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Report on the Environmental Economy 2009

Fact & Figures for Germany






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EXECUTIVE SUMMARY

REPORT ON THE ENVIRONMENTAL ECONOMY 2009

EXECUTIVE SUMMARY

The Report on the Environmental Economy, presented here by the Federal Environment Ministry and the Federal Environment Agency, provides an overview of the structure and relevance of the environmental economy and the diverse aspects which characterise the interaction of environment, environmental policy and economy. The report is based on numerous research projects conducted over the past few years, and also draws on data and figures compiled by research institutes and statistical offices. Thus all the information is brought together for the first time in a clear and up-to-date report.

THE MARKETS OF THE FUTURE ARE "GREEN"

Green lead markets are characterised by high growth

Energy efficiency, sustainable water management, sustainable mobility, energy generation, resource and materials efficiency, waste and closed cycle management are all key green markets of the future. In 2005 they already represented a global market volume of nearly 1000 billion euro. Estimates indicate that turnover from these environmental industries will more than double by 2020, to 2,200 billion euro. The largest absolute increase in market volume for the period 2005-2020 can be expected in the fields of energy efficiency (+450 billion euro) and sustainable water management (+290 billion euro).

Driving forces behind these developments are global trends such as population growth, the rapid industrialisation of newly industrialising and developing countries, and the emergence in these countries of a middle class with buying power. These factors lead to increased demand for consumer goods and scarce environmental resources, putting more pressure on all industrial sectors to make greater use of environmental and efficiency technologies, and to develop them further.

On the green lead markets, German companies have global market shares of between 5 and 30 percent

Germany's environmental industry is booming. From 2004 to 2006, 4 out of 10 companies in the environmental sector increased their turnover by more than 10 percent annually. In future, the German environmental industry will profit considerably from the dynamic growth of green lead markets worldwide, since it is very well positioned in international competition on many of these markets. Germany shows particular strength in sustainable energy generation and in waste and closed cycle management. German companies in these sectors account for more than a quarter of the global market.

Environmental protection is gaining in economic importance

In 2007, environmental goods accounted for over 5 percent of industrial goods production in Germany. Between 2005 and 2007 alone the value of production increased by 27 percent. Renewable energies, process measuring and control technology products and electronic goods saw the highest increases.

SMEs are a major feature of the environmental economy. Around 60 percent of turnover in environmental goods is generated by companies employing less than 250 people. About half of the companies are in the services industry. Thus, not only industrial production, but also services are important for the environmental economy.

Rapid growth also has a positive impact on the employment market

Between 2004 and 2006, the number of jobs in companies which are active on green lead markets rose by 15 percent per year. Companies expect a 13 percent increase in personnel between 2007 and 2009. These remarkable growth rates confirm the role of environmental technologies as an engine for employment in Germany.

Businesses expect further growth in the environmental economy

Surveys indicate that companies in the environmental economy anticipate high growth in turnover over the coming years – especially in the emerging branches of renewable energies and regenerative raw materials. Rising turnover means that in the medium term environmental technologies will outstrip traditional industries such as machine engineering and vehicle manufacture.

German companies are world leaders in trade with environmental goods

With a share of global trade of over 16 percent, Germany has recently extended its lead further. The environmental economy makes a major and increasingly important contribution to Germany's overall strong position in global trade. Progressive environmental legislation plays an essential role in this increased importance: state incentives and regulations create demand for environmentally friendly products and technologies, and are a vital force behind environmental innovations.

In the environmental economy research is exceptionally frequent, intensive and continuous

In the environmental economy, more than 5 percent of the turnover was invested in research and development in 2004, a significantly higher share than the 3 percent earmarked for R&D in overall industrial production. Nearly 80 percent of production in the environmental sector is particularly research- and knowledge-intensive. Machine engineering, process measuring and control technology, electrical engineering, electronics and the chemicals, plastics and rubber industry are among the most important branches of this market. Qualification requirements for employees in the environmental economy are correspondingly high. 30 percent are graduates, compared to 20 percent in other sectors.

Nearly 1.8 million people work in the environmental economy – a new high

In 2006 around 4.5 percent of Germany's entire workforce owed their jobs to environmental protection, compared with less than 4 percent two years earlier. This is equivalent to 300,000 additional green jobs.

The true figure is even higher, since reliable data is still not available for many new fields such as ecotourism, environment-related insurance and integrated environmental protection.

Environmental protection is becoming increasingly important for the employment market. Key factors are the growth of renewable energies, rising exports of environmental goods and the boom in environmental services. In contrast, traditional environmental sectors such as waste disposal, water body protection, noise control and air quality control are playing a less significant role. Environmental protection looks set to remain an engine for employment in the years to come - as long as there is a progressive environmental policy which is geared towards innovation.

Germany spends a total of around 1.5 percent of its gross domestic product on environmental protection

The largest share of the nearly 35 billion euro is spent by the state and privatised public water and waste management companies. The manufacturing industry contributes only nearly 20 percent. From the mid-1990s, expenditures by the manufacturing industry for environmental protection (waste management, noise control, water body protection, air quality control) were in decline, but since 2000 they have stabilised at a lower level. Compared internationally, German trade and industry's share in environmental protection expenditure is rather low. On the other hand, Germany leads the way with regard to the share of GDP spent on environmental protection by the state.

Environmental protection is economically viable

The public debate often gives the impression that environmental protection is solely a cost factor. However, this is a short-sighted view. In the first place, on balance, investments in integrated environmental protection technologies often lead to substantial savings in operational costs, for instance through lower energy and materials consumption or reduced waste management costs. Secondly, environmental protection leads to lower costs arising for society as a result of environmental damage. The Renewable Energy Sources Act also makes this clear: savings from avoided environmental damage are already equal to the additional costs arising from the Act. In 2020, such savings are expected to be twice as high as the additional costs.

Use of environmental resources has been decoupled from economic growth, but the positive trend needs to continue

Environmental resources are indispensable for the economy. But reserves of energy, raw materials, water and land, as well as the environment's capacity to absorb pollutants, are limited. How we deal with this scarcity is a key question of sustainable management. In Germany, consumption of nearly all resources – with the exception of land use for human settlement and transport – has fallen in the past decade. Energy and raw materials productivity are moving in the right direction, but substantial improvements are still needed. Land use for settlement and transport continues to increase, although the rate has slowed somewhat in recent years. Air pollution, on the other hand, has fallen steadily since 1990. Germany has nearly met its climate protection commitment under the Kyoto Protocol. Further efforts must be made, however, to achieve the German government's more ambitious target of a 40 percent reduction in emissions by 2020.

More efficient management of environmental resources pays off for industry

Generally, the premise "more goods with less resources" must apply. Businesses benefit from taking material and energy costs into account. In the manufacturing industry, average material consumption costs are as high as 40 percent of gross production value, whereas wage costs only account for around 25 percent. While efficiency in production has certainly improved, considerable potential remains: in the long term, labour productivity has increased far more than energy and materials productivity.

Developments of energy consumption, CO_2 emissions and materials consumption in the production sectors paint a varied picture. In terms of energy consumption, energy-intensive sectors were particularly successful in improving efficiency – one of the reasons

why energy-intensive goods production was not moved abroad. CO_2 emissions from production fell due to greater energy efficiency and increased use of renewables. Furthermore, the structural transformation taking place in Germany, in particular the above-average growth in service industries, has eased the burden on the environment.

Social responsibility and environmental protection have become strategic factors of good corporate management

Today companies are facing new challenges: rapid economic globalisation, mega trends such as climate change, scarcity and rising costs of resources, and a growing pressure to justify their activities to the public. Companies which adapt early on to these mega trends and the expectations of society can be more successful: they have "first mover" competitive advantages, can reduce risks, raise social acceptance of their activities and secure the continued existence of their company. At the same time, these factors present major economic opportunities. A corporate strategy geared towards sustainability offers win-win-win solutions for the environment, society and economic success.

There are already a range of principles and guidelines aimed at promoting corporate social responsibility, for example the ten universal principles of the United Nations Global Compact, or the OECD Guidelines for Multinational Enterprises. A credible policy of sustainable management considers all areas and functions of business. Within their key business processes, companies need to develop innovative, economically viable and precautionary solutions for improving environmental protection and working conditions, and they must take society's interests into account. A systematic environmental management as a core element of a comprehensive sustainability strategy in companies is useful here. The European Eco-Management and Audit Scheme (EMAS) is particularly suitable for this.

Ecology will be the economy of the 21st century

Environmental policy makes the economy sustainable. In addition to innovation aspects, environmental policy also includes elements of industrial location, investment and employment policy. In the face of global economic, social and ecological challenges, ecology and economy are becoming more and more interlinked.

Environmental issues can no longer be separated from economic concerns. Traditional environmental policy, which only deals with problems after they occur, cannot overcome these challenges. Neither is it enough to rely on the market mechanism. For government also has an important task: to ensure that prices reflect the ecological truth and to create, with a mix of supply and demand policies, framework conditions which foster the development and dissemination of environmental innovations.

Modern environmental policy is characterised by precautionary action. Only this enables it to trigger technology leaps and push through innovations and sustainability. Such a policy provides incentives for modernisation and thus strengthens German industry's international competitiveness. At the same time it also considerably boosts investment and secures and creates jobs.

KEY TOPIC: CLIMATE PROTECTION

Climate change is the key challenge of this century

Like the growing scarcity of raw materials and fluctuating energy prices, climate change makes it necessary to develop a much more efficient and low-emission economic management. This can only be achieved if investments are steered in an ecological direction worldwide.

With its Integrated Energy and Climate Programme (IECP), adopted in Meseberg in 2007, the German government launched the most ambitious and comprehensive climate protection project in the history of the Federal Republic. The decisions will help to reduce greenhouse gas emissions by around 34 percent by 2020 compared to 1990 levels. A number of other measures make it possible – at moderate avoidance costs – to achieve the German government's 40 percent reduction target.

The Integrated Energy and Climate Programme (IECP) steers investments in an ecological direction

Through the Integrated Energy and Climate Programme, the Meseberg decisions will facilitate a rise in net investments of over 30 billion euro per year from the middle of the next decade. The package of 29 individual measures will create at least 500,000 new jobs by 2020 and raise gross domestic product by at least 70 billion euro per year.

The Meseberg Programme is an important basis for the ecological restructuring of capital assets in Germany. In the light of globally increasing demand for clean and efficient technologies, the long-term rise in primary energy prices, Germany's need to catch up on investment, and the economic recession, the time is now right for an offensive to promote investments and steer them in an ecological direction.

Climate protection pays off

Most investments for the efficient use of energy already pay off in microeconomic terms. Moreover, they are worthwhile because they help prevent fol-

low-up costs of global climate warming. Climate protection measures also ensure that German industry specialises at an early stage in innovative technologies, thus strengthening its excellent competitive position on the global market. Foreign trade can therefore be expected to further boost demand for German climate protection technologies. This export momentum could generate around 200,000 additional jobs between 2015 and 2030.

INTRODUCTION

The environmental economy has developed into an important sector of the German economy. Whether one considers the classic sectors of the waste and recycling industries and water management, or new fields such as renewable energy sources: more and more people are working in areas which are concerned with conserving the environment or which help us satisfy our needs in ways that are more nature friendly and less resource intensive. Competent opinions even indicate that in the foreseeable future environmental technologies could acquire greater economic importance than traditional core industries of the Germany economy.

This is the first Report on the Environmental Economy, and is published jointly by the Federal Environment Ministry and the Federal Environment Agency. It sets out to describe the environmental economy in all its complexity, and at the same time to present an empirical view of the many and various interactions between the environment and the economy. The report is based on numerous research projects commissioned in recent years by the Federal Environment Ministry and the Federal Environment Agency. It also makes use of facts and figures obtained from research institutes and statistical agencies. It provides the first clear and up-to-date summary of the wealth of information and its complex interactions.

The Report on the Environmental Economy presents a profound compendium of current data. The publication also aims to make the interactions between environment and economy accessible to an interested public in a clear and comprehensible form. In addition to setting out the bare facts, the Report on the Environmental Economy therefore gives explanations of scientific concepts, methods and terms that are essential for understanding this field.

INTERACTION OF ECONOMICS AND ENVIRONMENT

The facts show clearly that there has been a change in the relationship between economics and environment. For a long time economics and the environment were seen as having opposing interests – and not as what they really are: two sides of the same coin. Today there is a growing awareness of the fact that in the long term only actions and approaches that make environmental sense are also economically sustainable. It is also becoming apparent that environmental protection and acceptance of social responsibility by businesses ensure greater efficiency, greater innovative power and greater competitiveness. This does not mean that no conflicts exist between the environment and the economy. But the existence of tensions does not mean that they are totally irreconcilable opposites. This is impossible, since nature is the basis of all economic activity. The production of goods requires raw materials, production facilities use up land, and production processes pollute the environment with harmful substances that have adverse impacts on natural resources such as water, soil and air.

For this reason, the Report on the Environmental Economy also looks into the interrelationship between the economy and the environment. On the basis of up-to-date figures and research findings it describes how sustainable the economic activities of our society are. Sustainability means that the present generation must not satisfy its needs at the expense of future generations. Thus the principle of sustainability imposes a framework of economic limits on economic activity.

FOUR KEY AREAS – STRUCTURE OF THE REPORT ON THE ENVIRONMENTAL ECONOMY

The first part of the Report on the Environmental Economy, “Environmental Protection as an Economic Factor: Facts, Figures, Trends” explains what economic activities are covered by the environmental economy and why this is a cross-sectional industry. Its importance to the national economy is shown by means of indicators: How many people work in the environmental economy? What share of Germany’s exports does it account for? How has it developed over time? In its answers to these questions, the Report on the Environmental Economy makes use of a wealth of methodological and empirical knowledge and compiles the latest data currently available.

The first part also looks into the question of how important environmental protection is for the labour market in Germany, i. e. how many people are employed in the environmental economy and how the individual areas of employment have developed in recent years. The analyses make it clear that environmental protection is already a driving force in employment, and that new “green jobs” can be expected in the years ahead. Other topics are the amount and breakdown of spending on environmental pro-

tection and the various costs and benefits of environmental protection at the levels of the individual business and the national economy. This is because only an overall picture that takes into account not only the cost of environmental protection, but also its benefits, can arrive at an economically viable assessment.

The second part of the Report on the Environmental Economy focuses on "sustainable economic activity". It presents concepts and objectives of sustainability, and uses important indicators to measure the sustainability of German industry. These show the extent to which the country succeeds in containing the negative impacts of economic activity on the environment and making efficient use of natural resources. Because sustainable economic activity also has an impact on the way business workflows are organised, this part also considers the question of environmental management in business and corporate responsibility.

The third part of the Report on the Environmental Economy, "The Markets of the Future are Green", presents six lead markets that are about to see substantial growth in their economic and environmental importance. These are the markets for sustainable energy generation, energy efficiency, resource and material efficiency, sustainable mobility, sustainable water management, and finally the closed substance cycle and waste management industry. Every single one of these green markets of the future has enormous economic potential, the size and development of which are thoroughly investigated. This also illustrates the contribution that these lead markets can make to growth and employment.

The fourth part, "Climate Protection", takes a detailed look at what is probably the most urgent environmental issue. The Federal Government, with its Meseberg decisions, has set in motion a package of ambitious measures designed to implement the national climate protection objectives. The macroeconomic impacts of this policy provide impressive confirmation of the basic message of the entire Report on the Environmental Economy.

PART 1:
ENVIRONMENTAL PROTECTION AS AN ECONOMIC FACTOR – FACTS, FIGURES, TRENDS

1. SIZE, COMPOSITION AND COMPETITIVENESS OF THE ENVIRONMENTAL ECONOMY

Key points at a glance

Environmental protection has become an important economic factor in Germany and other industrialised countries. In 2007 companies in Germany produced potential environmental and climate protection goods worth 69.5 billion euro. This means environmental protection goods already account for more than five percent of the industrial goods produced in Germany – and the trend is rising.

Small and medium enterprises make a major contribution here. Around 60 percent of turnover in environmental goods is generated by companies employing less than 250 people. Expenditure on research and development is unusually high in the environmental industry: a sign of its great innovative activity.

German companies are also successful on the global market: since 2003 Germany has led the world when it comes to trade in environmental protection goods. In 2006 its share of world trade was 16.1 percent. The environmental economy makes a major and increasingly important contribution to Germany's overall strong position in global trade. Other factors contributing to this growth in importance are the great environmental awareness of the German public and the progressive environmental legislation: governmental incentives and regulations prompt innovation in this research-intensive industry.

High environmental protection standards have encouraged companies to demonstrate and further develop their technological capabilities. They have turned their pioneering role in environmental protection goods and services into a strong position on the international markets.[1]

1.1 THE ENVIRONMENTAL ECONOMY – A CROSS-SECTIONAL INDUSTRY

There is no easily accessible statistical information on the environmental economy – unlike traditional branches of industry like the motor industry. This is due to the fact that environmental protection has a cross-sectional character and cannot be confined to a statistically definable part of the economy. The environmental industry comprises all those companies which provide goods and services for preventing, reducing and eliminating environmental pollution. It ranges across such widely differing fields as waste management and recycling, water conservation and wastewater treatment, air quality control, noise abatement, renewable energy sources, efficient use of energy, climate protection, and instrumentation and control technology. A large share is due to environmentally friendly goods and services in the field of "integrated environmental protection". This does not wait until the end of the production process, but reduces pollution loads or resource depletion from the outset – as in the case of water-soluble paints or process-internal water recycling systems.

A wide variety of methodological statistical approaches are used to collect data on the environmental protection market. For example, from 1998 to 2005 the Federal Statistical Office used a relatively narrow definition for a survey asking a limited circle of businesses about their sales of goods, construction activities and services intended solely for environmental protection purposes. This approach was broadened in the last revision of the Environmental Statistics Act, because integrated environmental protection and climate protection are growing more important all the time.[2]

Other analyses take in all goods which could by their nature – i. e. potentially – serve the interests of environmental protection. The information in this chapter is based largely on this potential-oriented approach. Since internationally comparable statistics are available on the production of and trade in potential envi-

1 Cf. Legler, Rammer, Frietsch et al (2006).

2 The reporting circle was considerably expanded at the same time. The results of the new survey reporting on 2006 were not yet available at the time of going to press.

Figure 1: Production of potential environmental protection goods, broken down by environmental purposes and branches of industry (in billion euro)

Environmental protection purposes	2002	2003	2004	2005	2006	2007
Waste	2.9	2.8	3.1	3.5	4.1	4.7
Wastewater	9.7	9.9	10.7	11.4	12.6	14.3
Air	14.1	14.6	15.5	15.8	17.8	19.7
Instrumentation & control	13.0	13.4	14.5	15.3	16.8	18.3
Energy / Environment[1]	9.0	9.4	10.0	10.0	12.3	14.1
of wich:						
Goods for efficient use of energy	6.0	6.4	6.3	6.4	7.2	7.9
Goods for efficient energy conversion	1.2	1.0	0.9	1.0	1.3	1.4
Goods for using renewable energy sources	1.7	2.1	2.8	2.6	3.8	4.8
Total[2]	47.4	48.5	52.6	54.6	62.1	69.5
for information: Percentage of total industrial production in %	4.7	4.8	4.9	4.8	5.1	5.3
Branch of industry	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Mechanical engineering	21.6	21.9	23.8	24.8	28.1	31.9
Instruments[3]	8.2	8.3	8.9	9.3	10.3	11.1
Electrical engineering	4.5	4.9	5.5	5.1	5.7	6.1
Metal production	2.8	2.8	3.2	3.5	3.8	4.4
Glass, ceramics, non-metallic minerals	3.6	3.5	3.6	3.6	3.9	4.2
Rubber / plastics processing	2.5	2.7	2.9	3.0	3.4	3.6
Electronics, media technology	0.4	0.5	0.9	1.3	2.1	3.1
Chemical industry	1.3	1.2	1.2	1.3	2.1	3.1
Metal processing	1.4	1.4	1.4	1.5	1.7	1.8
Paper industry	0.5	0.5	0.5	0.5	0.6	0.6
Textile industry	0.5	0.6	0.5	0.6	0.6	0.5

1 Excluding heat pumps
2 Including noise control, multiple assignments eliminated, some data estimated
3 "Instruments" is the standard international shorthand for "medical equipment, instrumentation and control technology, optical industry, clocks and watches". Regarding environmental protection goods, these are mainly goods belonging to instrumentation and control technology

Sources: Federal Statistical Office *(Statistisches Bundesamt)*, Fachserie 4, Reihe 3.1 and special analyses for NIW, OECD, ITCS-International Trade by Commodities, Rev. 3 (various years), calculations and estimates by NIW

ronmental protection goods, this approach also makes it possible to examine the position of German industry in relation to the international competition.[3]

1.2 PRODUCTION VOLUME

In 2007 companies in Germany produced potential environmental and climate protection goods to the value of 69.5 billion euro – over a quarter more than two years before (cf. Figure 1). Potential environmental protection goods – such as pumps, pipes, instrumentation and control equipment – can serve environmental protection purposes, but may also perform other functions. Experts believe that about 35 to 40 percent of these goods – corresponding to sales of some 24 to 27 billion euro – are actually used for environmental protection purposes.

This means that 5.3 percent of industrial production is due to potential environmental protection goods – and the trend is upwards. Whereas this share more

3 For a detailed description of the approaches and their advantages and disadvantages cf. Legler et al (2006).

or less stagnated at a much lower level from 1995 to 2005, the pace of growth has stepped up considerably since then: from 2005 to 2007 there was an increase of 27 percent. Environmental and climate protection are becoming increasingly important for the industry, and their share of industrial goods production is constantly growing. In particular there were substantial increases in renewable energy, instrumentation and control equipment and electronic products. For example, production of goods for using renewable energy sources almost trebled between 2002 and 2007. Major contributory factors here were the targeted state subsidies via the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz – EEG) and an ambitious climate protection policy on the part of the German government.

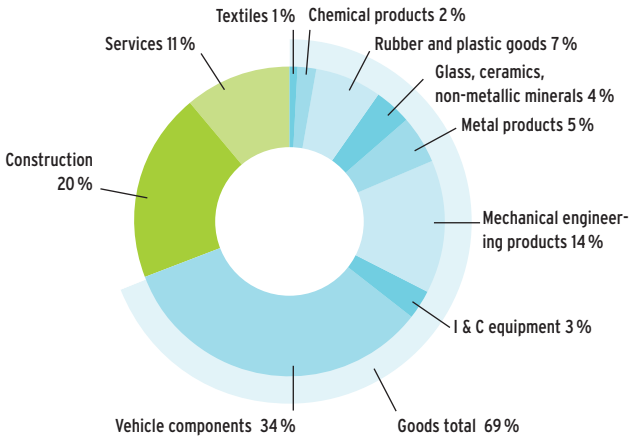
Until 2002 the growth in production of environmental protection goods was driven solely by the booming export business, while demand on the domestic market stagnated. In recent years, however, domestic business has gained increasing momentum: from 2005 to 2006 domestic demand grew by ten percent – driven above all by climate protection and the boom in renewable energy sources. Air quality control continues to be the main focus, however: dust filters, catalytic converters, filter systems and other goods accounted for nearly 29 percent of the production of environmental protection goods in 2007. Instrumentation and control equipment (over 26 percent) and technologies for water conservation and wastewater treatment (both over 20 percent) also account for large shares of the production of environmental protection goods.

1.3 INDUSTRIES AND COMPANY SIZES IN THE ENVIRONMENTAL ECONOMY

Breakdown by industry

Nearly half of the businesses in the environmental economy in 2005 were in the services sector. This is the finding of the official survey of goods, construction activities and services exclusively for environmental protection purposes. Official surveys nevertheless indicate that sales of services account for only ten percent of the environmental protection market covered by those surveys (cf. Figure 2).[4] The true importance of services is greater, however. This is because the survey by the Federal Statistical Office includes only business-oriented services such as studies and analyses, monitoring, expertises and planning.[5] Product support services, by contrast, which probably play a particularly important role in export business, are included with the sales of the goods. Moreover, services rendered by software, information technology and research companies, trading companies, banks and insurance companies and administrative authorities and the waste management sector are not included in the survey.

Figure 2: Sales shares of goods, construction and services for environmental protection (2005)



Sources: Federal Statistical Office *(Statistisches Bundesamt)*, Fachserie 19, Reihe 3.3 (various years), calculations by NIW

Among industrial goods the largest share of sales is accounted for by vehicles and vehicle components. The principal items are exhaust gas cleaning systems, waste disposal vehicles, street sweeping and vacuum cleaning machines, and vehicles for transporting wastewater and sewage sludge. In the mechanical engineering field, the second-largest heading in the industrial goods sector, companies make their highest environmental protection sales with filter, waste and wastewater treatment systems. Environmental protection integrated in systems and components is difficult to grasp in terms of goods-based definitions – which explains the small proportion of instrumentation and control systems. Environment-oriented building activities are due in particular to waste management facilities.

Great importance of small and medium enterprises

Small and medium enterprises are regarded as the mainstay of the economy. But what role do they play in a market whose growth is largely on the export front?

4 Cf. Federal Statistical Office *(Statistisches Bundesamt)*, Fachserie 19, Reihe 3.3, various years.
5 Cf. Branch of industry 74 (WZ 74).

Figure 3: Size of environmental protection companies (broken down by employee numbers)

Employees	0 – 49	5 – 99	100 – 249	250 – 499	500 or more	Not known	Total
All sectors	62.6	13.8	8.9	2.8	1.6	10.3	100.0
Type of output:							
Goods	47.3	20.6	17.0	7.6	5.4	2.1	100.0
Construction	50.8	26.0	14.8	2.9	0.8	4.7	100.0
Services	74.8	4.4	2.0	0.7	0.7	17.5	100.0
Total	62.6	1.8	8.9	2.8	1.6	10.3	100.0
For information: Distribution of businesses in manufacturing and construction sectors as a whole, broken down by employee numbers (in percent)							
Manufacturing sector	50.8	22.9	16.6	5.8	3.8		100.0
Construction sector	97.2	1.9	0.9		k.A.		100.0
Services (WZ 74)	98.2		1.8				100.0

Sources: Federal Statistical Office (*Statistisches Bundesamt)* (Fachserie 19, Reihe 3.3, Fachserie 4, Reihe 4.1.2 and 5.1, in each case 2005), and special analyses for NIW, Federal Statistical Office (*Statistisches Bundesamt)* (Wirtschaft und Statistik 1 / 2007), research data centres of the federal Länder (Stuttgart), special analyses for NIW. Calculations by NIW.

New research findings[6] show that the environmental protection industry is also a domain of SMEs. More than 60 percent of companies in the environmental protection market had fewer than 50 employees in 2005, and three quarters actually had fewer than 100. However, there are not so many small and medium enterprises active in the environmental protection sector as in comparable sectors of industry (Figure 3). As many as 13 percent of environmental protection companies producing goods have more than 250 employees – compared with an average of only 9.6 percent for the manufacturing industry. The situation in the environmental construction and environmental services sector is similar.

On the other hand, if one looks at the breakdown of sales by company size, the share of total sales by environmental protection suppliers that is due to small and medium enterprises is unusually large (Figure 4). For example, whereas in the manufacturing industry as a whole small and medium enterprises (up to 250 employees) make 31 percent of sales, total sales by companies of this size in the environmental protection sector come to nearly 60 percent.

There are thus numerous large companies operating in the environmental protection sector for which environmental protection is not a core business. By contrast, whereas the involvement of small and medium enterprises in the environmental protection market is smaller than usual in terms of numbers, their importance is above average in terms of market volume. Many of the small and medium enterprises have focused their spectrum almost entirely on environmental protection. Thus the environmental protection market is a mixture of small and medium enterprises with a high degree of specialisation in environmental protection goods and services, and large companies for which environmental protection is only a peripheral business.

1.4 RESEARCH AND INNOVATION IN THE ENVIRONMENTAL ECONOMY

Great research and development intensity

In the environmental economy research is exceptionally frequent, intensive and continuous. Nearly 80 percent of production in the environmental sector is particularly research- and knowledge-intensive: mechanical engineering, instrumentation and control technology, electrical engineering, electronics and the chemicals, plastics and rubber industry are among the most important branches of this market. In the environmental economy, more than 5 percent of the turnover was invested in research and development in 2004, a significantly higher share than the 3 percent earmarked for R&D in overall industrial production.[7] Qualification requirements for employees in the environmental economy are correspondingly high. 30 percent are graduates, compared to 20 percent in other sectors.[8]

6 The following findings are based on a special analysis by the Research Data Centres of the Länder on the basis of the survey "Sales of Goods, Construction and Services". This was carried out under an UBA research project at the request of the Lower Saxony Institute for Economic Research *(Niedersächsisches Institut für Wirtschaftsforschung – NIW)*. Cf. Legler et al (2008).

7 Cf. Legler, Rammer, Frietsch et al (2006).

8 Cf. Löbbe et al (1994); Horbach, Blien, v. Hauff (2001); Gehrke et al (2002); Wackerbauer, Triebswetter (2005); Schönert et al (2007).

Figure 4: Environmental protection sales broken down by employee numbers (in percent)

Employees	0 – 49	50 – 99	100 – 249	250 – 499	500 or more	Not known	Total
All sectors	17.9	16.8	24.7	14.5	23.1	3.1	100.0
Type of output:							
Goods	10.3	12.3	26.7	17.7	32.2	0.8	100.0
Construction	22.3	33.5	27.8	9.9	2.5	4.0	100.0
Services	60.8	14.1	4.8	2.3	2.0	16.1	100.0
Total	17.9	16.8	24.7	14.5	23.1	3.1	100.0
For information: Distribution of businesses in manufacturing and construction sectors as a whole, broken down by employee numbers (in percent)							
Manufacturing sector	6.1	8.1	16.8	15.3	53.7		100.0
Construction sector	55.0	17.2	23.7		4.2		100.0
Services (WZ 74)	63.6		37.4				100.0

Sources: Federal Statistical Office (*Statistisches Bundesamt)* (Fachserie 19, Reihe 3.3, Fachserie 4, Reihe 4.1.2 and 5.1, in each case 2005), and special analyses for NIW, Federal Statistical Office (*Statistisches Bundesamt)* (Wirtschaft und Statistik 1 / 2007), research data centres of the federal Länder (Stuttgart), special analyses for NIW. Calculations by NIW.

The following are particularly innovative:
- manufacturers of systems and components, mostly in research-intensive industries,
- suppliers in the market segments energy and environment, process engineering, air quality control and water conservation,
- suppliers of integrated technologies and green products, and
- young companies with a special focus on the environmental protection market.[9]

Companies in the environmental protection sector are well networked. Their readiness to cooperate in networks with partners from industry, academia and research is much more marked than in other sectors. This is an indication that innovation projects in the environmental economy are particularly ambitious.

Environmental policy as a driving force behind research and innovation

The dynamics of the environmental protection markets are influenced to a large extent by governmental intervention and incentives. In a survey by the Mannheim Innovation Panel *(Mannheimer Innovationspanel – MIP)* in 2003, more than one in five innovative companies said that their innovation activities had also been prompted by legislation and regulations. About nine percent cited environmental regulations as one of their stimulating forces, as revealed by the special analysis undertaken by the Centre for European Economic Research *(Zentrum für Europäische Wirtschaftsforschung – ZEW)*.[10] The influence on innovation varies from one branch of industry to another. The analysis shows that in the chemical, pharmaceutical and petroleum sectors, for example, it took environmental regulations to motivate 13 percent of all companies to supply greener products or to use new processes within their company (cf. Figure 5).

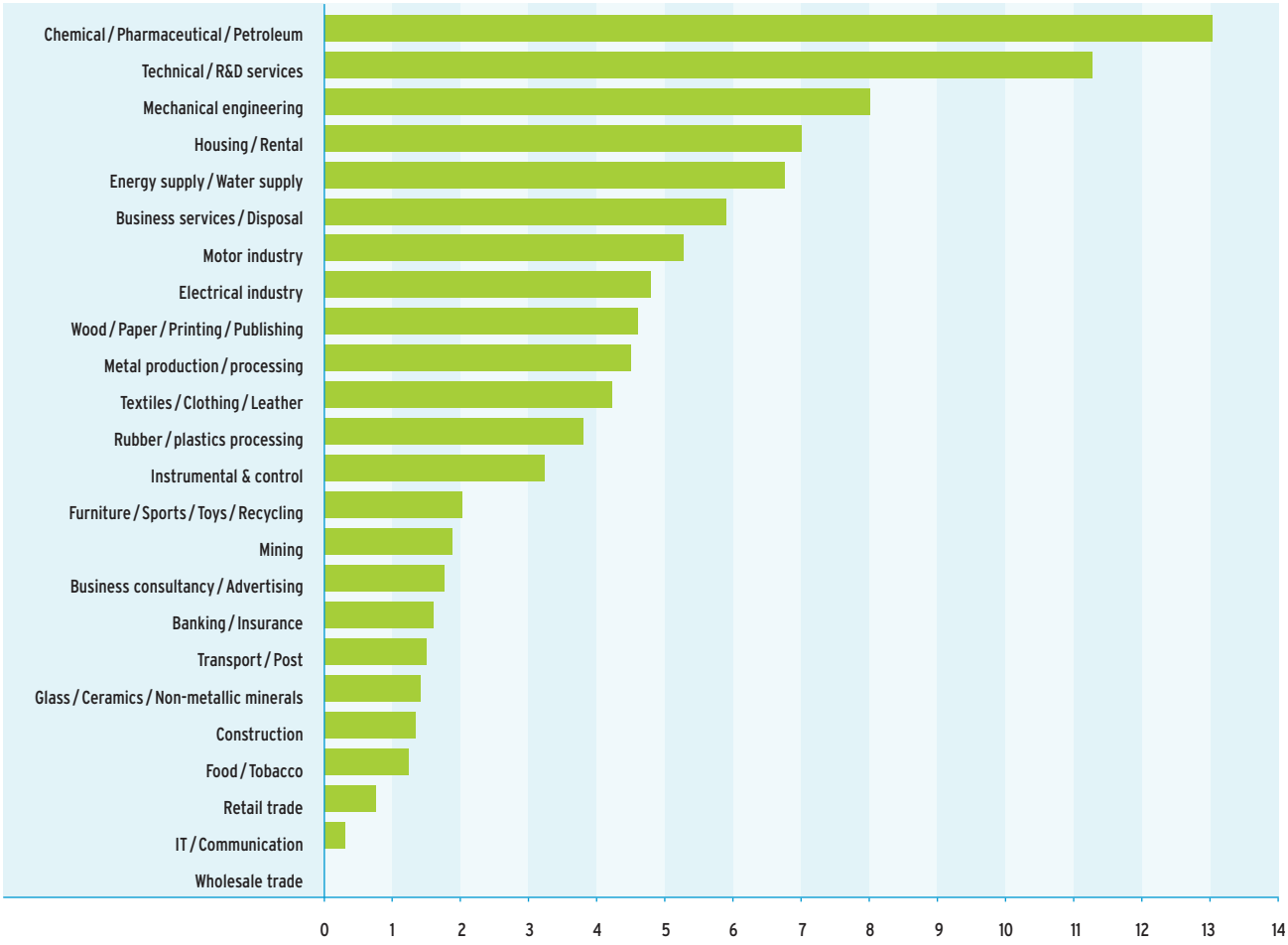
Environmental protection is thus an important motive for innovation. The following environmental regulations in particular have stimulated innovation:[11]
- Energy production: Renewable Energy Sources Act *(Erneuerbare-Energien-Gesetz – EEG)*, Heat-Power Cogeneration Act *(Kraft-Wärme-Kopplungs-Gesetz – KWK-G)* and Energy Industry Act *(Energiewirtschaftsgesetz – EnWG)*
- Resource and materials efficiency, avoiding dangerous substances: regulations prohibiting or reducing the use of various substances (e. g. lead, mercury, sulphur, CFCs, solvents, surfactants)
- Closed substance cycle management, waste, recycling: technical rules for recovery, treatment and other disposal of municipal waste *(TASi)*, End-of-life Vehicles Act *(Altfahrzeuggesetz – AltFzgG)*, Packaging Ordinance *(Verpackungsverordnung)*
- Sustainable mobility: Federal Immission Control Act *(Bundesimmissionsschutzgesetz – BImSchG)*, Technical Instructions for Air Quality Control (TA Luft), Eco Tax, Traffic Noise Control Act *(Verkehrslärmschutzgesetz)*

9 Cf. Gehrke et al (2002).

10 This analysis was made as part of a project funded by the Federal Environment Agency. Cf. Rennings et al (2008), and supplementary information in Legler. Cf. Rammer, Frietsch et al (2006).

11 Since the survey was conducted in 2003, it only covers regulations that had had a chance to make their effect felt by that time.

Figure 5: Innovation as a result of environmental regulations
Percentage of companies which have introduced innovations as a result of environmental regulations



Percentage of all companies in the relevant industry which introduced innovations prompted by environmental regulations during the period 2000-2002. All figures extrapolated to the parent population of companies.

Source: ZEW, Mannheim Innovation Panel, Survey 2003 – calculations ZEW

- Air quality control, pollution control: Federal Immission Control Act *(BImSchG)*, Technical Instructions for Air Quality Control *(TA Luft)*, exhaust emission standards
- Energy efficiency: Energy Saving Ordinance *(Energieeinsparverordnung – EnEV)*, Thermal Insulation Ordinance *(Wärmeschutzverordnung – WSVO)*
- Sustainable water management: EU Water Framework Directive, Drinking Water Ordinance *(Trinkwasserverordnung)*, Wastewater Ordinance *(Abwasserverordnung)* and wastewater legislation in the *Länder*.

Public subsidies for environmental innovations

Innovations are not only prompted by state requirements, but actually receive financial assistance from the state. In 2003, one in three environmental suppliers received money from one of the numerous assistance programmes, and among innovative environmental protection companies the figure was as high as one in two (cf. Figure 6).[12] Suppliers of integrated environmental protection technologies and in the fields of resource efficiency, air quality control, noise abatement and energy efficiency were particularly well represented.

Small companies too (up to 50 employees) have an above-average likelihood of benefiting from public innovation subsidies (cf. Figure 7). This is connected with the fact that many small companies in the environmental economy are highly specialised and research oriented. It is also an indication that assistance for small companies in the environmental sector is successfully making itself felt by comparison with other key areas of innovation policy.

12 Findings of the analysis by the Mannheim Innovation Panel. Cf. Rennings et al (2008).

Figure 6: Public subsidies for innovation by suppliers in the environmental market

	Energy efficiency	Closed-cycle management	Water management	Resource efficiency	Noise reduction	Integrated environmental protection	Air quality control	Building refurbishment	Waste recovery	Environmental management	Miscellaneous	Total	All companies*
	as percentage of all companies												
Public innovation assistance, total	45	30	40	71	44	47	46	31	13	36	28	32	16
of which: from Land ministries	18	14	19	25	14	20	21	15	5	20	13	15	8
from federal ministries	35	23	30	63	38	42	33	25	9	27	24	23	10
from EU	20	6	6	0	14	5	11	6	2	12	19	10	5
from others	3	3	4	0	3	5	5	4	1	7	0	2	1
	as percentage of innovative companies												
Public innovation assistance, total	65	49	56	71	68	75	70	52	30	53	47	51	35
of which: from Land ministries	25	22	28	25	21	31	31	26	10	27	20	23	15
from federal ministries	47	36	40	63	58	67	48	40	18	39	38	37	21
from EU	28	10	9	0	21	8	16	10	4	16	30	16	9
from others	5	5	5	0	5	8	7	7	2	10	0	3	1

Mean of sample (n=842).

* Companies with at least 5 employees in the sectors 10-45, 50-52, 60-74, 90, 92.1, 92.2.

Source: ZEW: Mannheim Innovation Panel, Survey 2005; UMFIS database – calculations by ZEW.

Figure 7: Public subsidies for innovation by suppliers in the environmental market, broken down by number of employees

	Energy efficiency			Closed-cycle management			Water management			Total			All companies*		
Employees	< 50	50 – 249	> 249	< 50	50 – 249	> 249	< 50	50 – 249	> 249	< 50	50 – 249	> 249	< 50	50 – 249	> 249
	as percentage of innovative companies														
Public innovation assistance, total	82	50	50	62	36	38	66	47	52	59	41	48	34	35	35
of which: from Land ministries	23	29	25	28	14	18	30	28	24	24	22	20	16	16	14
from federal ministries	54	38	44	44	28	27	47	32	36	41	29	36	21	20	21
from EU	30	25	25	12	8	9	5	13	12	14	19	15	8	9	12
from others	10	0	0	7	5	0	8	6	0	4	4	2	1	1	2

Mean of sample (n=842).

* Companies with at least 5 employees in the sectors 10-45, 50-52, 60-74, 90, 92.1, 92.2.

Source: ZEW: Mannheim Innovation Panel, Survey 2005; UMFIS database – calculations by ZEW.

1.5 POSITION OF THE ENVIRONMENTAL ECONOMY IN INTERNATIONAL COMPETITION

Environmental protection – a global growth market

Companies in the environmental economy operate on global markets, which is where they have generated a large proportion of their growth. And even if they are not active on the export front, they frequently compete with international competitors on the domestic market. The performance capacity of the environmental economy therefore has to be measured by international standards – especially since the growth and development opportunities of the German environmental economy will continue to depend heavily on exports in the future as well. The prospects are good: the volume of global trade in potential environmental goods has displayed above-average growth since 1993, averaging 9.5 percent a year (cf. Figure 8), which is more than trade in industrial goods as a whole (8.9 percent). The increase was particularly large in the case of renewables (+14.6 percent), noise abatement (+9.7 percent) and air quality control (+9.6 percent). In recent years (2003–2006) there has also been an above-average rise in exports of waste management goods.

Germany – Export champion in the environmental goods sector

In 2005 German industry exported potential environmental protection goods to the value of around 46 billion euro. This corresponds roughly to the volume of exports by the electrical engineering industry. And exports are still growing: to an estimated 56 billion euro in 2006 and 59.5 billion euro according to the provisional figures for 2007.

As the world's largest exporter of potential environmental protection goods, Germany had a 16.1 percent share of global trade in 2006, thereby increasing its lead.[13] In second position is the USA (14.9 percent), followed by Japan (9.2 percent) (cf. Figure 9).[14]

For years now, Germany has been unusually well represented on the world market for environmental goods: the most recent figures show that German companies had only an 11.1 percent share of global trade in industrial goods as a whole – five percentage points less than on the market for environmental goods. And in the field of potential environmental protection goods the growth in exports is also considerably higher than for industrial goods in general.

Figure 8: Development of global trade in potential environmental protection goods

Environmental protection purposes	Average annual change (in percent)			
	1993 – 2006	1993 – 1998	1998 – 2003	2003 – 2006*
Waste	9.1	9.1	2.6	20.8
Water	8.9	8.7	4.5	16.3
Air	9.6	9.6	6.0	16.2
I&C	9.4	9.3	6.1	15.5
Noise	9.7	10.6	5.5	16.5
Energy / Environment	9.9	9.0	6.5	18.3
of which				
Efficient use of energy	8.8	9.3	4.2	16.4
Efficient energy conversion	8.7	7.2	7.0	12.9
Renewable energy sources	11.6	10.8	12.7	28.3
Environment, total	9.5	9.0	5.7	17.1
Processed industrial goods	8.9	8.6	5.9	14.9

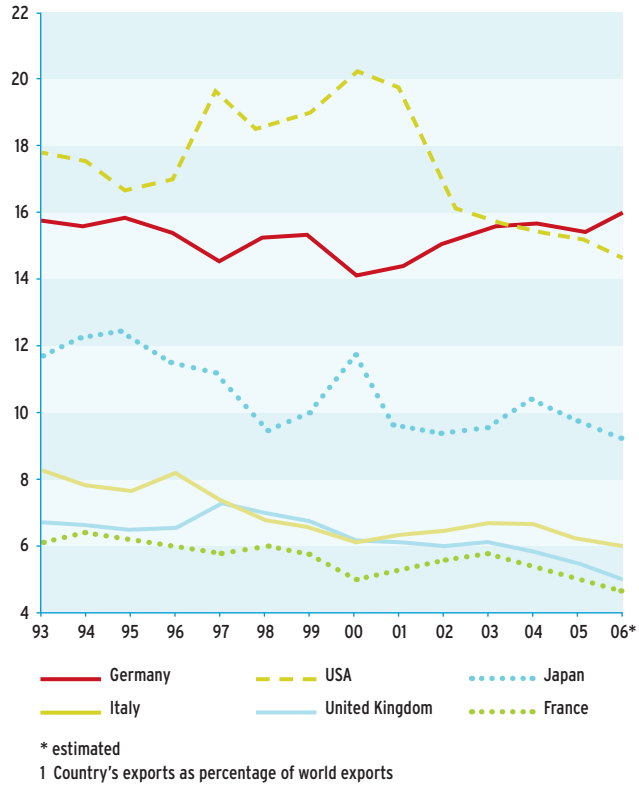
* 2006 estimated

Sources: OECD, ITCS – International Trade By Commodity Statistics, Rev. 3 (various years); COMTRADE database; WTO; calculations by NIW.

13 The estimates for 2006 are based on an analysis of data for ten countries which together account for nearly 80 percent of global trade in potential environmental protection goods.

