Worldwide **data recording**

Achievements and targets

- → Data recording
- → HSE management
- → Health protection
- → Safety
- → Environment
- → Energy
- → Water balance
- → Water pollution control
- → Air pollution control
- → Waste management

Bayer

Data recording

We align ourselves to international recommendations and guidelines

The aim of this section is to give as comprehensive and accurate a picture as possible of the Responsible Care activities of our Group which meets international environmental reporting standards and allows global comparison with our competitors. We therefore align our procedure for compiling data to the recommendations, guidelines and directives of the most important global institutions with relevance to the environment:

- **CEFIC Guidelines for Environmental Reporting**
  CEFIC is the European Chemical Industry Council, the umbrella organization of the European chemical associations.
- **DIN/ISO 14001**
  International standard for environmental management systems.
- **DIN 33922: Guidelines for drafting public environmental reports**
- **SustainAbility recommendations**
  SustainAbility Ltd. is a British consultancy company which has investigated past application and experience of companies in sustainability reporting and publishes its findings in an annual benchmark overview. SustainAbility works closely with UNEP.
- **United Nations Environmental Program (UNEP)**
- **Global Reporting Initiative (GRI)**
  GRI is an international stakeholder initiative which focuses on the establishment of international standards for environmental and sustainability reports and has compiled corresponding guidelines.
- **European Pollutant Emission Register (EPER)**

This ensures that consideration is made of all important health, environment and safety relevant indicators that in the view of international experts have a bearing on global sustainable development.

The data used by us were recorded using the Bayer site information system BAYSIS™, first introduced in 1999. This data compilation, processing and application system appraises HSE data from our production sites all over the world according to virtually uniform criteria. While our 1999 Responsible Care Report recorded data for some 170 sites, the data in this report covers all 206 sites, comprising in total more than 800 production, formulating and packaging plants. The base parameter on which most other environmental indicators such as emissions, energy consumption and material flow depend is thus recorded in its entirety.

→ Table of contents

Bayer

Some 170 individual indicators covering all aspects of HSE are compiled for each site. All data are collated centrally in Leverkusen, where their quality and plausibility are thoroughly checked.

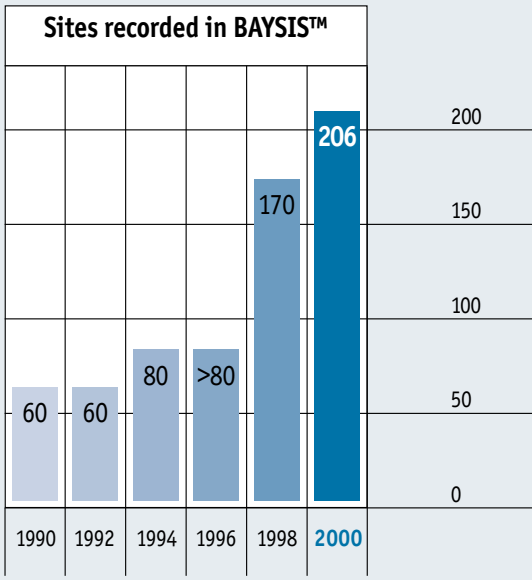
HSE reporting: a dynamic process

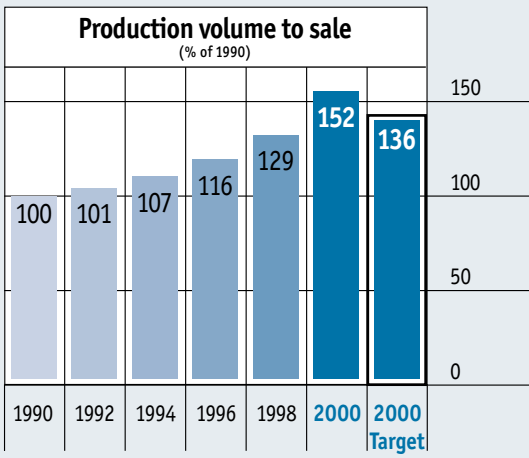
We have learned a great deal since issuing our first Group Environmental Report in 1995. In particular we have found reporting to be just as much a dynamic process as corporate growth. As a result, changes in boundary conditions must be taken into account when comparing data from different years.

Since publishing our first report we have continuously reviewed, adapted and expanded our data recording procedures in a dynamic learning and decision-making process, aligning them with global development, new scientific findings, ever changing boundary conditions and the modified targets that result from these. The definition of terms such as waste has had to be changed, and many indicators are now delimited differently from before.

For our first Group Environmental Report in 1995 our survey included only the 60 most important production sites in the world. Since then the number of sites covered has more than trebled. Many sites have recently been added owing to the foundation of new companies and acquisitions. In addition, some 50 sites have been sold or closed since the first survey, including 15 belonging to our former subsidiary Agfa. The current data cover the sites, purchased or sold in 2000, for the period during which they were affiliated to Bayer.

These changes mean that it is difficult to find a satisfactory method of comparing current and past data. Nonetheless we have still placed these data side by side so as to document and highlight developments.





We originally decided in 1995 to publish the targets we had set for ourselves in the fields of health, safety and the environment and to allow ourselves to be judged by them. We therefore compiled HSE data for the 60 most important sites for the period starting from 1990 and based our targets on these, first for 1996 and later for 2000. In the meantime, however, the make-up of our Group has changed, not least with the establishment of new companies, the acquisition of existing ones and lean restructuring measures such as divestitures, closures and sales. In addition, our portfolio has changed by 30 percent since 1996. Nonetheless we have still held firm to our targets for 2000.

It is obvious that the target of reducing emissions by a particular degree or saving on resources depends a great deal on production volume. It would seem to make sense therefore to align such targets to the expected growth rate. In setting our targets for 2000, we assumed that our total production volume would rise by 36 percent between 1990 and 2000, and we thus formulated our targets accordingly. The growth rate was in fact 52 percent, clearly exceeding expectations.

Although in absolute terms the increase in total production volume in some cases brought about a greater use of resources and an increase in emissions compared with previous years, our figures show that we have been able to increase resource productivity and, in relative terms, reduce specific emissions.

Targets

Our objective is to apply the model of sustainable development to all dimensions of Responsible Care in the Group. For this reason, we have specified appropriate performance indicators, which relate in the main to 2004. These targets are naturally aligned to the information currently available and the forecasts based on it.

In addition, we have also set ourselves targets aimed at further developing our HSE management systems. Overall, these targets will once again lead to an enhancement of performance. Nonetheless even a full implementation of these activities will probably affect certain data for the Group less than the expected restructuring measures and changes to the portfolio (e.g. through the sale of Erdölchemie and the integration of Aventis CropScience).

