in environmental policy. Thus, a general recommendations for all countries aiming seriously at a better air quality management policy would be to promote environmental consciousness, to establish ways and means for substantial participation of citizens in environmental policy and the causally interrelated policy areas (e.g., energy policy) and to create by a comprehensive, problem-oriented, and up-to-date environmental monitoring & reporting system a maximum of transparency on environmental matters for the general public.

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In this article only key publications on the respective subject are given in the footnotes. Therefore an additional list of literature covering central aspects of air pollution control policy is provided for at the end of the article.

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POLITYKA REPUBLIKI FEDERALNEJ NIEMIEC W ZAKRESIE OCHRONY ATMOSFERY

Dokonano przeglądu podstawowych kierunków strategii i polityki w zakresie ochrony atmosfery w RFN. Po krótkim rysie historycznym ochrony atmosfery w tym kraju podano zwięzły opis aktualnego systemu prawnego i norm, a także strukturę organizacyjną systemu kontroli zanieczyszczeń atmosfery. Na podstawie wyników badań dotyczących wielkości emisji zanieczyszczeń i jakości powietrza atmosferycznego w sąsiedztwie źródeł emisji omówiono osiągnięcia i niedomagania tej polityki. Zalecenia podane na końcu artykułu mają na celu poprawę efektywności działań na rzecz ochrony atmosfery.

ПОЛИТИКА ОХРАНЫ АТМОСФЕРЫ, ПРОВОДИМАЯ В ФЕДЕРАТИВНОЙ РЕСПУБЛИКЕ ГЕРМАНИИ

Произведён обзор основных направлений стратегии и политики в области охраны атмосферы в ФРГ. После краткого исторического введения в охрану атмосферы в этой стране приведено сжатое описание актуальной правовой системы и норм, а также организационной структуры системы контроля загрязнений атмосферы.

На основании условий исследований, касающихся величины выбросов загрязнений и качества атмосферного воздуха в соседстве источников выбросов оценены достижения и недостатки этой политики. Приведённые в конце статьи рекомендации имеют целью повышение эффективности действий, направленных на охрану атмосферы.