14 For the first time these calculations also include non-OECD countries – especially newly industrialised countries in Asia. This is because their involvement in the market for environmental protection goods has risen very sharply in recent years. In 2006 their share of global trade was around 16 percent. Owing to this change in the countries covered by the report, the export shares of all OECD countries are down compared with previous estimates, but the order of the leading nations – Germany, USA and Japan – remains the same.

Figure 9: Global trade shares[1] of the largest suppliers of potential environmental protection goods (in percent)



* estimated
1 Country's exports as percentage of world exports

Sources: OECD; ITCS – International Trade By Commodities, Rev. 3 (various years); COMTRADE database; WTO; calculations by NIW

The share of industrial goods exports accounted for by potential environmental protection goods rose to nearly seven percent in 2007 (2005: 6.4 percent). Exports were dominated by environmental instrumentation and control equipment with 19.7 billion euro, ahead of water and wastewater technologies with 17.8 billion euro and climate protection technologies with 12.8 billion euro.

It is not only in specific branches or regions that German environmental protection goods are in demand. In practically all regions of the world and throughout all environmental sectors the German environmental economy is outstandingly competitive.[15] German companies have a strong presence not only on the highly developed and demanding markets of the EU, the USA, Japan and other western industrialised countries, but also on the dynamically expanding markets of the emerging economies with their great need for innovative environmental protection solutions.

International competition also has an impact on the domestic market. Partly because of the growing international interlinking of markets, imports of potential environmental protection goods into Germany have shown an above-average increase in recent years: in 2006/2007 they accounted for 5.7 percent of all imports of industrial goods. However, since environmental protection goods as a share of industrial goods exports are considerably higher, at seven percent, Germany is still in a good position even taking into account the growing demand for imports. For comparison: exports of potential environmental protection goods are 1.8 times higher than imports, in the case of industrial goods the figure is only 1.45 times. The biggest contributions to Germany's foreign trade surplus are made by goods in the fields of waste, instrumentation and control technology, and (waste)-water technology. By contrast, climate protection goods, especially in the field of renewables, are still under great pressure from imports – in spite of marked improvements in the balance since about 2004.

Competitors on the global environmental protection market at a glance

Production of and trade in environmental protection goods are a domain of highly developed economies. In the industrialised countries environmental protection has become an increasingly important factor for competitiveness in recent decades. So it is not surprising that nearly all Central European countries occupy leading rankings.

Among them are countries with companies which display similar strength on the export front to German companies, but which have a stronger presence on their domestic market. Examples include the United Kingdom and Japan. However, this does not automatically mean that German companies are less competitive on their domestic market. What it does show is that the German market is open to modern environmental protection technologies from elsewhere – an example of international connections working for the benefit of the environment.

Environmental protection calls for tailor-made solutions. This requires close contact with the target markets. European countries are at an advantage here: their similar production structures and cultural backgrounds and the tendency to harmonise environmental legislation favour the exchange of high-quality environmental protection technologies within Europe. This makes it easier to cut production costs, providing a firmer foundation for exporting to regions outside Europe. Some of the emerging economies are catching up fast, however. China in particular is displaying unusually dynamic growth: every year its exports of potential environmental protection goods are growing roughly three times as fast as global trade.

15 Cf. Legler et al (2008).

2. IMPACT OF ENVIRONMENTAL PROTECTION ON EMPLOYMENT

Key points at a glance

In 2006 there were already 1.8 million people employed in the environmental sector in Germany – a new record. This means that 4.5 percent of all gainfully employed persons owe their job to environmental protection; two years earlier the figure was 3.8 percent. There has thus been a marked increase in the importance of environmental protection for the labour market in Germany. Three main factors were responsible for favourable influences on the labour market: the dynamic growth in renewables, the rise in exports of environmental protection goods, and the increase in jobs in the environment-oriented services sector. By contrast, the importance of environmental protection investment and material costs in the classic environmental protection sectors (waste disposal, water conservation, noise abatement, air quality control) has stagnated in recent years.

The figure of nearly 1.8 million persons estimated for 2006 represents the lower limit for the number of people actually employed in environmental protection in Germany – there are in fact many more working in this field. Quite a number of fields – such as eco tourism, environment-oriented insurance and product-integrated environmental protection – are difficult or impossible to quantify because of the lack of adequate data.

There are many indications that employment in the environmental protection sector will continue to grow in the years ahead – assuming a progressive, innovation-oriented environmental policy. Environmental policy instruments such as the Renewable Energy Sources Act and the successive tightening of the exhaust emission limits for cars and trucks under the European emission standards provide incentives for further technical developments and create a reliable framework of conditions for businesses. This generates a competitive lead over rivals who are confronted with less stringent regulations on their home markets.

2.1 IMPACT OF ENVIRONMENTAL PROTECTION ON EMPLOYMENT – AN OVERVIEW

Latest estimates indicate that in 2006 nearly 1.8 million employees owed their jobs to environmental protection. This was 4.5 percent of all gainfully employed persons – and almost 300,000 jobs or 0.7 percentage points more than in 2004. Thus the importance of environmental protection for employment in Germany has increased considerably in recent years (cf. Figure 10).[16]

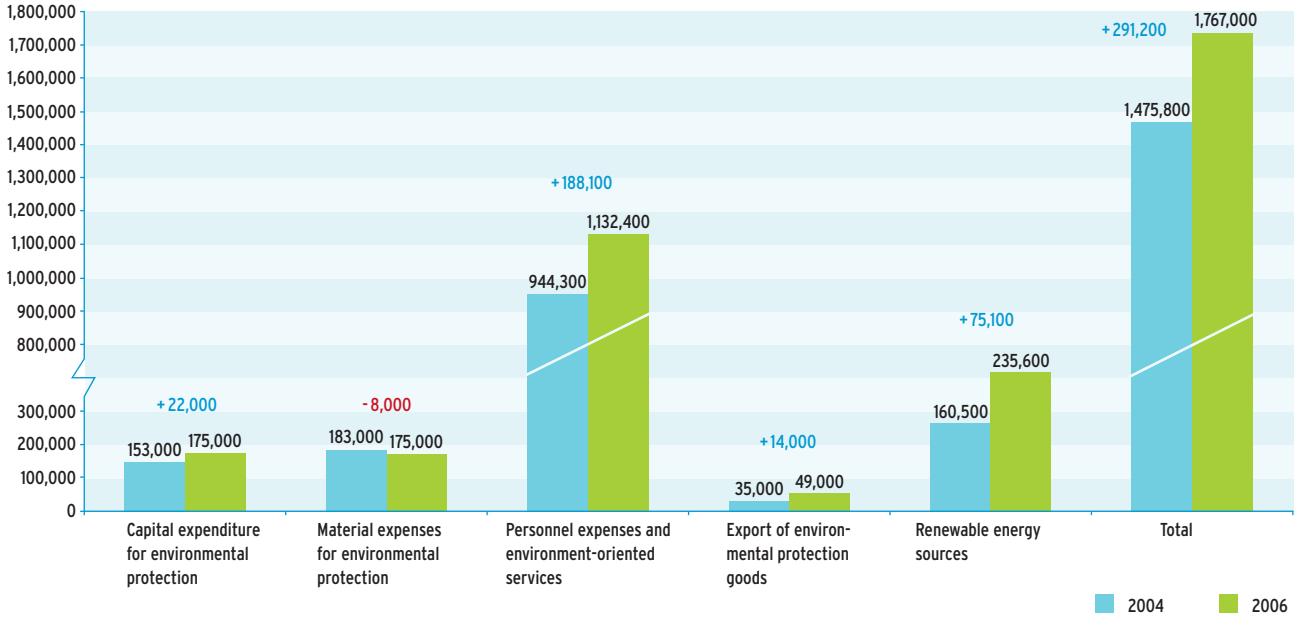
Waste disposal, water conservation, noise abatement and air quality control are classic areas where jobs are created when companies and the federal, regional and local authorities invest in environmental protection. Production of the material assets necessary for operating and maintaining environmental protection systems also creates jobs. Capital expenditure and material expenses for classic environmental protection involved a total of 350,000 employees in 2006. However, by far the largest share was due to personnel expenses and environment-oriented services with some 1.1 million jobs – nearly two thirds of all jobs in the environmental protection sector. Close on 50,000 additional jobs can be added for exports of environmental protection goods.

There is a reason for the fact that the 235,600 jobs due to renewable energy sources are shown separately: They did not emerge as an important field of action of environmental policy until the early 2000s, and their environmental employment effects have therefore only been analysed – in addition to the existing categories – since 2002.[17] There is also a lack of official statistics of the kind found in the classic

16 The results in this chapter are taken from an up-to-date study by the German Institute for Economic Research *(Deutsches Institut für Wirtschaftsforschung – DIW)*, the Lower Saxony Institute for Economic Research *(Niedersächsisches Institut für Wirtschaftsforschung – NIW)* and the ifo Institute for Economic Research *(Institut für Wirtschaftsforschung – ifo)*. Cf. Edler et al (2008).

17 The employment impacts of renewable energy sources are estimated regularly as part of a study commissioned by the Federal Environment Ministry, so these findings can be used here. Cf. Kratzat et al (2007).

Figure 10: Persons employed in environmental protection



Source: Edler et al (2008)

environmental protection areas. This separate classification has the advantage that the growing importance of renewable energy sources can also be seen at first glance in the employment figures as well. There have been constant improvements to methodology and the data situation in the environmental protection sector in recent years. However, quite a number of new fields – such as eco tourism, environment-oriented insurance and product-integrated environmental protection – are still not included adequately, or even at all, because of the lack of adequate data. The figure of nearly 1.8 million people

Statistics, research, estimates – a methodological overview

Environmental protection gives rise to far more jobs than just those directly based in the industry – for example jobs that are necessary for production of the intermediate inputs and for exports. The number of jobs that actually depend on environmental protection can only be estimated, since the environmental industry cannot be limited to individual sectors of the economy.

The most reliable way of estimating the impacts on employment is to use a combination of two approaches: demand-oriented estimates make use of data such as sales revenue or employee numbers. Conventional statistical surveys of these exist in branches like recycling and other waste management services, whereas in other cases analyses are made on the basis of company surveys in the environmental economy, panel surveys by the Institute for Employment Research *(Institut für Arbeitsmarkt- und Berufsforschung – IAB)* or association statistics. This makes it possible to register the employment impacts of environment-oriented services and to some extent in the field of renewable energy.

Demand-oriented estimates use data on domestic demand and exports to calculate impacts on employment. They are based on official data on material expenses, investments and exports in the environmental protection sector. First the domestic demand that triggers corresponding domestic production is determined. Model calculations based on input-output analysis are then used to identify the direct and indirect employment effects. Detailed information on labour productivity in the various economic sectors is included. The figures in Figure 10 on the employment effects of investments, material expenses and exports are based on demand-oriented estimates. The combination of the two approaches yields a sound overview of employment in the environmental protection sector – though it also requires careful analysis and the elimination of double counting.

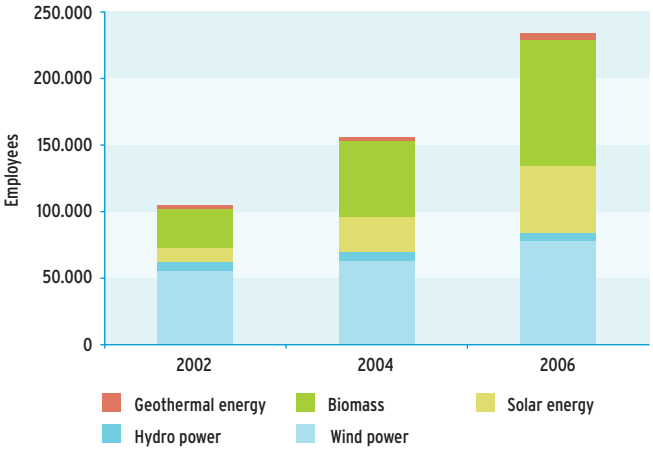
employed in the environmental sector in 2006 must therefore be regarded as the lower limit for actual employment in environmental protection.

2.2 EMPLOYMENT IN ENVIRONMENTAL PROTECTION – DEVELOPMENT OVER TIME

The trend is upward: the latest estimate shows 290,000 more employees in the environmental sector than in the previous year of the survey (cf. Figure 10). However, roughly half the increase is due to improvements in the data situation and methodology – in other words more people were employed in the environmental sector in 2004 than was assumed at the time.

The development is characterised by opposing trends. New jobs have been created particularly in the renewables sector, in the field of environment-oriented services and by the boom in exports of environmental protection goods. By contrast, the importance of environmental investments and material expenses in the classic sectors waste, water, noise and air showed a certain stagnation – the increase of 22,000 jobs due to investments is largely due to the improvements in estimation methods.[18] Nevertheless, thanks in particular to the improved financial situation of the federal, regional and local authorities, increased environmental investments by state and companies can be expected in the years ahead – with a correspondingly favourable impact on the labour market.

Figure 11: Employment impact of renewable energy sources



Rapid growth of employment in renewables sector

Use of renewable energy sources has increased considerably in recent years. This is also reflected in the employment figures. In two years they grew by nearly 50 percent – from 160,500 employees[19] in 2004 to 235,600 in 2006 (cf. Figure 11). Compared with 2002 the number of employees has almost doubled. With the exception of hydro power, all renewable energy segments contributed to this growth. By far the largest share is now due to biomass, which also includes biofuels and biomass heating fuels. The biggest growth rates were achieved by the solar sector and geothermal energy – albeit starting from a relatively low level.

In the coming years there is reason to expect that renewable energy sources – as an important cornerstone of climate protection – will continue to gain in importance. From 2006 to 2007 alone, sales revenue from installation and operation of systems for using renewable energy sources grew by nearly ten percent to about 24.6 billion euro. This took the number of jobs in the industry to around 250,000.[20] If the ambitious targets[21] for the expansion of renewable energy sources are met, dynamic growth in employment can be expected to continue. With its climate protection programme adopted at the closed meeting of the Cabinet in Meseberg in August 2007, the German government gave an important boost here (cf. Part 4 – Climate Protection).

More jobs through exports of environmental protection goods

Exports of goods and services for environmental protection are also increasingly helping to secure jobs within Germany. With its leading position on the international market, Germany has for years been profiting from the growing demand abroad. The estimated 2006 figure of 49,000 employees who owe their job to exports is hardly an adequate reflection of this. Since integrated environmental protection is not covered adequately, the employment effects of environmental protection exports are probably considerably higher.

In view of rapidly rising raw materials prices, a surge of industrialisation in the emerging economies and the challenges of climate change, there is a growing worldwide demand for environmental and climate protection technologies and for products that save natural resources. As export champions when it comes to trade in environmental protection goods,

18 Cf. details in Edler et al (2008).
19 To ensure comparability with the figures for 2006 this also includes the 3,400 employees in public and non-profit research.
20 Cf. Federal Environment Ministry *(BMU)* (2008b).
21 In August 2007 the German government decided that the share of gross power consumption accounted for by renewable energy sources was to rise to between 25 and 30 percent by the year 2020. In 2007 its share was 14.2 percent.

German companies have excellent prospects of success on these green growth markets of the future.

Environment-oriented services expanding

In 2006 almost two thirds of all jobs in the environmental sector were due to environment-oriented services. There were a total of more than 1.1 million employees who rendered environment-oriented services – for example in planning offices, environmental authorities, in trade with eco products, and in environmental education. Environment-oriented service providers are found in all branches of industry (cf. Figure 12), i.e. including those which according to official statistics strictly belong to the manufacturing sector[22] or agriculture and forestry. A comparison of employment in 2004 and 2006 shows a marked increase of around 188,000 persons. There was a slight decrease in environment-oriented services in the manufacturing and construction sectors, but a marked increase in employment can be seen in most other branches of industry.

The following remarks provide information about a number of particularly striking developments with regard to the methods of estimation used and the employment figures:[23]

- Some 41,600 people are employed in organic farming – a figure that experts have estimated for the first time with the aid of a special analysis of the agricultural structure survey. This explains a large part of the increase in the agricultural and forestry sector.
- Water services such as maintenance and repairs to the pipe system or the planning of water-saving systems are included in the statistics for the first time. Nearly 33,000 people work in this field, which explains a large part of the increase in employment in the energy and water supply sector. A further 49,000 employees are concerned with energy services such as contracting, energy consulting and the sale of electricity from heat and power co-generation and renewable energy sources.
- Trade in bio products is booming – and today that includes supermarket chains as well. Sales of organic foods rose by 40 percent between 2004 and 2006, giving rise to numerous new jobs in this field. In 2006 some 160,000 employees worked in the wholesale and retail trade in green products – which was 21,000 more jobs than in 2004.
- Calculations by the research institutes indicate that 70,000 people provide environment-oriented services in the field of transport and communications. Examples include environmentally sound transport services on the railways, new mobility services such as car-sharing, and the planning of cross-modal concepts and new traffic control systems.

Figure 12: Gainfully employed persons in environment-oriented services

	Employees		Difference
Branch of industry	2006	2004	2006 / 2004
1. Agriculture and forestry	103,900	57,500	+46,400
2. Manufacturing sector and mining	115,900	130,500	-14,600
3. Energy and water supply	86,700	58,700	+28,000
4. Construction	46,100	49,100	-3,000
5. Trade, repair and maintenance of goods	195,100	173,700	+21,400
6. Hotels and restaurants	5,900	5,800	+100
7. Transport and communications	72,100	68,900	+3,200
8. Banking and insurance	1,100	1,000	+100
9. Business services	257,300	226,000	+34,700
10. Public administration	62,600	44,900	+17,700
11. Education	20,000	22,400	-2,400
12. Other services	165,700	109,200	+56,500
Total	1,136,600	947,700	+188,100

Source: Edler et al (2008)

22 The production sector includes the manufacturing industry and mining, energy and water supply, and the construction industry.
23 Cf. details in Edler (2008).

- Roughly one quarter of the service employees in the environmental protection sector are in the "business-to-business services" field. This statistical category includes, for example, environment-related work in laboratories, architects' and engineers' offices, and environment-related research and development activities. From 2004 to 2006 the number of jobs increased by more than ten percent.
- In public administration, nearly 63,000 persons work on environmental protection tasks. The increase in employment is due to the fact that the new estimate of environmental protection employees includes the housing, energy and water supply sectors for the first time.

Environment-oriented services are likely to continue gaining in importance in the years ahead. This applies particularly to energy consulting in business and for house-owners, product-support services for exports of environmental goods, and services aimed at environmentally sound mobility.

2.3 GROSS VERSUS NET – TAKING STOCK OF THE EMPLOYMENT SITUATION

It is clear from the figures for 2006 what (gross) employment effects can be shown to exist in the environmental protection sector. When taking stock of the employment situation, i.e. in a net approach, the possible job cuts – e.g. due to displacement effects and cost, price and competition impacts – would have to be deducted from these jobs. However, it is not possible to determine these net employment effects by statistical means. This is only possible using model calculations or scenario analyses which contrast the status quo (including environmental measure) with a hypothetical situation (excluding environmental measure). The difference between the number of jobs in the two scenarios represents the net effect of the environmental measure. It follows that net employment effects cannot be calculated for environmental policy as a whole, but only for specific environmental policy measures or instruments.

In all scenario analyses, however, it is necessary to bear the following in mind: the primary aim of environmental protection is not to create as many jobs as possible, but to achieve environmental quality objectives efficiently – i.e. at minimum cost to the national economy. That environmental protection does on balance create jobs is due partly to the fact that labour-intensive sectors profit to an above-average extent.

For this reason reallocating funds to environmental protection often results in more jobs not only in gross terms, but also on a net view. Another point is that environmental protection measures to some extent replace imports with value added within the country – for example in the case of energy-saving investments that reduce consumption of fossil fuels such as oil or gas.

Several studies confirm this link. Four examples:

- Climate protection benefits the labour market, as is also clear from Part 4 of the Report on the Environmental Economy. Experts commissioned by the Federal Environment Ministry have calculated that investments of around 30 billion euro, for example in climate-friendly technology and energy efficiency, will be necessary to achieve the German government's climate protection target.[24] Some 800,000 additional jobs are expected by 2030.
- The ecological tax reform increases energy costs and at the same time reduces labour costs by reducing pension contributions. As long ago as 2001 the German Institute for Economic Research (DIW), at the request of the Ministry of Finance, confirmed the positive employment effects of this reform. Experts estimate a net increase in employment of 250,000 jobs.
- Recent studies commissioned by the Federal Ministry of Economics show that, on balance, promoting renewable energy sources also creates jobs. The researchers from the German Aerospace Centre *(Deutsches Institut für Luft- und Raumfahrttechnik – DLR)* counted up to 120,000 additional jobs.
- The Federal Environment Agency has had a simulation calculation performed to determine what consequences the reallocation of coal subsidies to energy-saving building refurbishment would have: the gross domestic product would increase, 30,000 new jobs would be created on balance, and six million tonnes of carbon dioxide emissions could be saved.[25]

The examples show that many environmental policy approaches also benefit the employment market: saving energy, encouraging recycling and repair of products, refurbishing older buildings, increasing energy prices, promoting new technologies and innovations – all these create jobs. Sustainable environmental policy is aimed at changing ecological structures. The ones who profit from this are the suppliers of environment-friendly goods and services, and all those branches of industry whose environmental

24 Cf. Jochem et al (2008).
25 Cf. in this connection Federal Environment Agency *(UBA)* (2003).

Environmental protection training initiative

Demographic change, diminishing interest in engineering sciences and prejudices against careers in waste management or wastewater technology – many factors can result in there soon being a shortage of new applicants for careers in environmental technology. Even today the numbers of students completing many technical degree courses are dwindling, and careers in supply and disposal technology have to contend with image problems.

The initiative "Environment Creates Perspectives" launched in August 2006 is intended to fill the imminent training gap. More than 40 companies and associations in the field of environmental technologies and renewable energy sources have joined the Federal Environment Ministry's training initiative, promising over 6,000 additional apprenticeships by 2009. The aim is to safeguard Germany's "technical lead" in the long term by means of a "training lead". Creativity and commitment are indispensable resources for this – especially in a country poor in raw materials. Gaps in future training intake years would limit the growth prospects.

The Federal Ministry of Research, the Federal Institute for Vocational Training *(Bundesinstitut für Berufsbildung – BIBB)* and the German Industry and Trade Council *(Deutsche Industrie- und Handelskammertag – DIHK)* are taking part in the initiative in order to define the profile of the apprenticeship trades more precisely and to clarify the requirements regarding company and educational content. There are also plans to network and bundle the initiative with other programmes such as "Jobstarter", a funding programme for more traineeships, in an effort to recruit companies for in-plant training.

resource consumption is low. Environment-intensive industries and production processes, by contrast, face the challenge of improving their environmental efficiency and making appropriate changes to their products and production.

3. COSTS AND BENEFITS OF ENVIRONMENTAL PROTECTION

Key points at a glance

Germany spends about 1.5 percent of its gross domestic product on protecting the environment. The greater part of this is due to state and privatised public enterprises with a total of around 80 percent – only a bare 20 percent is due to the production industries. From the mid-1990s, expenditure by the production industries on environmental protection was in decline, but since 2000 it has stabilised at a lower level. On an international comparison Germany is thus among the leaders for total spending on environmental protection – and in mid field when it comes to environmental protection expenditure by industry.

The public debate often gives the impression that environmental protection is solely a cost factor. However, this is a short-sighted view: environmental protection usually pays in economic terms as well, because the benefits are greater than the costs. On balance, investments in integrated environmental protection technologies often lead to substantial savings in operational costs, for instance through lower energy and materials consumption or reduced waste management costs. Environmental protection also has numerous benefits at corporate level that are difficult to quantify, for example better image, reduced likelihood of major accidents, or economic benefits arising from exports of environmental protection technologies. Good quality of the environment is also a positive factor for an industrial location, enabling it to use the good image of a region to attract qualified employees.

Since environmental protection helps to reduce environmental damage, it also results in lower costs arising for society. There is a reduction in so-called external costs due to air pollution, water pollution or climate change. This can be assessed in economic terms as well. For example, the Renewable Energy Sources Act already generates savings from avoided environmental damage that are equal to the additional costs arising from the Act. By 2020 the annual saving in external environmental costs will probably be double the additional cost.

3.1 WHAT IT COSTS TO PROTECT THE ENVIRONMENT

Total expenditure on environmental protection

In 2005, industry, state and privatised public enterprises spent 34.1 billion euro on protection of the environment.[26] This corresponds to a mere 1.5 percent of the gross domestic product. More than half of this figure is borne by the enterprises responsible for the public water supply and disposal and waste management services that were formerly in the public sector. The state bears a further 23 percent of the expenditure, and only the remaining 19 percent is borne by the production sector.

By far the most money goes into water conservation and waste management, which are primarily the responsibility of the state and privatised public enterprises. These two categories account for 91 percent of all spending on environmental protection. A further eight percent of expenditure is due to air quality control, and roughly one percent to noise control. As collection of data on climate protection and energy efficiency spending did not start until 2006, no analyses are available yet.

In 2000, state and industry spent slightly less on environmental protection than in 1995, but since then expenditure has been gradually rising again (cf. Figure 13). According to DIW estimates, the environmental protection expenditure of 34.2 billion euro in 2006 was roughly the same as in 2005, excluding spending on climate protection and energy efficiency.[27]

Environmental protection spending by industry

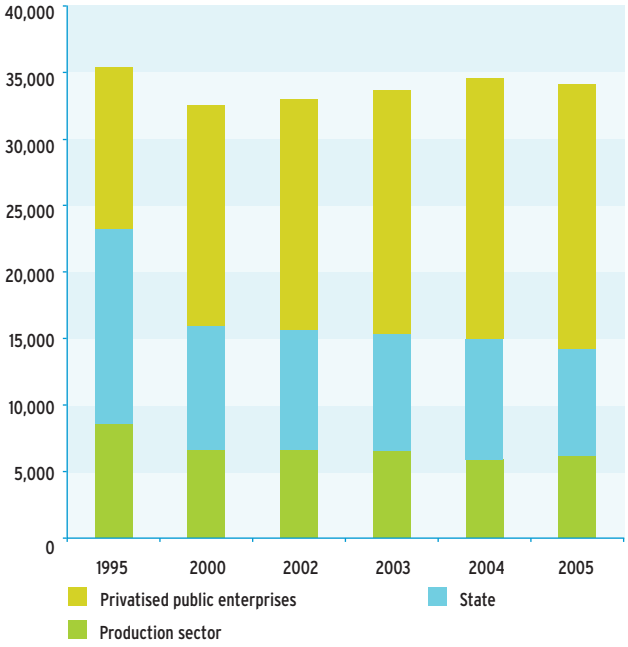
Expenditure by industry on environmental protection has been declining for years now. The share of national environmental protection expenditure that is borne by industry dropped from 25.2 percent in 1995 to 19.4 percent in 2004. Since 2003 there has been a clear downward trend in absolute terms as well: from 2003 to 2004 expenditure by the produc-

26 Cf. Federal Statistical Office *(Statistisches Bundesamt)* (2008b), figures for 2006 are DIW estimates. Cf. Edler et al (2008).
27 Cf. Edler et al (2008).

Underlying data

The Federal Statistical Office makes regular surveys of spending by the state and the production sector[28] on environmental protection measures in the classic environmental fields of waste management, air quality control, water conservation and noise control.[29] This spending comprises capital expenditure on environmental protection facilities[30] and ongoing expenditure on their operation. The most recent data available is for 2005. For 2006 the German Institute for Economic Research (DIW) has estimated total expenditure. International information on environmental protection spending is prepared by the OECD and Eurostat. The international data situation is very poor: some countries such as the USA have discontinued collection of such data, while in other countries the data is very out of date.

Figure 13: Development of spending on environmental protection (in million euro)



Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008b)

tion sector fell by 570 million euro, or nearly eight percent. This trend is continuing: in 2005 capital expenditure by the production sector was down a further 6.6 percent on the year before.

However, the Federal Statistical Office primarily collects data on additive environmental protection measures, which are only part of what industry actually spends on protecting the environment. At present the figures do not include expenditure on climate protection,[31] and integrated environmental protection is probably underestimated. For example, many process-oriented innovations serve to cut costs, but at the same time they have environmental benefits because they save resources and reduce emissions. The statistics on environmental protection spending do not take full account of such measures, and in some cases they do not include them at all.[32] A recent study in seven OECD countries (Canada, France, Germany, Hungary, Japan, Norway, USA) revealed that more than three quarters of the companies surveyed in these countries claim to invest primarily in integrated environmental protection measures.

Figure 14: Environmental protection spending by the production sector (in million euro)

Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008b)

28 The report does not cover expenditure by agriculture, construction, parts of the service sector and spending by private households.

29 Nature conservation, landscape maintenance and soil remediation account for a very small share, at only 2 percent of the total. As required by the revised Environmental Statistics Act, the Federal Statistical Office also covers environmental spending on climate protection, starting with the reporting year 2006. The first findings are not to be expected before the end of 2008.

30 As from the reporting year 2003, integrated environmental protection spending is also included.

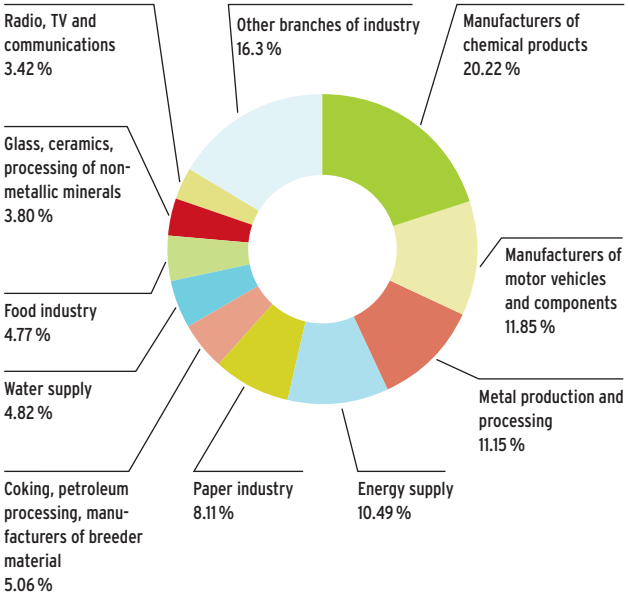
31 Climate protection is included as from the reporting year 2006. The Federal Statistical Office has not published any findings yet.

32 Cf. Frondel, Horbach, Rennings (2004).

Additive and integrated environmental protection

Additive investments relate to systems that are separate from the rest of the production process, such as incineration plants for waste, sewage works, noise barriers or exhaust air filters. Such measures are easy to identify and as a rule they are simple to verify in the accounts and hence for statistical purposes as well. **Integrated measures**, by contrast, form part of a larger system and are not clearly identifiable – recirculation of substances and cooling water, for example, or use of heat exchangers to recover heat of reaction.

Figure 15: Capital expenditure on additive and integrated environmental protection (2004)



Source: Federal Statistical Office *(Statistisches Bundesamt)* (2007b)

In Japan the share is the highest among the OECD countries surveyed, at 87 percent, while Germany has the lowest share of 58 percent.

Within the industrial sector, spending on environmental protection is highest in companies in the chemical, motor and metal industries (cf. Figure 15).[33] However, compared with other cost categories such as expenditure on materials and personnel, environmental protection spending plays no more than a minor role.

Environmental protection spending on an international comparison

On average, Germany does not spend much more than many other countries on protecting the environment. In most OECD countries the share of gross domestic product (GDP) accounted for by environmental spending is between one and two percent. Eurostat, the statistical office of the European Commission, estimates that the share of GDP spent on environmental protection in the European countries averages around 1.7 percent. The share of total expenditure that is borne by the industrial sector is on the low side in Germany compared with other countries.

3.2 HOW ENVIRONMENTAL PROTECTION CUTS COSTS

Environmental protection does not only give rise to costs in companies. On the contrary: by using sophisticated management techniques und integrated environmental protection technologies, companies can frequently achieve substantial savings. Opportunities to save money by means of systematic environmental protection exist in virtually all fields: in the energy, wastewater and waste sectors, in procurement, in packaging, production or product development.

For more than ten years the European Eco Management and Audit Scheme “EMAS” has proved to be an effective instrument in many companies. EMAS users generally achieve considerable savings and report a positive cost-benefit ratio. Thanks to this systematic environmental management, companies not only help to improve environmental protection at company level, but also contribute to achieving the societal goal of sustainable economic activity in Germany. Today there are hundreds of practical examples of companies which show that environmental protection measures frequently pay for themselves in a very short time. Integrated measures play a central role here. However, the benefits of corporate environmental protection go far beyond direct cost savings. It can prevent major accidents and industrial injuries, raise employee motivation, and improve the company’s image and legal security. And finally, an environ-

33 Cf. Federal Statistical Office *(Statistisches Bundesamt)* (2006a).

Some success stories from practical experience

- The energy consumption of Spandau printing works per unit of printed paper is well below the average for the industry. The location has been certified under EMAS since 1996, and since then its energy consumption has been more than halved by systematic environmental and resource management. In 2006 the Spandau printing works was awarded the title of "Environment-oriented company of the year" by the magazine "Druck und Medien". (Environmental Statement 2008, Axel Springer AG, Druckhaus Spandau)

- In 2007 the Bavarian regional building society *(Bayrische Landesbausparkasse – LBS)* reduced operational CO_2 emissions at its Munich facility by about two thirds compared with the year before. Implementation of the climate protection strategy is a central element of the corporate environmental commitment of BayernLB, and will continue to be pursued in the future: in 2008 operations by BayernLB at its Munich location are to have a neutral impact on climate. (Environmental Statement 2008, LBS Bayerische Landesbausparkasse)

- The brewery Aktienbrauerei Kaufbeuren AG has been certified under EMAS since 1999. In this time the brewery has completely replaced the boiler systems in its office building and home delivery garages. This enabled its oil consumption to be cut by more than one third. Its CO_2 evaporation was converted from electrical to water-bath evaporation. This made it possible to do without three large fans, eliminating their electricity consumption and the associated noise and draught problems. (Environmental Statement 2008, AKTIENBRAUEREI KAUFBEUREN AG)

- Environmental protection is of great importance in the PROSPER-HOSPITAL. The hospital is constantly working to improve environmental protection and thereby reduce its environmental impact. The measures bring financial rewards too. The conversion of the lift system brought an energy saving of 70 percent, and the installation of a new laundry system for bed-linen reduced water and energy consumption by 50 percent. (Environmental Statement 2008, Das Prosper-Hospital)

- Dr. Schaette AG, a company which develops, produces and sells animal health products and feed supplements based on natural raw materials for farm animals, introduced the EMAS environmental management system as long ago as 1996. Even after more than ten years of EMAS it is still possible to achieve further improvements. Last year the company saved about 81,000 litres of water, i.e. enough water to supply two 2 to 3-person households for a year. The saving last year was mainly due to a reorganisation of production which simplifies cleaning between product batches. (Environmental Statement 2008, Dr. Schaette AG)

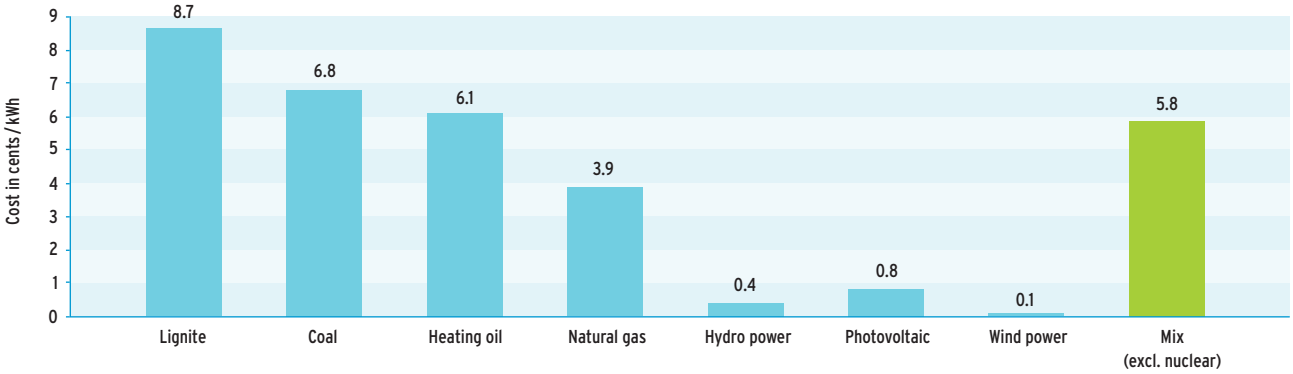
ment-oriented corporate policy is becoming an increasingly important criterion for investors and in bank credit ratings. This trend is being reinforced by environment-oriented scrutiny and rating of companies by rating agencies ("eco ratings").

3.3 ENVIRONMENTAL PROTECTION REDUCES FOLLOW-ON COSTS FOR THE NATIONAL ECONOMY

Poor air quality causes respiratory diseases, noise can result in sleep problems, polluted soils and water have to be cleaned – many economic activities give rise to environmental and health costs that are borne not by the polluter, but by the general public. Environmental pollution costs of this kind – also known as external (environmental) costs[34] – can range as far as climate effects that do not occur until the distant future. Thus environmental policy not only saves money at company level, but also reduces the follow-on costs to society of environmental pollution and health problems. The biggest factors responsible for environmental costs include generation of power from fossil fuels, and motorised transport.

34 External costs occur if economic actors cause negative effects or costs for third parties without taking account of them in their calculations.

Figure 16: Environmental costs of power generation (2005)



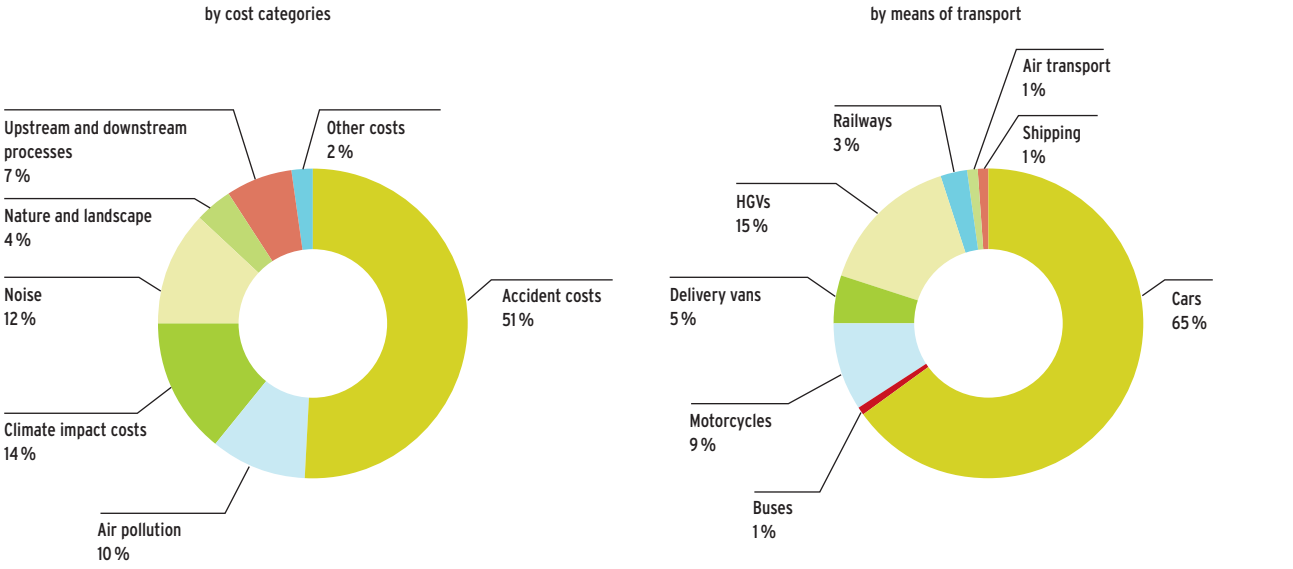
Source: Federal Environment Agency *(UBA)* (2007b)

According to estimates by the Federal Environment Agency[35], the annual environmental cost of power generation in Germany amounts to 36 billion euro. That is nearly six cents per kilowatt-hour of electricity. Fossil fuels are responsible for about seven cents per kilowatt-hour, whereas for electricity from renewable energy sources the figure is less than one cent (cf. Figure 16).

Harmful effects on human health and the environment occur primarily when fossil fuels are used. The atmospheric pollutants emitted – such as fine particulates, oxides of nitrogen and greenhouse gases – increase disease (asthma, coughs or bronchitis), damage buildings (external dirt) and contribute to climate change. These adverse effects occur at local, regional, national and global level.

Of course it is not possible to avoid environmental costs entirely, and this cannot be an objective of environmental policy. What is important, however, is that such costs are included in any overall economic assessment. Against this background, greater energy efficiency and the expansion of renewable energy sources are not only good for the climate, but also reduce economic follow-on costs by billions.

Figure 17: External costs of transport in Germany (2005)



Total costs: 80.4 billion euro

Source: Infras (2007)

35 Cf. Federal Environment Agency *(UBA)* (2007b); Federal Environment Agency *(UBA)* (2007c).

Figure 18: Average external environmental costs of road traffic (in cents per vehicle kilometre)

	Cars (fleet 2005)	HGVs (over 3.5 t)	Method
Climate costs	1.2	4.8	Method convention 70 euro / t CO_2
Air pollution	0.5	5.6	Health, material damage, crop losses according to ExternE (EU Commission 2005)
Nature and landscape	0.4	2.0	Cost of renaturing, restoration of waters, etc.
Noise	0.8	5.0	Health damage, rental price differences
Total environmentally relevant external costs	2.9	17.4	

Source: Federal Environment Agency *(UBA)* (2007c)

The external costs of transport in Germany add up to about 80 billion euro. According to an analysis for 2005 by the Zurich-based research institute Infras, 96 percent of these costs are due to road traffic. At least 40 percent of external costs are environmental follow-on costs[36] (Figure 17). External environmental costs of transport are an important indicator. They show in money terms what benefits environmental protection in the transport sector yields. For example, the state can lay down more stringent emission limits for vehicles or require manufacturers to install particle filters to filter out (harmful) fine particulates. The necessary capital expenditure or running costs have to be set against the benefits for health and environment. According to the Federal Environment Agency's calculations, car travel gives rise to nearly three cents per kilometre in environmental costs alone, and for heavy goods vehicles the average is more than 17 cents (Figure 18). In the case of cars, investing up to 3,000 euro per car in better protection of the environment would be justifiable in overall economic terms – because the external costs a car causes during its lifetime, assuming a total mileage of 100,000 kilometres, amount to 3,000 euro.

3.4 BENEFITS AND COSTS OF PROMOTING RENEWABLE ENERGY SOURCES

In 2007 a total of 87.5 billion kilowatt-hours of electricity was generated in Germany. This represents 14.2 percent of total power generation. For electricity suppliers – and hence to some extent for consumers as well – this meant additional costs (differential costs)[37] totalling 4.3 billion euro in 2007. Between 2000 and 2007 the apportionment[38] under the Renewable Energy Sources Act (EEG) rose from 0.2 cents per kilowatt-hour to 1.0 cents / KWh.

Figure 19: Costs and benefits of the Renewable Energy Sources Act (EEG)

	2007	2010	2015	2020
Cost of EEG (differential costs)	4.3 billion euro	6.3 billion euro	7.1 billion euro	5.9 billion euro
EEG apportionment	1.0 cent / kWh	1.5 cent / kWh	1.7 cent / kWh	1.5 cent / kWh
Cost to reference household (3,500 kWh / a)	3.0 euro / month	4.4 euro / month	5.0 euro / month	4.5 euro / month
External costs avoided	4.3 billion euro	no data	no data	>10 billion euro

Source: Federal Environment Ministry (BMU) (2008d)

36 Straightforward environmental follow-on costs include damage due to air pollution and noise, climate effects, damage to nature and landscape.

37 The differential costs defined in Section 53 of the Renewable Energy Sources Act are the difference between the tariffs paid and the average wholesale price of electricity. For power suppliers these costs are additional procurement costs which they pass on to the end customer via the electricity price.

38 The EEG apportionment corresponds to the calculated additional cost of the Renewable Energy Sources Act per KWh, assuming the costs are passed on completely and on a uniformly distributed basis.

The additional monthly cost due to the Renewable Energy Sources Act comes to barely three euro for an average household, or less than five percent of the electricity bill (cf. Figure 19). Grid expansion, administration and the additional cost of the control and reserve energy needed to equalise fluctuations in the output of photovoltaic and wind energy systems give rise to further costs. Experts put these at 300 to 600 million euro per annum.[39]

The economic benefit associated with the expansion of renewable energy sources does not have a direct impact at the company level.[40] External costs and environmental damage due to greenhouse gases and atmospheric pollutants are however considerably reduced by the growing abandonment of fossil fuels.[41] Estimates indicate that the Act reduced environmental damage by 4.3 billion euro in 2007 alone.[42] This means that the additional costs caused by the Renewable Energy Sources Act and the benefits assessed in economic terms work out much the same for 2007. However, not all the benefits of the Act can be quantified in economic terms: its positive influence on innovation and value added, for example, which goes hand in hand with the creation of extra jobs, ought to be included here as well. On balance, renewable energy sources gave rise to between 67,000 and 78,000 additional jobs in 2006.[43] The value of fuel imports, including biomass imports, fell by about one billion euro in 2007.