Instead of presenting our targets in the tables as we have done in the past we have therefore included a separate section on corporate objectives (see Responsible Care objectives) in which we give a summary of our targets.

→ Table of contents

Bayer

HSE management

Staff levels

More than three percent of our 120,000 employees were engaged primarily in HSE activities at the end of 2000. The table below details the number of staff working in the relevant occupations, especially those for which there are centralized units such as environmental protection or the fire department. In addition, there are many more safety experts attached mainly to the production units themselves. At Bayer AG alone, 223 employees are engaged in full-time occupational safety, plant safety or technical inspection in the central service divisions. This figure alone, however, does not reflect our company's full commitment to safety.

Staff levels at production sites at the end of 2000

	Africa	Asia, Australia	Europe	Latin America	North America	Total Group
Staff at production sites	1,205	6,553	64,337	6,479	21,867	**100,441**
Staff working in production	493	3,174	38,119	2,878	7,150	**51,814**
Staff working in environmental protection	16	168	1,262	103	251	**1,800**
Staff working in site fire departments	4	32	674	42	16	**768**
Part-time firemen	133	789	909	574	664	**3,069**
Physicians	7	22	56	29	7	**121**
Other medical staff	9	23	194	24	43	**293**

Fire and medical departments are only maintained at the larger sites. At many sites, especially the smaller ones, we have concluded agreements with municipal fire services and local physicians and clinics.

Rapid growth, particularly in many Asian countries, has made it necessary to employ more environmental protection staff than we originally intended (Target 2000: 1,590). On the other hand, in Western Europe the number of such staff has fallen slightly, primarily due to the increased effectiveness of in-process environmental protection.

Training

Our employees attend seminars on environmental protection and safety, repeated instruction sessions on handling dangerous substances, courses in their specialist field and general further education classes. This applies in particular to every new employee and also, at least in environmental protection and safety, to employees of the subcontractors working for us.

These figures speak for themselves: in 2000 alone approximately 42,000 employees around the world attended a seminar on environmental protection and safety lasting at least four hours. One in three employees of the Group is thus given such instruction every year (in 1998 it was one in five). Our goal of giving training in environmental protection and safety to at least 32,000 staff per year has thus been considerably exceeded. In total, 370,000 participants attended our environmental protection and safety seminars between 1990 and 2000. In addition, many more brief instruction sessions have been held in the plants themselves, for example on the German Regulations on Dangerous Substances and on topical safety issues.

Examples of HSE training in 2000

Participants in seminars of at least 4 hours' duration	Participants (thousand)
First aid courses	9
Seminars on environmental protection and safety	42

While at our European sites only one in five employees attended an environmental protection and safety seminar lasting four or more hours in 2000, virtually every employee did at the Latin American sites. In North America and Asia, two in every three employees were instructed in environmental protection and safety in 2000.

The reasons for this are obvious: the low number of seminars in Europe is due to the fact that environmental protection and safety are routinely integrated into our systematic several-year training programs for the various specialist occupations. Our sites in the United States and Latin America do not provide such out-of-plant training, and the training requirement at many of our new Asian sites is even greater, due to the higher number of new staff there.

The intensive courses, too, have played their part in reducing both the number and severity of industrial accidents and the number of inadvertent emissions into surface waters and air at virtually all sites.

The training and further education of our staff will continue to be a permanent focus of our HSE activities in the coming years.

→ Table of contents

Bayer

HSE audits

By the end of 2000, 37 sites had been certified to ISO 14001. Their environmental management systems thus officially comply with international standards. We expect the number of certified sites to increase as our internal auditing program advances.

We aim to continue the internal company HSE audit program BAIT (= Bayer Assessment and Improvement Tool) we began in 1998. During 2000 we had completed the audit at 14 major sites in different parts of the world. By 2004 we aim for all relevant Bayer production sites to have been validated by qualified external auditors. In addition, all sites have carried out a self-assessment using a specified checklist. Any need for action established has been tackled by the sites themselves. This program is to be repeated on a two-yearly basis.

Key data on HSE management
(number of sites)

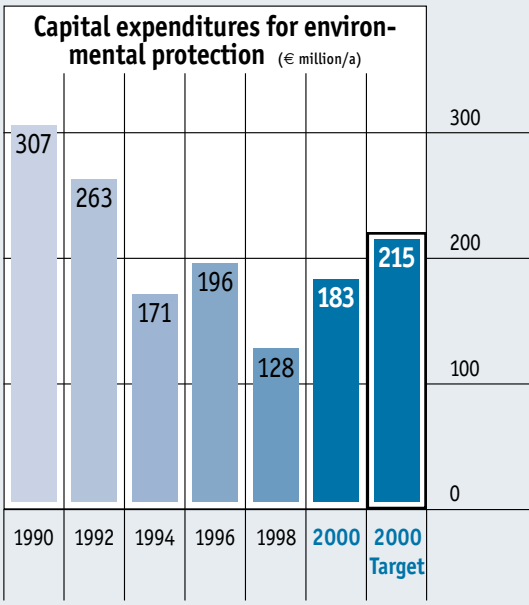
ISO 14001	1998	16
	1999	26
	2000	37
Company-internal HSE audit	1998	4
	1999	7
	2000	14

HSE expenditure in 2000

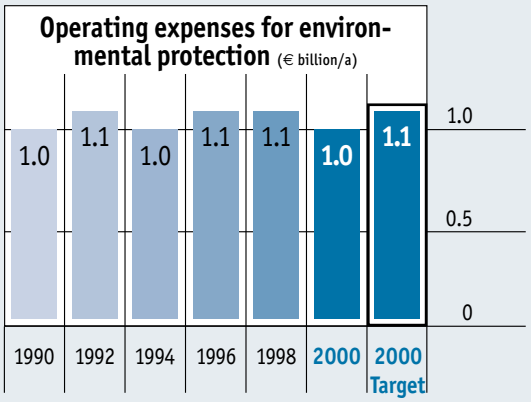
The total cost of our staff medical provision came to € 32 million in 2000, corresponding to around € 320 per employee at the production sites. The worldwide cost of maintaining site fire departments, which are also responsible for preventive fire safety, was € 73 million. Costs for other areas of safety were not recorded because these tend to be much more strongly integrated into the departments themselves than fire safety. Nonetheless we would still like to quote a figure for centralized safety: operating costs in the central safety departments amounted to approximately € 30 million at Bayer AG alone.

We had earmarked a total of € 215 million for capital expenditures in environmental protection in 2000, of which we only actually spent € 183 million. This was due to our in-process environmental protection measures bearing fruit. Around 40 percent of capital expenditures went into centralized facilities while the remaining 60 percent was spent on decentralized measures.