In the coming years we can expect to see a marked improvement in the cost-benefit ratio. If the expansion of renewable energy sources is maintained, the volume of environmental damage avoided should reach around 16 billion euro per annum by 2050.[44] Experts expect that from 2020 onwards subsidies will only be necessary for individual technologies such as photovoltaic systems and some of the energy from offshore wind farms.[45] According to estimates by the Federal Environment Ministry[46] the external costs avoided annually will then be nearly double the additional cost incurred in promoting renewable energy sources.[47]

Figure 20: Electricity bill of an average household

	2000	2002	2004	2005	2006	2007
Electricity bill euro / month (3,500 kWh / a)	40.67	46.99	52.48	54.23	56.63	60.31
Production, transport, distribution	25.15	28.32	31,56	32.73	34.53	35.70
Renewable Energy Sources Act	0.58	1.02	1.58	1.84	2.20	2.94
Heat / Power Cogeneration Act	0.38	0.73	0.91	0.99	0.90	0.85
Concession charge	5.22	5.22	5.22	5.22	5.22	5.22
Electricity tax	3.73	5.22	5.97	5.97	5.97	5.97
Value-added tax	5.61	6.48	7.24	7.48	7.81	9.63
Electricity bill at 2000 prices	40.67	45.45	49.41	50.07	51.44	54.23

Source: Federal Association of the Energy and Water Industries *(BDEW)*, calculations by Ifne

39 Cf. Diekmann (2007).
40 Cf. details in Federal Environment Ministry *(BMU)* (2008e).
41 For the methodology, cf. Federal Environment Agency *(UBA)* (2007b) and Krewitt et al (2006).
42 Cf. Federal Environment Ministry *(BMU)* (2008d).
43 Cf. Kratzat et al (2007).
44 Cf. Deutsches Institut für Wirtschaftforschung et al (2008).
45 Cf. Federal Environment Ministry *(BMU)* (2007d).
46 The estimate takes the revision of the Renewable Energy Sources Act into account.
47 Cf. in this connection Federal Environment Ministry *(BMU)* (2008d).

PART 2:
SUSTAINABLE MANAGEMENT

1. SUSTAINABLE MANAGEMENT – APPROACHES AND GOALS

Key points at a glance

Environmental resources are indispensable for the economy. But reserves of energy, raw materials, water and land are limited, as is the environment's capacity to absorb pollutants. Thanks to increasing productivity and cleaner production methods, consumption of almost all environmental resources in Germany has decreased over the past decade. In order to assess whether this development is sustainable, we need concrete details of the vision and objectives of sustainable management. At the level of the national economy, the German government's sustainability strategy with the objectives it sets out serves as a criterion for assessing the trend. The analysis shows that in most cases the trend is not yet sufficient to achieve the national sustainability objectives:

- Energy and raw materials productivity are moving in the right direction, but substantial improvements are still needed in the years ahead.
- On the climate protection front, Germany has already nearly met its commitment under the Kyoto Protocol to make a 21-percent reduction in greenhouse gas emissions by 2012 (compared with 1990). Further efforts must be made, however, to achieve the German government's more ambitious target of a 40 percent reduction in emissions by 2020.
- Land use for settlement and transport continues to increase, although the rate has slowed somewhat in recent years.
- Air pollution has fallen steadily since 1990. However, sufficient reductions have yet to be made in ammonia emissions, which are largely due to the agricultural sector.

1.1 THE ECONOMY NEEDS THE ENVIRONMENT – AN OVERVIEW

Sustainable management is a wide-ranging issue and one that is relevant to all social and economic processes. For a comprehensive treatment it would be necessary to throw light on all facets of sustainability. But this is not possible within the confines of a Report on the Environmental Economy. The following remarks therefore concentrate on the economic and environmental dimension of sustainability, focusing on trends in the use of the environment and efficiency in the production of goods and services.

The economy cannot function without making use of environmental resources such as energy, raw materials, water and land.
The environment

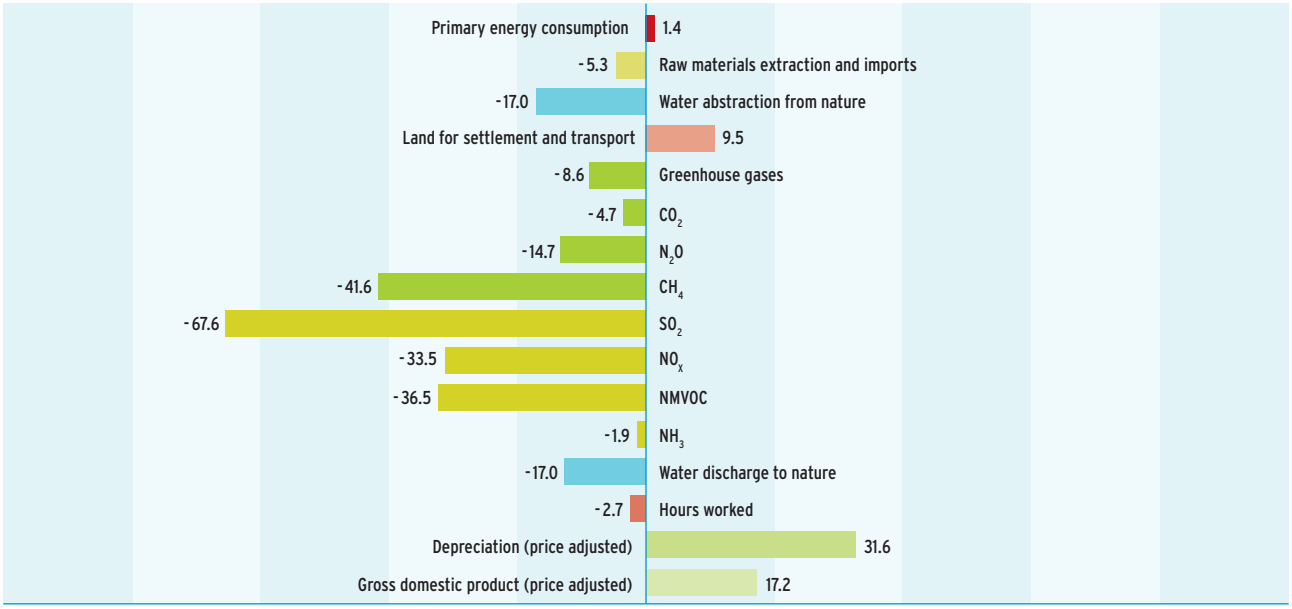
- serves as a setting and a base for economic activities;
- provides important inputs for production;
- absorbs air pollutants, waste and wastewater from production and consumption.

But there are limits to both the resources and the capacity of the environment to absorb residual substances and pollution. How we deal with this scarcity is the key question of management today. Forecasts indicate that the world's population will increase from the present 6.7 billion to 8 billion by 2025 and to 9.2 billion by 2050. With the increasing industrialisation of the emerging economies, the demand for resources is rising dramatically. But the industrialised countries' consumption of resources cannot be copied worldwide. The industrialised countries must therefore restrict their resource consumption and emissions faster than these are growing in the emerging economies and developing countries.[1]

Over the past decade the use of environmental resources[2] in Germany has fallen – with the exception of land take for settlement and transport purposes. Above all, there has been a substantial reduction in emissions of atmospheric pollutants (cf. Figure 1). The crucial question, however, is whether this trend is sufficient to permit sustainable management in the long term. To judge this we need a more concrete picture of the vision and objectives of sustainability.

1 For details see Part 3 – The markets of the future are green: chapters on energy efficiency and raw materials efficiency.
2 The Environmental Economic Accounts (EEA) provide further extensive information on economic use of the environment. Among other things, they present quantity trends over time – including broken down by households and production sectors. Source and further information: Federal Statistical Office *(Statistisches Bundesamt)* (2008b).

Figure 1: Changes in use of environmental resources for economic purposes (1995 – 2005) (in percent)



Source: Federal Statistical Office *(Statistisches Bundesamt)* (2007b)

Environmental resources are consumed both by private households and in the production of goods and services. The largest share of environmental consumption is accounted for by production. It is only in the case of land take – for settlement and transport purposes – that households lead the field. Their share of energy consumption is about a quarter, and just over one fifth in the case of CO_2 emissions.[3]

1.2 PRINCIPLES AND OBJECTIVES OF SUSTAINABLE MANAGEMENT

The idea of sustainability has a long tradition. As long ago as the 18th century the principle of sustainability became a guiding principle of forestry. In those days sustainable management meant not felling more timber than would grow again. Today sustainable development is taken to mean a management approach that meets the needs of present generations while maintaining the options and basis for life of future generations. This calls for sparing and efficient use of natural resources.

In other words, it is important to pay much greater heed to the future consequences of today's actions than is generally the case on the market. As a rule, market players act with short-term targets in view. Orientation to the vision of sustainability therefore makes it necessary to design the framework conditions to take account of long-term impacts and shortages (cf. Part 2, Chapter 4 – Environmental policy as economic policy). The German Bundestag's committee of inquiry into "Protection of man and the environment" defined principles and action guidelines for sustainable economic activity as follows:[4]

Principles of sustainability

- The rate of depletion of natural resources should not exceed their regenerative capacity (regeneration rule).
- Non-renewable resources should only be used to the extent that an equivalent substitute – possibly in the form of greater productivity – is created (substitution rule).
- Release Inputs of substances into the environment should be geared to its resilience (pollution rule).
- The time frame of anthropogenic inputs into and encroachments on the environment must bear a reasonable relationship to the time frame for the capacity of relevant natural processes in the environment to react (time rule).
- Dangers and unreasonable risks to human health due to anthropogenic influences are to be avoided.

3 For a detailed analysis of use of the environment by private households see Federal Statistical Office *(Statistisches Bundesamt)* (2006c and 2008c), and Federal Environment Agency *(UBA)* (2006 and 2006a).

4 Cf. Deutscher Bundestag (1998).

At the level of the national economy the German government's sustainability strategy adopted in April 2002 can be taken as a yardstick. It is not so much a theoretical position paper as a practical guide which states general requirements for ecologically, economically and socially balanced development. At its core are 21 indicators which are intended to show whether society and the economy are developing in a sustainable way.

National sustainability strategy – "Perspectives for Germany"

Intergeneration equity, quality of life, social cohesion and international responsibility are the four visions at the centre of the sustainability strategy. Clear quantitative targets and priority action areas are to help get closer to the vision of sustainable development. This means that here and now we should not live at the expense of people in other parts of the world and at the expense of future generations.
Some examples:

- Energy and resource productivity is to be doubled by 2020 compared with 1990. In other words more economic output is to be achieved with the same amount of energy.
- In the period from 2008 to 2012 emissions of climate-relevant greenhouse gases are to be reduced in accordance with the Kyoto Protocol by 21 percent compared with 1990.
- Renewable energy sources as a share of primary energy consumption are to rise to 10 percent by 2020, and their share of electricity consumption to between 25 and 30 percent.
- By 2020 new land take for settlement and transport purposes is to be reduced to 30 hectares per day.
- By 2010 the German government is seeking to reduce emissions of important air pollutants by 70 percent compared with 1990.

Additional information:
www.dialog-nachhaltigkeit.de

The following chapter deals with those indicators that relate to the direct use of environmental resources for economic purposes (cf. Figure 1).[5]

1.3 INDICATORS OF SUSTAINABLE MANAGEMENT[6]

Energy productivity

Indicator

Nearly every production activity consumes energy. Energy is also needed by private households for heating, travelling by car, and running electrical appliances. All this places a strain on the environment: landscapes, ecosystems, soils and rivers and lakes are polluted by the extraction of raw materials for energy and the emission of atmospheric pollutants and greenhouse gases during the combustion of fossil fuels. To ensure that economic development continues to be possible, economic output must be decoupled from energy consumption. The German government's sustainability strategy uses the indicator "Energy Productivity" to measure achievement of this goal.[7]

Goal

The German government is seeking to double energy productivity by 2020 compared with 1990.

Situation

Between 1990 and 2007, energy productivity in Germany has increased by nearly 40 percent (cf. Figure 2). This is an average of 1.7 percent a year. To achieve the goal of doubling energy productivity by 2020, energy productivity will have to increase by an average of 2.8 percent per annum in future. Important points of attack here are: improving the efficiency of coal-fired and gas-fired power plants, increasing the use of power plants with combined heat and power generation, reducing electricity consumption, energy-oriented building refurbishment, reducing fuel consumption by motor vehicles, and optimising traffic flows. The German government's climate protection programme takes up central issues here (cf. Part 4: Climate Protection).

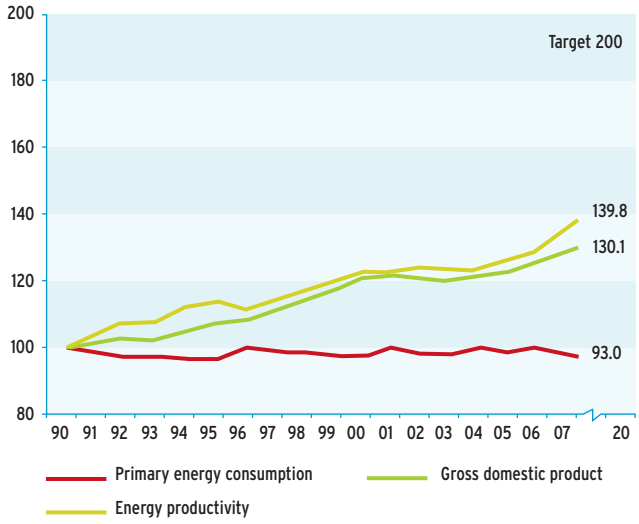
Resource productivity

Indicator

Non-renewable natural resources that are consumed today are no longer available to future generations. We must therefore make more sparing and more efficient use of raw materials. In its Environmental Economic Accounts (EEA) the Federal Statistical Office covers all resources removed from the environment and all pollutants emitted into the environment as a result

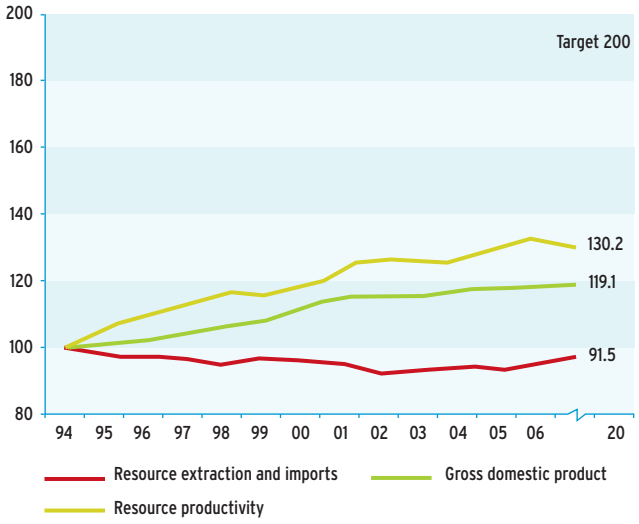
5 The sustainability strategy contains a total of 11 environmentally relevant indicators. These concern the topics: share of total energy consumption due to renewable energy sources, biodiversity and landscape quality, mobility, organic farming.
6 Cf. Federal Government *(Bundesregierung)* (2008).
7 Energy productivity is calculated from the ratio of gross domestic product to primary energy consumption.

Figure 2: Energy productivity and economic growth
(in percent)



Source: Federal Statistical Office *(Statistisches Bundesamt)*, Arbeitsgemeinschaft Energiebilanzen (AGEB)

Figure 3: Resource productivity and economic growth
(in percent)



Source: Federal Statistical Office *(Statistisches Bundesamt)*

of economic activities. This makes it possible to identify the extent and pace of the physical depletion of natural resources. Total input of resources and materials by the national economy is the reference quantity for the lead indicator "Resource Productivity".[8]

Goal

The German government is pursuing the aim of doubling resource productivity by 2020 compared with the base year 1994.

Situation

Between 1994 and 2006 resource productivity increased by slightly more than 30 percent: with input of materials falling (minus 8.5 percent), gross domestic product rose by 19.1 percent (cf. Figure 3). Since 2002, however, the increase in productivity has slowed down, and from 2005 to 2006 there was actually a slight fall in productivity. Although on the whole the indicator has moved in the right direction, the trend to date is not sufficient to achieve the target.

Various strategies can be used to achieve further increases in resource productivity. For example, one important goal is to increase the lifespan of products and design them so that the material can be reused. Non-renewable resources must gradually be replaced by renewable raw materials. We must also make technologies for resource-saving production methods available to the developing countries and emerging economies, because resource scarcity is a global problem.[9]

Climate protection

Indicator

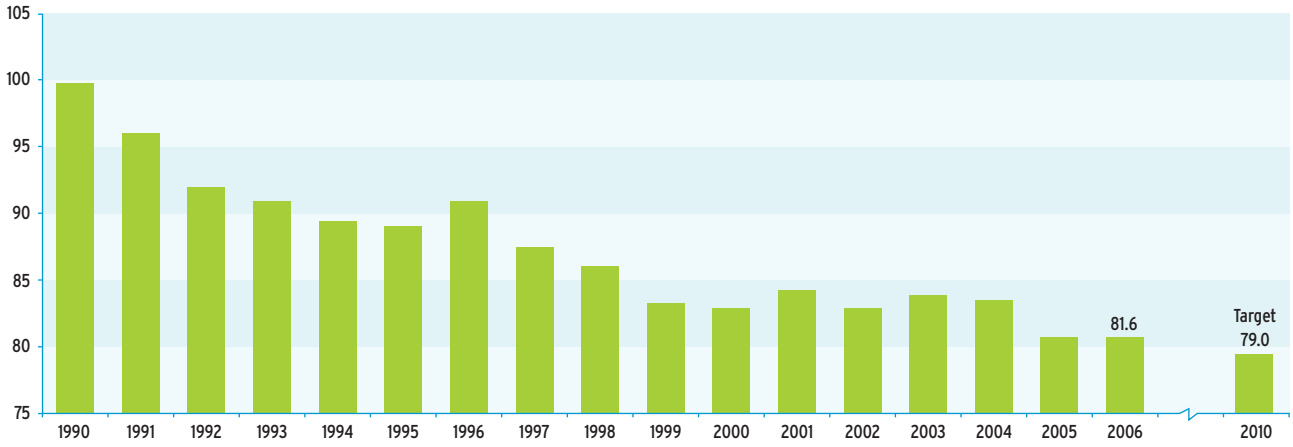
The threat of climate change is a great challenge. The rise in the concentration of various gases in the atmosphere since the start of the industrial revolution is reinforcing the natural greenhouse effect. It is caused by emissions that originate mainly from the burning of fossil fuels.[10] Non-energy production processes and consumer behaviour also play a role here. The principal greenhouse gases caused by man are carbon dioxide (CO_2), methane (CH_4), nitrous oxide / laughing gas (N_2O), chlorofluorocarbons (CFCs), perfluorinated and partially fluorinated hydrocarbons (FCs and HFCs), and sulphur hexafluoride (SF6). Reducing emissions of these gases is the object of international agreements – and also an important goal in the German sustainability strategy.

Goal

Under the Kyoto Protocol Germany undertook to reduce its emissions of greenhouse gases by 21 percent compared with 1990 between 2008 and 2012. The German government has also set itself the target of reducing greenhouse gas emissions to 40 percent below the level of 1990 by the year 2020.

8 Resource productivity is defined as the ratio of gross domestic product (in Euro, price-adjusted) to input of materials – measured as the exploited extraction of abiotic materials (in tonnes). It includes domestic extraction and imports of abiotic materials.
9 Cf. in this connection Part 3, Chapter 4: Resource and material efficiency.
10 Cf. IPCC (2007).

Figure 4: Greenhouse gas emissions in Germany (emission of six Kyoto gases in CO_2 equivalent, 1990 = 100)



Source: Federal Statistical Office *(Statistisches Bundesamt)*

Situation

Since 1990 Germany has made substantial reductions in its greenhouse gas emissions. By far the largest share of these emissions is due to carbon dioxide, which most recently stood at 87.6 percent. Compared with 1990, the greenhouse gas emissions expressed as CO_2-equivalents showed a drop of 18.4 percent by 2006 (cf. Figure 4). This means that only 2.6 percent points more are needed to reach the Kyoto target. Further efforts are however needed to achieve the targeted 40-percent reduction by 2020. Estimates indicate that the Integrated Climate and Energy Programme adopted by the German government would contribute a 36-percent reduction in greenhouse gas emissions by 2020.[11]

Land use

Indicator

Undeveloped and unfragmented land that is unspoiled by urban development is a finite resource. When land surfaces are sealed for housing and transport purposes, the soil can no longer perform its natural functions, biodiversity is reduced, and fertile, near-natural land is lost. Apart from these direct impacts on the environment, every new building in towns and municipalities also generates more traffic, leading to further environmental problems such as pollutant emissions, energy consumption and noise. What is more, new settlements need new infrastructure – which is technically complicated and expensive.

The German government has therefore included in the sustainability strategy an indicator of land take[12] for housing and traffic purposes.

Goal

The German government's target is that by 2020 not more than 30 hectares of new land per day are to be taken for housing and transport purposes.

Situation

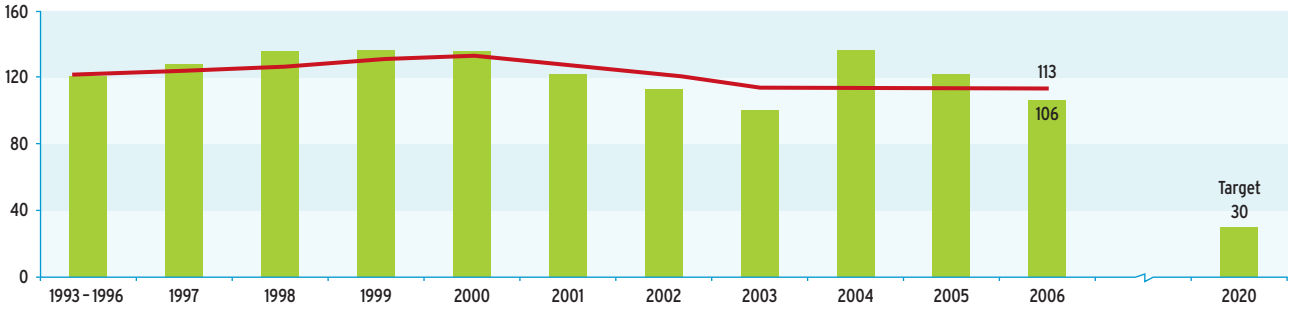
The growth of the area used for housing and transport purposes has slowed down in recent years. Nevertheless, the figures available to date indicate that this reduction will not be sufficient to achieve the target in view. Admittedly the data situation is not good enough to permit precise determination of the present trend. However, estimates indicate that land take fell slightly from 120 hectares per day during the period 1993 to 1996, to 114 hectares per day in 2006 (cf. Figure 5). But the total area used for housing and transport purposes is continuing to increase rapidly. Between 1992 and 2004 the area settled by private households increased by 22.1 percent, or 61 hectares per day.

By contrast, efforts to add more and more value with less and less developed land have met with success. Land intensity – the quotient of the settlement area used for production and the resulting (price-adjusted) gross value added – fell by 5.1 percent. Thus the increase in the settlement area used was smaller than the increase in economic output. However, this decoupling of macroeconomic production and land take is not due to more economical use of land in individual industries, but solely to changes in the structure of the economy: with a shift towards less land-intensive activities, such as the services sector.

11 Cf. details in Part 4.

12 New land take for settlement and transport purposes is measured in hectares per day.

Figure 5: Land take in Germany (increase in land used for settlement and transport, in hectares per day*)



* The land survey is based on an analysis of data from the cadastral authorities of the Länder which document actual use of land. As a result of changes in the cadastral records (reclassification of use types in the course of digitisation), the representation of land take at the current fringe is distorted.

Source: Federal Statistical Office *(Statistisches Bundesamt)*, Federal Agency for Construction and Regional Policy *(Bundesamt für Bauwesen und Raumordnung)*

Air quality

Indicator

Environmental protection has its origins in efforts to protect human health. A connection was established at an early stage between respiratory diseases and air pollutants, with the result that protective measures focused on reducing emissions of such pollutants. But air pollution also has adverse effects on ecosystems and biodiversity, especially if soils are overfertilised and become acid. Substantial reductions in emissions in Germany have been achieved since the 1980s by means of catalytic converters in spark-ignition engines and desulphurisation and NO_x reduction systems in power plants. Further efforts are nevertheless required. The indicator "Air Pollution" groups four major pollutants: sulphur dioxide (SO_2), oxides of nitrogen (NO_x), ammonia (NH_3), and non-methane volatile organic compounds (NMVOC).

Goal

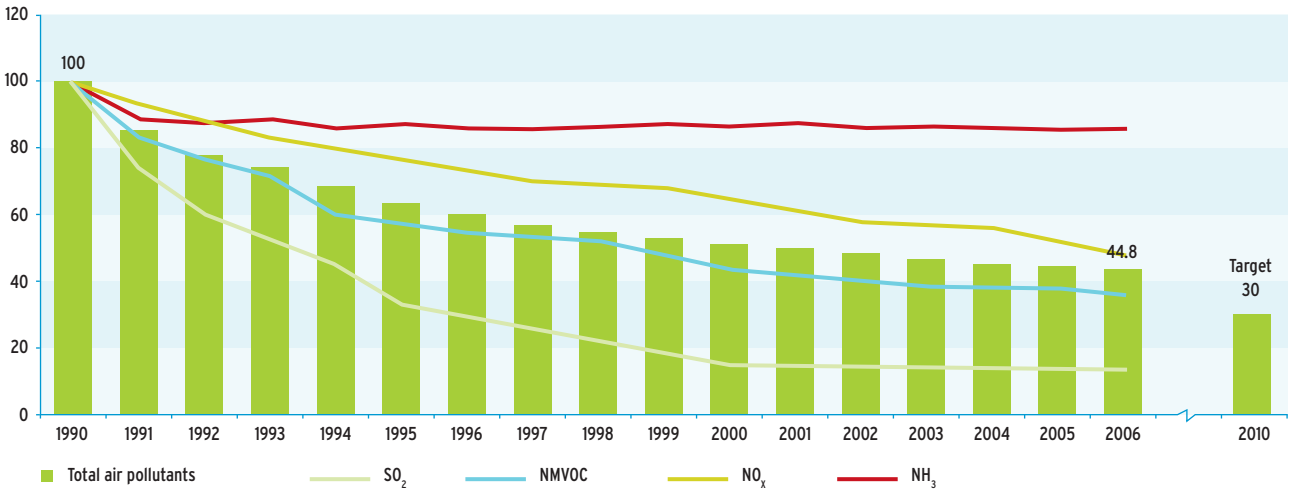
The German government aims to achieve a 70-percent reduction in emissions of the four air pollutants by 2010 (compared with 1990). Following completion of the negotiations on the EU Directive on National Emission Ceilings (NEC Directive), the German government will probably set a new target in 2009.

Situation

In 2006 emissions of air pollutants were already 55 percent down on 1990 – a welcome development. However, most of the sharp drop took place in the first half of the 1990s, whereas since 2000 emissions have only fallen by an additional six percent (cf. Figure 6). If the trend of the last few years is maintained, the target will not be met.

The individual emission types make different contributions to the trend. The biggest drop was in sulphur

Figure 6: Air pollution (Index 1990=100)



Source: Federal Environment Agency *(Umweltbundesamt)*

dioxide emissions, with a decrease of 89.6 percent. Factors contributing to this development were the desulphurisation of power plant flue gases, the partial replacement of high-sulphur German lignite by lower-sulphur fuels, and statutory limits on the sulphur content of liquid fuels. Emissions of non-methane volatile organic compounds (NMVOC) also underwent a substantial reduction of 64.2 percent during the period under review. The main reason here was the increasing use of catalyst technology in cars.

Emissions of nitrogen oxides have more than halved since 1990. Here too the catalytic converter played a significant role. Furthermore, a marked decrease was achieved at power plants with the aid of flue-gas denitrification systems. Emissions of ammonia, which originate almost entirely from the agricultural sector, have fallen by only 15.9 percent since 1990. The initial decline is due in particular to the reduction in livestock numbers in Eastern Germany in the wake of reunification. Since then this sub-indicator has shown little change.

1.4 CONCLUSION

Use of natural resources is an indispensable element of economic activity. This chapter has shown that use of the environment in Germany has shown a tendency to decline. At the same time the national income has increased, which means that use of the environment has become decoupled from economic growth. However, in most cases the trend is not yet sufficient to achieve the German government's sustainability objectives.

To be able to design successful measures it is important to analyse the causes. With regard to production – which is the focus of this report – this raises questions about the main groups responsible for use of the environment and about the reasons for the trend. Another important element in such a discussion is the question of whether we shift environmentally harmful production abroad to improve our own "balance sheet". Against this background the following chapter takes another look at selected indicators of the sustainability strategy (energy and resource utilisation, CO_2 emissions) and makes an in-depth analysis at the production level. The selection criteria are political sensitivity, importance at corporate level (e.g. as a cost factor or an element of strategy), and the data situation.

2. SUSTAINABLE PRODUCTION

Key points at a glance

Sustainable production calls for more economical use of environmental resources. One important starting point here is decoupling economic growth from environmental consumption, i.e. we must succeed in producing more goods with less environmental resources. Economic and environmental activity must focus much more strongly on the task of improving material productivity and energy productivity. The challenge of the 21st century is not the shortage of human resources, but the shortage of natural resources and the limited absorption capacity of our environment. Simply for economic reasons, it pays companies to devote greater attention to material and energy costs: in the manufacturing industry, average material consumption costs are as high as 40 percent of gross production value, whereas wage costs only account for around 25 percent.

Trends in energy consumption, CO_2 emissions and materials consumption in the production sectors paint a varied picture. Energy-intensive sectors in particular have succeeded in improving the efficiency of their energy consumption. This is also one reason why – according to the analyses by the Federal Statistical Office – the production of energy-intensive goods has not been shifted to other countries. Production-induced CO_2 emissions have dropped in response to improvements in energy efficiency and because there has been a substantial increase in the share of electricity generation due to renewable energy sources. As far as resource consumption is concerned, a number of material-intensive industries such as glass, ceramics, non-metallic minerals and metal production have made efficiency improvements, whereas other sectors such as electricity and gas production, construction, and food and drink have actually become even more material-intensive.

In general, the structural transformation taking place in Germany, especially the growth in service industries, has eased the burden on the environment: compared with other production sectors the provision of services involves lower energy consumption and lower inputs of materials.

2.1 EFFICIENT USE OF THE ENVIRONMENT – TAKING STOCK

Without exception, environmental productivity has improved throughout the economy in recent years (cf. Figure 7). Today the amounts of resources consumed and pollutants emitted to generate the same earnings are considerably lower than ten years ago. This is to be welcomed, both from an environmental and from an economic point of view, because efficiency improvements are frequently associated with an improvement in economic performance.[13] Compa-

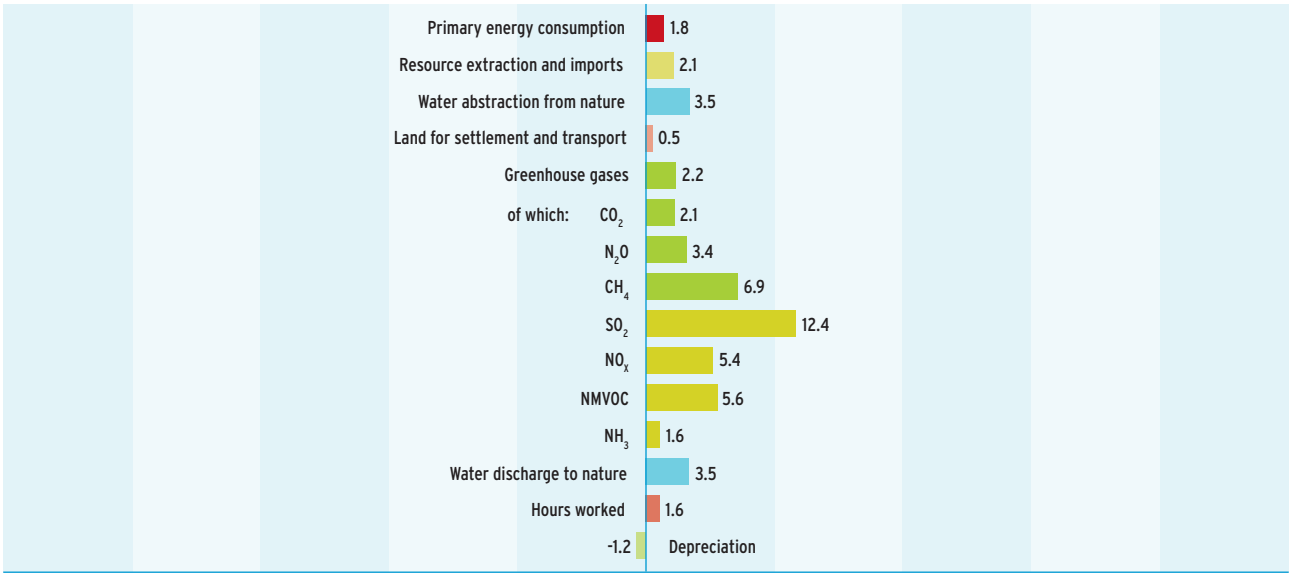
Productivity and intensity – indicators of efficiency

The productivity of an input factor such as energy, land or CO_2 emissions indicates how much economic output was produced by using one unit of this factor.

$$\text{Productivity} = \frac{\text{Gross domestic product}}{\text{Input factor}}$$

Productivity is an expression of how efficiently an economy uses labour, capital and the environment. Productivity increases if the gross domestic product increases with the same input of raw materials or energy , or if the same gross domestic product is generated with a lower factor input. The reciprocal of productivity is intensity: thus an increase in productivity means a decrease in intensity – the production process becomes more efficient.

Figure 7: Trend in productivity of environmental resource consumption (1995 – 2007) (average annual change in percent)



Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008a)

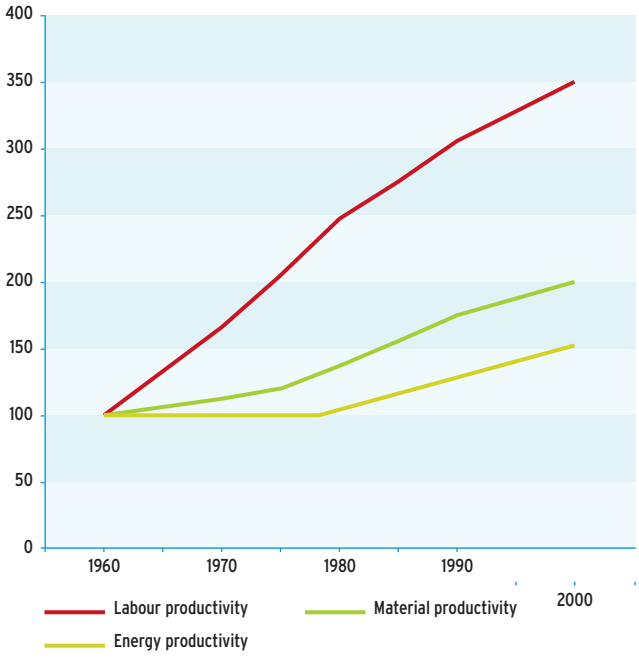
nies that produce more efficiently than their competitors have a competitive lead – especially at times of rising energy and raw materials prices.

In the past few decades, however, the factor with which companies have achieved most of their productivity increases has been labour. From 1960 to 2000 labour productivity increased by three and a half times, whereas materials productivity only doubled in the same period and energy productivity actually rose by only about fifty percent (cf. Figure 8). Falling labour input combined with growing national product is characteristic of industrial development over the last century. More than in other countries, productivity in Germany has improved at the expense of employment.[14]

In the long term this trend is not viable, either from a company point of view or at national level. Economic and environmental activity must focus much more strongly on the task of improving material productivity and energy productivity. The challenge of the 21st century is not the shortage of human resources, but the shortage of natural resources and the limited absorption capacity of our environment.

Simply for economic reasons, it pays companies to devote greater attention to material and energy costs: in the manufacturing industry, average material consumption costs are as high as 40 percent of gross production value, whereas wage costs only account for around 25 percent (cf. Figure 9). In a number of industrial core areas the cost of material accounts for more than half of the gross production value. For example, the motor industry, mechanical engineering and the food industry are particularly dependent on

Figure 8: Labour, material and energy productivity



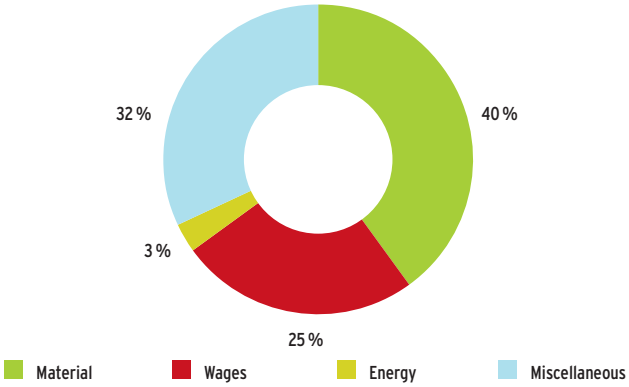
Trend versus 160=100 ("old" Länder)

Source: Federal Environment Ministry *(BMU)* (2007a)

13 In the short term this is subject to the proviso that the technologies for emission reduction / resource saving are also efficient from a cost point of view.

14 Cf. McKinsey (2007a).

Figure 9: Factor costs in the manufacturing industry



Source: Federal Environment Ministry *(BMU)* et al (2006)

raw material prices. In 2005 material costs in these industries accounted for 52.6 percent, 42.2 percent and 51.9 percent respectively.[15] The trend of rising energy and material prices means that in all probability this dominance will continue to increase.

Not only the level of raw material prices, but also the sizeable fluctuations increase the pressure on companies to cut their costs, push ahead with resource-saving innovations and replace raw materials. Quite a number of studies show that the field of material and energy savings still offers considerable unexploited potential for increases in productivity. Experts expect energy and raw materials prices to continue rising.[16]

Companies that are prepared for this will be better able to maintain their position on the market in the long term. And Germany, with its expertise in efficiency technologies, can claim an important locational advantage.

2.2 ENERGY CONSUMPTION AND ENERGY INTENSITY OF PRODUCTION

Energy consumption broken down by economic activities

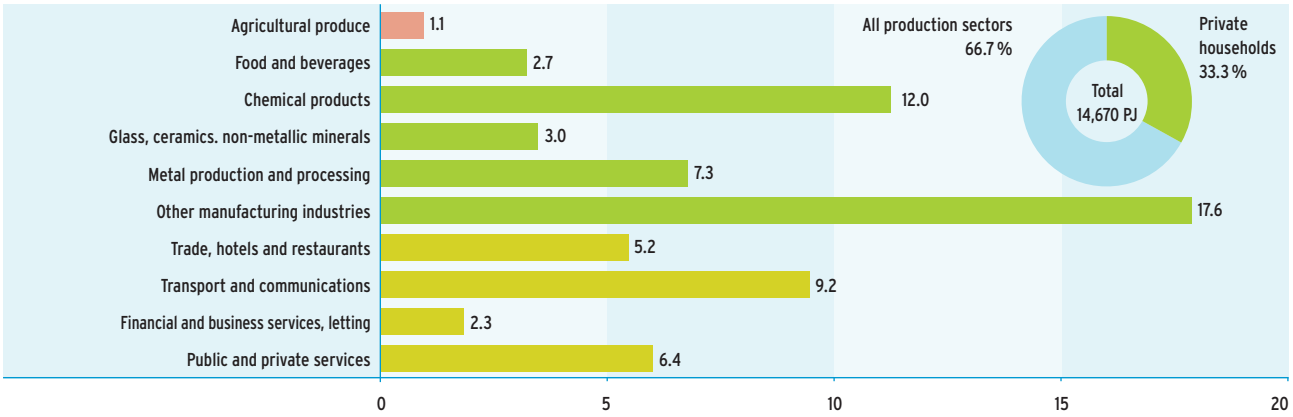
In 2006 two thirds of the energy used was accounted for by production, and one third by private households.[17] The most energy was used by the chemicals sector (12 percent), the steel industry (7.3 percent) and the service sector transport and communication (9.2 percent) (cf. Figure 10). The total share of energy consumption due to the services sectors came to around 23 percent.

Trend in energy consumption

Energy consumption in Germany fell by about 7 percent from 1991 to 2007. The trend was affected by fluctuations, however, for example as a result of energy price developments and annual temperature fluctuations.

Whereas energy consumption increased from 2005 to 2006, there was a very sizeable decrease of 4.8 percent from 2006 to 2007. Part of this drop is due to the relatively mild winter. But even after eliminating

Figure 10: Primary energy consumption by economic activities (2006) (in petajoules)



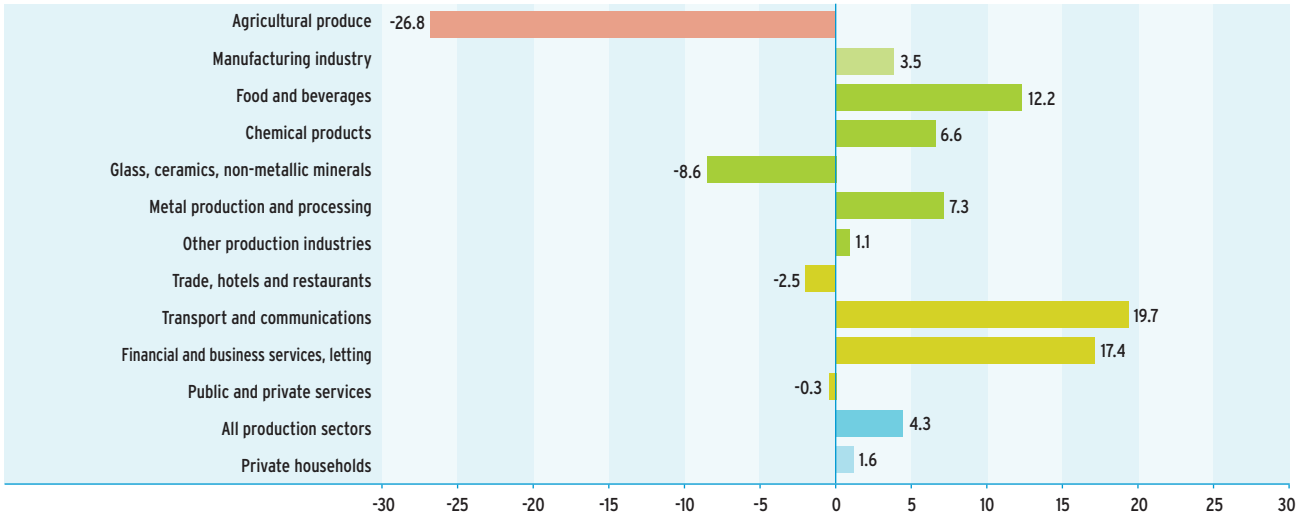
Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008a)

15 Cf. Federal Statistical Office *(Statistisches Bundesamt)* (2007d).

16 This emerges from a survey by the Centre for European Economic Research (*ZEW)* published in October 2007. According to the energy market barometer, more than 80 percent of the 200 experts in the fields of science, energy supply, trading and service companies predict a long-term increase in the prices of gas, crude oil, coal and electricity.

17 The data and analyses in this chapter are largely based on the Environmental Economic Accounts *(GEEA)* of the Federal Statistical Office. The most recent findings of the special analyses are currently available for 2005 and to some extent for 2006. Information on 2007 is available at the level of the national economy – for example on energy consumption or CO_2 emissions – but not broken down by the groups responsible.

Figure 11: Trend in primary energy consumption by economic activities (1995 – 2006) (change in percent)



Source: Federal Statistical Office *(Statistisches Bundesamt)*, National Environmental Accounts (2008a)

this influence, there is still a 3.7-percent reduction in energy consumption from 2006 to 2007.[18]

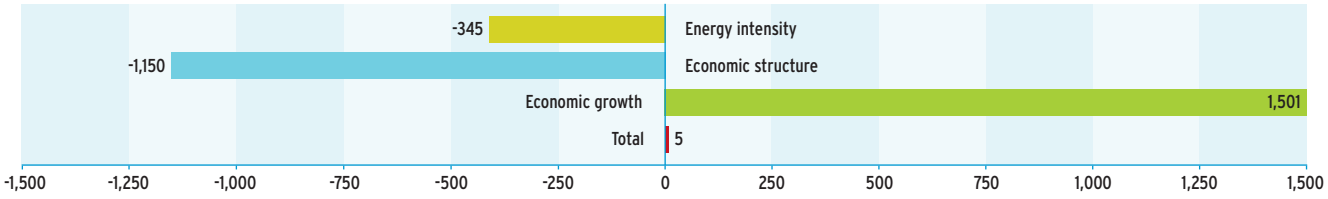
The following findings on the development of energy consumption in the individual product sectors are based on special analyses of the Environmental Economic Accounts which are only available for the period 1995 to 2006 (2005).[19] As a result they do not reflect the recent positive trends in the reduction of energy consumption.

From 1995 to 2006, energy consumption increased by 4.3 percent. In 2005 much less energy than eleven years before was consumed by agriculture, the non-metallic minerals industries, the distributive trades and the hotel and restaurant sector. By contrast, there was a sharp increase in energy consumption by the services sectors transport and communications, and by business-to-business services.

However, the development of energy consumption in absolute figures is not necessarily very informative. For example, if dwindling sectors such as mining and agriculture use less energy, this basically has nothing to do with more sustainable production. On the other hand, rising energy consumption may be connected with the growing economic importance of a sector. What is essential is information about whether production has become more efficient – i. e. using less energy per unit of goods produced – and whether there has been a structural shift towards less energy-intensive production. The reasons for the trend in energy consumption can be examined more closely by means of "decomposition analysis": this reveals what influence the factors economic growth, economic structure and energy intensity have on consumption.

The analysis (cf. Figure 12) shows that with conditions otherwise unchanged, economic growth would have

Figure 12: Factors responsible for the trend in energy consumption (change 1995 – 2004 by influencing factors in petajoules)



Source: Federal Environment Agency *(Umweltbundesamt)*

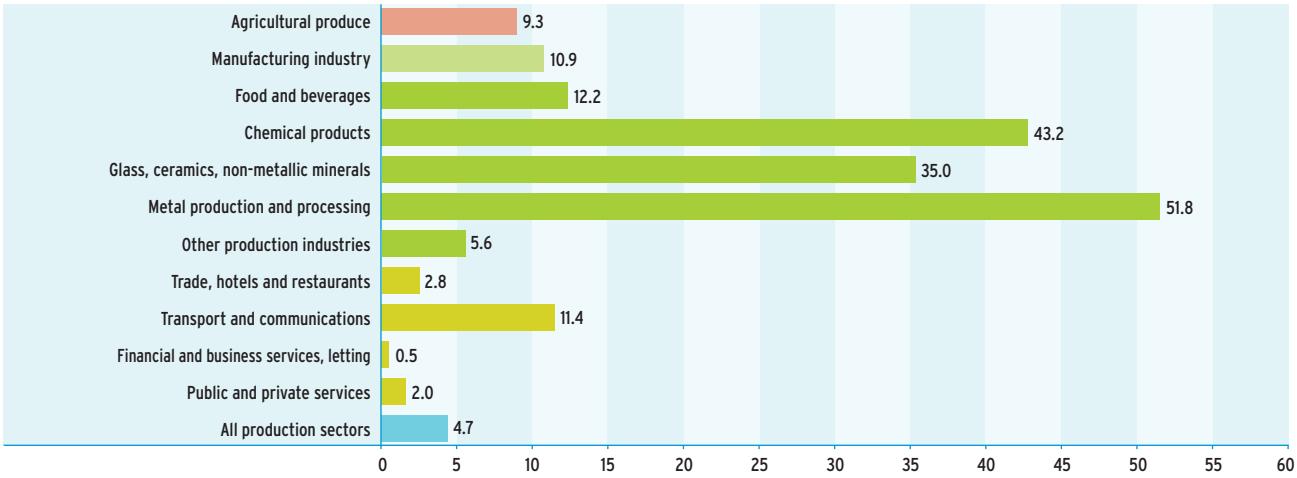
18 Cf. Arbeitsgemeinschaft Energiebilanzen (2008).
19 Cf. Federal Statistical Office *(Statistisches Bundesamt)* (2008b), to some extent special analysis for the Federal Environment Agency.

led to an increase in energy consumption of 1501 petajoules – which corresponds to the amount of primary energy from lignite power plants that is consumed in Germany in a year.[20] By contrast, the changes in economic structure exerted strong downward pressure on energy consumption owing to the increase in less energy-intensive production sectors. Thus on balance there was also a decrease in energy intensity, in other words production became more efficient. Taken together, these opposite trends resulted in almost constant energy consumption at the level of the national economy over the period 1995 to 2004.[21]

Energy intensity in the production sectors

Energy intensity in the various production sectors of the economy presents a very varied picture. On average, the manufacturing sector consumes nearly 11 megajoules (MJ) per euro generated. The metal sector with 51.8 MJ / euro and the chemicals sector with around 43 MJ / euro are particularly energy-intensive. In absolute terms as well, these two sectors are among the biggest energy consumers in the production sector in Germany (cf. Figure 10). Services, on the other hand, have a much lower average energy intensity (Figure 13).

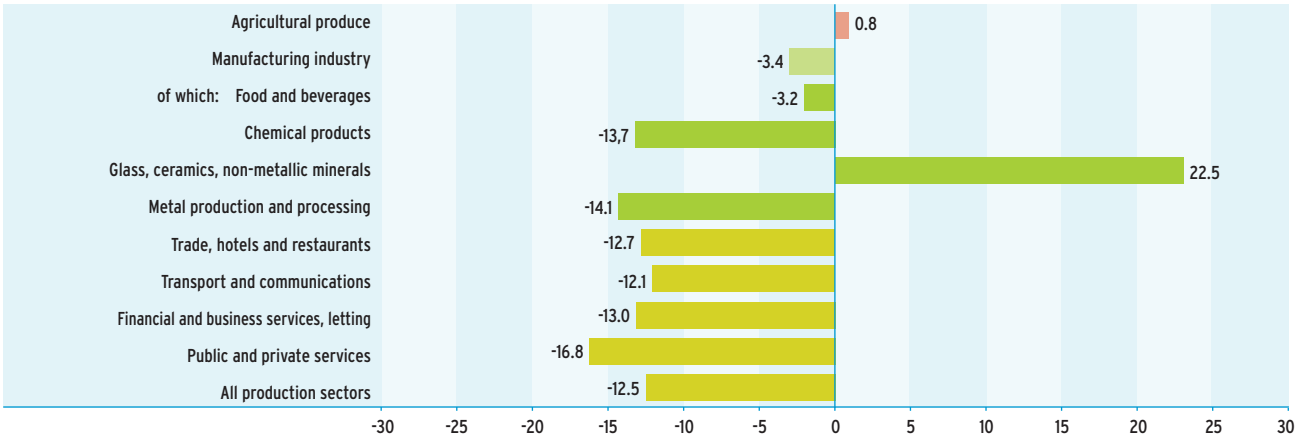
Figure 13: Energy intensity by production sectors (2006)



Energy intensity: Energy consumption (MJ) per euro gross value added (current prices)

Source: Federal Statistical Office *(Statistisches Bundesamt)*, National Environmental Accounts

Figure 14: Trends in energy intensity (1995 – 2006) (change in percent)



Energy intensity: Energy consumption (MJ) per 1000 euro gross value added (price adjusted)

Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008a)

20 Cf. Arbeitsgemeinschaft Energiebilanzen (2008).

21 The decomposition analysis is based on a special analysis by the Federal Statistical Office which is only available for the year 2004.

Trends in energy intensity in the production sectors

Between 1995 and 2006 the energy intensity of all production sectors together fell by an average of 12.5 percent (cf. Figure 14). This is a drop of nearly two percent per annum. At the same time – as explained in the previous section – there was a slight overall increase in energy consumption, which means that the reduction in intensity is due to the growth in the gross product.

In recent years energy efficiency has increased in the chemicals and metal production sectors in particular. The situation with regard to glass, ceramics and non-metallic minerals is a special case. The large percentage increase in energy intensity is mainly due to a change in the method of statistical data acquisition.[22] In terms of the national economy this has little impact, since this sector's share of gross product is relatively small.

Service providers achieved an above-average increase in their energy productivity, in other words their operations were less energy intensive. Factors contributing to the decrease in overall energy intensity included the construction and conversion of power plants, and energy savings in all sectors of the economy. The increasing economic importance of services also resulted in the growth being achieved on a relatively energy-saving basis.

2.3 CARBON DIOXIDE EMISSIONS AND CO_2 INTENSITY OF PRODUCTION

CO_2 emissions by economic activities

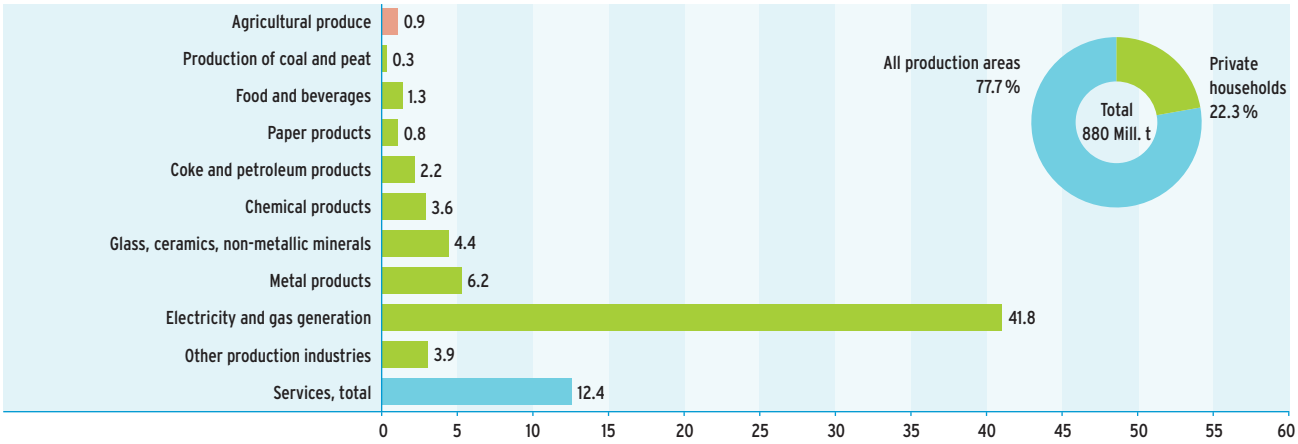
In 2007, total emissions of CO_2 equivalents by the economy as a whole came to 981.3 million tonnes.[23] At 87.6 percent, carbon dioxide accounted for by far the largest share.[24] A differentiated picture of CO_2 emissions broken down by economic activities is currently available for the years 1995 to 2006 only.[25]

More than three quarters (77.7 percent) of direct CO_2 emissions in 2006 were due to production, 22.3 percent to consumption by private households (cf. Figure 15). The biggest polluters here, at 40.9 percent, are the electricity and gas suppliers – primarily because they supply electricity to the other production sectors and to households.[26]

Trends in CO_2 emissions

Germany is one of the few countries that have succeeded in reducing their carbon dioxide emissions in the last decade.[27] In total, emissions were down by nearly 42 million tonnes (Figure 16). Direct CO_2 emissions by private households in Germany – e. g. emissions due to heating and transport – fell by 24.2 million tonnes between 1995 and 2006. Emissions by the production sector in Germany fell by 17.7 million tonnes.

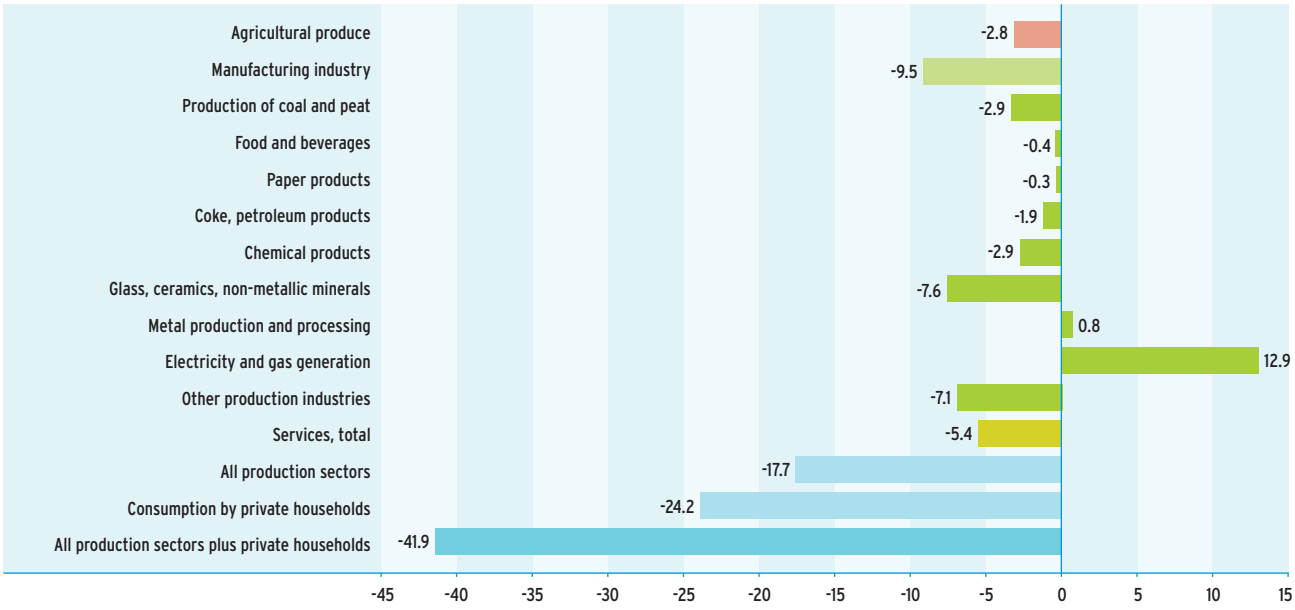
Figure 15: CO_2 emissions by economic activities (2006) (in percent)



Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008a)

22 Cf. Federal Statistical Office *(Statistisches Bundesamt)* (2008b).
23 Cf. Federal Environment Agency (UBA 2008).
24 For information on emissions of the greenhouse gases CO_2, N_2O and methane see Federal Statistical Office *(Statistisches Bundesamt)* (2007b).
25 Cf. Federal Statistical Office *(Statistisches Bundesamt)* (2007b).
26 As well as the presentation of direct emissions selected here, the emissions caused by power generation could also be allocated to end consumers (as in Chapter 2.2 Energy Consumption). Both variants can be found in the chapter on "Energy" in the EEA volume of tables on Environment utilisation and the economy (2007).
27 All in all, Germany reduced its greenhouse gas emissions by 20.4 percent between 1990 and the end of 2007, and has thus almost achieved the Kyoto target (minus 21 percent).

Figure 16: Trends in CO_2 emissions by economic activities (1995 – 2006) (in million t)



Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008a)

Most production sectors managed to reduce their CO_2 emissions between 1995 and 2006. Only the growth-induced increase in emissions in the major sectors metal production and electricity and gas production detracted from the reduction.

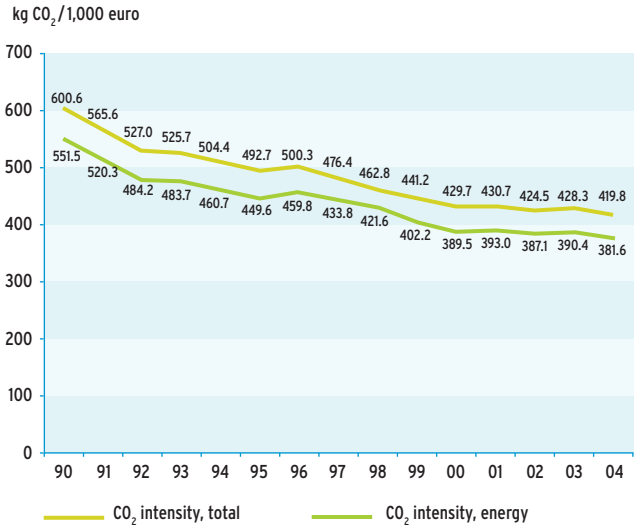
CO_2 intensities in the production sectors

In Germany carbon dioxide accounts for 97 percent of energy-induced greenhouse gas emissions.[28] Over the past 15 years both overall CO_2 intensity and the CO_2 intensity of energy production have fallen by around 30 percent (cf. Figure 17).

Since this period also saw an absolute reduction in CO_2 emissions and at the same time an increase in gross domestic product, economic development has been decoupled from CO_2 emissions. Several factors contributed to this: not only the increasing shift from solid to liquid or gaseous low-carbon fuels, but also the growing share of electricity generation accounted for by renewable energy sources, a reduction in conversion losses, improved efficiency in new plants, and numerous energy-saving measures.

Since 1990, CO_2 intensity has fallen faster than energy intensity. This means not only that the reduction in CO_2 emissions is due to lower energy consumption in the production sector, but also that energy production as a whole has a smaller CO_2 footprint.

Figure 17: CO_2 intensity of the German economy



Source: Federal Statistical Office *(Statistisches Bundesamt)* (2006b)

2.4 ENERGY-INTENSIVE INDUSTRY – NO MIGRATION ABROAD

Energy prices in Germany are considerably higher than in many other industrialised countries. On the one hand this provides companies with great incentives to make more efficient use of energy. This means they can cope with rising prices better than their competitors. On the other hand, some people

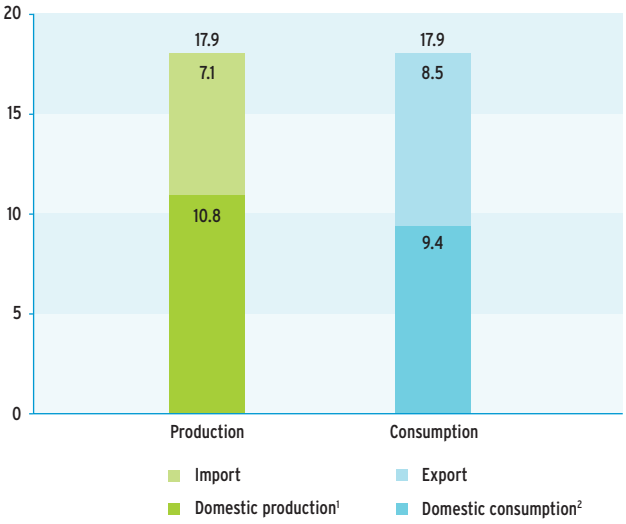
28 Cf. Federal Environment Agency *(UBA)*, October 2006, cited from UBA et al (2007).

have voiced misgivings that energy-intensive companies might transfer their production abroad because of high costs or import energy-intensive goods and intermediate products. Such a trend would have to be rated unfavourably from an environmental point of view as well, since the average energy efficiency of production abroad is likely to be lower than in Germany. To gain a complete picture of the efficiency of environmental utilisation, it is therefore important to analyse changes in foreign trade flows. Only this can show whether German companies are shifting their use of the environment to other countries.

A comparison between the production and the consumption view for the year 2006[29] shows that more energy (10.8 exajoules) was used in domestic production in Germany than for the manufacture of all goods consumed in Germany (9.4 exajoules) (cf. Figure 18). If, following the consumption approach, international energy consumption were attributed where the goods were consumed, then Germany would rank better than if the usual production-oriented approach were taken. The same applies to the resulting CO_2 emissions.

The analysis of foreign trade flows shows that, on balance, production of energy-intensive goods between 1995 and 2006 was not shifted abroad. Exports of important energy-intensive goods such as basic chemicals, plastic products, cement, glass and petroleum products were actually higher in 2006 than in 1995: their export surplus increased. Thus the improvements in energy efficiency have made the basic industries more competitive – which means a long-term locational advantage for Germany.

Figure 18: Energy input for production of goods in 2006 – production and consumption

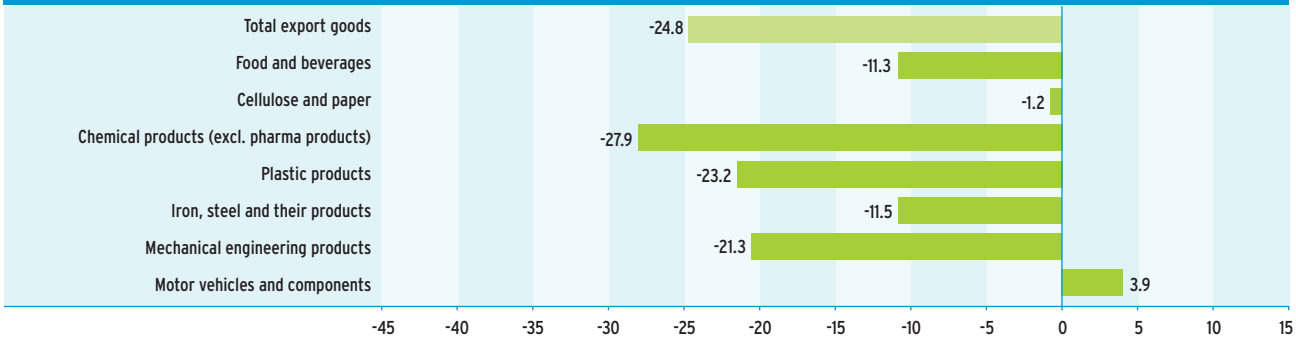


1 including export goods
2 including imports

Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008a)

Germany's strength is its exports. A large proportion of its growth is due to the steady rise in exports. Exports of energy-efficient goods have displayed above-average growth. The analysis by the Federal Statistical Office reveals that the energy intensity of export goods shows a particularly sharp drop compared with the average, in other words there has been an above-average increase in their energy efficiency. Whereas the energy intensity of export goods fell by an average of nearly 25 percent (Figure 19), the average figure for all production sectors was only 12.5 percent (Figure 14).

Figure 19: Energy intensities* of selected export goods (1995 – 2006) (change in percent)

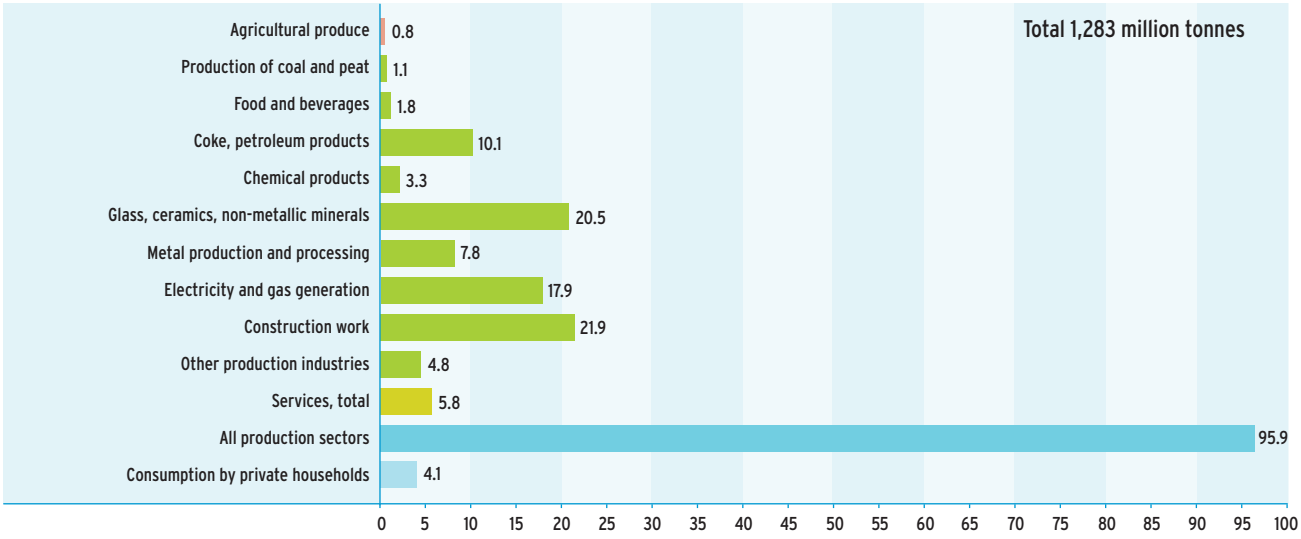


* Energy consumption (MJ) per 1,000 euro export value

Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008a)

29 The results are based on a special analysis by the Federal Statistical Office for the Federal Environment Agency in 2008. They are an update on the topic of "Environmental-Economic Aspects of Globalisation" and were presented and published in connection with the press conference on the Environmental Economic Accounts 2007.

Figure 20: Use of non-renewable raw materials by economic activities (2006) (in percent)



Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008a)

2.5 RESOURCE UTILISATION AND RESOURCE PRODUCTIVITY IN PRODUCTION

Resource utilisation broken down by economic activities

In its "Environmental Economic Accounts (EEA)" the Federal Statistical Office systematically registers the material flows in nature that are due to economic activities, for example the extraction of fuels, water, minerals, and also the removal of agricultural produce. Here the national input of non-renewable resources is the reference quantity for the lead indicator "Resource productivity" in the German government's sustainability strategy. Resource productivity is defined as the ratio of gross domestic product (in euro, price-adjusted) to input of materials – measured as the exploited extraction of abiotic resources (materials).[30]

1283 million tonnes of raw materials – within the meaning of the resource indicator – were consumed in 2005 as intermediate products in production and for consumption by households (cf. Figure 20). This is more than 15 tonnes per head of the population. 96 percent of raw materials are needed for production, four percent for consumption by private households. The largest share of raw materials is consumed by the production sector (89.1 percent), including in particular the industrial sectors glass, ceramics, non-metallic minerals, construction and power generation. Thus national input of raw materials and the development of the sustainability indicator are largely determined by development in these industries.

Trend in raw material utilisation

In 2005 consumption of raw materials by the production sector was considerably lower than ten years before. The most substantial reduction was in the most material-intensive sector – glass, ceramics, non-metallic minerals – followed by construction (cf. Figure 21). In all other production sectors the changes were only slight.

As in the case of energy consumption, the drop in environmental consumption may be due to various causes – for example a decline in production volume – and does not necessarily permit direct conclusions about more efficient use. To be able to draw such conclusions, it is also necessary to include the development of production volume in the analysis.

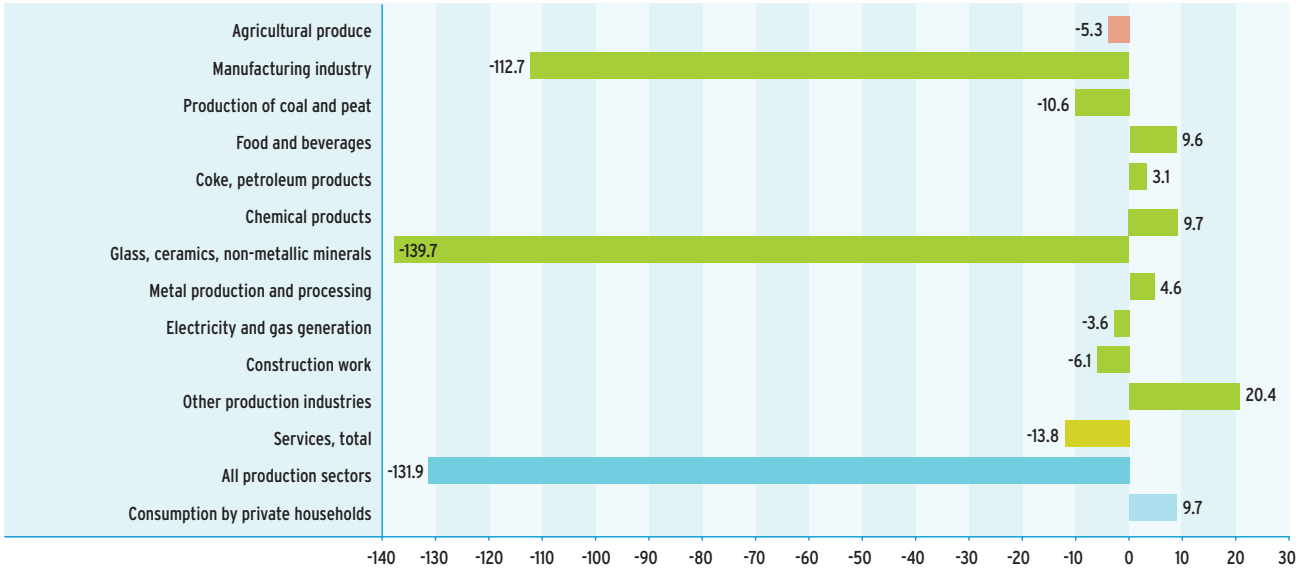
Material intensities in the production sectors

The resource indicator in the national sustainability strategy reflects the national aggregate efficiency of resource utilisation. How this develops at the level of the individual production sectors can be seen from the indicator of material intensity, which the Federal Statistical Office prepares on a differentiated basis in the context of its analyses on the Environmental Economic Accounts. This indicator is defined as material input per gross product and therefore corresponds – at the level of the production sectors – to the reciprocal of productivity. Thus the greater the productivity or material efficiency of production, the lower the material intensity.[31]

30 It includes domestic extraction and imports of abiotic materials.

31 The analysis shown here relates to material input as defined for the purpose of the resource indicator. Cf. Federal Statistical Office *(Statistisches Bundesamt)* (2007b).

Figure 21: Trends in consumption of non-renewable raw materials (1995 – 2006) (change in million tonnes)



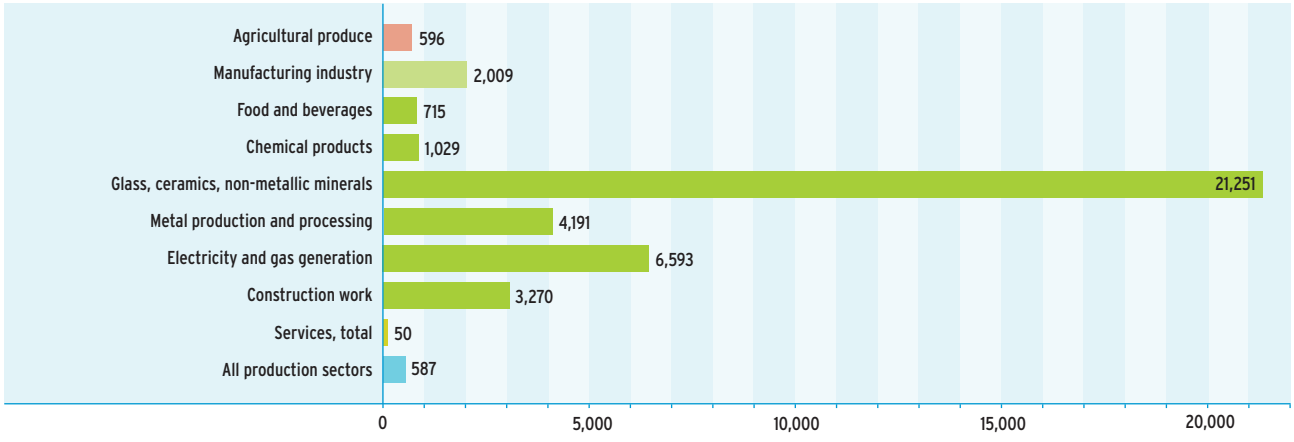
Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008a)

The comparison of industries reveals a wide range. Whereas the most material-intensive production sector – glass, ceramics, non-metallic minerals – consumes 21,251 kilograms of raw materials per 1000 euro gross production value, the services sector only needs an average of 50 kg (cf. Figure 22). The cross-industry average for the production sector is 2,009 kg/1000 euro.

The development of the figures from 1995 to 2006 (cf. Figure 23) does not reveal any clear cross-industry trend. The material-intensive sectors – glass, ceramics, non-metallic minerals and metal production – have become considerably more efficient. Another material-intensive sector – electricity and gas – also shows a slight improvement, but the situation for construction and food has deteriorated: the input of material per euro of gross product has increased. The services sector, which is in any case not very material-intensive, has become even more efficient.

Only the economic structure effect was responsible for the reduction in materials consumption (-351 million tonnes). This is due to the fact that the less material-intensive industries (especially the services sector) have grown, whereas industries with high consumption of material, such as the construction sector, have shrunk. However, economic growth and the overall increase in raw materials consumption acted in the opposite direction, with the result that materials consumption fell by only 124 million tonnes.

Figure 22: Material intensity by production sectors (2006)



kg material input per 1,000 euro gross value added (current prices)

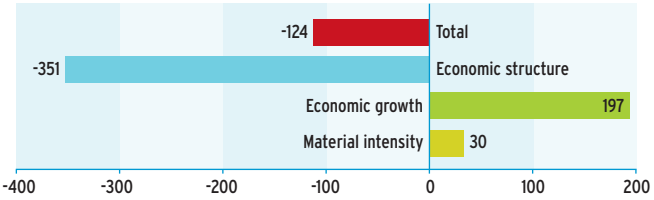
Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008a)

Figure 23: Change in material intensity by production sectors

Production sectors	Change 2006 from 1995 in percent
Agricultural produce	- 9.5
Manufacturing industry	- 15.2
of which:	
Food and beverages	45.0
Chemical products	5.3
Glass, ceramics, non-metallic minerals	- 12.4
Metal production	- 13.0
Electricity and gas	- 6.7
Construction work	26.7
Services	- 32.7
All production sectors	- 24.6

Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008a)

Figure 24: Factors responsible for changes in material consumption (change 1995-2006 by influencing factors in million tonnes)



Source: Federal Statistical Office *(Statistisches Bundesamt)*

3. CORPORATE SOCIAL RESPONSIBILITY: BALANCING ECONOMIC, ENVIRONMENTAL AND SOCIAL INTERESTS

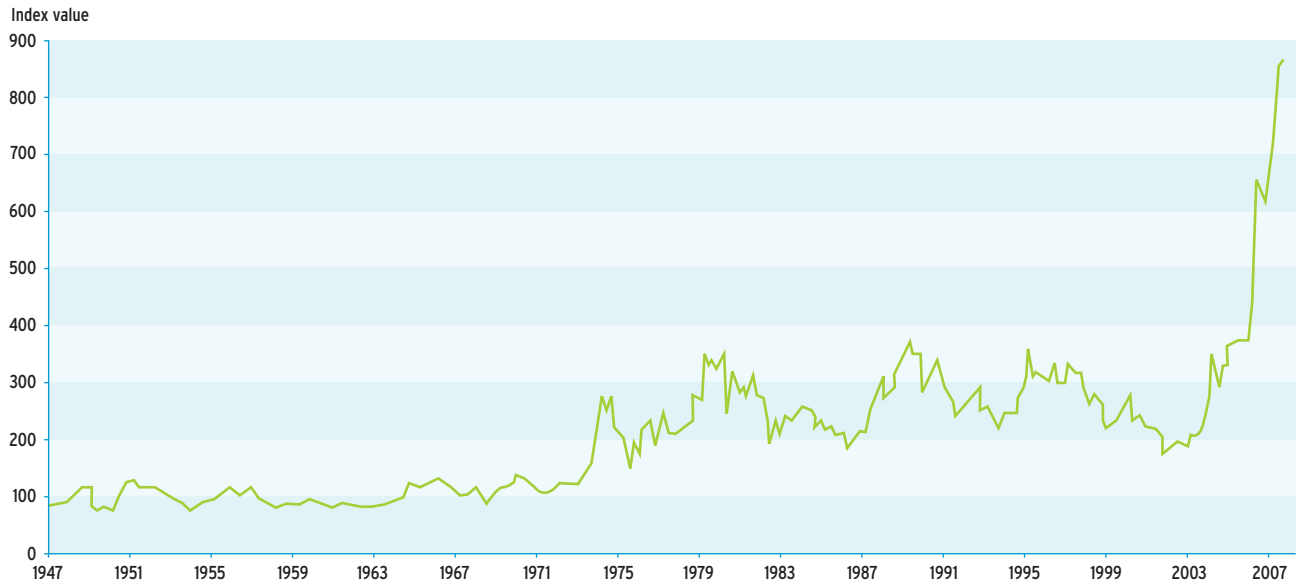
Key points at a glance

- Rapid economic globalisation and mega trends like climate change, scarcer and more expensive raw materials etc. and increasing pressure to justify their activities are presenting companies today with new challenges.
- Environmental protection and the assumption of social responsibility are becoming regarded increasingly clearly as strategic factors of business policy. At the same time catering for these factors offers considerable economic opportunities.
- A corporate strategy geared towards sustainability offers win-win-win solutions for the environment, society and economic success. There are already a number of principles, guidelines and instruments for credible, responsible company management that can serve as a orientation for businesses.
- Environmental management systems such as EMAS and concepts of Corporate Social Responsibility (CSR) can – if they impinge on all areas and functions of the business – support and focus corporate strategy and policy.

3.1 CHALLENGES FOR BUSINESSES

Today companies are facing great challenges: for one thing there have been major changes in the framework conditions for economic activity. Fiercer competition on prices and costs and global competition for locations are putting great pressure on business decisions. New rivals to be reckoned with in the global competition for market shares have arrived on the scene in the shape of India and China. There is also great pressure on costs. This is due to high energy costs, for example, but also to the fact that important raw materials are becoming scarcer and less readily available, and this leads to relatively high prices – as can be seen from the example of the trend in the metal price index. Even if the prices of crude oil and a number of raw materials have fallen again, the continuing demand from the strong young econo-

Figure 25: Trend in metal price index since 1947



Source: Federal Environment Ministry *(BMU)* (2008g): Megatrends der Nachhaltigkeit. Unternehmensstrategie neu denken.

mies in Asia for raw materials, semi-finished products etc., and the increasing scarcity of resources will lead to relatively high price levels in the future.

On the other hand globalisation, with its many and various impacts on national economic and social systems and on people's lives, has led to growing expectations about the responsibility of companies to regard themselves as part of society and to gear their activities to social challenges as well. The question being asked by the public, the financial markets and insurance companies is no longer simply what companies do with their profits, but also how they make their profits.

3.2 SUSTAINABILITY MEGA TRENDS

These developments, which quickly make themselves felt in companies, are joined by sustainability[32] mega trends that bring changes in ecological framework conditions: climate change, dwindling resources, global shortage of freshwater, loss of biodiversity, and deforestation and desertification. On the social front there are demographic change, worldwide population growth and increasing poverty.

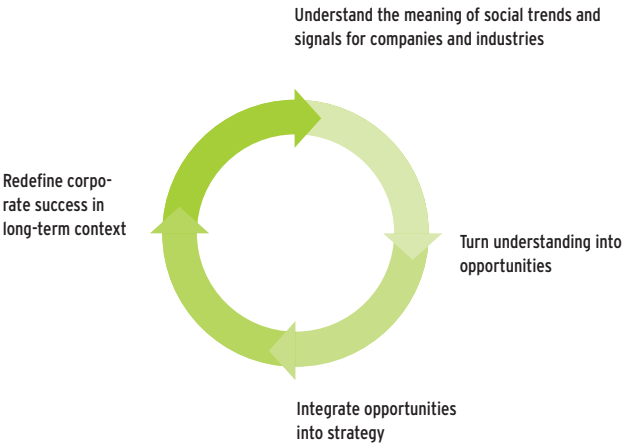
These mega trends and new contextual conditions for economic activity are already being perceived by many companies as risk factors, e.g. in the form of the rising energy and raw material prices mentioned above, shortage of qualified personnel, and specific demand on foreign markets.

Information about these mega trends helps companies to identify and assess risks and opportunities. To be able to take adequate account of such developments when developing strategies and making decisions, they need to change their traditional business models. The new challenges can be transformed into business opportunities: markets for renewable energy technologies and efficient drive systems, further training for older employees, resource-saving innovations or solutions adapted to the conditions in partner countries are all economic opportunities that can be set against the risks mentioned.

3.3 CONCEPTS OF SUSTAINABLE MANAGEMENT AS AN OPPORTUNITY

Today companies are faced with the task of combining business calculations with environmental and social goals. Under the new framework conditions outlined here, this is increasingly becoming an economic necessity. The great complexity of this makes itself felt in companies as an interface management and integration task.[33]

Figure 26: Strategic model for the company of tomorrow



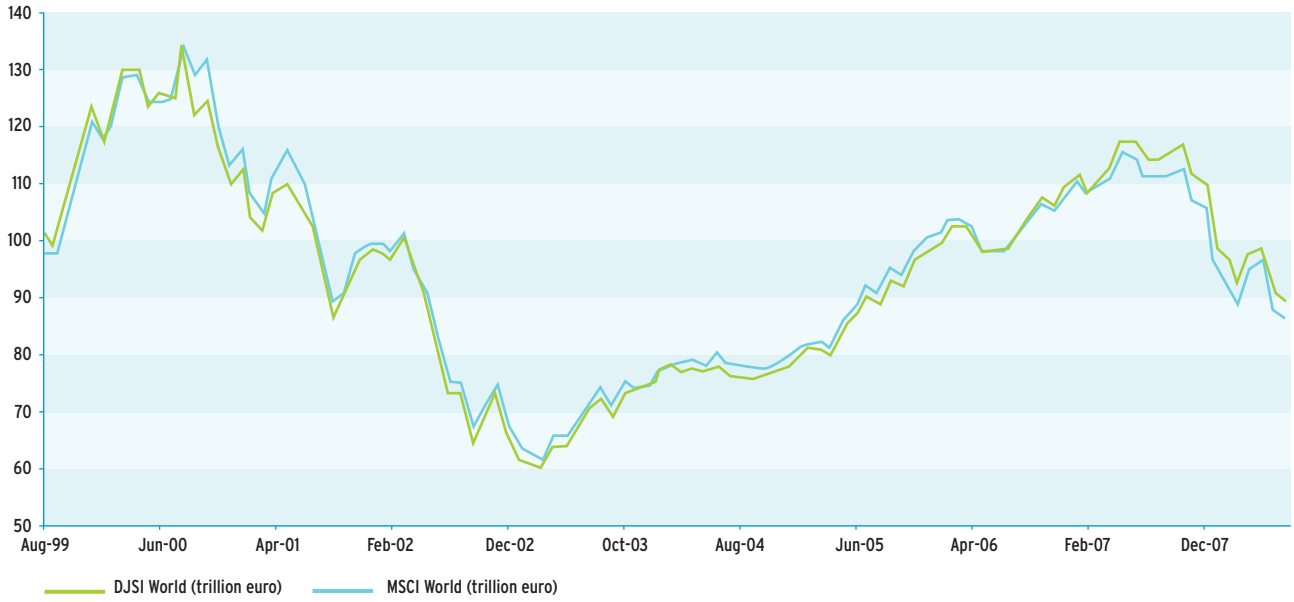
Source: Federal Environment Ministry (BMU 2008g)

Concepts of sustainable management and corporate social responsibility (CSR) may be an answer to such expectations.[34] In its communication of 2006[35], the European Commission described the social responsibility of companies as an ambitious concept "whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis. It is about enterprises deciding to go beyond minimum legal requirements and obligations stemming from collective agreements in order to address societal needs (...)". This means that acceptance of social responsibility by companies is not "business as usual", but goes much further!

Catering for environmental and social interests in company management has become a critical factor for the success of many businesses. This is because companies which make a substantial contribution to environmental protection, the well-being of their employees and the sustainable development of society not only meet the expectations of their customers and their clientele. They also do it in their own self-interest: they are putting themselves in a position to cope with the challenges of the future. This is a future characterised by rapidly changing structures, e.g. in sales or procurement markets, faster innovation cycles, or demographic developments.

32 Cf. Federal Environment Ministry *(BMU)* (2008g).
33 For measures and instruments, see the overview in: BMU / econsense / CSM (Ed.) (2007).
34 Cf. Federal Environment Ministry *(BMU)* (2008h).
35 Cf. COM (2006).

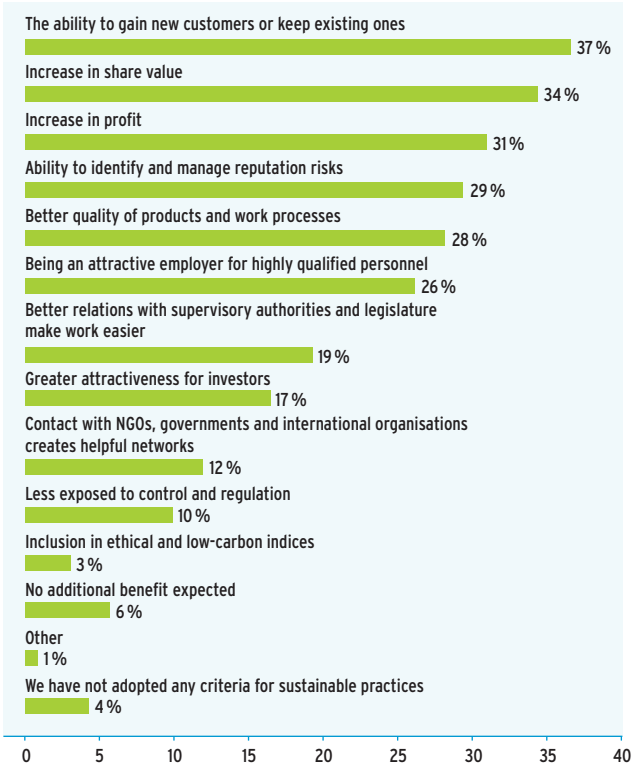
Figure 27: Dow Jones Sustainability World Index (DJSI World)



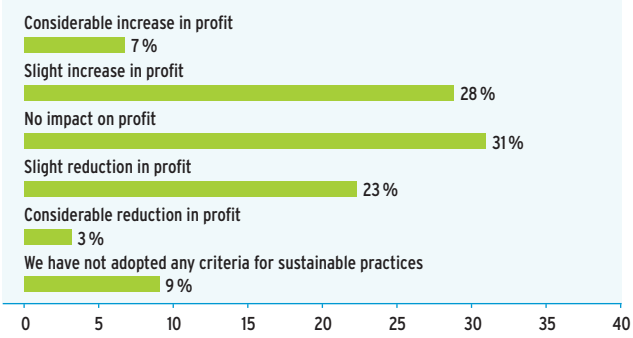
Source: SAM (2008)

Figure 28: Assessment of the contribution made by sustainable practices in companies

What are the biggest advantages that your organisation expects to gain by adopting the criteria of sustainable practices above and beyond what is prescribed by law? Select up to three items



What effects do you expect the adoption of criteria for sustainable practices to have during the next five years?