Annual operating expenses for environmental protection are considerably higher than capital expenditures. The former came to € 1 billion in 2000. In other words, we spend almost € 3 million every day alone on operating environmental protection facilities.



We were nonetheless able to achieve savings of around € 100 million on our Target 2000 of € 1.1 billion. Operating expenses have thus remained at a 1990 level.



Environmental protection costs are influenced by country-specific factors such as differences in purchasing power. Despite such restrictions, specific environmental protection expenditure in Latin America is at around the same level as in Europe and North America. We see this as a result of our voluntary commitment to achieve comparable standards worldwide. Values in Africa and Asia can deviate from the norm for localized reasons: in Africa, the costs are affected by the production structure peculiar to that continent. Our 50-percent affiliate Chrome International South Africa Ltd., in which we have concentrated all our previous worldwide chrome activities, registers particularly high production volumes. This explains why in Africa environmental protection costs per ton of sales product are lowest. In Asia most sites are still in the process of being built.

Environmental protection expenditure in 2000

	Africa	Asia, Australia	Europe	Latin America	North America	Total Group
Environmental protection expenditure (€ million)	6	19	827	25	267	1,144
Environmental protection expenditure (% of total Group expenditure)	1	2	72	2	23	100
Specific environmental protection expenditure (€/t sales product)	12	35	75	78	86	74

Health protection

Occupational medicine is a branch of medicine concerned with the interaction between work and health. Its aim is to help promote and maintain the physical, mental and social well-being of workers in their occupations and to prevent work-related damage to health. It is also intended to ensure that workers are assigned to occupations for which they are physiologically and psychologically suited. The company's occupational physicians have a supervisory, advisory and supportive function in all aspects of health protection, occupational medicine and environmental medicine. The legislation on occupational safety defines this function as additionally encompassing preventive health protection in the workplace, an aspect that includes identifying potential hazards: inspecting facilities and workplaces, and recommending or mandating suitable protective measures, prevents incidents. Other tasks include early detection of work-related disorders through regular screening by specialists in occupational medicine.

Occupational diseases at production sites

	Africa	Asia, Australia	Europe	Latin America	North America	Total Group
Cases acknowledged in 2000	2	3	86	7	32	**130**
Acknowledged cases per 1,000 workers	2.0	0.4	1.3	1.2	1.4	**1.3**

Occupational diseases are conditions which workers develop as a result of their employment activities. An occupational disease can develop if a worker is exposed to chemical, physical or biological factors at the workplace. Chemical substances such as asbestos can cause asbestosis and cancer; benzidine can cause bladder cancer. Chemical exposure can also lead to skin diseases (allergies). Certain metals and noise may also be the cause of occupational diseases.

We have recorded data on occupational diseases worldwide. In Germany, we adhere to the Occupational Diseases Ordinance: suspected cases of occupational disease are reported to the statutory accident and occupational disease insurers for evaluation and, where appropriate, compensation. However, because few other countries have comparable systems, we additionally draw on other criteria to identify potential occupational diseases.

In 2000, worldwide 130 cases of occupational disease were acknowledged in the Bayer Group. The figure for Bayer AG was 78, of which 31 were associated with at least a 20 percent reduction in the individual's fitness for work. Some of the cases acknowledged in 2000 as occupational diseases derive from exposure which occurred decades ago. We found that the most common causes of disease were exposure to noise and asbestos. In the past asbestos was used at Bayer in heat-insulating materials and seals and in the form of asbestos cement in building slabs and other construction materials. However, in recent years, other materials have been used in place of asbestos, so no new cases are now likely to develop. Sources of noise exposure have also been eliminated. Equipment has been enclosed or replaced by low-noise systems. In workplaces where there is still noise exposure, employees are provided with personal protection equipment (ear protectors) and are monitored regularly by occupational physicians.

We documented the incidence of occupational diseases per worker on a regional basis for comparison of distribution. This really ought to have been done on the basis of the number of people employed at the time of exposure; we based our survey on the current number of workers. Because we employed considerably more people in the past, the figures generated are too high overall. Occupational diseases are unlikely to occur in Asia because of our relatively short period and superficial level of involvement in that region in the past. We expect the incidence of occupational diseases to decline in the future because of our commitment to continuous improvement in the conditions in which our people work.

Safety

Occupational safety

Industrial injuries to Bayer staff at production sites						
Injuries leading to days of absence	1,920	1,534	1,191	954	1,285	979*
Fatal injuries	1	3	3	2	3	3*
* total for Group	1990	1992	1994	1996	1998	2000

We have been able to reduce industrial injury figures over the past decade by more than 50 percent through training, investment and continuous dialog with our staff. We are looking to continue this positive trend. By 2004 we hope to have halved injury figures again.

Industrial injuries at production sites				
Industrial injuries (Bayer Recordable Incident Rate) to Bayer staff	number	1,285	1,190*	979*
Industrial injuries per million hours worked (MAQ)	number/mill. h	6.4	5.2*	4.2*
Industrial injuries (Bayer Recordable Incident Rate) to subcontractor staff	number			349
Industrial injuries to subcontractor staff per million hours worked	number/mill. h			10.4
Days of absence due to industrial injuries (Bayer staff)	number	15,557	15,802*	14,837*
Days of absence of Bayer staff per million hours worked	number/mill. h	78	69*	64*
Days of absence due to industrial injuries (subcontractor staff)	number			4,706
Days of absence of subcontractor staff per million hours worked	number/mill. h			140
Fatal industrial injuries to Bayer staff	number	3	3	3
Fatal industrial injuries to subcontractor staff	number	2	0	1
* total for Group		1998	1999	2000

From 1990 to 1996 we recorded notifiable injuries leading to more than three days of absence all over the world. Since 1998 we have recorded accident statistics according to stricter criteria. The Million Working Hour Quota (MAQ) serves as the yardstick, comprising the number of industrial injuries for every million working hours performed. A Bayer Recordable Incident is defined as such when an employee is given a doctor's certificate as a result

→ Table of contents

of an accident and is absent for at least one day. The day of the accident does not count.

Injuries are recorded irrespective of whether there is a legal obligation to notify the authorities in the country concerned. The advantage of this change in the accident reporting procedure is that it enables comparison to be made on an international scale. Compared with 1998 we have managed to reduce the MAQ by 20 percent and at the same time the number of days of absence by 1,330, which corresponds to a reduction of nine percent.

The United States has the lowest injury rate. There, not even half as many injuries occur per million hours worked as on average in the Group, which is the result of a particularly strong safety culture. It is our aim to at least halve the Group MAQ and the total of accident-related days of absence by 2004, by adopting findings from the United States in other countries, for example.