Source: Economist Intelligence Unit (2008)

Companies which adapt early on to these developments and associated expectations of society can be more successful, because they

- raise social acceptance of their activities,
- react faster and exploit competitive advantages,
- reduce their risks and thereby secure the continued existence of their company.

The future therefore belongs to those companies which make an active contribution to ethical and sustainable corporate leadership in their own country, and also at their international locations. Companies that are fit for the future display “Sustainability Leadership”!

Assessments by financial analysts and the results of company ratings make it clear that economic success and effective sustainability management go together in a company.

Indices like the Dow Jones Sustainability World Index can demonstrate the growing importance of sustainable management for business success, and over time they can confirm that such companies take a more robust approach to economic crises. Statements by company chairpersons also point towards a positive assessment of sustainable business practice. More than one third of the decision makers asked actually saw an increase in profits as a result of sustainability-oriented measures (see Figure 28).

3.4 PRINCIPLES AND INSTRUMENTS OF RESPONSIBLE COMPANY MANAGEMENT

Guidance for companies

There are not yet any generally recognised criteria to provide a guide to content for the voluntary implementation of responsible corporate management. The ISO 26000 standard, the content of which has been widely discussed but which will probably not be available until 2010,[36] will make an important contribution here.

There are already a range of principles and guidelines aimed at promoting corporate social responsibility, for example the ten universal principles of the United Nations Global Compact, which companies can undertake to comply with on a voluntary basis. The principles of the Global Compact are based on a worldwide consensus which derives from the Universal Declaration of Human Rights, the ILO Declaration on Fundamental Principles and Rights at Work, the Rio Declaration on Environment and Development, and the United Nations Convention against Corruption. The UN Global Compact asks companies to embrace, support and enact, within their sphere of influence, a set of core values in the areas of human rights, labour standards, the environment, and anti-corruption:

Figure 29: Principles of the Global Compact

Human rights

Principle 1: Businesses should support and respect the protection of internationally proclaimed human rights; and
Principle 2: make sure that they are not complicit in human rights abuses.

Labour

Principle 3: Businesses should uphold the freedom of association and the effective recognition of the right to collective bargaining;
Principle 4: the elimination of all forms of forced and compulsory labour;
Principle 5: the effective abolition of child labour; and
Principle 6: the elimination of discrimination in respect of employment and occupation.

Environment

Principle 7: Businesses are asked to support a precautionary approach to environmental challenges;
Principle 8: undertake initiatives to promote greater environmental responsibility; and
Principle 9: encourage the development and diffusion of environmentally friendly technologies.

Anti-corruption

Principle 10: Businesses should work against corruption in all its forms, including extortion and bribery.

Source: United Nations (2008)

The most elaborate and most comprehensive rules for socially responsible and environmentally aware corporate management are to be found in the OECD Guidelines for Multinational Enterprises. Updated in 2000, the OECD Guidelines contain recommendations on central areas of corporate responsibility (Figure 30). They contain voluntary standards for responsible business conduct in the fields of human rights, corruption, taxation, employment, consumer protection, environment, and disclosure of information.

Examples of the recommendations to companies in the environmental field include the following:

- establishing an efficient internal environmental management system,
- providing transparent environmental reporting,
- pursuing the precautionary principle,
- ensuring effective planning for emergencies,
- constantly improving environmental protection.

36 Cf. http://www.iso.org

Figure 30: OECD Guidelines

Basic duties of companies
Sustainable development, compliance with human rights, promotion of local capacity etc.

Information policy
Publication of an annual report, disclosure of information on social and environmental issues etc.

Employment policy
Compliance with core standards of the International Labour Organisation (ILO) etc.

Environmental policy
Establishment of environmental management systems and ensuring transparent environmental reporting, pursuing the precautionary principle etc.

Combating bribery
Refusal to accept bribes, transparency of anti-corruption measures etc.

Consumer interests
Ensuring fair business, marketing and advertising practices and ensuring safety and quality of goods and services etc.

Science and technology
Protection of intellectual property, know-how transfer

Competition
Observing the rules of fair competition, refraining from establishing anti-competitive cartels etc.

Taxation
Making a contribution to the public finances of the host countries, complying with fiscal regulations etc.

Source: OECD (2005)

The Guidelines are more detailed than other principles and indicate approaches to operational implementation. Recognised by all OECD member states and other non-member states, they are the only comprehensive code for responsible business conduct that has been adopted at multilateral level. Together with the other OECD states, Germany has committed itself to promoting these Guidelines. Thanks to this governmental recognition and the possibility of turning to national contact points and initiating mediation procedures in cases of infringement, the Guidelines have a more binding character. Companies that take their social responsibility seriously can adopt the OECD Guidelines as a minimum standard and starting point and give an undertaking to their stakeholders that they will comply with them. This does not of course exclude the possibility of companies setting an individual note when developing their own specific approach.

Elements of credible corporate policy

A targeted look at the social role of companies can support and simplify the necessary development of the core business processes. Essentially, the following thematic areas should be included:

- the company's vision and mission statement as a guide to and expression of its corporate philosophy,
- systematic control and integrated management,
- consideration of employee interests,
- attention to environmental protection and humane working conditions in the supply chain,
- dialogue with stakeholders,
- informing the public.

Vision and mission statement

If sustainable management and social responsibility are to be more than image maintenance and reputation management, company-specific environmental, social and ethical values need to be integrated as binding elements in the company's strategy and objectives. This can be done by drafting appropriate guidelines or by integrating such values in the existing corporate philosophy.

Systematic control and integrated management

A comprehensive and systematic management system is needed to organise responsible action in business processes so that the company not only avoids risks, but also seizes opportunities for sustainable development. To this end, companies must not only create the necessary organisational workflows, but should also provide the relevant human and financial resources.

A credible policy of sustainable management considers all areas and functions of business. Within their key business processes, companies need to develop innovative, economically viable and precautionary solutions for improving environmental protection and working conditions, and they need to take society's interests into account. A clear and lasting commitment by company management is therefore called for to ensure the implementation of ambitious environmental and social achievements. This will largely determine how rigorously such a structural organisa-

tion is designed within the company, because the cross-sectional task involves several fields of action and hence several different areas of the company (Personnel, Purchasing, Production, etc.). As a rule, integration in core business processes only functions if the areas concerned are suitably involved.

Involving employee representatives

The central fields of activity here are the working conditions of the company's own employees and, increasingly, those of the suppliers as well. Apart from personnel department staff, the employee representatives are the "natural" experts and should therefore be closely involved in innovation processes.

If the aim is to achieve resource-efficient optimisation of production processes, for example, this is not just a question of management, but also depends on involving the workforce, as they play a direct part in the processes. Thus, especially from a cost point of view, environment and labour are not opposites, but equal-ranking factors – particularly in a globalised world. Investment in education. qualification and training is the basis for successful innovation, research and technology and the international competitiveness of companies.

Responsibility in the supply chain

Globalisation of the markets has resulted in keener competition. Non-governmental organisations and critical customers believe that major groups in particular have a duty to ensure that this is not played out at the expense of the weakest vessels. They should ensure that humane working conditions are maintained and serious environmental pollution avoided in the production of raw materials and the manufacture of purchased products and components, i. e. they should take into account not only the economic, but also the environmental and social aspects within a supply chain or network. Sustainable supply chain management comprises the planning, control and monitoring of the entire flow of materials and services. It also includes the associated flows of information and money within a network of companies.

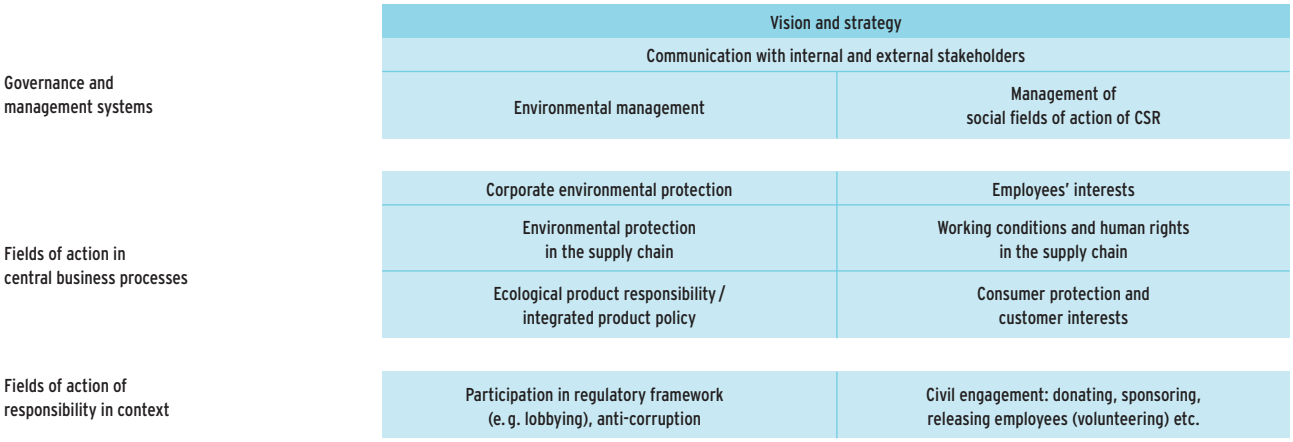
By means of active dialogue and cooperation with customers and with upstream and downstream businesses it is possible to ensure that the products are produced as close as possible to the demand; at the same time this makes it possible to minimise entrepreneurial risks. Past experience shows that consumers react extremely sensitively to these aspects in particular. With the public becoming increasingly critical, stories about child labour or intolerable conditions in "sweatshops" in the supply or production chain can result in substantial image and acceptance problems.

Stakeholder dialogues strengthen confidence in companies

Since stakeholders expect a lot from companies when it comes to environmental and social responsibility, consistent processes are needed to ensure conformity between external requirements and corporate guidelines and activities.

To be aware of these social expectations, companies must enter into a closer dialogue with their stakeholders. They should regularly identify and assess their stakeholders' demands with a view to drawing conclusions about any need for action. Furthermore, greater consideration of external points of view when developing and updating corporate strategy helps to identify risks and opportunities at an early stage.

Figure 31: Sustainable management is a cross-sectional task



Source: Federal Environment Ministry *(BMU)* (2008h)

Informing the public

Many companies publish regular reports about the impacts of their operations on the environment and society, and about the associated environmental and social activities. The titles may vary – from Sustainability Report through Corporate Responsibility Report to Environmental and Social Report – but the purpose of these publications is the same: the aim is to strengthen society's confidence in the company's activities by means of regular, full and transparent information. Even small and medium enterprises regularly present environmental statements or sustainability reports.

Sustainability or CSR reporting makes a crucial contribution to the implementation of a socially responsible corporate strategy – both externally and internally. Firstly, it indicates to external stakeholders how a company deals with environmental, social and economic challenges, and thereby creates the basis for trust and a forward-looking dialogue with them.[37] Secondly, continuous reporting does much to foster the necessary processes of change within the company, by accounting for developments and advances and making it easier to understand them.

Sustainability reports by companies have a long tradition in Germany. Since the beginnings in the 1980s, many large, medium and small companies have – on a voluntary basis – published sophisticated EMAS environmental statements[38] and sustainability reports about the environmental and, increasingly, about the social impacts of their activities. In those days Germany played a pioneering role internationally, but today other industrialised countries can also boast impressive statistics when it comes to reports of this kind.

This shows that many companies have realised that good and credible, and also internationally recognised reporting about their various sustainability and corporate social responsibility (CSR) activities is in their own interests. By this means they safeguard the acceptance of their economic activities that is indispensable for their future business success.

Any company can make the effort to present a transparent, credible and comparable picture of its economic activities and its environmental and social impacts. The reports should provide a full overview of the main aspects and should openly address problems or topical criticisms of the company. There is a trend towards presenting such reports not only on paper, but also increasingly as Internet-based sustainability reports.[39]

The "Sustainability Reporting Guidelines" of the Global Reporting Initiative (GRI) are the best-known list of criteria for sustainability reporting. They are regarded as the only internationally recognised cross-industry reference document to date.[40]

The following may be regarded as basic principles of sustainability reporting[41]:

Figure 32: Basic principles of sustainability reporting

Truth:
The statements in the sustainability report should be true. It is also important to provide a balanced presentation of positive and negative information, to permit a reasonable assessment of the company's sustainability performance.

Materiality:
The sustainability report should contain the relevant information about important aspects of sustainability. Mention should be made of any risks suspected on the basis of scientific findings. Explanations should be given of any missing facts and figures that are customary in the industry.

Clarity:
The sustainability report should be clearly formulated. The individual topics should be presented, structured and described clearly and comprehensibly.

37 The Institute for Ecological Business Research *(Institut für ökologische Wirtschaftsforschung – IÖW)* and the business association future e.V. assess the quality of the content and communication in socially-oriented reporting by the 150 largest German companies. Since 2001 they have carried out a ranking of sustainability reports. Assessment of these reports is based on an exacting set of 48 social, environmental, economic and communication-oriented criteria. IÖW et al (no year).

38 Cf. BMU, Umweltbundesamt (2007).

39 Cf. Isenmann / Gómez (2008).

40 See under http://www.globalreporting.org

41 Cf. Federal Environment Ministry *(BMU)* (2007e).

Continuity and comparability:
Temporal and geographical accounting limits should be documented and should cover the greater part of the company. To ensure comparability, the content of an organisation's sustainability report should normally retain the same structure. Survey and assessment methods should be used on a long-term basis and be published on the Internet. Indicators should be prepared on the basis of generally recognised definitions. The source of any benchmarks referred to should be cited.

Public access to information:
The sustainability report should be made available to the public. Anyone who is interested in the organisation's sustainability performance should be able to gain trouble-free access to the published information free of charge (on the Internet, for example).

Source: BMU (2007e)

Systematic environmental management as a core instrument of sustainable management

Systematic environmental management is a core element of comprehensive sustainability management in companies. The following are suitable candidates:

- the environmental management standard DIN EN ISO 14001 and
- the European Eco-Management and Audit Scheme (EMAS).

Environmental management standard ISO 14001

The ISO 14001 standard "Environmental management systems – Requirements with guidance for use" lays down globally recognised requirements for an environmental management system, focussing in particular on a process of continuous improvement.[42] The standard, in force since 1996, was revised in 2004. This set of standards of the ISO 14000 series for environmental management and instruments is suitable for worldwide use by all economic sectors and organisations.

In terms of content, the standard first requires the formulation of an environmental policy. This is followed by planning, and finally the environmental management system is introduced. Control and correction measures are initiated, and the system is then assessed. From now on the environmental management system undergoes a continuous improvement process designed to help achieve the objective in question. This can be certified by accredited certifiers under a private contract. The period for repeat certification is not explicitly laid down, but a three-year interval is usual.

EU Eco Management and Audit Scheme (EMAS)

The ISO 14001 requirements for an environmental management system are also a core element of the European EMAS regulation.[43] However, EMAS also requires compliance with the statutory provisions, an "environmental statement", special efforts with regard to environmental performance (continuous improvement, external communication) and the involvement of the workforce. Validation by officially appointed independent environmental verifiers, in other words an external view of the company, contributes to the great credibility of EMAS.

Companies believe that the review of compliance with environmental regulations which is carried out in the EMAS validation process is of special importance. The resulting improvement in legal certainty and the reduction in liability risks thanks to timely identification and rectification of any infringements of the law is becoming increasingly important in a context of complex business relationships.

In certain cases it is also possible for state authorities to grant simplified procedures in the enforcement of environmental legislation. Such simplifications may consist in reduced enforcement checks, and also in reduced licensing and monitoring fees for industrial installations.

EMAS regularly identifies economically profitable environmental protection measures, i.e. systematic detection of company resource and efficiency potential. Examples include savings on raw material inputs, reducing wastewater, waste and energy consumption by systematically checking workflows and processes.

The EMAS system provides numerous application-oriented guidelines and new ideas for structural changes in the field of management and controlling:

- The guide document on the selection and use of environmental performance indicators[44], published by the European Commission specifically for EMAS users, provides a number of indicators

42 VCf. ISO (no year).
43 Cf. OJ L 114 p. 1, of 24.4.2001, see under: http://www.emas.de
44 COM: Guidance on the selection and use of environmental performance indicators 2003/532/EG (OJ L 184 p. 19), 2003.

that can be used to measure eco efficiency. It also presents a system that shows companies how the various indicators are used in operational practice. This enables them to make continuous improvements in their energy and resource efficiency.

- The EMAS Energy Efficiency Toolkit for Small and Medium-sized Enterprises offers detailed, application-oriented instructions to allow SMEs to exploit cost-saving potential in the energy sector. It also contains model examples from business practice.[45]

- The "EMAS easy" Toolkit, which is available in several languages, describes how SMEs can achieve EMAS validation quite simply on 10 pages in 10 days with 10 persons. It also contains model systems for registering corporate energy and resource utilisation.[46]

- The office of the Environmental Verifier Committee offers an extensive list of target-group-specific practical guides to EMAS.[47]

ISO 14001 and EMAS are the environmental management systems in most widespread use. Participation in both systems is voluntary. Companies taking part undertake to improve their corporate environmental protection and thereby contribute to sustainable advances in the fields of environmental situation and quality of life – of their employees as well.

Some 6692 sites throughout Europe currently take part in EMAS – and the number is growing. For comparison: a year ago the figure for Europe was about 1000 lower. The number of participants in Germany has been stable for about two years, and currently totals 1907 sites (11/2008). In Europe as a whole, 68 percent of the sites are SMEs, and the same applies to Germany. The production sector accounts for roughly half the participants, and rapid growth can be observed in the fields of energy and water supply, transport companies, the service sector (e.g.: tourism) and public administration authorities.

In Germany some 4877 companies and establishments are certified under ISO 14001.[48]

Systematic environmental management as an engine for innovation

Increasing experience in environmental protection makes for a maturing process which in turn lays the foundations for further measures. Quantifiable targets are set, and these can be checked by means of environmental indicators. With its requirement to continuously improve environmental performance, EMAS creates a need to add to existing knowledge. This may be legal or substance-related knowledge, knowledge about methods, and social qualification. Such knowledge frequently originates at the level of the Environmental Officer and subsequently passes to top management. Thus environmental management may be regarded and used as the basis for an innovation management system.

Innovations which are based on a functioning environmental management system can be identified in various areas of the company, e.g. in its organisation, process workflows and in the product sector:[49]

Examples in the field of organisation:
- Introduction of environmental cost accounting,
- Inclusion of environmental components in the suggestions scheme,
- Initiation of processes for developing environmental targets and measures,
- Environmental benchmarking, life cycle assessments,
- Introduction of environmental R&D criteria,
- Use of goal agreement systems with environmental components,
- Integration of environmental evaluation procedures,
- Inclusion of environmental aspects in capital project appraisals,
- Introduction of environmental aspects in job evaluation.

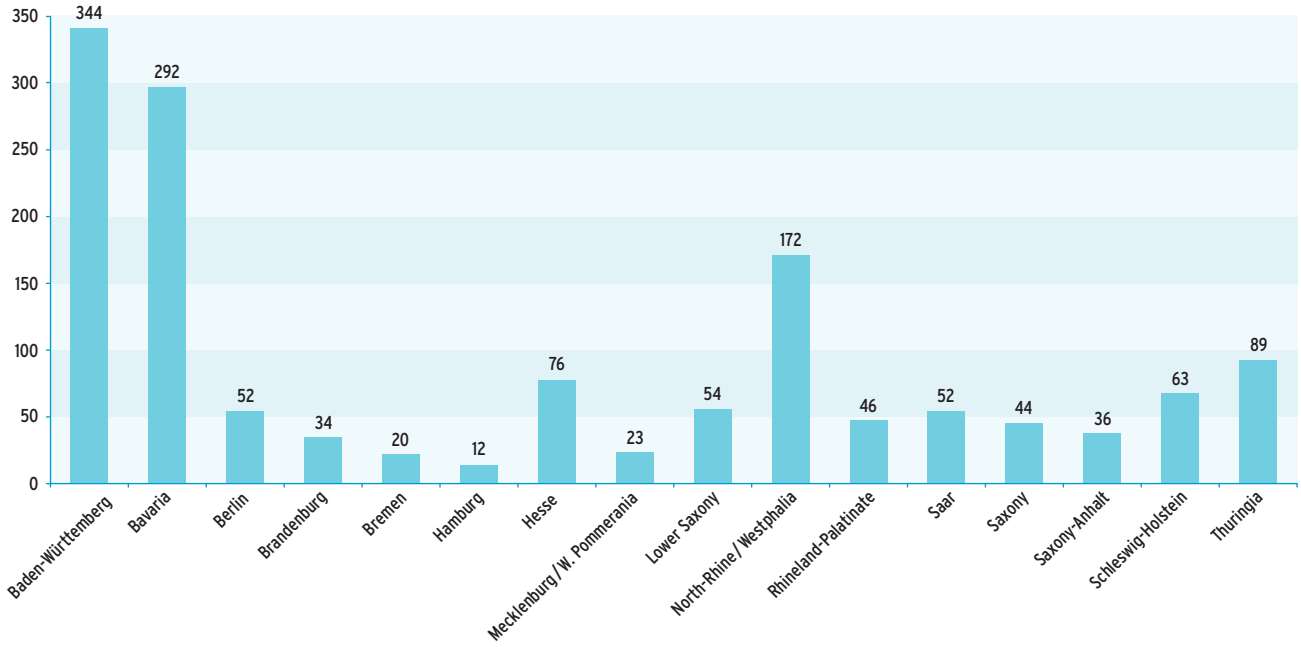
Measures designed to make innovative changes in process workflows and product planning are frequently set in motion as a result of environmental audits under EMAS and/or the use of indicators, as these can draw attention to weaknesses.

Examples of environmental process innovations:
- Measures in the fields of energy supply, recycling, waste management, supply chains, communication/reporting.

Product innovations frequently occur in the field of product-related organisational measures:
- Product planning with the aid of checklists or with the participation of the Environmental Officer,
- as a result of the introduction of environmental research and development criteria in product design.

45 COM: EMAS Energy Efficiency Toolkit for Small and Medium sized Enterprises, 2004.
46 For more information, see: http://www.emas-easy.de
47 Cf. EMAS (2006).
48 Cf. ISO (2008): The iso survey 2007; survey status December 2007. See under http://www.iso.org
49 Cf. for example Rennings et al (2005).

Figure 33: Number of EMAS registered companies / organisations in the German Länder (as of April 2008)



Source: Federal Environment Agency *(Umweltbundesamt)*, based on information from DIHK

EMAS is a modern environmental management system, but its potential in the companies is far from exhausted. EMAS supports innovation and competitiveness; its users act responsibly; it makes them fit for future challenges and is extremely useful in helping companies to accept social responsibility.

PART 3:
THE MARKETS OF THE FUTURE ARE GREEN

1. OVERVIEW

As we have seen in the first part of this report, the environmental economy is already an important economic factor. The development of this economic sector is still in its infancy, however, as environmental and efficiency technologies will play a key role on many markets in the 21st century. Especially on the "classic" markets – e.g. in the motor industry – the use of such technologies is becoming increasingly important and is a major determining factor for the competitiveness of a company. The former president of the Club of Rome, Prince Hassan of Jordan, put this in a nutshell: "The markets of the future are green".

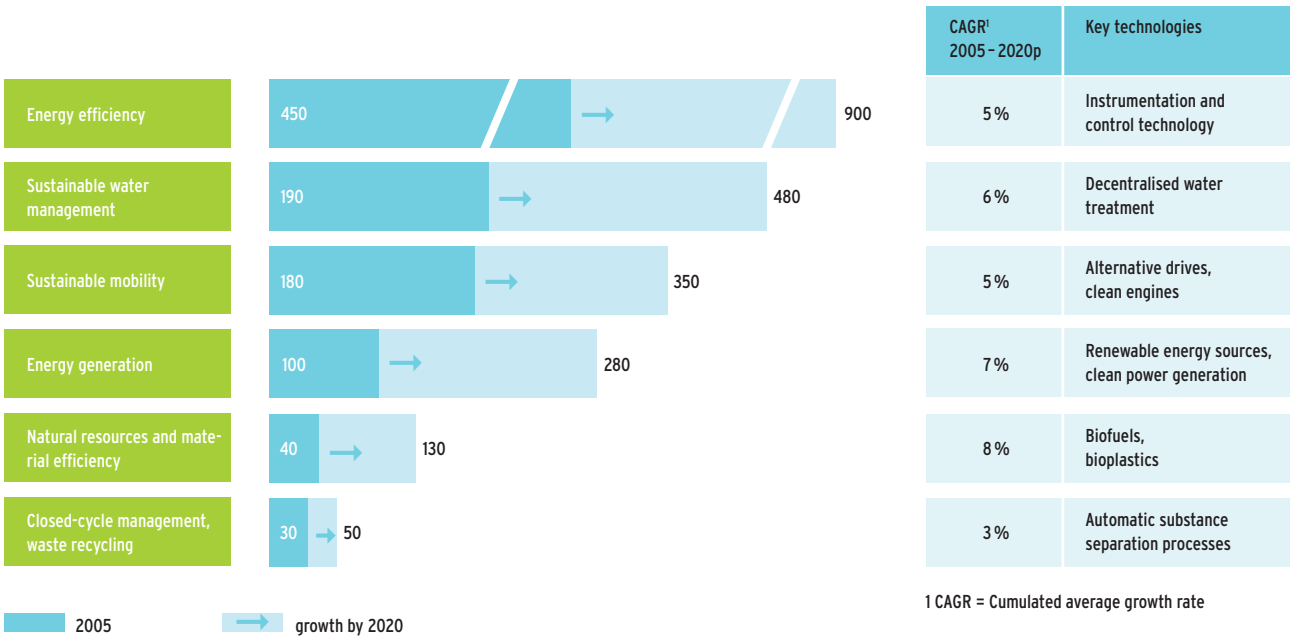
Global mega trends such as worldwide population growth, the industrialisation of the emerging economies and developing countries, and the emergence of affluent middle classes in these countries will increase the pressure to make greater use of environmental and efficiency technologies and continue developing them. The growing global demand for goods and services can only be satisfied if we succeed in producing "more" with "less" – i.e. decoupling economic growth from the consumption of natural resources.

Whether from an environmental or an economic point of view, there is no alternative to such a development: for example, former World Bank director Sir Nicholas Stern estimates that by 2050 climate change, if it continues unchecked, will be costing up to 20 percent of the global social product. The consequential costs of the loss of biological diversity could amount to around six percent of the global social product by 2050. Moreover, raw materials will be less plentiful in future and hence probably considerably more expensive than today, and in many cases the capacity of our ecosystems to absorb pollutants is already exceeded.

This section looks at six green markets. These are the markets for sustainable energy generation, energy efficiency, resource and material efficiency, sustainable mobility, sustainable water management, and closed substance cycle and waste management. They are characterised by the fact that firstly, they play a key role in safeguarding the existence of human beings and satisfying their basic needs, and secondly, they are of special economic importance.

The analysis of these markets is based on numerous studies carried out for the Federal Environment Ministry and the Federal Environment Agency. The central questions were: What products and technologies characterise these markets? How will the global market volume develop in the long term? And how do German companies stand in relation to the international competition? The analysis used information from "technology foresight" studies and literature and market studies, interviews with experts, and a

Figure 1: Growth of market volume in the green markets of the future (2005 – 2020)



1 CAGR = Cumulated average growth rate

Source: Roland Berger Strategy Consultants (2007)

survey of more than 250 research institutes and 1500 companies from the identified green markets of the future.[1]

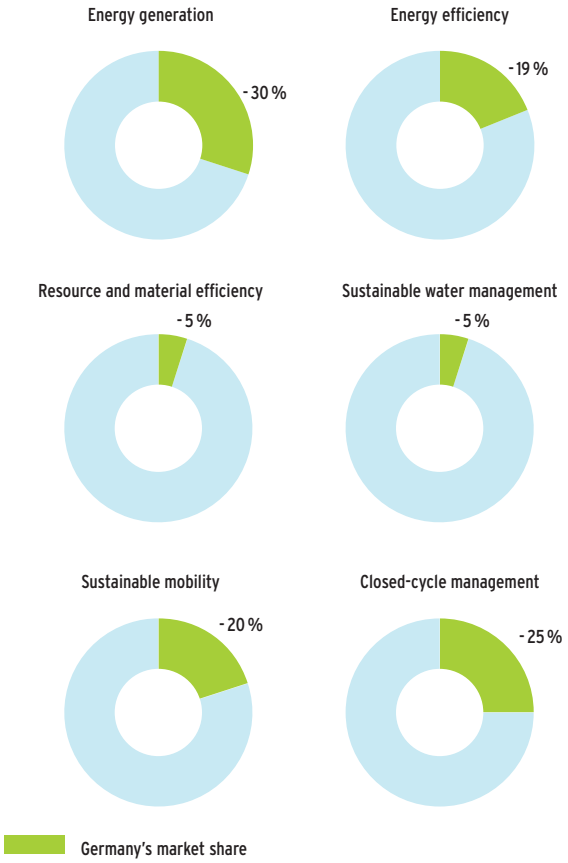
The research findings show that these green markets of the future will display very dynamic worldwide development, and "GreenTech made in Germany" is capable of being a major driver for more growth and employment. According to a study by Roland Berger, the world market volume of the six green markets of the future will more than double from 1,000 billion euro in 2005 to 2,200 billion euro in 2020. As shown in Figure 1, the largest absolute increase in market volume for the period 2005-2020 can be expected in the fields of energy efficiency (+450 billion euro) and sustainable water management (+290 billion euro).

In future, the German environmental industry will profit considerably from the dynamic growth of green lead markets worldwide, since it is very well positioned in international competition on many of these markets. German companies currently have market shares of between 5 and 30 percent on the individual markets of the future (cf. Figure 2). Germany shows particular strength in sustainable energy generation and in waste and closed cycle management. German companies in these sectors account for more than a quarter of the global market.

Assisted by the rapid growth of the global economy and the good competitive position of German companies on the international green markets of the future, the German environmental economy has already experienced a boom in recent years. According to a survey conducted by Roland Berger Strategy Consultants of around 1,500 companies operating on these markets, about 40 percent of the companies succeeded in stepping up their sales by more than ten percent per annum from 2004 to 2006 – and some industries like the solar sector actually achieved annual growth rates of 50 percent or more. Average growth rates range from 11 percent in the resource and material efficiency market to up to 30 percent in the green power generation sector (see Figure 3). Moreover, the companies questioned expected this upward trend to continue. The field was headed by sustainable energy generation with an expected average growth of 27 percent from 2007 to 2009.

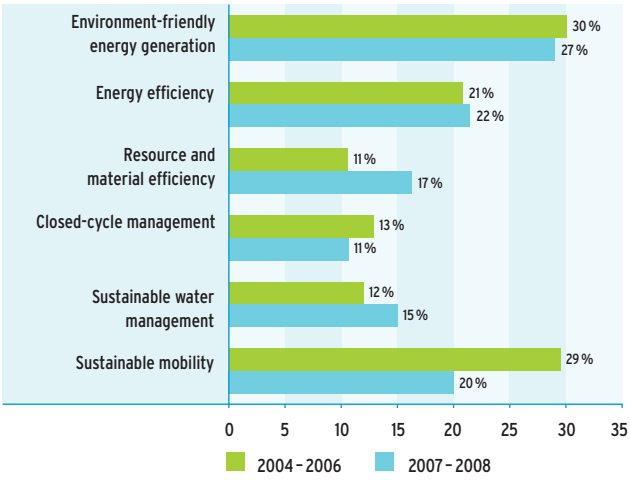
The rapid sales growth was accompanied by a marked increase in employment. Personnel numbers at the companies surveyed rose by an average of 15 percent between 2004 and 2006. From 2007 to 2009 the companies expected their workforce to grow by 13 per-

Figure 2: German shares of world markets for green technologies



Source: Federal Environment Ministry (BMU 2007c)

Figure 3: Sales growth of companies on green markets of the future



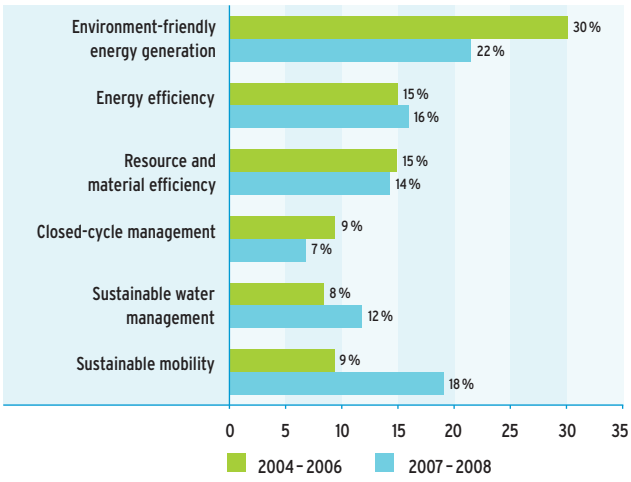
Source: Roland Berger

1 The studies from 2007 and 2008 are published (in German) in the series "Umwelt, Innovation, Beschäftigung" (UIB) (Ed. BMU / UBA).

cent (cf. Figure 4). These figures provide impressive confirmation that environmental and efficiency technologies play an important role in creating new jobs in Germany.

The overall economic importance of the green markets of the future will continue to grow in the years to come. By 2030, according to a study by Roland Berger Strategy Consultants,[2] German industry will be earning as much as 16 percent of its total sales revenue from environmental technologies – which is four times the 2005 figure. This means that in the medium term the environmental protection industry will overtake the classic industries such as mechanical engineering or the motor industry as far as economic importance is concerned.

Figure 4: Growth of personnel numbers in green lead markets



Source: Federal Environment Ministry *(BMU)* (2007c)

>>> Further reading:

Much of the information on the green markets of the future is based on the Environmental Technology Atlas for Germany published by the Federal Environment Ministry:
"Green Tech made in Germany 2.0", online:

http://www.bmu.de/umwelttechnologieatlas.

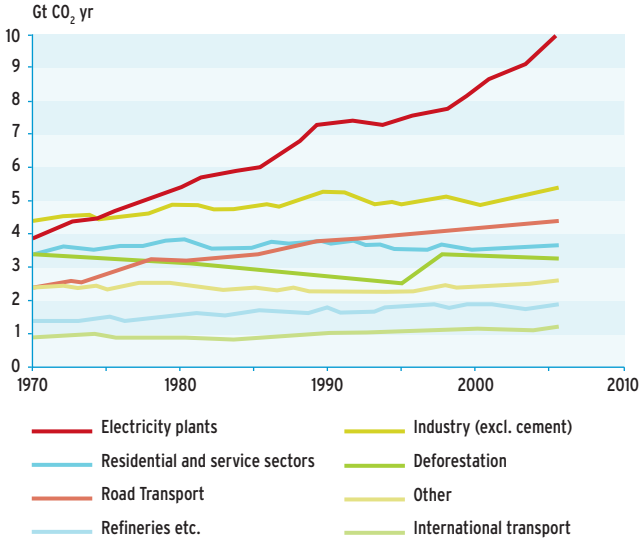
2 Cf. Roland Berger Strategy Consultants (2007).

2. SUSTAINABLE ENERGY GENERATION

2.1 CHALLENGES FOR SUSTAINABLE ENERGY GENERATION

In view of the growth of the population and the global economy, the International Energy Agency expects global demand for primary energy to increase by 55 percent between 2005 and 2030.[3] If this demand were to be met using fossil fuels such as coal, gas and oil, this would have fatal consequences for our climate, because most greenhouse gas emissions are due to use of fossil fuels. And the greater part of this is in turn due to electricity generation, which has seen a very sharp rise in carbon dioxide emissions in recent decades compared with other sources (cf. Figure 5).

Figure 5: Sources of global CO_2 emissions (1970 – 2004)



Source: PICC (2007)

To limit the scale of climate change, there must be a drastic reduction in global CO_2 emissions.[4] And this – in view of the economic backlog in the developing countries – applies particularly to the industrialised countries. The EU Council of Ministers has therefore decided to cut the EU's greenhouse gas emissions by 30 percent by the year 2020, provided other countries make comparable efforts. Apart from this, the EU has undertaken to reduce emissions to at least 20 percent below 1990 levels. Renewable energy sources as a share of power generation are to be stepped up to 20 percent, and energy efficiency is to be increased by the same percentage.

Over the same period, Germany intends to reduce greenhouse gas emissions by 40 percent. To achieve this, the German government has adopted the Integrated Energy and Climate Programme, a concrete programme comprising 29 measures.[5] Energy production technologies are to make the biggest contribution to this reduction (cf. Part 4 Climate Protection). First place here is taken by the further expansion of renewable energy sources in the electricity sector, which will lead to a CO_2 saving of around 55 million tonnes a year. Efficiency improvements at fossil power plants (-15 million t) and combined heat-and-power generation (-14.3 million t) will also help to meet the target.

The European Union has introduced European emissions trading at company level as the most important instrument for meeting its emission reduction commitment. In Germany emissions trading covers more than half of CO_2 emissions by plants in the energy sector and CO_2-intensive industries. The CO_2 reduction targeted for the second trading period from 2008 to 2012 is 57 million tonnes a year, slightly more than the contribution to be made by renewable energy sources.

2.2 PRODUCTS AND TECHNOLOGIES FOR SUSTAINABLE ENERGY GENERATION

There are two central levers for gradually reducing CO_2 emissions in the energy production sector: firstly, reducing emissions caused by burning fossil fuels, and secondly, making greater use of renewable energy sources. The market of the future for sustainable energy generation therefore consists mainly of the following product groups:

- renewable energy sources such as hydro power, solar thermal energy, photo¬voltaics, wind power, geothermal energy, biogas and biomass systems;
- efficient power plant technologies such as gas-and-steam plants, low-CO_2 coal-fired power plants or combined heat-and-power systems, e.g. CHP plants;

3 Cf. International Energy Agency (2007).

4 IPCC (2007). To limit global warming to 2–2.4°C, it is necessary to reduce global greenhouse gas emissions by 50 to 85 percent by the year 2050 (compared with 2000).

5 Cf. Federal Environment Ministry *(BMU)* (2007b).

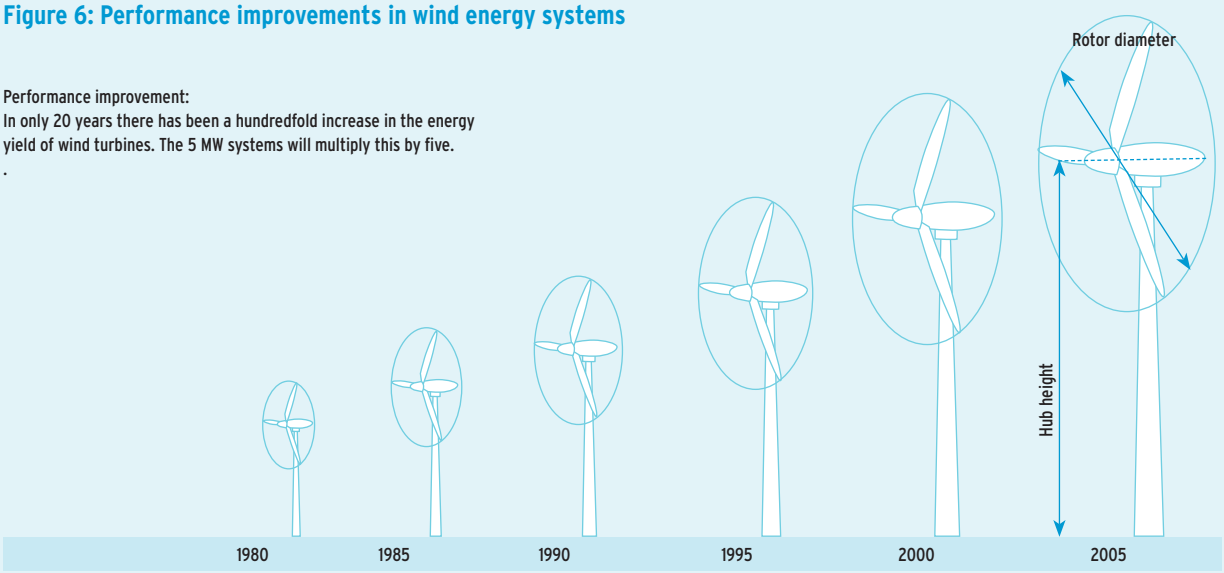
– energy storage technologies such as compressed air, magnetic, underground or hydrogen storage;
– hydrogen technologies and fuel cell applications.

As these innovative technologies are used more and more, their cost will fall, enabling them to become increasingly competitive on the market compared with established technologies. This trend can be seen particularly clearly in the case of renewable energy sources (cf. info box).

Diminishing cost of innovative technologies – the example of renewable energy sources

Figure 6: Performance improvements in wind energy systems

Performance improvement:
In only 20 years there has been a hundredfold increase in the energy yield of wind turbines. The 5 MW systems will multiply this by five.
.



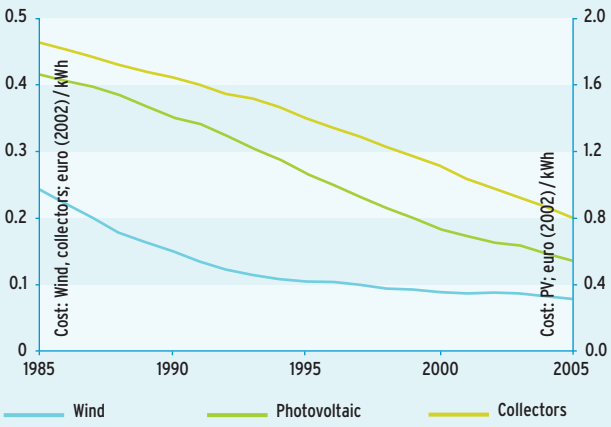
	1980	1985	1990	1995	2000	2005
Rated output:	30 kW	80 kW	250 kW	600 kW	1,500 kW	5,000 kW
Rotor diameter:	15 m	20 m	30 m	46 m	70 m	115 m
Hub height:	30 m	40 m	50 m	78 m	100 m	120 m
Annual energy yield:	35,000 kW / h	95,000 kW / h	400,000 kW/h	1,250,000 kW / h	3,500,000 kW / h	17,000,000 kW / h

Source: Bundesverband Windenergie e. V. (2008)

As relatively recently as 1983 an attempt to build a wind energy system with a rotor diameter of 100 metres, a tower height of 96 metres and an output of 3000 kilowatts, failed as a result of technical problems. In those days the state of the art was much smaller systems with an output in the region of 30 kilowatts. It was not until a few years ago that the manufacturers – following ongoing research and further development of the technology – succeeded in building such large systems (cf. Figure 6).

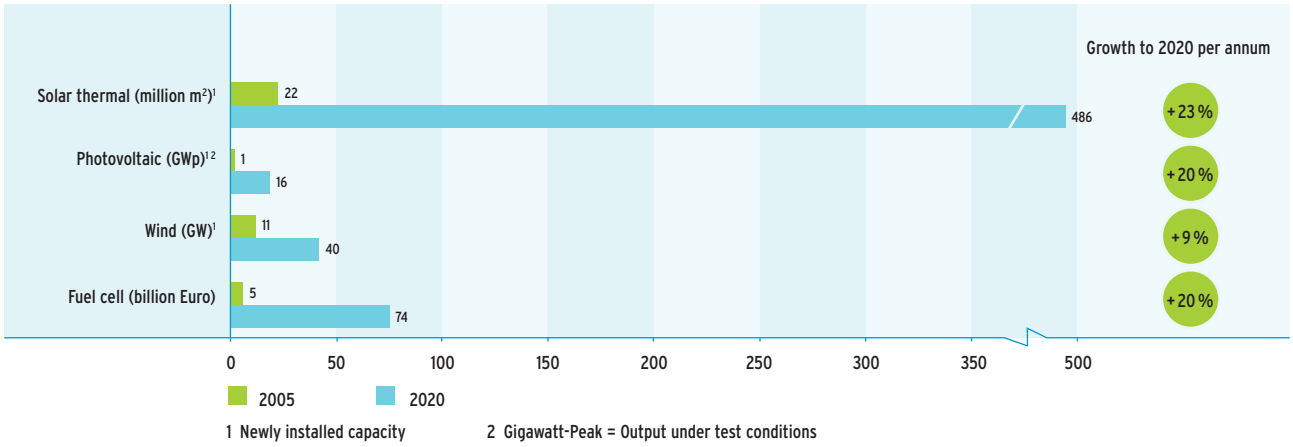
The manufacturers succeeded not only in substantially increasing the output of wind energy systems, but also in drastically reducing the average cost per kilowatt-hour generated (cf. Figure 7). There were two reasons for this: firstly experience gained during production (learning curve) and secondly, increased sales leading to economies of scale.