Injury figures in 2000
(situation according to region)

	Africa	Asia, Australia	Europe	Latin America	North America	Total Group
Injuries at production sites	9	105	644	67	104	979*
MAQ at production sites	3.4	5.6	6.4	4.5	2.2	4.2*

* total for Group

Unfortunately, there were three fatal accidents in 2000. In both Great Britain and Morocco, an employee died in a traffic accident during a business trip. In Leverkusen a DyStar employee died as a result of an explosion. At the Krefeld-Uerdingen site an employee of one of our subcontractors died as a result of injuries suffered following a fall during installation work.

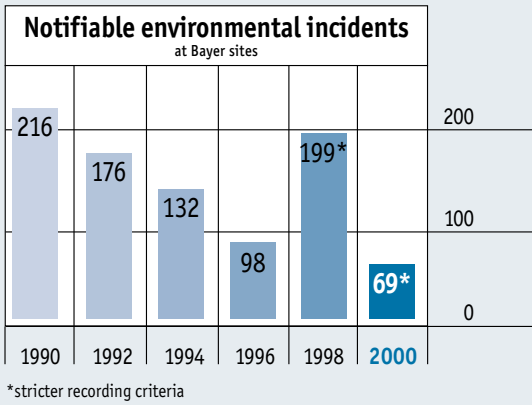
For many years now typical chemical injuries have made up only a small proportion of the notified injuries. Bayer AG's staff have been involved more in commuting accidents than in occupational ones. We are therefore looking to further improve the general safety attitudes of our employees, including on the road.

Injury figures for the subcontractors employed at Bayer have been higher over a similar period. We therefore want to work with our subcontractors to reduce this number of injuries by 50 percent by 2004.

Process and plant safety

Plant safety and notifiable incidents				
Precautionary information for neighborhood community published	number of sites	56	58	84
Notifiable environmental incidents	number/a	199	68	69
Incidents causing damage	number/a	13	6	7
		1998	1999	2000

Safety is a top priority at Bayer – and plant safety in particular. Chemical facilities can operate successfully only if the plants and processes are safe and reliable. And safety and reliability can be ensured only by taking the necessary organizational measures to ensure that people and the environment have optimum protection against risks that can emanate from production facilities. One of the ways we do this is to make sure our processes and plants are designed with this in mind.



*stricter recording criteria

At Bayer, we have established systematic methods to ensure that our processes and production plants are designed with safety as the governing principle. Our Directive and our Handbook on Process and Plant Safety have embodied this principle as an integral part of our safety management system for more than 15 years. Consistent application of these principles and methods has resulted in the high standards we have achieved – standards we will raise through continuous improvement. The significant drop in the number of notifiable environmental incidents in the last ten years – despite the fact that the criteria have become stricter – is proof of our commitment to safety, as is the reduction in the number of injuries documented in the previous section. Occupational safety for our employees goes hand-in-hand with exemplary process and plant safety.

By proceeding thoroughly and systematically at all stages in the life of a product or production plant, and combining with this the vast experience collected over many years, we can minimize the likelihood of major incidents occurring (like the most recent one in Wuppertal in 1999). We even use incidents of no dramatic negative consequence to review our procedures and make further improvements to our technical or organizational set-up. That is what continuous improvement is all about.

The Process and Plant Safety Department, together with Bayer AG's Technical Inspection Department, makes its expertise available to all sections of the company whenever and wherever needed. The 90-member Technical Inspection Department, with its externally recognized experts, is responsible for the safety, optimum design, ongoing monitoring and regular inspection of chemical plants and apparatus such as reaction boilers and pressurized tanks. With their specialized knowledge of chemical requirements, the members of this department are in an ideal position to advise on the scope of the testing procedures and the time schedules involved.

→ Table of contents

The Process and Plant Safety Department has 50 employees who ensure that

- suitable methods and tools are provided for systematic safety checks and that they are constantly updated in accordance with the very latest findings,
- reliable safety data are determined and evaluated, e.g. in the laboratory certified to ISO 17025,
- experts are available who can also deal with difficult safety matters.

In 2000, these experts supervised 2,084 measurement projects aimed at minimizing the risk of explosion within Bayer AG's plants alone. 181 plants took advantage of the department's consulting and support services.

According to the annual report from the major incidents officers, 530 comprehensive safety checks were carried out at Bayer AG alone in accordance with our Directive on Process and Plant Safety.

Safety experts in the affiliated companies – for example, the 20 or so colleagues at our American subsidiary, Bayer Corporation in Pittsburgh – and in Bayer AG's various operating divisions provide necessary on-site support. They follow the same principles and methods as the specialist departments at Bayer AG and, wherever necessary, can call on their help. Our success is evident in Bayer Corporation being ranked by the American Chemistry Council for two consecutive years (1999 and 2000) as the second safest large chemicals company in the United States.

Protecting people and the environment from risks that can emanate from production facilities is not necessarily guaranteed merely through the safe operation of the plants. Precaution must be taken to ensure that "nothing happens if something happens."

For this reason, our major production facilities have their own fire departments and own emergency physicians and medical staff on site. At the smaller sites, fire safety and first aid are integrated into the local infrastructure through cooperation with the local fire department, hospitals and physicians.

All the elements of a wide ranging and efficient emergency response are described in the alarm and emergency response plans such as those specified for the EU by the Seveso II Directive.

The status of our process and plant safety organization and of our incident management system is constantly featured in our dialog with the people living in the neighborhood of our production sites. We regularly organize, for example, an Open House to show the public our production plants and fire department, our environmental protection and safety systems and the measures we take to train our staff.

Transport safety

In 2000, the total volume of sales products, raw materials and solid waste transported worldwide under the responsibility of the Group was approximately 28 million metric tons. Around a half of this was transported under the auspices of Bayer AG. Hazardous goods accounted for 51 percent in the Group and 46 percent at Bayer AG.

While the majority of the goods are still transported by road, 4.7 million metric tons are conveyed by pipeline, thereby avoiding public transport routes.

All the means of transport, e.g. tankers and containers, and packaging, e.g. drums, cans, boxes and sacks, have been tested and approved for the relevant form of transport.

Within Bayer AG in 2000, there were 72 company-owned road vehicles (vans, small trucks, multi-bucket trucks, low-loading lifting vehicles, road tankers, mixed cargo trucks, rail-road vehicles, etc.) as well as 17 Bayer-owned and 641 rented rail tankers currently in service. At Bayer AG in 2000, there were seven hazardous goods officers, 434 assisting personnel and 164 people with other responsibilities (e.g. drivers). In 2000, 142 of the assisting personnel as well as newly hired employees were trained or retrained. In addition, special training courses were held on specific aspects of hazardous goods transport.

The facilities Bayer has for handling goods include:
- Port facilities
- Railway freight facilities
- Bulk and part-load handling centers, and
- Filling units for liquid-carrying containers.

In the event of a transport incident in Germany, Bayer's hazardous goods officer submits an accident report. Nine notifiable incidents occurred which came under the responsibility of Bayer AG in addition to some that fell under the responsibility of third parties. As far as the Bayer Group is concerned, reports were compiled on the incidents listed in the table according to CEFIC criteria.

Transport data* for the Group in 2000
(mill. t/a)

Goods conveyed	**28.2**
● Non-hazardous goods	13.7
● Hazardous goods	14.5
Means of transport	28.2
● Road	10.7
● Rail	3.9
● Internal waterways	6.5
● Sea	2.3
● Air	0.03
● Pipeline	4.7

* listing according to CEFIC guidelines, data for USA incomplete

Transport incidents* in the Group in 2000
(number)

Total number of transport incidents	**33**
● Road	26
● Rail	2
● Internal waterways	2
● Sea	2
● Air	1
● Pipeline	0
Total number of transport incidents involving chemical leakage	**26**
● Road	21
● Rail	2
● Internal waterways	2
● Sea	0
● Air	1
● Pipeline	0

* listing according to CEFIC guidelines, data for USA incomplete

Environment

Production

Most key environmental indicators depend on one base parameter: the production volume to sale. Generally speaking the more that is produced, the more resources that are consumed and the higher the emissions. Thanks to intelligently designed production processes, however, we have once again been able to increase resource productivity and at the same time reduce specific emissions.

When defining our Targets 2000 in 1996 we assumed an increase in our total production volume of 36 (=136 %) percent taking 1990 (=100 %) as the base year. We have exceeded this expectation considerably: the tonnages produced in 2000 were in fact 52 percent higher than in 1990.

Only a small percentage of this increase can be attributed to acquisitions. The sites acquired from the American Lyondell Chemical Company in 2000, for example, were responsible for an increase of only around four percent. The difference made by the additional sites covered by BAYSIS™ compared with 1998 is even less significant. An increase has thus been achieved in real terms.

Total production volumes to sale in 2000
(situation according to region)

	Africa	Asia, Australia	Europe	Latin America	North America	Total Group
Number of production sites	10	56	71	27	42	**206**
Production volume (million metric tons)	0.49	0.54	11.1	0.32	3.1	**15.5**
Proportion of production (%)	3	3	71	2	20	**100**
Change in volume compared to 1998 (%)	– 9	+ 80	+ 13	– 12	+ 43	**+ 18**

Bayer's Western European sites continue to be the top producers: eleven million out of Bayer's total production volume of 15.5 million metric tons are manufactured in Western Europe. The increase in production in this region has mainly been recorded at Bayer's German sites. These produced almost one million metric tons more sales product in 2000 than in the previous year, an increase of almost a quarter. This compensated for losses through divestitures and sales of companies. The contribution to growth of our sites in France, Italy and Spain was also above average.

Our North American sites too produced around one million metric tons more sales product in 2000 than in 1999. This increase was primarily due to the expansion of the sites in Addyston, Ohio, Baytown, Texas, and Sarnia, Ontario, and acquisitions in South Charleston and Institute, West Virginia, Channelview, Texas, and Sheffield, Massachusetts. Production volumes in Latin America, however, fell again slightly, owing to further streamlining of our production.

The highest growth in relative terms was recorded in Asia. This was due mainly to the fact that we have recently expanded our activities in this region by a considerable degree. Production volumes in Thailand, where we have significantly expanded our Map Ta Phut site, have practically doubled, as have the figures for India through acquisitions and for China through the start-up of new production sites.

Sustainable raw materials

Wherever it makes economic and ecological sense, we use sustainable raw materials, provided that the products manufactured from them meet our quality standards. There are, however, limits to how widely these natural substances can be used. It makes no sense, for example, to produce a biofuel if its manufacture or transport would require the consumption of more fossil fuels than would have been saved.

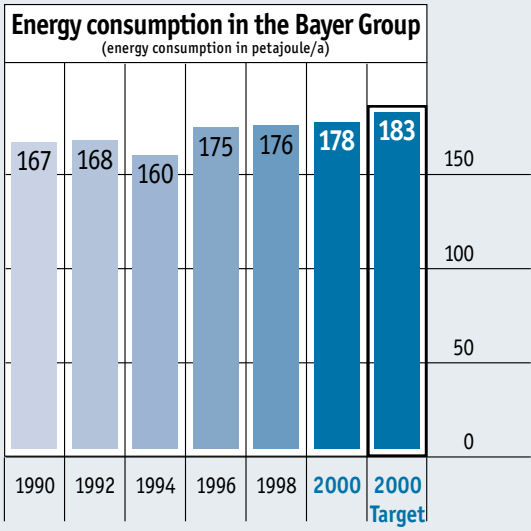
Our table gives examples of important fields of application for sustainable raw materials.

Use of sustainable raw materials

Business Group	Substance group/Use
Pharmaceuticals	Sugar, starch and alcohol of plant origin as pharmaceutical formulating aids
Crop Protection	Starch for the formulation of crop protection agents
Consumer Care	Fruit for the formulation of pesticides
Polyurethanes	Sugar for the production of high-grade polyurethane insulating materials
Specialty Products	Oils and fats as auxiliaries for the manufacture of coatings, textile raw materials and leather processing chemicals
Basic and Fine Chemicals	Molasses as reducing agents
Wolff Walsrode	Cellulose as a starting product for the manufacture of film and methyl cellulose, a thickener, for example, for cement manufacture
Haarmann & Reimer	Fruit, sugar and plant extracts for the manufacture of aromas and flavors

Energy

Despite increasing production volumes, our worldwide energy consumption has hardly grown since the middle of the 1990s. This good news is the result of both a significant increase in our energy efficiency and the application of the latest technology, for example for energy supply in Baytown, Texas. In Dormagen meanwhile, we replaced the lignite power station with a modern combined cycle plant, which has been on stream since the middle of 2000. Combined cycle plants are among the most efficient generators of energy, enabling almost 60 percent of the energy contained in natural gas to be converted into electricity, while coal-fired power stations have an efficiency of only around 40 percent. In addition, we have converted most of our chlorine production units to the energy-saving membrane technology. In the United States too we have launched an energy saving program. In absolute terms, however, our energy consumption there has risen, caused primarily by the expansion of some sites, in particular Baytown. Similarly, in Asia expansions will continue to cause the energy requirement to rise.