Figure 7: Development of energy generation costs of wind energy, photovoltaic and collector systems between 1985 and 2005



Source: Nitsch / DLR (2007)

Figure 8: World market projections for sustainable energy generation



Source: Federal Environment Ministry *(BMU)* (2007c)

2.3 MARKET POTENTIALS

Fact file: sustainable energy generation

Size of world market	
2005	100 billion euro
2020	280 billion euro
Germany's share of world market	
2005	~ 30 percent
Sales growth	
2004 to 2006	30 percent
2007 to 2009	27 percent
Growth in personnel numbers	
2004 to 2006	30 percent
2007 to 2009	22 percent

The world market for sustainable energy generation currently stands at around 100 billion euro. According to a forecast by Roland Berger Strategy Consultants[6] it is likely to grow to 280 billion euro by 2020, which means it will virtually treble.

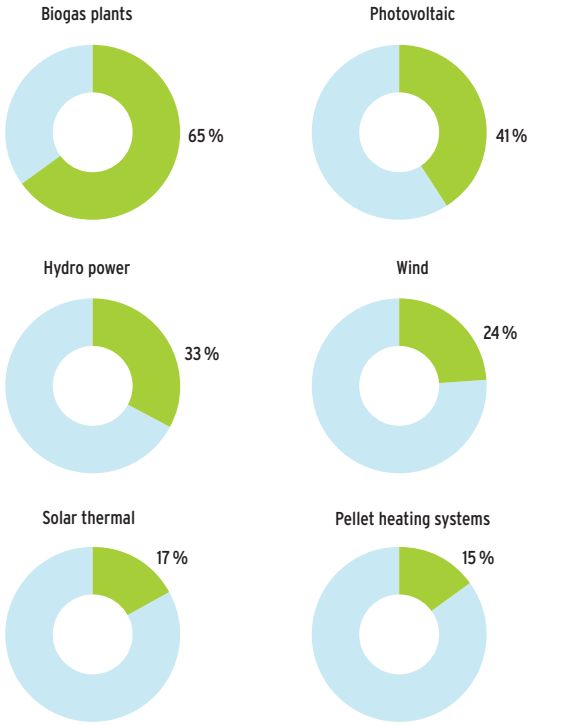
The authors of the study expect the most dynamic development in the field of renewable energy sources. This applies especially to the young technologies such as solar thermal energy, photovoltaic and wind energy systems, with worldwide annual sales growth of 10 to 20 percent.

2.4 POSITION OF GERMAN COMPANIES

Shares of world market and world trade

In many technologies for sustainable energy generation, German companies are among the best in the world – so they are very well equipped to profit from the enormous market potential. In biogas systems,

Figure 9: World market shares of German companies in the field of sustainable energy generation



Source: Federal Environment Ministry (BMU 2007)

6 Cf. Roland Berger Strategy Consultants (2007).

German companies have a world market share[7] of more than 60 percent; this is followed by photovoltaic systems with around 40 percent and hydro power with 33 percent (cf. Figure 9).

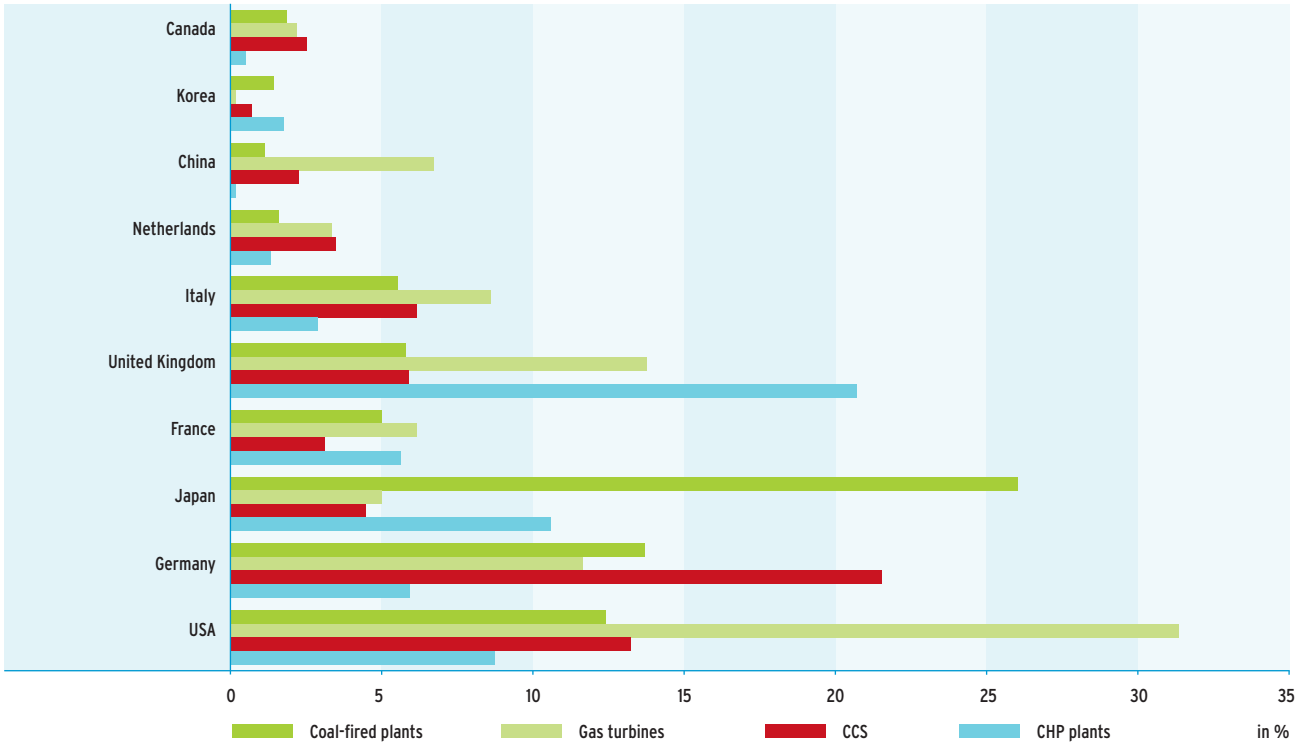
German companies' shares of world trade present a similar picture. In foreign trade in goods for sustainable energy generation, Germany led the world in 2004 with 15 percent, just ahead of the USA and Japan (13 percent each).

Breaking this analysis down into individual product groups and technology lines reveals a more differentiated picture: In the field of efficient power plant technologies, Germany lies in third place with 12 percent, behind the USA (25 percent) and the United Kingdom (13 percent). Above all, German companies are strong in exports of technologies connected with CO_2 capture and storage (22 percent). Germany also leads the field when it comes to hydrogen technologies (25 percent) and decentralised energy generation (17 percent). The USA, by contrast, occupies a strong position in the gas turbine sector, with over 30 percent of world trade. Japan leads on efficient coal-fired power plants, also with more than 25 percent, and in the field of combined heat-and-power generation the United Kingdom lies ahead with more than 20 percent.

In foreign trade in renewable energy technologies, Japan was still the unchallenged leader in 2004 with 30 percent of world trade, followed a long way behind by Germany (13 percent) and the USA (11 percent). The reason was Japan's particularly strong position in the photovoltaic sector with 42 percent of world trade – Germany's share was only 9 percent (cf. Figure 11). The large Japanese share of world trade was partly due to poor domestic demand in Japan. In Germany the situation was the reverse – the heavy domestic demand was straining the German manufacturers' production capacity to the limits, and to some extent it was necessary to import photovoltaic systems.

Within the space of a few years this situation has changed. In 2007 one in four solar cells installed worldwide, and one in three wind turbines, came from Germany. According to the Federal Wind Energy Association (Bundesverband WindEnergie), as many as 70 percent of the wind turbines and components produced in Germany were exported.[8]

Figure 10: Shares of world trade in power plant and conversion technologies (2004)

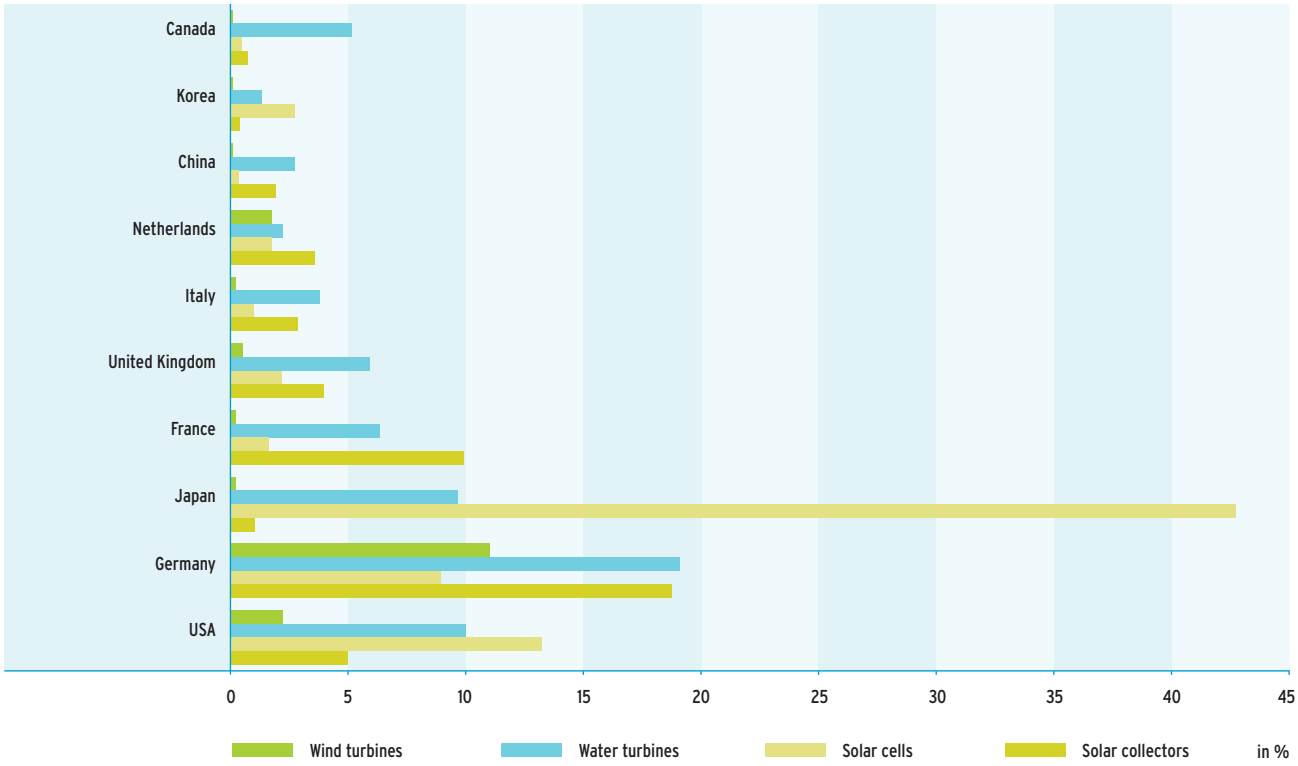


Source: Walz et al (2008)

7 The share of the world market differs from the share of world trade in that the world market share also includes goods sold on the domestic market, while the world trade share (national exports as a share of total exports) only includes goods traded outside national boundaries.

8 Cf. http://www.wind-energie.de

Figure 11: Shares of world trade in renewable energy technologies (2004)

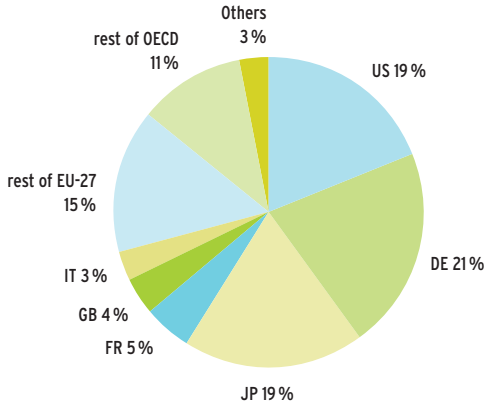


Source: Walz et al (2008)

Patents held by German companies

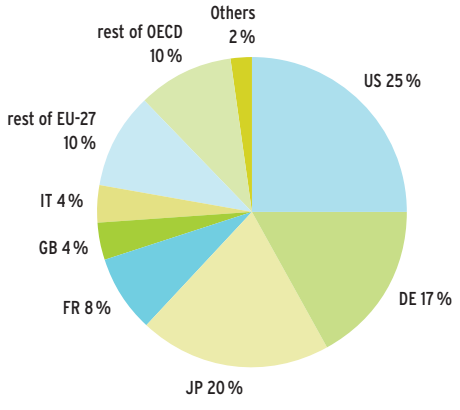
With regard to patents – another indicator of international competitiveness – Germany is also very well placed in the renewables sector (cf. Figure 12). German companies take first place in the fields of wind power, solar thermal energy, geothermal energy and biomass and biogas. Although Japan and the USA were well ahead on photovoltaic systems in 2004, a reversal of the trend has since taken place here as well, as in the case of exports. It is striking to note Denmark's relatively large share of patents (9 percent) in the wind energy sector; this is due to many years of substantial state subsidies. In the field of efficient, low-emission power plant and conversion technologies, Germany – as was evident from the other indicators – is not so well placed as in the renewables sector. In terms of the number of patents in this product group, German companies hold only third place behind the USA and Japan (cf. Figure 13).

Figure 12: Patents on products in the renewables sector by countries



Source: Walz et al (2008)

Figure 13: Patents on efficient, low-emission power plant and conversion technologies by countries



Source: Walz et al (2008)

2.5 EMPLOYMENT EFFECTS OF RENEWABLE ENERGY SOURCES[9]

Environmental technology creates jobs – and this is particularly true of renewable energy sources. A business survey by Roland Berger revealed that the number of employees in the field of renewable energy generation increased by 30 percent per annum between 2004 and 2006.[10] The companies expect the workforce to increase by an average of 22 percent annually in the following years. The growth in employment is thus well above the growth rates of all other green lead markets.

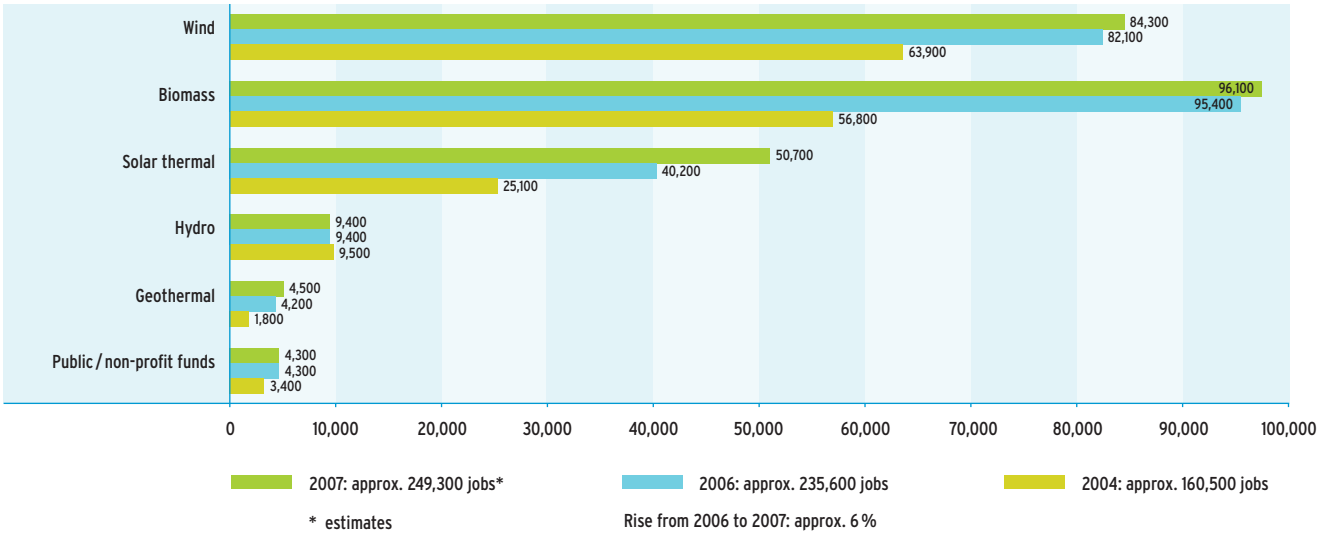
Two further studies confirm this forecast. The Federal Environment Ministry found out that in 2007 nearly 250,000 people were employed in the renewable energies sector (cf. Figure 14).[11] A survey in 2005 had already revealed that companies in the renewables sector were expecting the number of employees to rise by 54 percent by 2010 compared with 2004.[12] Developments in the past few years have been so rapid that this figure is already out of date. The employment effects expected for 2010 materialised as early as 2007.

2.6 PROSPECTS

Sustainable energy supplies can only be achieved by using innovative, environmentally sound technologies. As the example of renewable energy sources shows, however, such technologies are not always competitive right from the outset. This is due firstly to the failure to charge the external environmental costs of energy generation, which distorts competition at the expense of green technologies. Secondly, production costs are often very high when innovative technologies are introduced – though they fall rapidly in the course of time thanks to learning effects and the economies made possible by large-scale production. For these reasons it may be necessary for the state to provide temporary support for the development and market diffusion of such technologies.

One striking example of this is the Renewable Energy Sources Act *(Erneuerbare-Energien-Gesetz – EEG)*. Within a short time it has become an international model for the promotion of renewable energy sources. An EU report comes to the conclusion that feed-in arrangements of the kind used in the EEG are generally the most effective and the most efficient.[13]

Figure 14: Gross employment due to renewable energy in Germany (2004 – 2007)



Source: Kratzat et al (2008)

9 Cf. in this connection Part 1, Chapter 2.
10 Cf. Federal Environment Ministry *(BMU)* (2007c).
11 Cf. Federal Environment Ministry *(BMU)* (2008c).
12 Cf. Kratzat et al (2006).
13 Cf. COM (2008).

Quota systems with tradable certificates, as in other European countries, do not result in comparable success because plant operators do not know from the start how much revenue they can expect per kilowatt-hour of electricity, which means that the risk for the investors is considerably greater.

German companies are well placed on the future market for sustainable energy generation. Opportunities exist primarily on the world market for renewable energy sources, which many forecasts expect to expand rapidly in the years ahead. Exports in particular will be a central growth factor, driven by the increasing cost-effectiveness of renewable energy technologies and advances in climate protection. At least 66 countries – including 22 less developed countries – have already set targets for the expansion of renewable energy sources, and in the EU alone some 20 states have introduced feed-in tariffs following the example of the Renewable Energy Sources Act.[14] This shows how important it is to propagate the use of successful climate protection instruments in other countries.

The European emissions trading scheme will also put considerable pressure on companies to reduce CO_2 emissions from energy generation using fossil fuels. In the years ahead, the decline in the number of emission allowances means that the price of certificates is likely to rise to a level that creates distinct incentives for innovation and new climate-friendly technologies.

A major new challenge is emerging as a result of the growing competition from less developed countries that are strong on technology. China, for example, has caught up by leaps and bounds on the solar cell production front, and in 2007 it became the world's largest manufacturer.[15] The German government must meet this challenge by means of an innovation-friendly environmental and climate protection policy that helps German companies to maintain or gain their technical leadership.

14 Cf. REN21 (2008).

15 Cf. Manager-Magazin (2008).

3. ENERGY EFFICIENCY

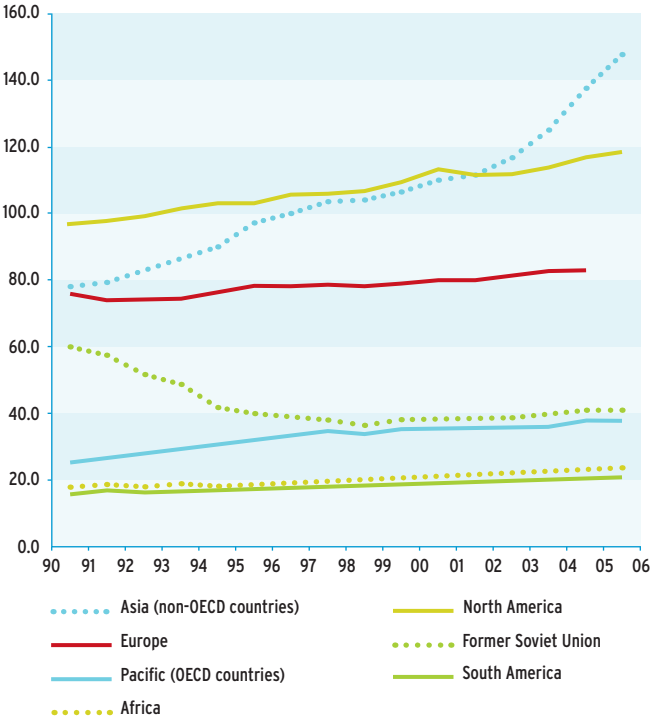
3.1 NEED FOR IMPROVEMENTS IN ENERGY EFFICIENCY

Energy is an important basis for prosperity and economic growth. So that economic growth can continue to take place, energy efficiency must constantly be increased, in other words we must succeed in producing the same quantity of goods with much less energy. This calls for the development and introduction of innovative energy saving technologies.

In Germany, energy productivity – a measure of energy efficiency – increased by nearly 40 percent from 1990 to 2007.[16] In spite of this increase, energy consumption fell by only 7 percent during this period. This means that in the past economic growth has more or less cancelled out the efficiency gains. Against this background, we must not let up in our efforts to continue improving energy efficiency. The worldwide trend provides a dramatic picture of the need for efficiency improvements: unlike in Germany, worldwide primary energy consumption rose by 30 percent between 1990 and 2005. Consumption is growing almost everywhere – even in regions that already consume large amounts of energy, such as Europe or North America (cf. Figure 15).

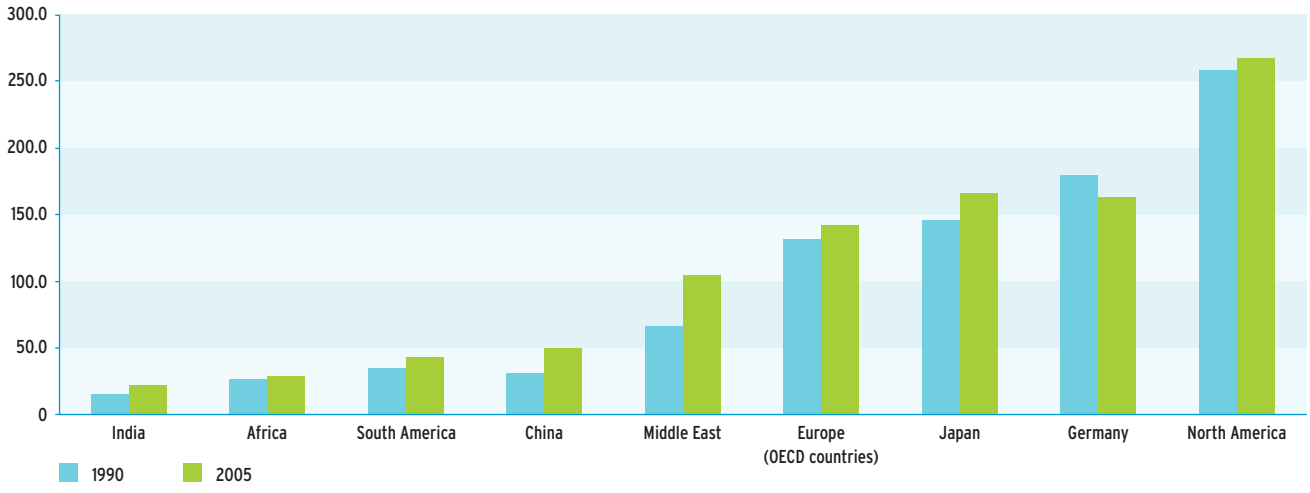
In Germany today, every member of the population consumes slightly less energy than a few years ago. But on the whole, per capita consumption is still very high compared with most countries (cf. Figure 16).

Figure 15: Primary energy consumption trends in world regions (in exajoules)



Source: Federal Economics Ministry *(BMWi)* (2008)

Figure 16: Comparison of per capita primary energy consumption (in GJ)



Source: Federal Economics Ministry *(BMWi)* (2008)

16 The energy productivity of the national economy is defined as the quotient of gross domestic product and primary energy consumption. Energy productivity increases if less energy is consumed per unit of national income. Cf. details in Part 2, Chapter 1.3.

If other countries raised their standard of living to the same level as the industrialised countries, there would be a dramatic increase in worldwide energy consumption.

Diminishing resources, environmental damage and especially climate change make it necessary to cut back our energy consumption. It is not sufficient to produce energy from climate-friendly sources – we also need to use energy more efficiently. The cost alone compels us to do so. Germany's foreign energy bill rose from 58.1 to 74.1 billion euro in only one year, from 2005 to 2006.[17] Greater energy efficiency makes the economy more competitive, because many investments pay for themselves in a short time. The European Commission believes that investments in energy efficiency could create up to a million jobs in Europe and at the same time yield energy cost savings running into double-digit millions.[18]

In an international survey of energy providers, 80 percent took the view that new technologies for saving energy would have the greatest impacts on the energy market in the coming ten years. Simply expanding energy generation capacity would not be sufficient to meet the worldwide growth in demand for energy. A majority of the respondents saw governments in a key position with regard to promotion of efficient generation and use of energy.[19]

Recent studies confirm the existence of great economic energy-saving potential for electricity and heating fuels in all consumption sectors, which would make it possible to avoid about 110 to 130 million tonnes of CO_2 emissions by 2020:[20] The Federal Environment Ministry has reacted to the challenges by proposing a national energy efficiency plan which mainly comprises measures to increase energy efficiency on the consumption side.

3.2 ENERGY EFFICIENCY PRODUCTS AND TECHNOLOGIES

Efficiency improvements are possible for almost all energy applications. In addition to various innovative technologies, organisational innovations such as energy contracting are also gaining importance. Here a service provider supplies heat or lighting, and the customer pays for the service rendered. The contrac-

The National Energy Efficiency Plan

The National Energy Efficiency Plan lists a number of concrete measures for all sectors and demands ambitious efficiency standards for buildings and products. To exploit the potential in the thermal sector, the Federal Environment Ministry proposes rigorously updating the Energy Saving Ordinance, making the demand-oriented energy pass for buildings a general requirement, stepping up the CO_2 building refurbishment programme, and creating tax incentives for increasing refurbishment rates in existing buildings.

In the transport sector the change in vehicle road tax to a CO_2-based tax is also intended to help reduce the final energy consumption of road vehicles. The proposal envisages that household appliances should in future be subject to dynamic minimum efficiency standards based on the "Top Runner" principle: the most efficient and most economical appliance should set the standard in its category which all other market players then have to achieve within a specified period.

Labelling of appliances with the total costs, i. e. acquisition and operating costs, and better labelling of energy consumption in line with the state of the art, are further elements. The Federal Environment Ministry proposes tying the existing eco tax concessions to the introduction of energy management systems, so that companies have to do something for climate protection in return for the extensive exemptions.

Source: Federal Economics Ministry (BMU 2008)

17 Cf. BGR (2007).
18 Cf. COM (2005).
19 Cf. Europäischer Wirtschaftsdienst (2008).
20 See for example Wuppertal Institut für Klima, Umwelt, Energie (2006); Prognos (2006); McKinsey (2007b).

tor thus has an incentive to provide this service as efficiently as possible. An increase in energy efficiency can also be achieved by switching transport to modes of transportation that use less energy, or by ensuring better organisation of traffic flows.

The Fraunhofer Institute for Systems and Innovation Research (ISI) was commissioned by the Federal Environment Agency to make a detailed investigation of the economic dynamics of certain particularly relevant products and technologies.

- **Energy-efficient building technology** makes a considerable contribution to efficient use of energy. In Germany about 40 percent of final energy requirements are due to space heating and water heating. Studies show that home owners and tenants underestimate the potential for saving on heating costs and overestimate the capital expenditure required. According to the IPCC, a 29-percent reduction in carbon dioxide emissions is possible by 2020 in the building sector alone without incurring any increase in costs.[21] The use of energy-efficient technology is necessary not only in new buildings, but also when refurbishing older buildings. In both cold and warm climate zones it is possible to save large amounts of energy in buildings. Energy-efficient building technology comprises individual components such as thermal insulation, ventilation and air conditioning systems, elements of building services automation, energy-efficient conventional heating systems, and heat pumps. To these must be added the task of linking up the individual components to create energy-efficient overall systems such as low-energy or passive houses.

- **Uses of electricity in buildings** have increased considerably in recent years. More and more electrical appliances are using more and more energy in Germany. To reduce electricity consumption it is therefore especially important to ensure that energy-saving electrical appliances and lighting become established. For example, it would be possible to save up to 11 billion kilowatt-hours of electricity by making increased use of energy-saving lamps, and about 8 billion kilowatt-hours by replacing old household appliances and electrical equipment. This corresponds to the annual electricity consumption of 6.8 million two-person households.[22]

- **Energy-efficient methods and processes** in industry are specific to the individual industries and technologies. Some industries such as steel production or paper manufacture have already made substantial improvements in their energy efficiency in recent years. In many cases, however, it would be possible to save even more energy, e. g. by recovering heat from industrial processes.

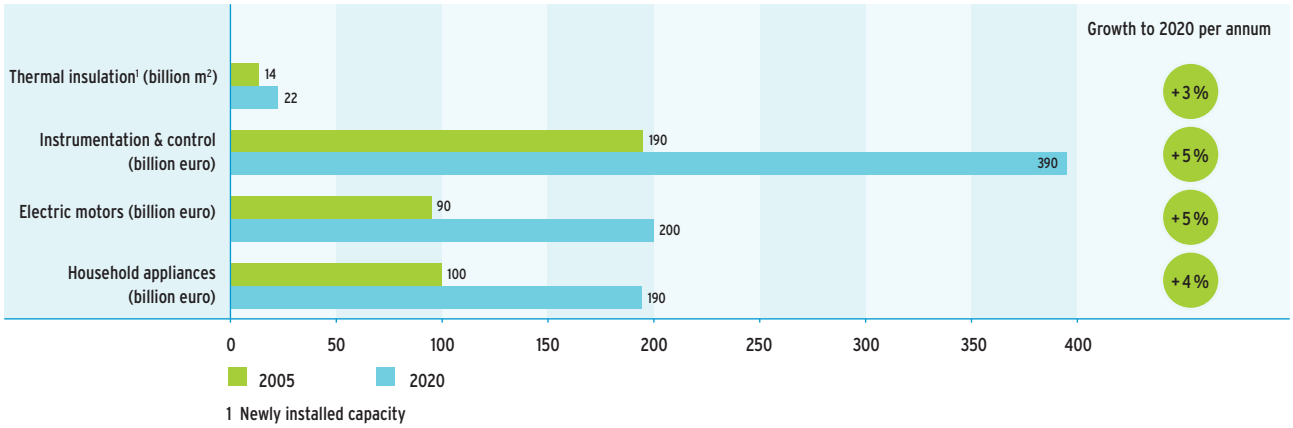
Saving energy in computer centres[23]

In many areas, modern information and communication technology (ICT) can make a major contribution to saving resources and reducing greenhouse gases: by intelligent control of power networks, cars or buildings, or by avoiding traffic through teleworking and phone or video conferences. At the same time using computers and the Internet also involves considerable consumption of electricity. According to calculations by the Borderstep Institute, electricity consumption by servers and computer centres in Germany has more than doubled since the year 2000 and stands at 10.1 TWh in 2008. This is equivalent to the power output of four medium-sized coal-fired power plants. The relevant electricity costs come to around 1.1 billion euro.

There can hardly be another area that offers such potential for energy saving as servers and computer centres. The chain starts with the software and ranges through the IT hardware and power supply right up to building planning and cooling. If the energy-saving solutions already being used by pioneers were implemented for the majority of German computer centres, the operators could save electricity costs totalling 3.6 billion euro by 2013. Moreover, this would halt the rapid growth in power consumption by computer centres and would reduce their energy consumption by as much as 40 percent by the year 2013.

21 Cf. Levine et al (2007).
22 Cf. Federal Environment Ministry *(BMU)* (2007c).
23 Cf. Fichter (2007).

Figure 17: World market projections for energy efficiency



Source: Federal Environment Ministry *(BMU)* (2007c), p. 61

– **Energy-efficient industrial cross-sectional technologies** are technologies that are used in many places independently of a specific industry. Examples include heat exchanger systems, electric motors, pumps or fans. Given the innumerable electric motors used in trade and industry, there are great economic opportunities for saving electricity; these alone amount to 10 percent of Germany's total electricity consumption and hence about 5 percent of Germany's total greenhouse gas emissions.[24] Since they tend to be of minor importance for the individual user, the potential that exists here is very often underestimated – although the opportunities for savings are substantial. Industrial cross-sectional technologies are responsible for some 60 to 70 percent of industrial demand for electricity and about 30 percent of the industrial demand for heating fuel.[25] Merely in the field of ancillary equipment such as pumps, fans and centrifuges, using energy-saving motors and controlled drive systems would make it possible to save 27 billion kilowatt-hours of electrical energy per year in Germany.[26]

3.3 MARKET POTENTIALS

Today the products and services that make a contribution to energy efficiency already have a world market share of 450 billion euro. By 2020 this volume will probably double – which makes energy efficiency the lead market with the largest predicted market volume.

Fact file: Energy efficiency[27]

Size of world market	
2005	450 billion euro
2020	900 billion euro
Germany's share of world market	
2005	~ 10 percent
Sales growth	
2004 to 2006	21 percent
2007 to 2009	22 percent
Growth in personnel numbers	
2004 to 2006	15 percent
2007 to 2009	16 percent

However, with annual growth rates of three to five percent in certain core areas (cf. Figure 17), the market is considerably less dynamic than other green markets of the future. This is connected with the fact that the future market for energy efficiency is characterised by mature industries – and for such industries average growth rates of this magnitude are quite considerable.

In a number of sub-markets, however, sales growth is extremely rapid. The period from 2004 to 2006 saw particularly good performance by companies whose products permit more energy-efficient processes in

24 Cf. Federal Environment Agency *(UBA)* (2007d).
25 Cf. Walz et al (2008).
26 Vgl. ZVEI (2007).
27 Cf. ZVEI (2007).

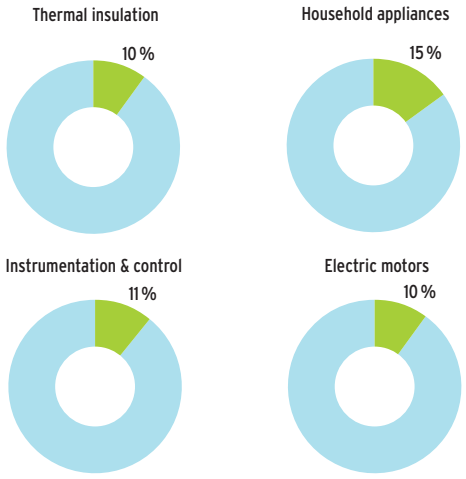
industry – for example manufacturers of process air technology and heat exchangers. Their sales grew by more than 25 percent a year. Companies in these fields can also expect very rapid growth in the years ahead.

3.4 POSITION OF GERMAN COMPANIES

Shares of world market and world trade

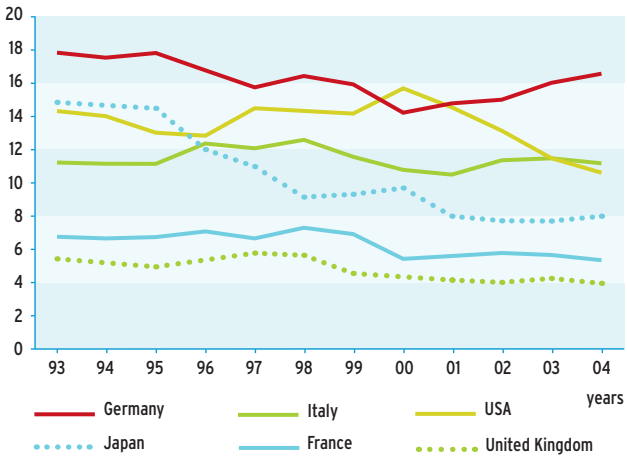
In efficiency technologies as a whole, German companies have a world market share of more than ten percent, and for many technologies they are therefore in a good position (cf. Figure 18). The companies are highly profitable on average, and nearly one third report a return on sales in excess of ten percent.

Figure 18: World market shares of German companies in the field of energy efficiency



Source: Federal Environment Ministry *(BMU)* (2007c), p. 62

Figure 19: Development of world trade shares in the market for energy efficiency (in percent)



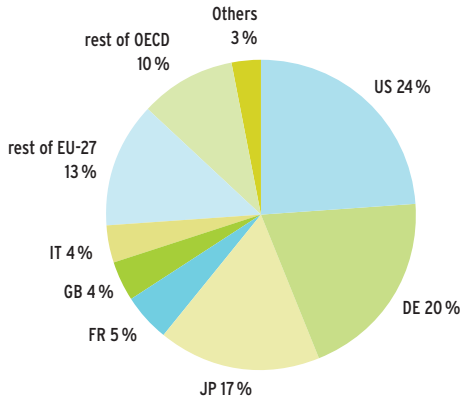
Source: Walz et al. (2008)

In exports of energy efficiency products Germany, with 17 percent of world trade, lies well ahead of Italy, the USA and Japan (cf. Figure 19). International sales opportunities exist particularly in the industrialised markets of Europe and North America.

Patents held by German companies

In recent years the trend in patent applications in the energy efficiency market has been similar to the trend in patent applications in general. In the field of electrical appliances, however, companies registered an above-average number of patents. The field is headed by the USA with 24 percent of patent applications. Germany, with 20 percent, had the second-largest share of patents for energy efficiency, followed by Japan with 17 percent (cf. Figure 20).

Figure 20: Patents in the market for energy efficiency, by countries



Source: Walz et al. (2008)

3.5 PROSPECTS

In view of growing energy consumption, rising energy prices and more demanding statutory standards, the market for energy efficiency will continue to gain in importance. In particular, the threat of climate change forces us to use energy much more efficiently than we do today. The importance of energy-efficient technologies and products will grow, and their market share will increase. German companies are well placed for this on the world market, and their products are internationally competitive.

Energy consumers are seizing the opportunity to use energy efficiently, but they are not yet doing so to a sufficient extent. In the public debate too, more efficient use of energy is frequently neglected, although a wide variety of opportunities exist in this field in particular not only to improve environmental and climate protection, but also to save money. This is

where policy can help by drawing attention to the economic benefits of efficient use of energy.

Past experience has shown that policy can make an important contribution to creating new markets for energy-efficient products and promoting innovative environmental technologies. Progressive environmental legislation makes it possible for companies on the world market for energy-efficient products to establish a lead over competitors who are currently not yet facing such stringent regulations on their domestic markets. For some years now, the German government has been promoting efficient use of energy, for example by founding the German Energy Efficiency Agency, which helps companies to exploit their energy-saving potential. The Kreditanstalt für Wiederaufbau (KfW) offers a wide range of assistance programmes. The Integrated Energy and Climate Programme (IECP) which the German government adopted in Meseberg last year provides a further stimulus to greater energy efficiency (cf. Part 4).

4. RESOURCE AND MATERIAL EFFICIENCY

4.1 CHALLENGES TO RESOURCE AND MATERIAL EFFICIENCY

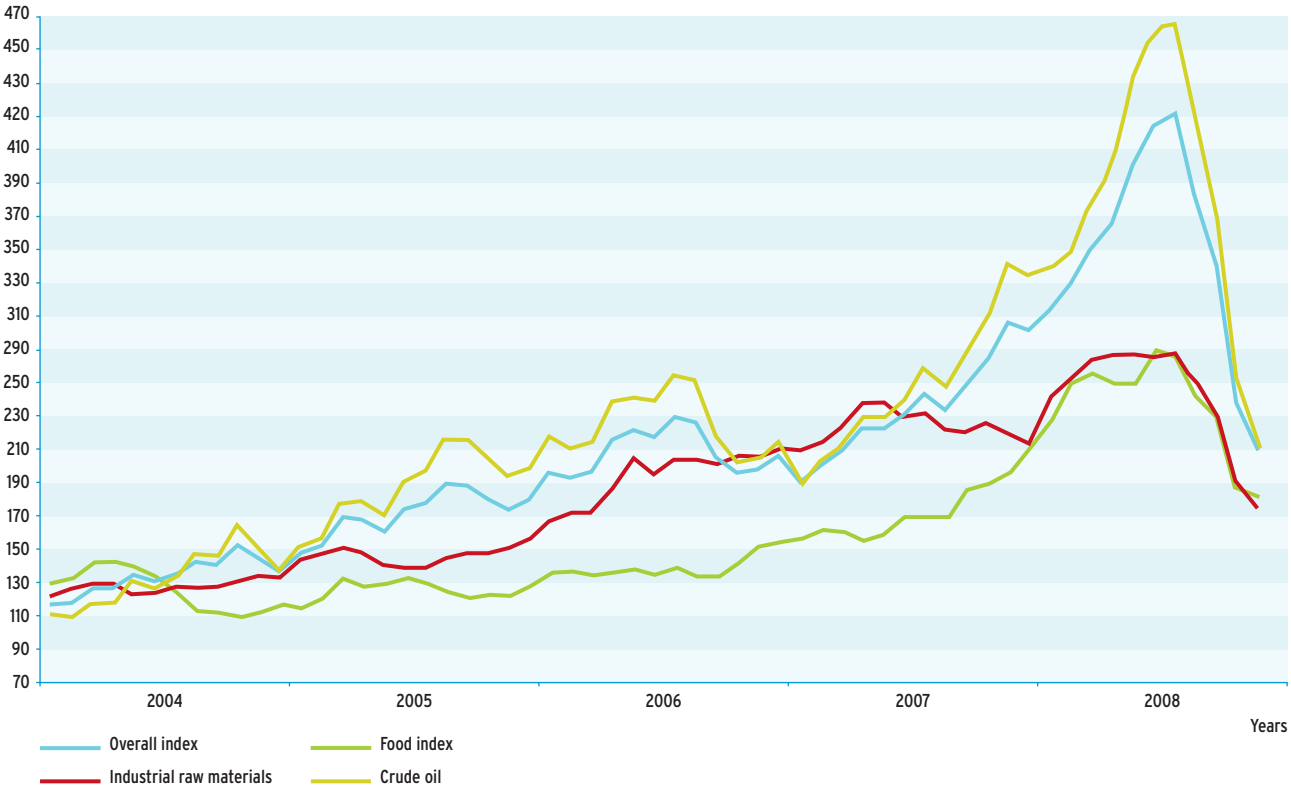
Raw materials are essential for economic development, but these resources are becoming increasingly scarce. Since 2002 the demand for raw materials has outstripped the supply. As a result, prices are rising rapidly. From 2002 to 2006 the price of nickel rose by 350 percent, and the price of copper by as much as 400 percent. On average, world market prices for raw materials imported into the Euro zone rose by 81 percent between 2000 and 2005. Quite apart from cyclical price fluctuations, this trend will continue in the long term, because the growing demand by the emerging economies and the growth in the world population will make raw materials even scarcer.

Within the EU, Germany is the biggest consumer of metallic raw materials. In 2006 it imported raw materials to the value of 106 billion euro, or about 14.5 percent of total imports. Compared with 2005 the value of raw materials imports rose by 37 percent, but the value of imports in general only increased by 16.5 percent.[28]

Rising raw materials prices are a burden on industry in particular. In the manufacturing sector, material costs as a share of gross production value are around 40 percent. Energy costs account for 32 percent, whereas the share due to personnel costs is only 25 percent.[29] The motor industry and the food industry are particularly badly affected by high raw materials prices. Here the share due to material costs is over 50 percent.

However, increasing consumption of raw materials is only one factor of economic importance. The extraction, transport and consumption of raw materials place heavy burdens on the environment as well: they consume land and energy, and release pollutants. The manufacture of cement and steel alone is responsible for around 15 percent of global CO_2 emis-

Figure 21: Trends in world market prices for raw materials (HWWI index)



Year 2000 = 100. Monthly averages (the average for the last month shown is incomplete until the month has ended.

Source: Hamburgisches WeltWirtschafts Institut (2008)

28 Cf. Federal Statistical Office *(Statistisches Bundesamt)* (2007e).
29 Cf. in this connection Part 2, Chapter 2.1 – Sustainable management.

sions. Producing biotic raw materials requires agricultural land which cannot then be used for other purposes.[30] The metal content of ores from traditional deposits is declining. Today individual raw materials are obtained from remote regions. The risks to the environment are considerable, for example when producing oil in Alaska or extracting ore in the rainforest. There is also the problem of disposing of industrial and mining waste, especially when it contains heavy metals such as lead and cadmium.

4.2 PRODUCTS AND TECHNOLOGIES FOR SUSTAINABLE USE OF RESOURCES

Making sustainable use of raw materials means first and foremost using them much more efficiently. The aim must be to reduce raw materials consumption not only in relative terms – i. e. per unit of added value – but also in absolute terms. Part of this strategy is to design products so that they last longer and are easier to recycle or reuse. And non-renewable resources must increasingly be replaced by renewable raw materials. And finally, developing countries need access to resource-saving production methods, because scarce resources are a global problem.

Products and technologies for sustainable use of resources are difficult to identify, because they are relevant in all branches of industry and all phases of production. As a result, estimates of market volume and the position of German industry in international competition are only available for individual fields of these cross-sectional technologies. They do however permit a good insight into the dynamics of the market as a whole.

Greater efficiency and longer product life

Resource-saving and low-waste production processes comprise a large number of process technologies in all sectors of the economy. One example is powder coating, in which surplus coating that escapes unused into the surroundings is completely recovered. A major contribution to greater material efficiency is also made by "tribological methods". These minimise losses that occur in mechanical friction, abrasion and lubrication situations. Experts estimate the annual losses due to wear in industrialised countries at around five percent of gross domestic product – which in Germany's case means about 35 billion euro a year. Given systematic application of the existing tribological knowledge it would be possible to save an estimated five billion euro per annum.

Lightweight construction technologies combine different materials and different material qualities in ways that save weight. One example is "Tailored Components" in the motor industry: these combine different materials, material qualities and dimensions to form a lighter component of the required strength. Bionic design principles can also be used for lightweight construction. Bionics seeks to apply structures and functions found in nature. For example, scientists can use knowledge about the structure of trees to develop principles for a strong, material-saving design of components, decipher indicators of high stress tolerance and use these findings in product design. Lightweight construction techniques inspired by bionics are frequently used in the motor industry, where they have reduced the weight of individual vehicle components by 15 to 30 percent.

Long-lasting and repair-friendly product design helps to save resources. One well-known example is the "lotus leaf effect". The observation that water runs off a lotus leaf has helped to develop water-repellent and self-cleaning materials. This knowledge has much extended the life of many products. This reduces not only material consumption, but also costs.

Miniaturisation is the trend towards making components such as memory chips and products such as mobile phones even smaller. This helps to save raw materials. Advances in nanotechnology and molecular biology support this development.

Nanotechnology applications help to save material. One example is nanotechnology primers, which are applied in thinner coats than iron phosphate primers, for example, but provide the same protection and are free from heavy metals. Whereas 200 grams per square metres are sufficient for the nanotechnology corrosion protection solution, conventional iron phosphate coating requires three times as much paint. Nanotechnologies can also increase product life, e. g. in the case of dirt-repellent textiles, UV-protected clothing, antibacterial wall paints and self-cleaning building facade elements. As well as exploiting the great environmental relief potential of these innovative technologies there is also a need to investigate and if necessary minimise potential risks.

White biotechnology applications reduce material requirements by enabling chemical and organic processes with low energy input. To do so they use enzymes or micro-organisms. Examples include the

30 Whereas the area of land used for agricultural purposes has been declining in Germany since 1992, the area needed for growing renewable raw materials (mainly rape oil, starch, sugar, sunflower oil) has increased by nearly 500 percent. The production of rape oil accounts for more than 75 percent of this area.

use of biotechnology processes to reinforce the fibres of clothing made from natural materials.

Recycling is easier if the resource concerned is mixed with other materials as little as possible. Lead in batteries or glass from glass recycling are good examples of efficient recovery of raw materials. Modern production plants of the kind typically found in industrialised countries already make considerable use of this potential. Reuse of metals has a long tradition in Germany. Here use is made of modern technologies for recovery of steel, lead and copper. One current challenge is recycling of first-generation solar cells to recover the silicon used in them.

Landfill sites are valuable repositories of raw materials. The landfill sites in the USA alone are thought to contain 56 million tonnes of copper, nearly four times annual worldwide production. Technologies already exist for reusing these raw materials. When they come into large-scale use will depend on how raw material prices develop. The more expensive the primary raw materials, the more economic it becomes to recover them from landfill sites.

Use of regrowable raw materials

German industry is making increasing use of regrowable raw materials. In the chemical industry ten percent of all raw materials used already belong to the category of regrowable raw materials; this amounts to 2.7 million tonnes in 2005. Between 1993 and 2005 the land area used for regrowable raw materials in Germany increased by nearly 500 percent from 0.3 million to 1.5 million hectares. These resources can basically be used in all industries. In addition to classic uses in house construction, for example, as environmentally friendly thermal insulation material, they are also suitable for use as packaging material, lubricants, textiles or bioplastics. In Germany, about 25 percent of regrowable raw materials are recovered as material, while the remainder is used for energy production.

4.3 MARKET POTENTIAL: THE EXAMPLE OF BIOPLASTICS

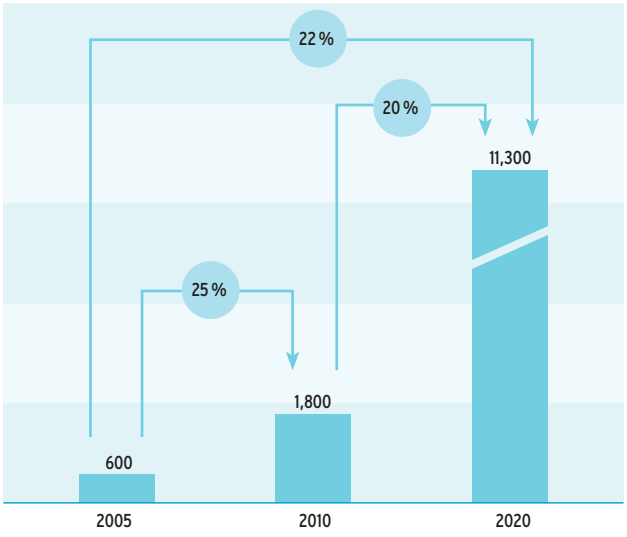
The demand for products and technologies for greater resource efficiency will increase in future, because raw material prices will rise again in the medium and long term. Information on market potential is only available for individual areas. The Federal Environment Agency has had the market prospects for bioplastics investigated as an example.[31]

Bioplastics are made from regrowable raw materials like sugar, starch or cellulose. At present they are still more expensive than conventional plastics, but high oil prices are making them increasingly competitive. Bioplastics can be used in many different ways and have a number of advantages: They save resources and help reduce CO_2 emissions. Many of these plastics are also biodegradable. Compared with petrochemical plastics, however, they still play a very minor role: in 2006 their share of worldwide plastics production capacity was only about 0.2 percent. But the market is growing fast and furiously – by up to 30 percent a year. Businesspeople estimated that the world market volume for 2005 averaged around 600 million euro and expected annual growth to average 25 percent until 2010.[32]

The bioplastics available today could replace five percent of conventional plastics. There is also a need to open up new areas of application, for example compostable mulch films. Even after 2015, companies expect annual growth of just over 20 percent. This development is probable as a result of the foreseeable investment in larger installations. The market projection to 2020 in Figure 22 shows a growth scenario that is at the lower end of the company estimates.

The most important sales markets for bioplastics are currently Europe and North America. However, companies believe that there will be substantial shifts in

Figure 22: World market projection for bioplastics until 2020 (in million euro)



Source: Roland Berger Strategy Consultants (2007)

31 Cf. Beucker et al (2007).

32 Cf. Roland Berger Strategy Consultants (2007). The survey covered European companies in this industry.

Figure 23: Germany's competitive position on resource efficiency

Technology	Competitive position of German industry
Resource-saving and low-waste production processes	Pioneer
Recycling of production waste	Upper mid range
Recycling of household waste	Pioneer
Use of renewable raw materials	Pioneer
Lightweight construction technologies	Pioneer
Long-life, repair-friendly product design	Mid range
Miniaturisation	Mid range
Nanotechnology applications	Pioneer

Source: Based on Deutsches Institut für Wirtschaftsforschung et al (2007)

the regional importance of markets in the next few years. The experts surveyed expect an above-average increase in demand in Asia, and above all in China. It is therefore important for European companies to lose no time in positioning themselves in this fast growing market.

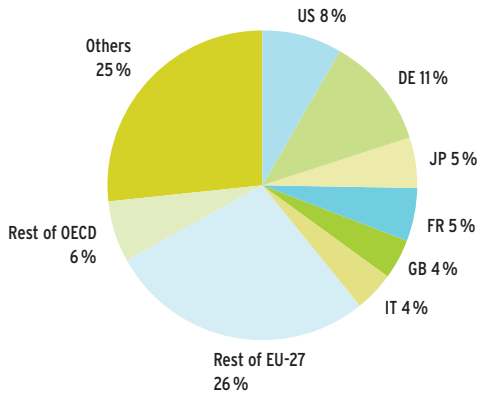
4.4 POSITION OF GERMAN COMPANIES

In the market of the future for resource and material efficiency, Germany is not in a bad position, but it is not as strong as in most other areas. Experts see German companies as most likely to play a pioneering role in the fields of lightweight construction technologies, nanotechnology, use of regrowable raw materials, recycling of household waste, and low-waste production processes (cf. Figure 23).

According to estimates by the Fraunhofer Institute for Systems and Innovation Research[33], the volume of world trade in technologies and products for resource and material efficiency[34] came to 112 billion euro in 2004. German companies, at eleven percent, have the largest share, followed by the USA with eight percent and Japan and France with five percent each (cf. Figure 24).

The analysis of the patent data shows that Germany's share of patents in all product groups is constant at around 14 percent. The largest number of patent applications comes from the USA (29 percent), followed by Japan with 18 percent.

Figure 24: Shares of world trade in material efficiency



Source: Walz et al (2008)

4.5 PROSPECTS

In several important market segments, German companies are already in an excellent international position. This is also a result of the Closed Substance Cycle and Waste Management Act passed as long ago as 1994, which creates incentives for recovery and resource-efficient economic activity. The take-back ordinances for packaging, batteries, end-of-life cars and waste wood which were in force in Germany were subsequently established at European level as well.

Despite this, the topic of material efficiency has so far played no more than a minor role in the eyes of developers, manufacturers, distributors and consumers. In recent years a number of raw materials have been affected by drastic price increases, but unlike the prices of motor fuels, electricity, heating oil or gas they have not been at the focus of public awareness. In view of the foreseeable problem of the increasing scarcity of certain raw materials and the environmental burdens associated with the production and use of raw materials, Germany and the EU will have to redouble their efforts in the field of recycling and substitutes for metals and plastics. Resource efficiency is one of the issues of the future. Experts expect the market for resource-efficient products to display dynamic growth.

To make companies aware of this issue, the German government has launched a kick-off programme which is supported by the German Materials Efficien-

33 Cf. Walz et al (2008), p. 88.

34 The analysis relates to the following product groups: regrowable raw materials, corrosion protection, fibre reinforcement and plastics additives.

cy Agency (DEMEA). With its Environmental Innovation Programme the Federal Environment Ministry is also supporting resource-saving product developments. The Resource Efficiency Network is intended to facilitate experience sharing between politics, science, research and consumers, and to serve as an ideas platform, especially for small and medium enterprises.

5. SUSTAINABLE MOBILITY

5.1 CHALLENGES FOR SUSTAINABLE MOBILITY

Mobility is one of the basic requirements of modern industrial societies. A functioning economy depends upon a well developed transport infrastructure to ensure reliable and inexpensive transport of goods and persons from A to B.

The age of globalisation is characterised by affordable transport facilities. International division of labour is increasing, world trade is booming, goods are being transported over longer distances, and mobility needs in the developing countries are growing rapidly. If the present trends were to continue, this would mean:

- In the coming 20 years global trade will quadruple, while passenger transport will treble.[35]
- In Europe the volume of goods transported is expected to show a 40-percent increase by 2030. Over the same period, passenger transport will rise by 30 percent.[36]
- In China there would be an estimated 140 million cars on the road in 2020 – seven times as many as today.
- The number of aircraft would double in the next 20 years, assuming that passenger numbers increase by 160 percent and freight volume by 230 percent.
- International marine freight traffic could grow even faster. Forecasts indicate an increase to nearly five times the present level.

However, man and the environment will have a high price to pay if transport grows unchecked. Transport is a major cause of CO_2 emissions and hence of climate change. In the 15 states of the EU before its eastern enlargement, the transport sector is responsible for about one fifth of carbon dioxide emissions, whereas the worldwide figure is one eighth.[37] Air pollution and noise problems are increasing considerably in many urban agglomerations, with adverse effects on health and quality of life.

More economical engines and quieter rail vehicles have reduced many problems and improved efficiency in recent years, but this progress has been cancelled out by the steady growth in transport. Total CO_2 emissions in the transport sector in Europe increased by more than a quarter from 1990 to 2004.

In view of the forecast growth rates, it will be a great challenge to satisfy growing mobility needs without having undue adverse impacts on environment, health and quality of life. To this end it is essential to make use of advances in environmental technology and transport people and goods much more efficiently – which means reducing resource consumption, air pollution, greenhouse gases and noise. Nevertheless, experience in recent years shows that this is not enough. It is also necessary to curb the growth in transport volume, ensure better utilisation of transport facilities, and expand greener means of transport. This task for the whole of society calls for a fundamental change in the transport industry and offer great opportunities for the environmental economy.

Sustainable mobility means guaranteeing economic and social needs within the limits set by environmental requirements. The overriding aims of this strategy are:

- Decoupling economic growth from transport growth and avoiding transport as far as possible (reducing transport);
- Using and networking environmentally sound and efficient means of transport, and facilitating the change to greener means of transport (switching transport);
- Making technical improvements in the greenness and resource-efficiency of the modes of transportation and operating them with minimum impact on the environment (emission reduction and transport optimisation);
- Running transport systems within a framework of fair competition, which also means charging the external costs they cause (including environmental costs).

5.2 PRODUCTS AND TECHNOLOGIES FOR SUSTAINABLE MOBILITY

Products and technologies for sustainable mobility are characterised by the fact that they reduce environmental impacts due to transport. At the request of

35 Cf. Boeing (2006), as quoted by Deutsches Institut für Wirtschaftsforschung et al (2007).
36 The forecasts on the development of transport in Europe up to 2030 are taken from Mantzos and Capros (2006).
37 Cf. Federal Environment Ministry (BMU 2007c), p. 132.

the Federal Environment Agency, the Fraunhofer Institute for Systems and Innovation Research (ISI) made a detailed study to identify which product groups are particularly relevant here.[38]

Efficient propulsion technologies and modern fuels improve efficiency and reduce fuel consumption. For example, the HCCI process[39] can be used to achieve greater fuel efficiency in petrol and diesel engines. Hybrid drive systems combine conventional combustion engines with an electric motor and store energy when braking. This can also result in significant fuel savings. Battery driven electric drive motors can supplement existing drive concepts and permit low-emission local operation.

Environmentally sound vehicle engineering helps to improve the environmental efficiency of traffic. Advances in materials research, for example, make it possible to reduce vehicle weight and improve aerodynamics. Rail vehicles can be designed to permit simple connection with other modes of transportation. Tyre manufacturers develop innovative products to reduce rolling resistance and hence fuel consumption.

Emission reduction technologies reduce pollutant emissions and noise problems due to traffic. They thereby make an important contribution to protecting health and improving the quality of life. There is a special need for further development of filters and catalytic converters for railways and ships and – for all means of transport – for the further development of noise abatement technologies. This also includes modern technologies in track construction and quieter road surfaces.

Environmentally sound infrastructure and traffic management are aimed at environment-friendly construction methods in the development and replacement of transport routes (e.g. through recycling of construction materials) and better utilisation of infrastructure capacity, i.e. of the rail, waterway and highway systems. This may, for example, be achieved by means of improved control of traffic in urban agglomerations, e.g. using telematics-based traffic control and charging systems. In many places there is also a need for massive expansion of the infrastructure for relatively green modes of transportation such as railway and inland waterway. For example, there is a need to improve port infrastructures so that regional transport can increasingly be shifted to seagoing ships ("Short Sea Shipping").

Biofuels are in use today mainly in the form of biodiesel and ethanol as admixtures to conventional motor fuels. From an environmental and climate protection point of view they are only to be regarded as a favourable solution in certain conditions, because growing the energy crops often gives rise to considerable greenhouse gas emissions and other serious adverse impacts on the environment. The development of "second-generation" biofuels – which can also be produced from forest wood or waste – will improve the environmental and climate balance. This is because compared with the first generation they have double the energy yield per unit area and a much better CO_2 balance. These fuels are currently displaying a very dynamic innovation situation.

5.3 MARKTET POTENTIALS

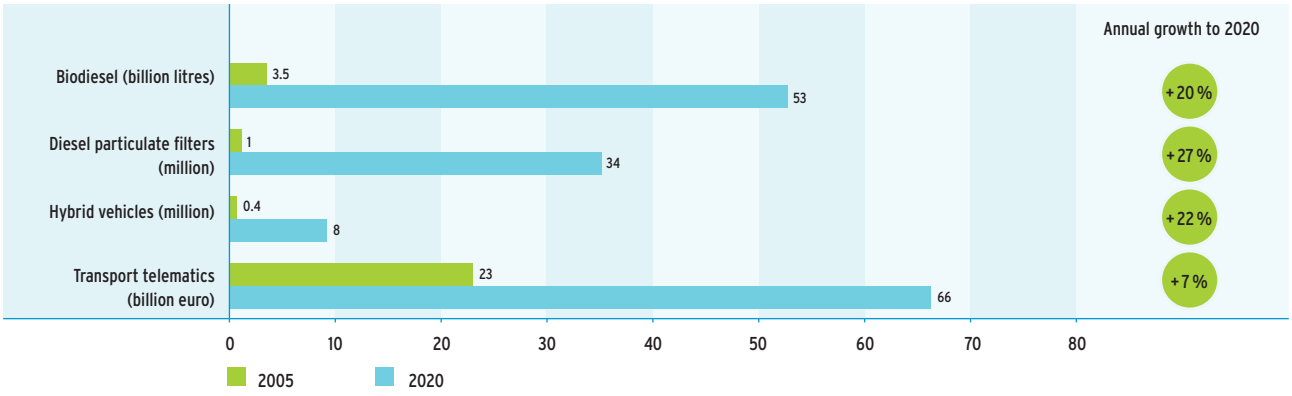
Fact file: Sustainable mobility

Size of world market	
2005	180 billion euro
2020	350 billion euro
Germany's share of world market	
2005	approx. 20 percent
Sales growth	
2004 to 2006	29 percent
2007 to 2009	20 percent
Growth in personnel numbers	
2004 to 2006	9 percent
2007 to 2009	18 percent

Products and services which make a contribution to sustainable mobility already represent a world market of 180 billion euro.[40] By 2020 this volume will probably double. Roughly half of this market is due to efforts to develop more economical combustion engines. Other significant shares are accounted for by rolling stock and track construction, jet propulsion and shipbuilding. Alternative drive systems and biofuels are currently a relatively small market, but the motor industry still expects to see continued stable growth.[41]

38 Vgl. Walz u.a. (2008).
39 HCCI-Verfahren: Homogeneous Charge Compression Injection (gleichmäßige Ladung durch Kompression und Einspritzung).
40 Cf. Federal Environment Ministry (BMU 2007c).
41 Cf. Deutsches Institut für Wirtschaftsforschung.

Figure 25: World market projection for sustainable mobility



Source: Federal Environment Ministry *(BMU)* (2007c)

Example: Market of the future: Hybrid vehicles

As a rule, hybrid vehicles combine a petrol or diesel engine with an electric motor. This combination makes it possible to run the combustion engine in a favourable mapping range and to store braking energy. Depending on the driving characteristics and the kind of hybrid drive, these vehicles consume up to 25 percent less fuel than vehicles with conventional combustion engines. The saving is greatest in city or local traffic with frequent braking and acceleration. Hybrid drive systems are also suitable for buses and delivery vans. Thanks to its lower consumption, the hybrid technology makes an important contribution to the EU target of reducing passenger car carbon dioxide emissions to 120 g/km.

The pioneers of this climate protection technology are Japanese companies. In the USA, for example, Toyota and Honda have a market share of over 90 percent in the hybrid vehicle segment. Today the major European car makers are also seeking to get into the market, and will be adding hybrid vehicles to their range of models in the near future.[42]

Growth of the markets for certain technologies, such as efficient petrol and diesel engines, is on the moderate side. Other innovative environmental technologies in the transport sector, by contrast, are displaying an extremely dynamic trend. In the hybrid drives sector, experts expect very strong growth until 2020, at 22 percent per annum (cf. Figure 25).

Experts also forecast very rapid growth for biofuels and particle filters – where annual growth rates in excess of 20 percent can also be expected up to 2020. In the transport telematics sector, annual growth of seven percent is expected, which means that by 2020 the market will treble compared with 2020.

5.4 THE POSITION OF GERMAN COMPANIES IN INTERNATIONAL COMPETITION

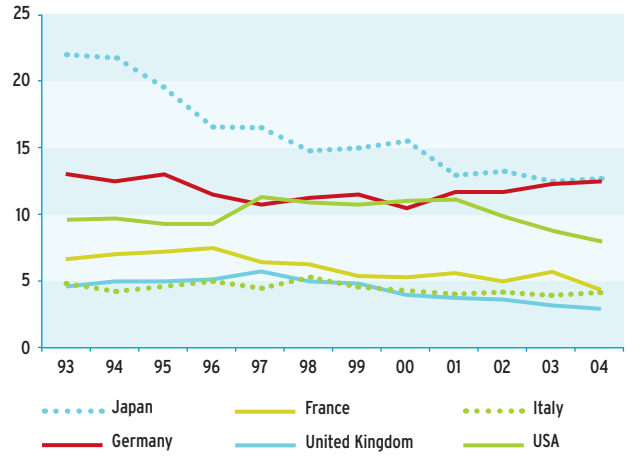
Shares of world market and world trade

Overall, German companies currently have a world market share of around 20 percent of the sustainable mobility technologies and products investigated. Germany and Japan lead the world in international trade in products for sustainable mobility. Whereas Germany's share has remained more or less constant at 14 percent over the last ten years, other major industrialised countries in the EU, the USA and above all Japan have lost considerable ground (cf. Figure 26).

In the field of vehicle technology and design, German companies may be well represented on the research front, but have not succeeded in translating this into corresponding market shares. The biggest

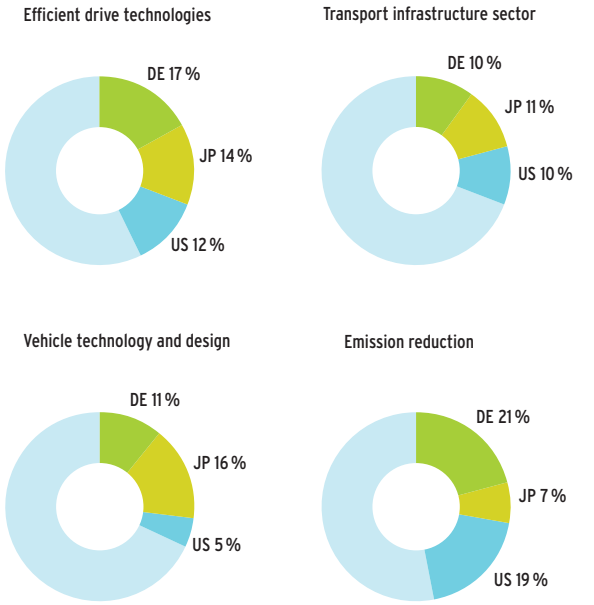
42 Cf. Doll (2007).

Figure 26: Development of world trade shares on the market for sustainable mobility (in percent)



Source: Walz et al (2008)

Figure 27: World trade shares of the three largest suppliers of sustainable mobility products



Source: Walz et al (2008), own compilation

competitors are Japan, France and Italy. Korea and China – because of their low labour costs – are also becoming increasingly competitive (cf. Figure 27). Dynamic SMEs and major companies in Germany have a first-class reputation worldwide in the field of sustainable mobility. Germany plays a leading role in road and rail infrastructure (but not in shipping). Emission reduction technologies are areas where Germany and Japan are well placed. German companies produce about half the filter and catalytic converter systems used worldwide, and in the case of transport telematics their share is one fifth. In less highly developed markets such as fuel cell technology or second-generation biofuels, Germany leads the field in product development.

Patents held by German companies

The number of patent applications is an important indicator of innovations. On this criterion the field of sustainable mobility is developing much faster than the rest of the economy. Research is concentrated in a small number of countries – headed by Germany. German companies account for nearly a quarter of patent applications. The total share of the four biggest industrialised countries comes to 74 percent (cf. Figure 28) – which is not only the result of a motor industry concentrated in a small number of countries, but also of environmental policy in these countries. Stringent air quality control legislation and promotion of public transport have provided incentives for companies to innovate.

Efficient drive technologies account for 54 percent of all patents.[43] German companies enjoy above-average representation here, with a share of 31 percent. German companies are particularly innovative when it comes to improving combustion engines, whereas in the case of fuel cells and hybrid technologies the innovations are tending to be made in the USA and Japan. These are technologies that will probably become more important in the future.[44]

The patent analysis shows that German companies lead the field on research and development in many areas – for example, efficient drive technologies – or are at least well to the fore. However, the pressure of competition is great. Japan, a number of Germany's European neighbours, and in future probably China as well are important competitors. Germany also needs to catch up in certain areas, for example alternative drive systems and lightweight construction.

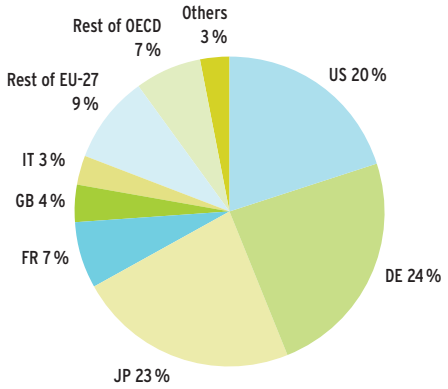
5.5 PROSPECTS

The market for products and technologies aimed at sustainable mobility is growing very rapidly and will – as a result of growing traffic volume, rising energy

43 The shares of patents due to the individual product groups are: efficient drive technologies: 54 percent, vehicle engineering and design: 23 percent, biofuels: 13 percent, transport infrastructure: 7 percent, and emission reduction technologies: 3 percent.

44 For a detailed analysis of patent specialisation in the individual product groups, see Walz, R. et al (2008).

Figure 28: Patent shares on the market for sustainable mobility, by countries



Source: Walz et al (2008)

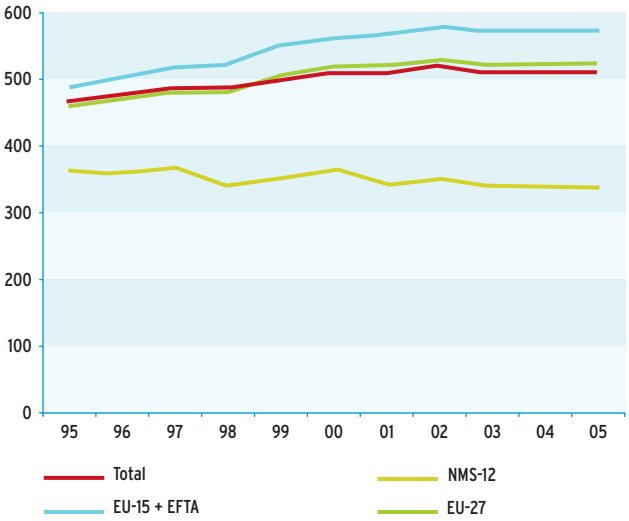
prices and more stringent environmental legislation – continue to gain in importance. In the field of efficient drive technologies, Japan and the major European countries are extremely specialised thanks to ambitious environmental standards and high fuel prices. However, Germany still has considerable ground to catch up when it comes to alternative drive systems.

Through their environmental legislation, policy makers make a considerable contribution to creating new markets for sustainable mobility products and propagating innovative environmental technologies. The ban on leaded petrol in the early 1990s, the compulsory introduction of low-sulphur diesel fuels, and the exhaust emission limits of the EURO standards provided companies with incentives to press ahead with the technical development and improvement of their products. The EURO-5 and EURO-6 standards published in 2007 are due to enter into force in 2009 and 2014 respectively. Such progressive environmental legislation helps companies on the world market for environmentally efficient products to establish a lead over competitors who are not yet faced with such stringent regulations on their home markets. As the example of exhaust emission standards in China shows, a pioneering role in environmental protection can also boost exports of German products, because other countries base their policies on the example of the pioneer.

6. WASTE MANAGEMENT

6.1 CHALLENGES FOR WASTE MANAGEMENT

Figure 29: Development of municipal waste in the EU
(in kg per head)



Source: EEA (2008)

Quantities of waste are growing almost everywhere in the world. For example, the EU originally set itself the target for the year 2000 of reducing municipal waste to 300 kilograms per person per year. This was the quantity in the EU in 1985. This target was nowhere near met, however, and efforts to reduce waste quantities significantly in the following years were not successful either (cf. Figure 29).

Every year more than 300 million tonnes of waste are produced in Germany. The statistics show that waste quantities fell slightly after the turn of the century (cf. Figure 30). This was due largely to the slack economic situation in the construction industry, leading to a reduction in the amount of building and demolition waste. Municipal waste quantities also fell by as much as 12 percent from 2002 to 2005. The task of avoiding waste and ensuring its environmentally safe and economically efficient disposal nevertheless presents Germany with a major challenge.

The growing quantities of waste call for an environment-friendly closed-cycle management system geared to the following priorities:

1. **Avoiding waste:** As a rule the most effective approach to sparing the environment and reducing resource consumption is not to cause waste in the first place. Material-saving and resource-efficient production methods are of central importance here (cf. Chapter 4 – Resource and material efficiency). Consumers are called upon to play their part too. For example, they can dispose of unwanted packaging at the point of sale and thereby put pressure on producers to dispense with superfluous packaging.

2. **Recovering waste:** The principle of closed-cycle management[45] requires that waste be collected and sorted so that the largest possible proportion of the resources and materials it contains can be recovered for use as substances. Closing substance cycles reduces consumption of raw materials and energy and thereby makes an important contribu-

Figure 30: Development of waste quantities in Germany

	Volume of waste (1,000 tonnes)			
	2002	2003	2004	2005
Total	381,262	366,412	339,368	331,889
of which:				
Municipal waste	52,772	49,622	48,434	46,555
Mining industry rubble (non-hazardous waste)	45,461	46,689	50,452	52,308
Building and demolition waste (including road construction rubble)	240,812	223,389	187,478	184,919
Waste from production and industry	42,218	46,712	53,005	48,106

Source: Federal Statistical Office *(Statistisches Bundesamt)*, Statistisches Jahrbuch 2007, and Federal Environment Agency *(UBA)* et al. (BGR, destatis) (2007)

45 See also Closed Substance Cycle and Waste Management Act *(Kreislaufwirtschafts- und Abfallgesetz)*, Section 4.

tion to improving the quality of the environment and saving resources. A further contribution can be made by waste incineration with energy recovery, as this destroys toxic substances which would otherwise go for landfill and spares the climate. In Germany about 10 million tonnes of secondary fuel could be obtained from waste every year.

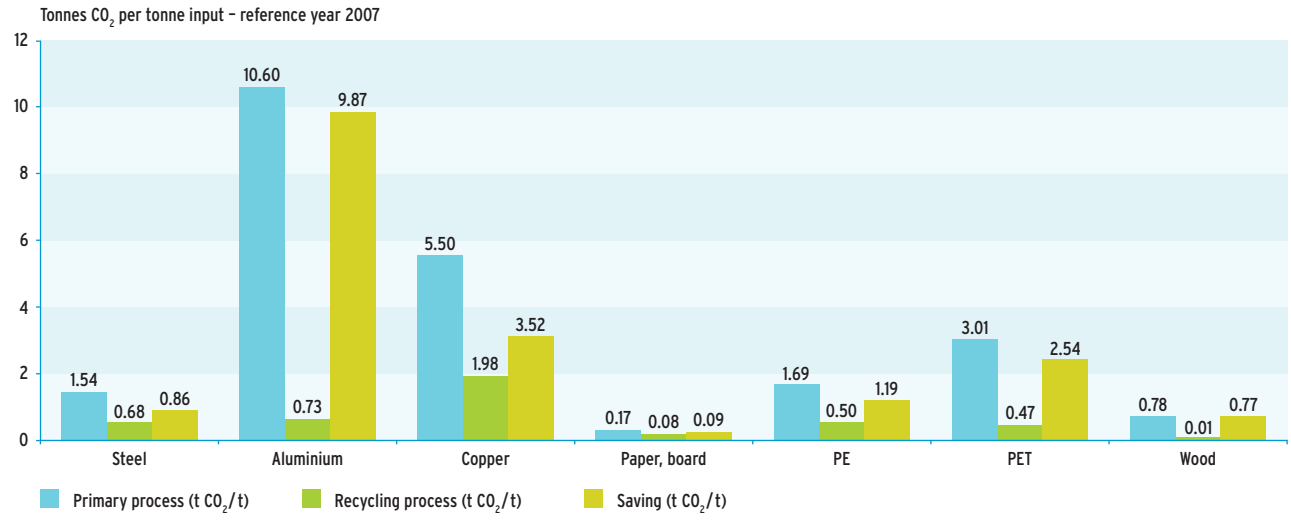
3. **Ensuring environmentally safe waste disposal:** Waste that cannot be avoided or recovered has to be disposed of by environmentally safe means. In most countries this is currently not the case – landfill gases affect the climate, and water seeping from leaking landfill sites often pollutes the groundwater.

Germany has already made substantial progress with recovery and environmentally safe disposal of waste as a result of the ambitious statutory requirements. About 86 percent of construction waste and 57 percent of municipal and production waste was recovered in 2004.[46] Companies in the waste management sector have responded to the legislation by developing appropriate technical solutions and are profiting from the high standards, e.g. by exporting innovative technologies. This is reflected by rising sales figures. Exports of goods in the waste management sector rose by 20 percent between 2003 and 2006.[47] According to an estimate by the iwd *(Institut der deutschen Wirtschaft)* in Cologne, the production of secondary raw materials boosted the gross domestic product by 3.7 billion euro in 2005 and created an additional 60,000 jobs.[48] These positive employment effects are due largely to the fact that recycling replaces considerable quantities of raw materials imports with domestic added value. Recycling also offers great opportunities for companies, since it cuts spending on raw materials. Rising raw material prices make it worthwhile for companies to develop completely new business fields, such as the use of old landfill sites as a source of raw materials.

From an environmental point of view, recycling offers several advantages: it not only avoids pollution of the environment during raw material production, but also makes a contribution to climate protection (cf. Figure 31). This is because recycling processes usually need less energy than the primary process. For example, the energy consumed in the recovery of aluminium is about 95 percent less than for the electrolysis of newly smelted aluminium.

Moreover, recycling and the recovery of substances as energy mean that less waste ends up on landfill sites. Landfill sites containing organic material release methane emissions, with harmful effects on the climate. The EU's municipal waste alone emitted greenhouse gases equivalent to 114 million tonnes of CO_2 in 2004.[49] For this reason, landfill is only permitted

Figure 31: Recycling reduces CO_2 emissions



Source: Fraunhofer (2008)

46 Cf. Federal Environment Ministry *(BMU)* (2007c), p. 99.
47 Cf. in this connection Part 1, Chapter 1.
48 Cf. Institut der deutschen Wirtschaft, Cologne (2006).
49 Cf. Prognos (2008).

in Germany for waste that has undergone preliminary treatment to minimise the possibility of further chemical reactions and thus presents far less of a risk to the environment.

6.2 PRODUCTS AND TECHNOLOGIES FOR WASTE MANAGEMENT

Waste management covers a broad spectrum of products and technologies that serve the purpose of waste avoidance, recovery and disposal. In some cases it is very personnel intensive – and this applies especially to services in waste management such as collection, sorting and treatment of waste.

Waste management requires a number of different technologies:

- Technologies for reducing quantities of waste occurring in production,
- Technologies for collection, sorting and size reduction of waste, for example automated substance identification and separation processes or logistical optimisation processes,
- Recycling technologies,
- Technologies for composting organic waste,
- Technologies for recovering waste as heat, and
- Processes for environmentally safe disposal of waste.

Substance separation processes, for example, play an increasingly important role in sustainable waste management. Substance identification and separation techniques can be used to sort substances on the basis of matching attributes. Automated processes speed up separation and ensure that waste is largely sorted into homogeneous fractions. This makes it possible to obtain secondary raw materials or substitute heating fuels from waste. These technologies can also be used to extract harmful or hazardous residual substances. Automatic separation also reduces costs, making it less economically attractive to burn unsorted waste or dispose of it as landfill.

Fact file: Production of facilities in waste management[50]

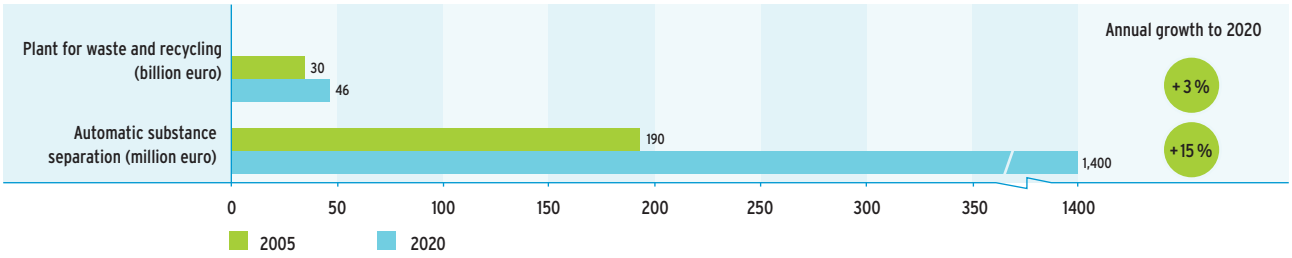
Size of world market	
2005	30 billion euro
2020	46 billion euro
Germany's share of world market	
2005	24 percent
Sales growth	
2004 to 2006	13 percent
2007 to 2009	11 percent
Growth in personnel numbers	
2004 to 2006	9 percent
2007 to 2009	7 percent

6.3 MARKET POTENTIALS

In 2005 the world market for facilities in waste management had an estimated volume of around 30 billion euro. By 2020 it will have grown by more than half to 46 billion euro. This market is of special economic interest from a German point of view, because German companies have a technical lead in many fields and can therefore profit substantially from the predicted growth.

Waste management is an environmental market that has been established for decades, but at the same time it is a market with a future, because many regions of the Earth still need to improve their waste management. The booming economies of countries like China and India and the growth of the global

Figure 32: World market volume of waste and closed substance cycle management



Source: Federal Environment Ministry (BMU 2007c), p. 104

50 Cf. Federal Environment Ministry *(BMU)* (2007c).

Figure 33: Treatment of waste in the EU (in percent)

Source: Eurostat (2007)

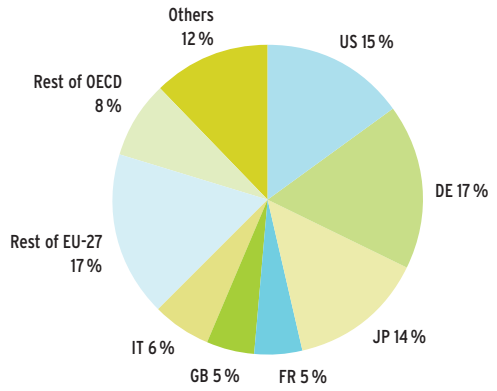
population increase demand for innovative waste technology. The raising of environmental standards – particularly in the East European member states of the EU – creates new opportunities for growth.

The market for automatic substance separation plants offers especially good growth prospects (cf. Figure 32). According to the findings of a business survey by Roland Berger, the world market volume can be expected to rise from 109 billion euro in 2005 to 1.4 billion euro in 2020.[51] The main driving forces behind this positive trend are cost benefits arising from the automation process, more demanding statutory regulations, and increasing quantitative and qualitative demand for secondary raw materials.

At present there are some 2000 large recycling plants in Europe and the USA. In most of these the degree of automation is limited. In many countries waste is not sorted at all. Figure 33 shows how the various countries in the EU treat their waste. This makes it clear that many countries could make further improvements in their recycling rate and closed cycle management. The squandering of raw materials, the dangers arising from landfill sites, and more stringent environmental requirements imposed by the European Union are forcing most countries to act.

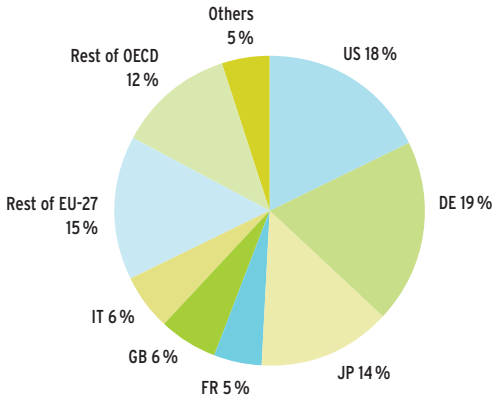
51 Cf. Roland Berger Strategy Consultants (2007), p. 83.

Figure 34: World trade shares on the market for waste management



Source: Walz et al (2008, p. 186)

Figure 35: Patent applications in the waste management sector (2000 – 2004)



Source: Walz et al (2008), p. 182

6.4 POSITION OF GERMAN COMPANIES

Shares of world market and world trade

German companies currently have a world market share of around 24 percent in the field of plant for waste management and recycling. In the automatic substance separation sector, German companies actually have two thirds of the world market.

This good position of German companies is also reflected in the foreign trade statistics. In the field of waste management and recycling technologies, Germany with 17 percent has the largest share of world trade ahead of the USA and Japan (cf. Figure 34).

Patents held by German companies

Germany's leading position on the world market for waste and recycling technologies is also due to the innovative capacity of German companies. One indicator of this is patent applications, where German companies lead the world. About 19 percent of patents in the closed substance cycle and waste management sector between the years 2000 and 2004 were accounted for by Germany (cf. Figure 35), followed by the USA with 18 percent and Japan with 14 percent.

The patent shares of the individual countries vary very considerably in the different product groups and technologies. For example, the USA ranks first in patents for low-waste production processes, Japan in patents for landfill technology. Germany enjoys a very good position over a broad range, and in most technologies it has patent shares of around 20 percent. This is true of collection, separation and size reduction of waste, and also of recycling processes and processes for energy recovery from waste. Its position is not so strong in landfill and composting of waste, and in low-waste production processes.

6.5 PROSPECTS

The market for waste and closed substance cycle management in Germany has grown steadily over the past decades. One main driving force has been environmental policy, which has successively developed waste legislation. With its new model of closed substance cycle management, it made a paradigm shift that gave a new economic stimulus – e.g. for separation of waste or recovery as material. Important ideas also came from the European Union – from the End-of-Life Vehicles Directive through the Waste Electrical and Electronic Equipment Directive to the latest revision of the Framework Directive on Waste. It is partly because of this progressive legislation that the German waste and closed substance cycle industry occupies a leading international position today. There are good prospects that it will be able to defend or even improve this position in the years ahead, since the waste and closed substance cycle industry is outstanding on an international comparison for its great innovative strength and competitiveness (cf. Figure 36).

Worldwide demand for waste technologies will continue to grow. This is due to various factors:

- The considerable backlog of demand in many countries with regard to environmentally appropriate collection, recovery and disposal of waste,
- The long-term rise in energy and resource prices, which makes recycling increasingly economic, and
- Long-term global trends such as the growth of the world's population, urbanisation and the rapid economic growth of many developing countries and emerging economies, all of which tend to increase the volume of waste.

Figure 36: Germany's competitiveness in the waste management industry compared with its main competitors

Product group	Patents		Foreign trade	
	Relative position	Main competitors	Relative position	Main competitors
Waste management, total	+++	US, JP, IT	+++	US, JP, IT
Collection	++	GB, US, ES	+++	US, IT
Size reduction	++	US, JP	+++	IT, JP
Separation	++	US, GB	++	US, IT
Recycling	+++	US, JP, IT	++	US, JP
Waste treatment	++	US, JP	+++	IT, US, JP
Use for energy	++	JP, US, IT	+++	JP, US, IT
Landfill	+	JP, US, KR	++	US, JP, GB
Low-waste production processes	++	US, JP, KR	++	JP, US

ES: Spain; GB: United Kingdom; IT: Italy; JP: Japan; KR: Korea; US: USA

Source: Walz (2008), p. 192

Since by no means all problems arising from waste are solved, environmental legislation at national and EU level will probably continue to undergo further development. This could set further growth surges in motion in the field of waste and recycling technologies. Furthermore, rising raw material prices could lead to the emergence of completely new business fields in the future. For example, these include the use of old landfill sites as a source of raw materials, known as "urban mining".