Energy consumption in the Bayer Group
(according to type of energy)

Natural gas	petajoule/a	86	81	75	81	74	71	82
Liquid fuels	petajoule/a	9	15	15	9	9	5	12
Coal	petajoule/a	25	24	18	20	21	17	20
Electricity purchased	petajoule/a	25	25	28	31	35	39	33
Waste heat utilization e.g. in waste incineration	petajoule/a	19	20	21	22	23	21	25
Steam purchased (ext. supplier)	petajoule/a	3	3	3	11	14	24	11
Specific energy	% of 1990	100	99	89	90	82	70	81
	Unit	1990	1992	1994	1996	1998	2000	2000 Target

Overall, we have been able to reduce our specific energy requirement by 30 percent compared with our base year of 1990. That means that to produce one ton of product we use almost a third less energy than we did a decade ago, testimony to our efforts to achieve greater energy efficiency.

Our energy requirement of 178 petajoules (1 petajoule = 1 thousand trillion joules = 10^{15} joules) is significantly below our forecast for 2000 of 183 petajoules.

There are only two areas in which we have not been able to achieve our Energy Targets 2000. Increased production and a restructuring of our energy supply have caused us to purchase more electricity and steam from external sources than we had forecast.

Energy consumption in 2000
(situation according to region)

	Africa	Asia, Australia	Europe	Latin America	North America	Total Group
Energy consumption (petajoule/a)	2	4	123	4	45	**178**
Energy efficiency (gigajoule/t)	4	7	11	13	14	**11**

As would be expected, Europe and North America require the most energy, as they are where most of our production takes place. In Asia, the energy requirement will rise significantly in the next few years owing to the expansion of a number of sites. Africa is a special case in that it has the lowest specific energy requirement owing to the production structure peculiar to our South African sites, which focus exclusively on the extraction and processing of chrome ore.

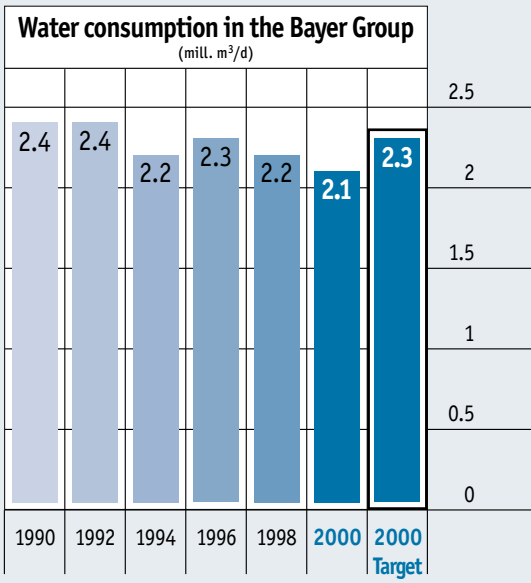
Our aim is continuous improvement in energy efficiency.

Water balance

Water is a valuable commodity that in many countries is not available in sufficient quantities to meet the needs of the population. Already one in three people lives in an area of water shortage. We have therefore set ourselves the target of handling this resource as sparingly as possible all over the world and minimizing our impact on water availability.

In spite of considerable increases in production volumes, our water consumption fell further in 2000. Our daily worldwide water requirement was 2.1 million cubic meters, 0.2 million less than our Target 2000.

As in the past, most of the water we use, about 1.7 million cubic meters per day (Target 2000: 1.9 million per day), is needed for the cooling of our power stations and production plants. Since cooling water remains in closed pipeline systems and is therefore not contaminated, it can be used several times or discharged directly into the receiving waters on site after monitoring.



Water consumption in the Bayer Group
(incl. Chemical Park partners) according to type

Total water consumption	mill. m³/d	2.4	2.4	2.2	2.3	2.2	2.1	2.3
Cooling water	mill. m³/d	2.1	2.0	1.9	1.9	1.8	1.7	1.9
Process effluent and sanitary wastewater	mill. m³/d	0.35	0.33	0.32	0.35	0.35	0.32	0.38
Specific wastewater volume	% of 1990	100	98	87	81	74	58	70
	Unit	1990	1992	1994	1996	1998	2000	2000 Target

Some 15 percent of the water we require goes into production or sanitary applications. Despite an increase in production, this volume has also considerably dwindled. To manufacture one ton of sales product we now need 40 percent less water than we did ten years ago. Our figures also include the wastewater volumes of our Chemical Park partners so Bayer actually consumes less than the figures suggest.

→ Table of contents

Our African sites have the lowest water consumption and thereby the lowest wastewater volumes. Owing to the shortage of water almost everywhere in that region we have primarily set up production units there that require little water and thus generate insignificant volumes of wastewater.

Wastewater volumes in 2000
(situation according to region)

	Africa	Asia, Australia	Europe	Latin America	North America	Total Group
Process effluent and sanitary wastewater volume (mill. m^3/d)	0.0003	0.010	0.21	0.007	0.089	**0.32**
Process effluent and sanitary wastewater per t sales product (m^3/t)	0.22	6.8	6.9	8.0	10.5	**7.5**

Water pollution control

We have made continued advances in minimizing the pollutant loads contained in our wastewater.
The further reduction in the sum parameter **Chemical Oxygen Demand (COD)** is primarily the result of a number of improvements to our units and treatment processes. In total, we have reduced the COD load of our wastewater by 58 percent since 1990, a result which has also been aided by changes to the product portfolio.

COD, AOX and salt loads in wastewater

COD	thou. t/a	77	74	66	57	48	32	48
AOX	t/a	200	150	130	128	112	73	95
Salts	mill. t/a	1.4	1.3	1.3	1.2	1.4	2.0	1.5
	Unit	1990	1992	1994	1996	1998	2000	2000 Target

We have also considerably exceeded our own target for 2000 with respect to the sum parameter **Adsorbable Organic Halogen Compounds (AOX).** Instead of the expected 95 metric tons AOX we discharged only 73 metric tons into receiving waters. Compared to the 200 metric tons recorded in the base year 1990 this is a reduction of almost two thirds.

We expect a further reduction in specific emissions of COD and AOX, albeit a smaller one compared to previous years.

Our knowledge to date on discharges of dissolved inorganic salts has proven to be deficient. Figures for salt loads are higher than originally thought. Since 1990 salt discharges from Bayer AG's sites and from the Chemical Parks, for example, have risen owing to increases in production volumes. In the past two years the salt load in the wastewater of our American site Baytown has increased by 0.2 million metric tons and that of our European site Antwerp by just under 0.1 million metric tons. The total salt load of the Group was around two million metric tons in 2000, a large proportion of which is discharged into coastal waters. Owing to increases in production volumes we have therefore failed to meet the Target 2000 of 1.5 million metric tons.

Heavy metals

Heavy metal discharges into receiving waters (t/a)							
Cd (cadmium)	0.3	0.3	0.1	0.2	0.2	0.2	0.2
Cr (chromium)	30	25	10	9	9	6.2	7
Cu (copper)	18	17	12	13	11	12	13
Hg (mercury)	0.07	0.07	0.04	0.05	0.05	0.08	0.05
Ni (nickel)	13	13	9	10	9	7	9
Pb (lead)	4	4	4	3	3	2	3
Sum of heavy metals	65	59	35	35	32	27	32
	1990	1992	1994	1996	1998	2000	2000 Target

As impurities of natural raw materials such as oil, coal and ores, many of our heavy metals are recycled back into production. In addition, a number of heavy metals are present in our production wastewater in such small traces that they can no longer be detected analytically. They are nonetheless still recorded in our balance sheet of heavy metal emissions because we make assumptions for residual concentrations for readings below the detection limit. In total, the heavy metal load of our wastewater in 2000 was more than 50 percent down from our 1990 level.

Chromium emissions fell from 30 metric tons in 1990 to 6.2 metric tons in 2000 (Target 2000: 7 metric tons). The restructuring of our chromium activities had a positive effect here.

Cadmium can no longer be detected in most of our wastewater streams.

Since we are converting our chlorine manufacturing facilities in Germany to the mercury-free membrane technology, our mercury output will fall considerably in the medium term (by more than 50 percent). Because of the ongoing conversion, however, our emission target for 2000 was not attained.

In addition to the heavy metals cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni) and lead (Pb), three new metals have recently been included in our worldwide monitoring system, namely arsenic (As), tin (Sn) and zinc (Zn). In 2000, the Group discharged 0.7 metric tons of arsenic, two metric tons of tin and 14 metric tons of zinc into receiving waters. Zinc emissions compared with 1998 were halved and the arsenic discharge remained at its previous low level. For tin we have no meaningful data for comparison.

Nutrients

Nutrient discharges into receiving waters (thousand t/a)							
Total phosphorus	3.0*	1.9*	1.6*	1.6*	0.8*	0.8	0.8*
Ammonium nitrogen	7.5	4.0	3.0	3.5	1.0	1.3	3.2
Nitrate nitrogen	6.7	5.8	6.4	7.7	5.1	2.1	7.1
Nitrogen in ammonium and nitrate	14.2	9.8	9.4	11.2	6.1	3.4	10.3
Nitrogen and phosphorus wastewater loads	17.2	11.7	11.0	12.8	6.9	4.2	11.1
* improved data recording	1990	1992	1994	1996	1998	2000	2000 Target

Phosphorus is not present in wastewater in its elementary forms but primarily as phosphate or in organic compounds. Phosphates are nutrients for algae and other aquatic plants. In surplus amounts they cause an overfertilization of water systems (eutrophication).

The improved standard of our data recording systems has made corrections necessary for our total phosphorus emissions. Our actual Group phosphorus emissions in 1990 were around twice as high as originally calculated in 1995 i.e. 3,000 metric tons and not 1,600 metric tons. By various strategies we have since reduced the phosphorus load in our wastewater by three quarters. We have both lessened the use of phosphorus compounds and applied various methods to prevent phosphorus from entering receiving waters such as precipitation with iron and aluminum salts.

At Bayer AG's sites we were able to reduce phosphorus emissions by nearly 90 percent between 1990 and 2000. On the other hand, these emissions rose significantly at our U.S. subsidiary, Bayer Corporation, because of large increases in production volumes.

The ammonium nitrogen found in our wastewater has two sources: our production units and our biological treatment plants, where it forms during the degradation of organic nitrogen compounds. Since 1990 we have been able to reduce ammonium discharges by around 85 percent from 7,500 metric tons to 1,300 metric tons. We have achieved this with a nitrification process whereby the ammonium is oxidized to nitrate by special bacteria known as nitrificants.

Like phosphorus, nitrate helps the growth of water flora and may cause eutrophication in unfavorable circumstances. Therefore it is not sufficient just to turn ammonia into nitrate; nitrate itself must be removed from the wastewater. We have achieved this at the Leverkusen site, for example, by changing the functional operation of the wastewater treatment plant. Treated wastewater rich in nitrates is mixed with fresh wastewater from production, which contributes the easily biodegradable carbon compounds required for the bacterial degradation of nitrate (denitrification). A second nitrification/denitrification stage in this treatment plant should reduce the nitrogen load by a further 130 metric tons per year.

Air pollution control

Gases of relevance to the climate

The Kyoto Protocol of the United Nations Framework Convention on Climate Change specifies, among other things, the reduction of greenhouse gas emissions. Greenhouse gases are gases suspected of having an effect on the Earth's climate. Carbon dioxide here serves merely as a reference substance. One metric ton of laughing gas has 310 times as much Greenhouse Warming Potential (GWP) as carbon dioxide. "Kyoto gases" other than those listed in the table do not contribute significantly to Bayer Group emissions.

Greenhouse potential of gases of relevance to the climate according to Kyoto Protocol
(GWP*)

Carbon dioxide	1
Laughing gas	310
1,1,1,2-tetrafluoroethane	1,300

* GWP = Greenhouse Warming Potential; GWP indicates how many times greater the supposed effect on the climate is than that of carbon dioxide. The greenhouse gas equivalent of an emission is calculated by multiplying the amount emitted by the GWP factor.

Gases of relevance to the climate according to Kyoto Protocol

Carbon dioxide*	mill. t/a	10.1	10.5	9.4	9.6	9.6	9.2	9.6
Laughing gas	thou. t/a	15.9	16.0	14.7	5.7	2.7	1.5	
1,1,1,2-tetrafluoroethane	t/a	–	–	–	45	45	33	
CO_2 equivalents of gases of relevance to the climate	mill. t/a	15.0	15.5	14.0	11.4	10.5	9.7	
*without CO_2 equivalents from purchased electricity and steam	Unit	1990	1992	1994	1996	1998	2000	2000 Target

For the Bayer Group, our aim was to decrease carbon dioxide emissions to 9.6 million tons by 2000. In spite of increases in production, acquisitions and launches of new production sites we have achieved this, the reduction in fact being to 9.2 million metric tons. Our objective now is to identify further ways of reducing emissions of climate-relevant gases in the Group. At Bayer AG, emissions of the climate-relevant gases carbon dioxide and laughing gas (dinitrogen monoxide), calculated as greenhouse gas equivalents, fell by almost half between 1990 and 2000 (owing to improved chlorine manufacture through the introduction of the energy-saving membrane technology, optimization of other production plants and the start-up of a combined cycle power plant).

We have determined conventional laughing gas emissions using production data on adipic acid, hydroxylamine and nitric acid and for power stations. The discharge of laughing gas from our wastewater treatment plants still needs to be considered. The gas is released as a by-product of the nitrification and denitrification processes we apply. Most of the main sources of laughing gas have been eliminated in the last few years, for example the laughing gas emissions from adipic acid production, which are now decomposed thermally.

Methane (GWP = 21) does not have quite the enormous Greenhouse Warming Potential of laughing gas. If the amount of natural gas we consume as a primary energy source is taken into account, these emissions are insignificant. Around 33 metric tons are released every year via the known sources.

→ Table of contents

Volatile organic compounds

We have also more than met the Target 2000 for emissions of volatile organic compounds, summed up as the standard parameter VOC. Although we had already achieved substantial improvements in previous years, we were still able to reduce emissions further in the most recent period under review.

Volatile organic compounds							
VOC (thousand t/a)	24.5	20.6	17.4	14.0	14.0	9.1	9.6
BTXE (benzene, toluene, xylene, ethylbenzene; t/a)	929	780	748	266	215	170	
ABS (acrylonitrile, 1,3-butadiene, styrene; t/a)	649	685	540	373	440	443	
Important organic chlorine solvents (chloromethane, dichloromethane, trichloromethane, tetrachloromethane, 1,2-dichloroethane; t/a)	2,201	1,742	1,606	2,167	1,391	628	
	1990	1992	1994	1996	1998	2000	2000 Target

Our knowledge of the release of volatile organic substances has been systematically increased in the past few years through the introduction of new measuring programs. As a result, values for some of these pollutants appear to have been particularly high in previous years. Despite these more complete records, we have significantly improved our balance sheet compared with 1990. BTXE emissions, for example, fell by over 80 percent. Our goal is to decrease emissions of acrylonitrile, 1,3-butadiene and styrene by a further 45 percent to 250 metric tons per year by 2004. We have also been able to reduce emissions of organic chlorine solvents significantly.

Particulates

In the period up to 1998 we were able to reduce particulate emissions continually by way of both technical improvements and restructuring measures. A true comparison would indicate that we have also achieved our target for particulates since, the higher value given being due to a newly acquired site. We nonetheless expect to achieve our target by 2002.

Particulates (thousand t/a)	2.8	2.3	1.8	1.7	1.3	1.9	1.6
	1990	1992	1994	1996	1998	2000	2000 Target

Volatile inorganic compounds

Important inorganic emissions (thousand t/a)							
VIC (without CO_2, CO, NO_x, SO_2)	1.7	1.4	1.3	1.4	1.3	1.1	1.3
Sulfur dioxide (SO_2)	20.6	21.6	14.3	9.9	7.7	6.6	10.0
Nitrogen oxides (NO_x, without N_2O, calculated as NO_2)	18.4	17.6	15.1	12.1	12.2	11.2	12.0
Carbon monoxide (CO)	13.7	10.9	9.2	11.4	9.3	3.8	9.5
Sum of above parameters	54.4	51.5	39.9	34.8	30.5	22.7	32.8
	1990	1992	1994	1996	1998	2000	2000 Target

Sulfur dioxide emissions have also been reduced. This achievement is thanks to in-process innovations and the conversion of our power stations to low-sulfur fuels. Reductions have been particularly marked at our sites in Germany, Belgium and France. Mainly by replacing older plants we aim to decrease sulfur dioxide emissions by a further 25 percent by 2004.

An almost 40 percent drop in nitrogen oxide emissions (NO_x, e.g. NO and NO_2) since 1990 is another positive result. This success has been primarily achieved at our German and Canadian sites. In other countries emissions have remained virtually the same. We expect to reduce nitrogen oxide emissions to 7,500 metric tons per year by 2004 through technical measures and divestitures.

Through the start-up of additional waste air treatment facilities we emitted around 70 percent less carbon monoxide into the atmosphere in 2000 than we did in 1990, only 3,800 metric tons in fact. This means that here too we significantly bettered our target (9,500 metric tons).

The figures show that, with a few exceptions, we are achieving uniformly high standards all over the world. Primarily responsible for the increased emissions in Latin America is a newly acquired site. We aim to have improved this situation by 2002.

Specific emissions into the air in 2000
(situation according to region)

	Africa	Asia, Australia	Europe	Latin America	North America	Total Group
Carbon monoxide (kg CO/t sales product)	0.2	0.7	0.2	1.9	0.3	**0.2**
Nitrogen oxides (without laughing gas, kg NO_X/t sales product)	0.2	0.2	0.8	1.3	0.7	**0.7**
Sulfur dioxide (kg SO_2/t sales product)	0.2	1.7	0.3	2.2	0.5	**0.4**
Volatile organic compounds (kg VOC/t sales product)	0.0	0.2	0.5	0.9	1.0	**0.6**

Waste management

The best waste management is to not produce waste in the first place. While we are committed to this idea, it obviously has its limits. Our figures nonetheless show that we are successful with our disposal concept: prevent, reduce, recycle. We have managed to reduce our waste volumes worldwide from 2.4 million metric tons in 1990 to 1.8 million metric tons in 2000 (Target 2000: 2.1 million metric tons). This is a reduction of a quarter. The fact that waste volumes fell while production volumes grew is a testimony to our improved resource productivity.

Solid waste volumes

Total waste (including recycled waste and waste from external sources)	mill. t/a	2.4	2.3	2.1	2.1	2.1	1.8	2.1
Waste from chemical production (Bayer)	mill. t/a	1.33	1.27	1.10	1.05	1.10	0.76	1.07
Other waste	mill. t/a	1.06	1.02	0.98	0.86	0.86	0.86	0.89
External waste (taken on by Bayer sites for disposal)	mill. t/a	0.02	0.02	0.04	0.14	0.11	0.15	0.14
Relative level of waste volumes	% of 1990	100	96	88	85	86	73	87
		1990	1992	1994	1996	1998	2000	2000 Target

Our data also include waste that is recycled into new products, in volume terms a third, and waste we dispose of for others, which is the case, for example, at Leverkusen and Belford Roxo (Brazil). This comprises just under 10 percent of our total waste volume. Our disposal capacities are now virtually utilized to the full. The capacities we now offer to third parties are increasingly reserved for waste whose disposal is particularly problematical. Here, the high standard of equipment in our plants and our special know-how are of particular benefit.

The main producer of waste is Germany – due to the high production volumes – followed by South Africa (recovery of chrome ore) and the United States. The waste volumes at Bayer AG have been reduced by 0.2 million metric tons in the past three years. Falling waste volumes in North and Latin America are also the result of sales of companies and closures.

We landfill about half of our waste. Approximately a third is recycled into new material while energy is recovered from more than half of the waste incinerated. Around a quarter of the waste is disposed of externally.

Final fate of waste
(% of solid waste disposed of)

	1996	1998	2000
Landfilled	47	50	47
Incinerated	17	14	19
Recycled	36	36	34
Disposed of externally	23	31	26