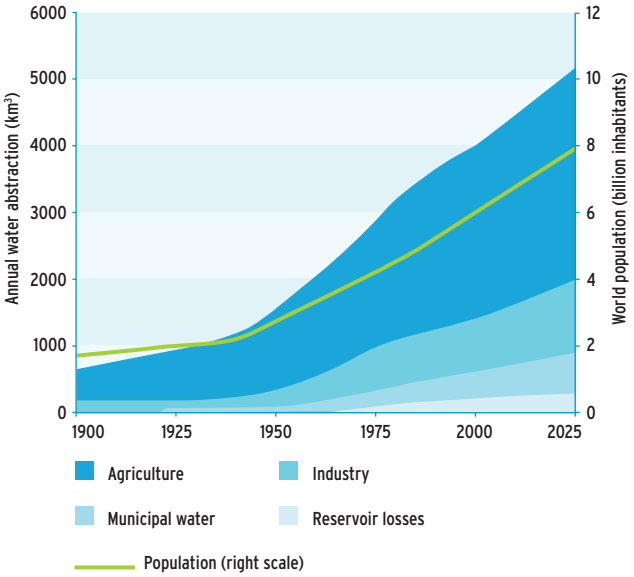
7. SUSTAINABLE WATER MANAGEMENT

7.1 CHALLENGES FOR SUSTAINABLE WATER MANAGEMENT

About 1.2 billion people, especially in less developed countries, have to live without clean drinking water. Even more people – 2.6 billion or about 40 percent of the world's population – have no basic sanitation (cf. Figure 38).[52] "No access to water and sanitation is a polite way of describing a form of scarcity that threatens life, destroys opportunities and undermines human dignity," is how the United Nations Development Programme (UNDP) comments on this fact.[53] About 80 percent of all diseases in less developed countries are due to contaminated water and poor wastewater disposal. This causes the death of some 1.8 million people a year – mostly children under five years of age.[54]

In the past century, water consumption has grown faster than the population. There is no sign of a change in this trend. Irrigation in the agricultural sector plays the greatest role worldwide, especially in the developing countries. Here over 80 percent of water abstracted currently goes for irrigation. The agricultural sector will continue to be the biggest consumer of water (cf. Figure 37).[55]

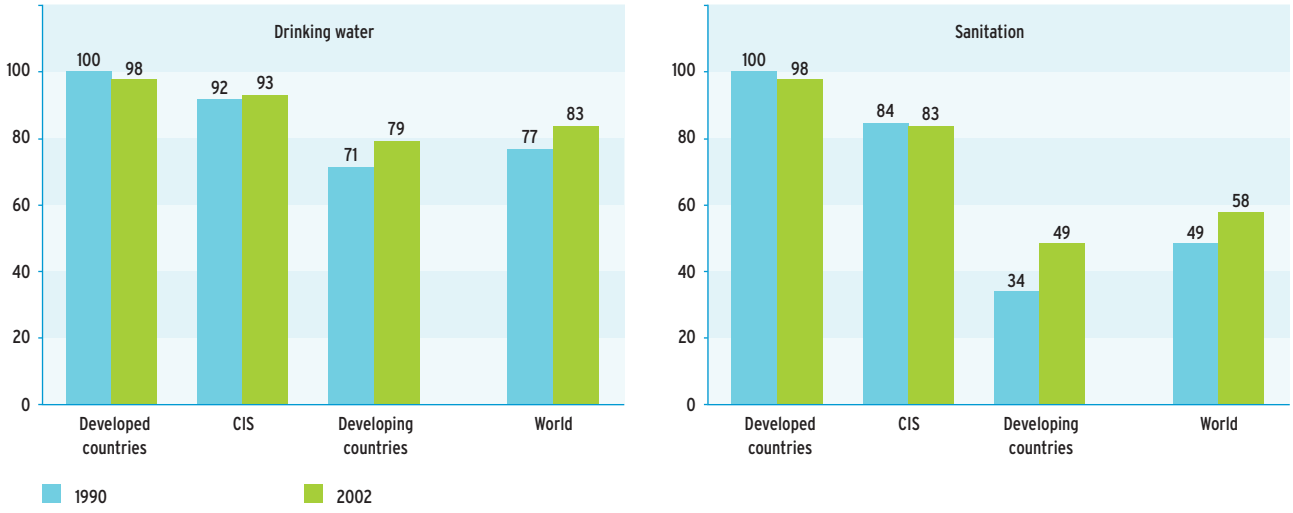
Figure 37: Global water abstraction



Source: Sustainable Asset Management (2006)

Clean water and good sanitation are basic requirements for sustainable development. Overcoming the water crisis is therefore one of the great global challenges. Consequently one of the Millennium Goals of

Figure 38: People with access to drinking water and sanitation (in percent)



Source: WHO / UNICEF (2005)

52 Cf. WHO / UNICEF 2006.
53 Cf. United Nations Development Programme (UNDP) 2006.
54 Cf. UNICEF (2008).
55 Cf. United Nations Development Programme (UNDP) 2006.

the United Nations is to halve the number of people without access to drinking water and sanitation by 2015. To achieve this goal it will be necessary to create access to clean drinking water for 80 million people a year.

Apart from the quantitative scarcity, water pollution is another central problem. According to the Organisation for Economic Cooperation and Development (OECD), 90 percent of wastewater in the less developed countries flows untreated into surface waters.[56] In the industrialised countries about 35 percent of households are still not connected to the public sewage system. Especially in eastern Europe, the Caucasus, Central Asia and south-eastern Europe there is still a lack of clean drinking water and sewage works.

7.2 PRODUCTS AND TECHNOLOGIES FOR SUSTAINABLE WATER MANAGEMENT

Sustainable management of water resources is one of the greatest environmental policy challenges of this century. Innovative technologies for sustainable water management play a key role in safeguarding the basis for life of the world's population. The market of the future in the field of sustainable water management essentially comprises the following product groups and technologies:

Water supply: This includes technologies not only for producing and treating untreated water (including sea water), but also for distributing it to private and business consumers. means of saving water resources include, for example, systems for using rainwater or grey water or leak detectors. Membrane-bound filter technologies are playing an increasingly important role in the treatment of untreated water. These technologies make it possible not only to kill off bacteria and viruses, but also to keep them away from drinking water altogether.

Wastewater disposal: This comprises draining wastewater from the place where it originates and purifying it, after which it can safely be discharged or re-used. The resources consumed in wastewater purification can be reduced by means of modified process design, energy recovery and recycling of raw materials. This makes wastewater treatment both more economic and greener. New technologies are being tried out to remove contamination by medicines.

Decentralised water management: Decentralised water management focuses on the water cycle as a whole. Instead of central supply and disposal structures it offers smaller, inexpensive systems. The aim is to close substance cycles in small areas and make efficient use of resources – e.g. the nutrients present in wastewater and the water itself. For example drinking water treatment, rainwater utilisation and wastewater treatment can be integrated in a single concept by purifying rainwater and using it at the place where it occurs. Wastewater that is only slightly dirty can be used for flushing toilets, for example (grey water recycling).

Water utilisation efficiency: Technologies for more efficient use of water are a decisive element in sustainable water management. Both private households and industry can save water with the aid of efficient equipment and process optimisation measures. For example modern washing machines, dishwashers and fittings are using less and less water. In predominantly agricultural countries, up to 80 percent of the water is used by agriculture – and here water losses occur when storing water, transporting it to the fields and using it for actual irrigation. Such losses could be reduced by using the highly efficient trickle irrigation method, for example. This technology makes it possible to reduce evaporation losses and, in dry countries, to reduce salinisation of the soil.

Technological flood control: As a result of climate change, technologies and products for flood control are becoming very much more important, because extreme weather events will be a more common occurrence. Dykes and retention basins must be built to reduce the impact of floods. Reservoirs and polders must be geared to the new situation, as must sewage systems and rainwater treatment facilities. There is also a need for instruments which supply data on water levels, flow rates and other parameters and process them in models. With their help it is possible to control rainwater and effluent flows better, manage reservoirs as flood buffers and thereby avoid flooding. This makes it possible to substantially reduce the dangers to man and the environment.

7.3 MARKET POTENTIALS

According to estimates by Roland Berger Strategy Consultants, the world market for sustainable water management is currently around 190 billion euro. By the year 2020 it is expected to grow by an average of six percent to 480 billion euro.[57] The World Water Council believes there is a need for capital investment of 180 billion US dollars per year in water infra-

56 Cf. OECD (2003a).

57 Cf. Roland Berger Strategy Consultants (2007).

Fact file: Sustainable water management

Size of world market	
2005	190 billion euro
2020	480 billion euro
Germany's share of world market	
2005	~ 5 percent
Sales growth	
2004 to 2006	12 percent
2007 to 2009	15 percent
Growth in personnel numbers	
2004 to 2006	8 percent
2007 to 2009	12 percent

structure in the developing countries.[58] This is more than twice the present level of spending. According to UNO, some 11.3 billion US dollars would have to be invested every year to achieve the millennium goal in the field of water supply.[59] It is estimated by SIWI[60] (Stockholm International Water Institute) that investment at a rate of 136.5 billion US dollars a year would be needed to provide all people with access to water and a sewage connection in their home.

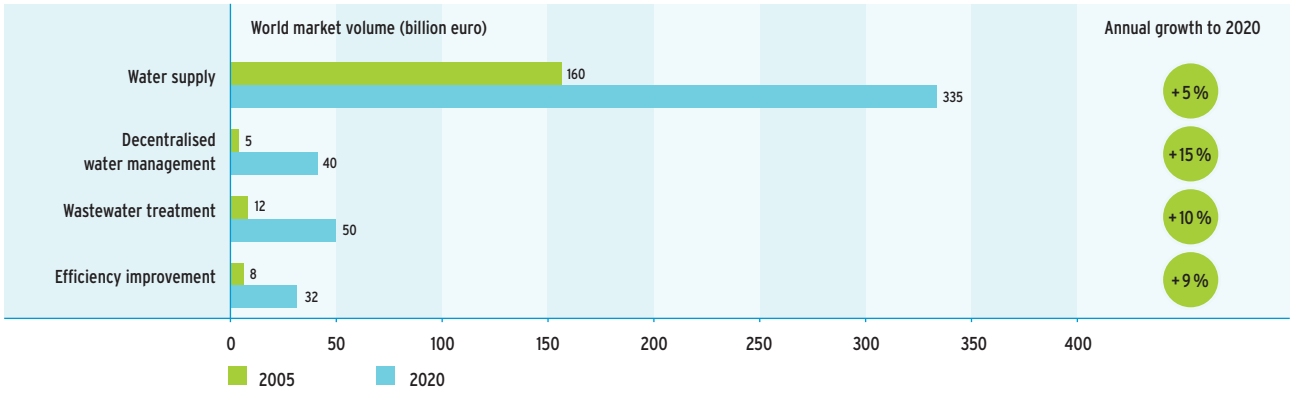
In the EU, funds of between 170 and 230 billion euro will be needed in the years ahead to comply with the wastewater directives in force today.[61]

At present water supply, in other words the provision and distribution of water, accounts for by far the largest share of the world market for sustainable water management, with an annual volume of around 160 billion euro. However, other market segments will grow considerably faster by 2020 and will therefore gain in importance. Growth is expected to be fastest in the field of decentralised water management, followed by wastewater treatment and products for efficient use of water.

The world market for decentralised water management currently has a volume of around five billion euro, of which three quarters is due to small wastewater treatment plants. At present the sales markets are primarily in Europe, where this market will continue to grow as a result of the stringent EU standards. This will remain the case in the short and medium term, because the Central and East European member states of the EU still have to bring their dilapidated wastewater infrastructures into line with the Brussels standards. By 2020, however, the industry expects to see marked expansion beyond the borders of Europe as well.

Excellent prospects for the future for Germany also exist in the market for membrane technologies. Especially in the field of water purification and drinking water production there is a wide range of possible applications for filtration membranes. This technology has continued to develop rapidly in recent years. Since 1990 the price of microfiltration membranes has fallen by 80 percent. Today there are sea-water desalination plants that produce drinking water for less than one euro per cubic metre. Owing to the

Figure 39: World market projection for sustainable water management



Source: Federal Environment Ministry *(BMU)* (2007c)

58 Cf. World Water Council (2003).
59 Cf. WHO / UNICEF (2005).
60 Cf. SIWI (2005).
61 Cf. Sustainable Asset Management SAM (2006).

sharp drop in costs, the use of membrane technologies is becoming increasingly common.[62]

Estimates for the year 2010 expect demand for membrane filters to reach around three billion US dollars in the USA alone. By 2020 the worldwide market volume is likely to grow to 70 billion dollars.[63] Because of the shortage of water in many countries around the world, which in view of climate change will probably grow worse, wastewater treatment and drinking water production, including from sea water, will become increasingly important. Here membrane technologies again play a growing role. The expected extremely rapid growth of this market is due to the interaction of these factors. Germany is in a favourable position to secure a large share of this fast-growing market.

7.4 POSITION OF GERMAN COMPANIES

Shares of world market and world trade

Germany currently has only a five-percent share of the world market for sustainable water management. However, this overall figure includes some very good market positions in individual technologies. In decentralised water management, German companies actually lead the field worldwide (cf. Figure 40).

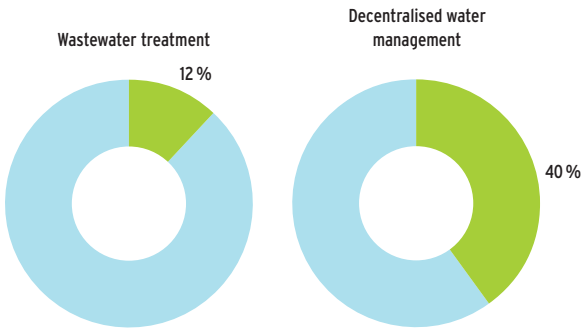
With regard to world trade in sustainable water management products, Germany has occupied the leading position for some years now, ahead of Italy and the USA. They are followed after a sizeable gap by Japan, France and the United Kingdom (cf. Figure 41).

With an annual export volume of 13 billion US dollars, water and wastewater technology as a whole is one of the export hits of German environmental technology. The world trade shares in sustainable water management also conceal considerable variations between the product groups and the associated technologies. For example, Germany's share in the sewage technology sector is 31 percent, while in sea-water desalination the United Kingdom takes first place with 30 percent. The USA is particularly successful when it comes to exports of products for water analysis, where its share of world trade is 28 percent.[64]

Patents held by German companies

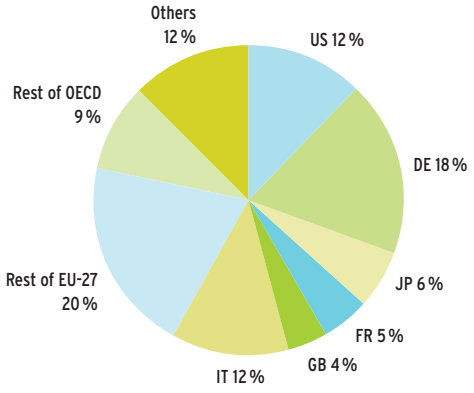
In the market for sustainable water management, Germany takes second place behind the USA, with 17 percent of all patent applications (cf. Figure 42).

Figure 40: World market shares of German companies in the field of sustainable water management



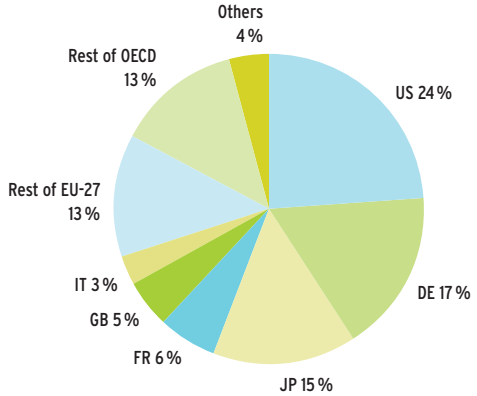
Source: Federal Environment Ministry *(BMU)* (2007c)

Figure 41: World trade shares of the main exporting countries in the field of sustainable water management (2004)



Source: Walz et al (2008)

Figure 42: Patents applied for in the field of sustainable water management between 2000 and 2004



Source: Walz et al (2008)

62 Cf. Luther et al (2007).
63 Cf. Luther et al (2007).
64 Cf. Walz et al (2008).

Figure 43: Germany's competitiveness in sustainable water management compared with its main competitors

Product group	Patents		Foreign trade	
	Relative position	Main competitors	Relative position	Main competitors
Water supply	+	CA, IT	+++	IT, GB, JP
Wastewater disposal and sludge treatment	+++	FR, CA	+++	IT , US, (JP, CH)
Water utilisation efficiency	+++	IT, KR	+++	IT
Flood control	+++	GB, KR, NL, FR	++	US, CH, GB, FR

CA: Canada; CH: Switzerland; GB: United Kingdom; FR: France; IT: Italy; JP: Japan; KR: Korea; NL: Netherlands; US: USA

Source: Walz (2008), p. 160

Germany's shares showed a decline in the years 2000 to 2004[65], however. Japan, with a slightly smaller number of patent applications, shows a steadily rising trend and could well overtake Germany in the future. Germany is the leader in the fields of water distribution, decentralised water treatment, sewage systems and flood control.[66]

7.5 PROSPECTS

The world market for sustainable water management will expand rapidly in the coming years. As well as Eastern Europe, emerging economies such as China in particular will become increasingly important as sales markets. German companies have a good starting position for taking part in this growth. This is suggested by the large number of patent applications on an international comparison, and also the large world trade shares as indicators of Germany's strong position in international competition. Environmental policy has contributed to this favourable starting position by imposing ambitious statutory standards, because it has promoted the development of innovative technologies that were capable of meeting these requirements.

However, there is also room for improvement. For example, domestic demand for innovative solutions is relatively slack in the field of wastewater disposal. This is because most of the wastewater disposal operations of municipal authorities focus primarily on safety and reliability when buying their plant. Cost-effectiveness and innovativeness tend to be of minor importance.[67] To take advantage of the environmental benefits of innovative technologies, it will be necessary to take up the challenge of getting water management operations interested in using innovative solutions as well.

Another problem lies in the fact that many of the mainly small and medium-sized companies in the German water management sector have hardly any international orientation. In the past, the German water management sector has frequently been unable to offer appropriate package solutions at international level that meet the specific requirements in the individual countries. To be successful with exports of water technologies, it will be essential to advise the countries in question on creating the necessary legal and institutional framework conditions, offer integrated management concepts (e.g. river basin management involving water users, and in particular the agricultural sector), and develop financing concepts. Project planning and management, deliveries of technical components, and operating and management concepts must be combined to meet specific needs.

A crucial step towards remedying these deficits has been taken with the introduction of the new German umbrella brand "German Water Partnership", by means of which the German water industry and research sector aims to further improve its position on the international markets. This is a joint initiative by a large number of companies in the German water sector, water research establishments, and trade associations in the water management field. Five federal ministries are also involved: the ministries responsible for research, economics, development cooperation and the environment, and the German Foreign Office. As a central point of contact for inquiries from abroad, the initiative will bundle and strategically align the wide range of skills in the field of water technology.

65 No more recent figures exist.
66 Cf. Walz et al (2008).
67 Cf. Walz et al (2008), p. 162.

PART 4:
KEY TOPIC: CLIMATE PROTECTION

1. CLIMATE PROTECTION POLICY – THE GERMAN GOVERNMENT'S OBJECTIVES

Key points at a glance

Climate change, diminishing resources and fluctuating energy prices are among the central challenges of this century. They make it necessary to develop much more efficient and low-emission economic management. This can only be achieved if investments are steered in an ecological direction worldwide. With its Integrated Energy and Climate Programme, adopted in 2007 in Meseberg, the German government launched the most ambitious and comprehensive climate protection project in the history of the Federal Republic. The decisions will help to reduce greenhouse gas emissions by around 34 percent by 2020 compared to 1990 levels. A number of other measures make it possible - at moderate avoidance costs – to achieve the German government's 40 percent reduction target.

The Meseberg Programme is at the same time a suitable basis for the ecological restructuring of the capital stock in Germany. In the light of globally increasing demand for clean and efficient technologies, high primary energy prices and Germany's need to catch up on investment, the time is now right for an offensive to promote investments and steer them in an ecological direction. Calculations performed for the Federal Environment Ministry show what a programme that achieves a reduction of 40 percent would mean for the German economy:

Climate protection measures would result in net investment rising by over 30 billion euro a year from the middle of the next decade, and would raise gross domestic product by at least 70 billion euro a year. At least 500,000 additional jobs would also be created by 2020.

This is because nearly all investments in more efficient use of energy are basically profitable. Every tonne by which greenhouse gas emissions are reduced pays off for Germany. Moreover, climate protection measures ensure that German industry specialises in innovative technologies at an early stage, thus strengthening its excellent competitive position on the global market. Foreign trade can therefore be expected to further boost demand for German climate protection technologies. This export momentum could generate around 200,000 additional jobs between 2015 and 2030.

The state budget also profits from the climate protection package. The nearly two billion euro of subsidies per year that are needed for a "minus 40-percent programme" would be offset by rising tax revenue and the upturn on the employment market.

1.1 CLIMATE PROTECTION AS AN ENVIRONMENTAL AND ECONOMIC NECESSITY

Protection of the Earth's climate is a central element of sustainable development. Whether the battle against man-made global warming is successful depends above all on the political will to adopt and implement far-reaching climate protection measures – at international, but also at national, regional and local level.

The debate about future climate policy is increasingly turning into an economic discussion as well. With the UK government's publication in 2006 of the Stern Report "The Economics of Climate Change", if not before, it became clear that climate protection is not only necessary from an environmental point of view, but also makes economic sense as an investment in the future.[1]

Against this background there is a general consensus in German environmental policy that further measures to protect the climate are necessary – though there is some controversy about their specific details. It is however clear that the criteria for all governmental measures apply in this field as well: they

1 Vgl. Stern (2007).

must be effective, efficient and based on the "polluter pays" principle, and must take adequate account of the capacity of the parties concerned.

In the European climate protection decisions of March 2007 and the Integrated Energy and Climate Programme of August 2007 which was then adopted by the German government (IECP), together with the relevant implementation decisions in the Cabinet, Bundestag and Bundesrat, Germany now has a comprehensive range of climate protection instruments.

The energy and climate programme adopted by the Cabinet at its closed meeting in Meseberg is the most ambitious and most extensive climate protection project ever introduced in the Federal Republic. It sets new standards in energy and transport policy, gets to grips with energy saving and energy efficiency, and imposes obligations on all sectors and emitters of greenhouse gases.

1.2 THE INTEGRATED ENERGY AND CLIMATE PACKAGE (IECP)

The Integrated Energy and Climate Programme (IECP) adopted in August 2007 and the decisions on its practical implementation define the following basic targets for 2020:

- A 40-percent reduction in German greenhouse gas emissions compared with 1990 is offered as a contribution to global emission reductions;
- The share of electricity generation due to renewable energy sources is to be at least 30 percent;
- The share of heat production due to renewable energy sources is to reach 14 percent;
- Biofuels are to be expanded without endangering ecosystems or food security.

Furthermore, under the Sustainability Strategy there is also the goal of doubling energy productivity compared with 1990.

To achieve these targets, the Meseberg programme comprises 29 points which are to take effect – supplementing emissions trading by companies and other existing instruments. In the opinion of international observers, this package ensures that Germany lives up to its reputation as a pioneer of climate policy.

Figure 1: The German government's Integrated Energy and Climate Programme (IECP)

On 5 December 2007 the Cabinet presented an extensive package of 14 acts and ordinances implementing central points of the Meseberg Programme. A second package followed on 18 June 2008. The main projects are:

Energy efficiency

More efficient power plants. The German government is promoting the construction of new power plants by means of an amendment to the Combined Heat and Power Act *(Gesetz über die Kraft-Wärme-Kopplung – KWK)*. The goal: to double the share of high-efficiency CHP plants in electricity production from 12 percent to 25 percent by 2020. The promotion of micro CHP plants under the Climate Protection Initiative will create additional incentives to develop markets and tap CHP potential in the field of heat and power supply for relatively small projects.

Smart metering. Smart electricity meters and variable load-related tariffs will be introduced. As from 2010, smart meters must be installed in new buildings and in cases of building refurbishment. If a meter is replaced, a smart meter must be provided. Also with effect from 2010, variable load-related tariffs must be offered. This enables consumers to save energy costs, and increases the efficiency of utilisation of Germany's power plants. Details of the requirements are defined in an ordinance.

Energy-saving buildings. To raise energy efficiency in the buildings sector, the energy requirements for buildings are to be increased by an average of 30 percent. In view of the expected long-term increase in energy prices, these measures will pay for themselves in only a few years. Furthermore, enforcement will be considerably improved by the introduction of private-sector proof requirements (e. g. declaration by specialist company) and the involvement of chimney sweeps.

Funds for refurbishment of older buildings. A total of 1.4 billion euro per annum will be made available for building refurbishment until 2011. This includes favourable loans and grants for private individuals, refurbishment of federal buildings, and assistance with redevelopment of the social infrastructure such as schools and day nurseries at local authority level.

Renewable energy sources

More green power. The revised version of the Renewable Energy Sources Act *(Erneuerbaren-Energien-Gesetz – EEG)* provides that the share of electricity generation due to renewable energy sources is to increase to at least 30 percent by 2020 and to continue rising steadily thereafter. Among other things, this will be achieved by means of better tariffs for electricity from offshore wind farms.

More heat from renewable energy sources. The Renewable Energies Heat Act *(Erneuerbare-Energien-Wärmegesetz – EEWärmeG)* lays down that by 2020 fourteen percent of the heat generated in Germany must come from renewable energy sources. Appropriate heating systems have to be installed in new buildings. At the same time the German government is stepping up the grants under the market incentives programme for heat from renewable energies in new buildings and refurbishment projects to up to 500 million euro a year.

More biogas. Through the revised version of the Ordinance on Access to the Gas Network the German government is seeking to ensure that more biogas is fed into the natural gas network and thereby made widely available. By 2030 the share is to rise to ten percent.

Transport

More biofuels. By 2020 there is to be a moderate increase in the share of biofuels. The proviso is that biodiesel and vegetable oil fuels must be produced sustainably, i. e. they must not destroy any environmentally valuable land and must not endanger food security.

Motoring with clean power. An electromobility development plan is to create reliable framework conditions for industry, researchers and consumers and bundle efforts in the fields of battery technology and vehicle technology. The important point here is that sustainable electromobility must be based on electricity from renewable energy sources.

Lower tolls for cleaner HGVs. The amendment to the Toll Level Ordinance provides that HGVs with high emissions are to be subject to considerably greater charges than those with low emissions. The individual toll rates are to be adjusted in line with the new Cost of Infrastructure Report 2007.

Lower taxes for fuel-saving cars. The road tax on new cars is in future to be calculated on the basis of CO_2 emissions instead of cubic capacity. If the relevant negotiations with the federal Länder are concluded in the autumn, the tax can come into force in 2010.

2. ECOLOGICAL RESTRUCTURING OF CAPITAL ASSETS

Figure 2: Structure of German capital assets, by asset types (2005)

Asset type	Capital assets (in trillion euro)
Residential buildings	3.4
Non-residential buildings	2.3
Machinery	0.7
Vehicles	0.2
Remainder	0.2
Total	6.8

Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008a)

Steering a modern economy onto a climate-friendly development path is a great challenge. The capital assets[2] of German industry are worth about seven trillion euro. This is equivalent to more than three times Germany's social product. A large proportion of these capital assets will have to be replaced over the next 10 to 15 years – in a way that enables them to be used profitably in future while consuming much less energy and causing much lower greenhouse gas emissions.

The increased use of renewable resources calls for additional investment and new technologies. The implementation of the Meseberg programme will therefore mean a substantial investment boost for the German economy, and will also open up new export potential. It is of course not possible to make detailed predictions about such developments and their impacts decades in advance. That is why the study commissioned by the Federal Environment Ministry on "Investments for a Climate-Friendly Germany"[3], the results of which are referred to in this chapter, uses figures largely to estimate the kind of scale involved in the impacts of the Meseberg programme and other measures.

Of the roughly 7 trillion euro of existing capital assets in Germany, about half is due to residential

Figure 3: Structure of German capital assets and greenhouse gas emissions by sectors (2005)

Sector	Capital assets			
	Buildings (trillion euro)	Other plant and vehicles (trillion euro)	Total (trillion euro)	Emissions (million t CO_2eq)
Services and private households	5.3	0.6	5.9	169
Energy supply	0.1	0.1	0.2	366
Industry	0.2	0.3	0.5	213
Others	0.1	0.1	0.2	257
Total	5.7	1.1	6.8	1,005

Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008a), Federal Environment Agency *(UBA)* (2007a), calculations by PIK (Potsdam Institute for Climate Impact Research) and ECF (European Climate Forum)

Figure 4: Gross and net investment, and depreciation by sectors (2005)

	Gross	Depreciation	Net
Services	326	246	80
Energy supply	9	10	-1
Industry	55	63	-8
Rest	14	16	-2
Total	404	335	69

Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008a)

2 Capital assets are a measure of average annual gross fixed assets. They comprise all assets produced which are used in production for more than one year.

3 Cf. Jochem et al (2008).

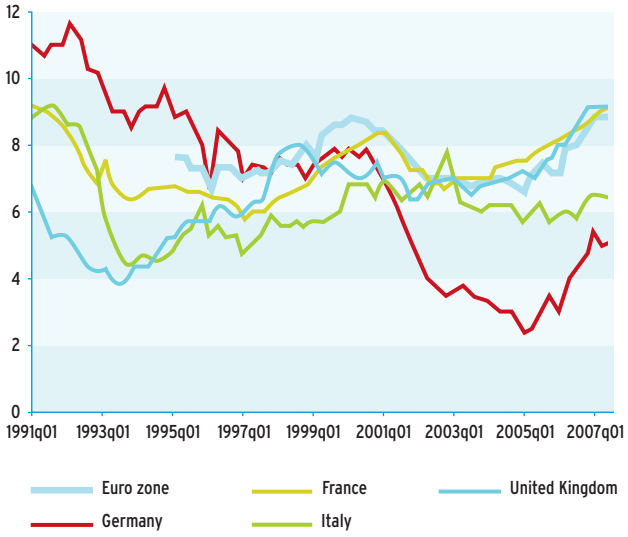
buildings, another 2.5 trillion euro to non-residential buildings, 10 percent to machinery and less than 5 percent to vehicles (cf. Figure 2). The large share of buildings indicates the great need for investment in this sector of capital assets.

The breakdown by sectors shows a relatively small share for industry and the energy sector, but also a large proportion of plant and machinery in industry (cf. Figure 3). Capital assets are renewed by annual gross investment, and a positive difference between gross investment and depreciation reflects an increase in capital assets, i. e. net investment (cf. Figure 4). In 2005 net investment in Germany, at 69 billion euro, stood at only about 17 percent of gross investment. There was a marked trend towards a service economy, with the industrial, energy and farming sectors actually displaying disinvestment.

Net investment as a percentage of gross national product has been falling in Germany for decades: from between 10 and 15 percent in the 1960s to less than five percent since 2003. An international comparison shows that this is currently on the low side compared with many other countries (cf. Figures 5 and 6).[4]

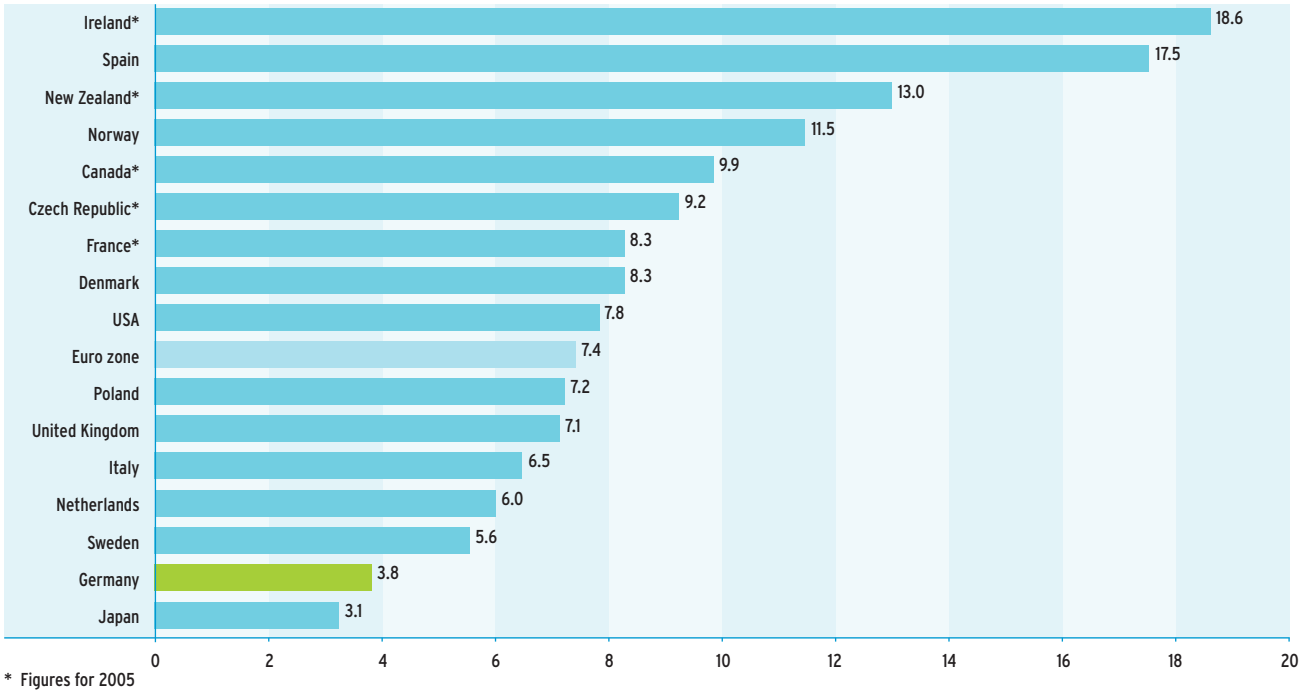
In a remarkable parallel with the falling net investment ratio, Germany's economic growth rate has displayed a downward trend in recent decades

Figure 5: Net investment in plant and equipment as a percentage of net domestic product in selected countries in the Euro zone (1991 – 2007)



Source: Horn, Rietzler (2007)

Figure 6: Net investment ratios on an international comparison (2006) (in percent)

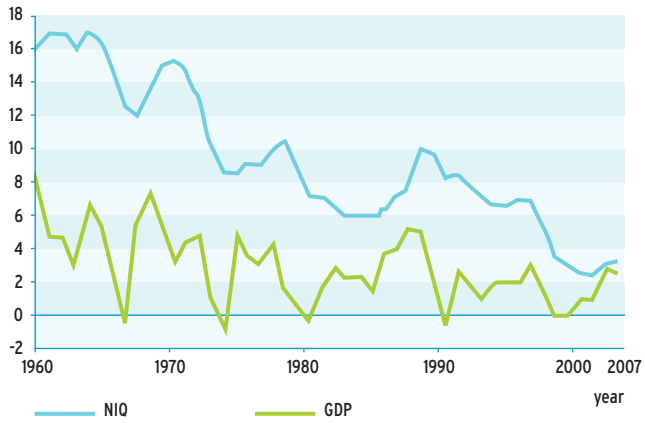


* Figures for 2005

Source: Sinn (2007)

4 Whereas Germany's falling net investment ratio is a robust scientific finding, the analysis of the causes is by no means clear. For the state of the discussion, see for example: Bond et al (2003) and Culpepper (1999).

Figure 7: Net investment ratios (NIR) and growth rates (GDP) in Germany (1960 – 2007) (in percent)



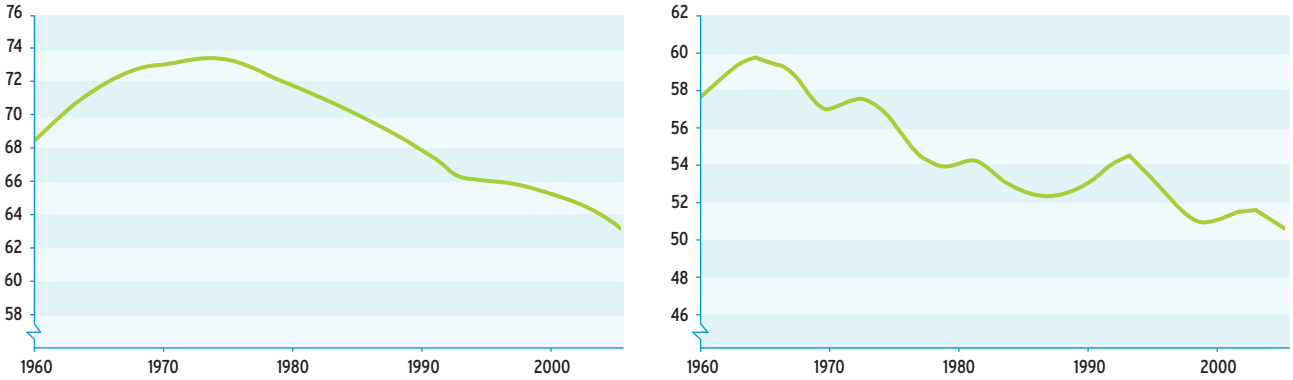
Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008b), DG ECFIN (2007)

(cf. Figure 7)[5]. The fall in the net investment ratio has gone hand in hand with increasing obsolescence of Germany's capital assets (cf. Figure 8). This means we now have the opportunity to build up a more modern, resource-conserving stock of capital assets. This applies particularly to existing buildings, where there is a great need for reinvestment in buildings created between 1946 and 1973.

Against this background, successful implementation of the Meseberg programme prompts extensive additional net investment averaging over 35 billion euro in 2020.

It has to be borne in mind that emission-reducing investments amounting to about five percent of GDP are already in progress. The Meseberg programme

Figure 8: Undepreciated fixed assets as a percentage of total assets (left buildings, right equipment)



Source: Federal Ministry of Finance *(BMF)* (2005)

Figure 9: Emission-reducing investments (2005) (in billion euro)

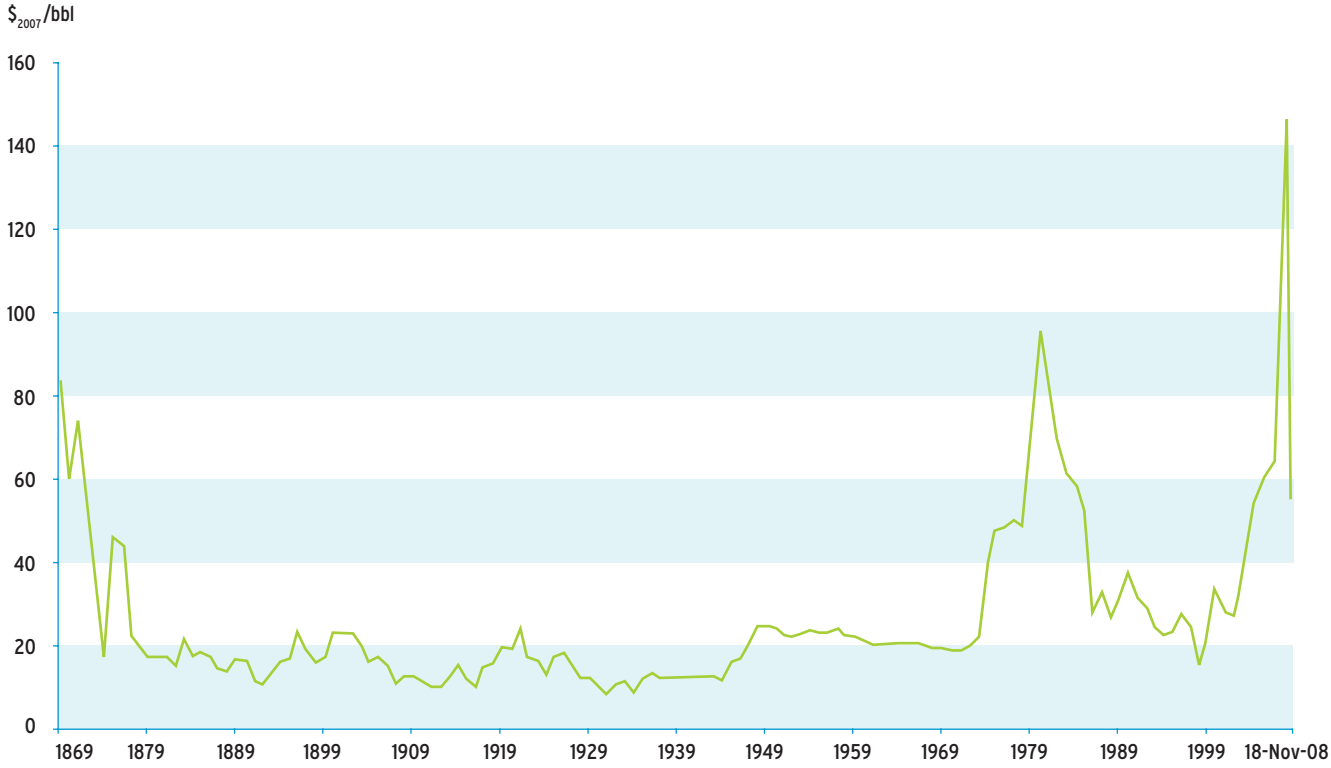
	Gross investment	of which: emission-reducing	Additional need due to Meseberg programme
Buildings	197	40	14
Machinery	121	39	3
Power Plants / Networks*	12	5	10
Vehicles	50	10	2
Rest	20	1	1
Total	400	95	30
Share of GDP (%)	20	5	1,5

* Including renewable energy sources

Source: Federal Statistical Office *(Statistisches Bundesamt)* (2008a), BEE (2006), BDEW (2008), calculations by PIK and ECF

5 As long ago as 2002 / 03 the German Council of Economic Experts *(Sachverständigenrat zur Begutachtung der wirtschaftlichen Entwicklung)* stated in its annual report, on the basis of a thorough empirical analysis: "First of all, growth is primarily to be secured by a sustainable strengthening of private investment activity." (SVR 2002: 336). Whether the rise in German net investment in the last two years is more than a short-term fluctuation, may well depend upon whether the coming years see the start of a surge in environmental investment.

Figure 10: Development of real price of oil (1869 – 2008) ($2007 / bbl), Annual means for WTI.
The figure for 2008 is the spot price for WTI on 22 May 2008.



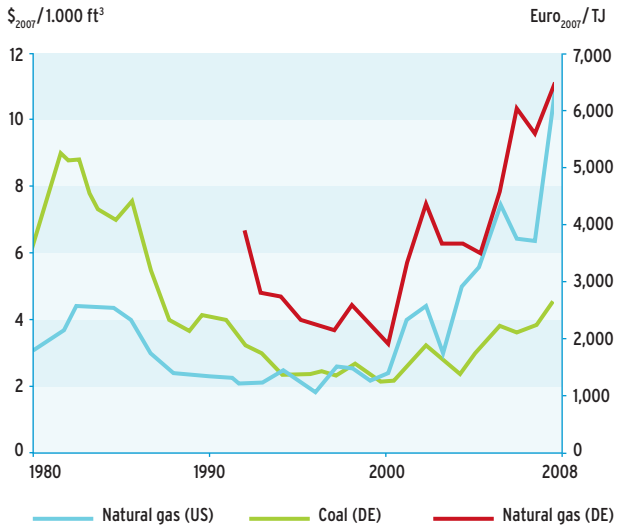
Source: WTRC (2007), Inflationdata (2008), Bloomberg (2008)

will increase these by about one third to 6.5 percent of GDP (cf. Figure 9).

Climate protection and energy efficiency measures are also an answer to the long-term trend in the price of important forms of energy – first and foremost the price of oil, which experts believe will continue rising in the long term.

Gas and coal prices have also displayed fluctuations of over 300 percent in recent decades (cf. Figure 11). In view of the growing demand from China, India and other emerging economies on the one hand and difficulties in stepping up production on the other, we can no longer expect constant or even falling long-term energy prices in the decades ahead. This will increasingly become one of the central challenges for today's economies. A surge of environmental investment could make the German economy less dependent on the volatility of energy prices, develop the technologies and infrastructure for a climate-friendly and energy-efficient economy, and help to overcome the investment deficits of the past, thereby generating growth and employment.

Figure 11: Development of real gas prices (US natural gas prices) [$2007/1,000 ft³] and border prices Germany [Euro2007/TJ], and real prices of third-party hard coal free German border [Euro2007/TJ]



Source: BAFA (2006), EIA (2008), Bloomberg (2008);
Federal Economics Ministry *(BMWi)* (2008), VdKI (2008)

3. IMPACTS OF AN AMBITIOUS CLIMATE PROTECTION POLICY

Rigorously implemented and supplemented by a number of supporting measures leading to a 40-per-cent reduction in greenhouse gas emissions compared with 1990, the Meseberg programme could be a four-fold success. According to the findings of recent studies[6], these measures not only help to achieve ambitious climate policy targets and create a sustainable climate-efficient and energy-efficient economic structure. The minus-40-percent target has the additional result that from the middle of the next decade net investment rises to over 30 billion euro per annum for several decades and that gross domestic product also grows to at least 70 billion euro a year on a long-term basis. Moreover, at least 500,000 jobs would be created by 2020.

>>> Further reading:

The information in this part is taken from the study commissioned by the Federal Environment Ministry on "Investments for a Climate-Friendly Germany". Internet: http://kliminvest.net/download.html

3.1 IECP: FALLING ENERGY REQUIREMENTS, LOWER GREENHOUSE GAS EMISSIONS

If the German government's Integrated Energy and Climate Programme is rigorously implemented, CO_2 emissions in 2020 will be down by about 34 percent compared with 1990. According to recent calculations, the measures adopted help to reduce emissions of climate-relevant greenhouse gases by some 173 tonnes CO_2 by the year 2020.[7] Thus the Meseberg programme brings the German government a good deal closer to its target of reducing greenhouse gas emissions by 40 percent compared with 1990 – though it has not crossed the finishing line yet. Further economically meaningful measures to achieve the minus-40-per-cent target are put forward in the "Meseberg-Plus" package.

The CO_2 reductions are variously distributed among the different instruments:

- The two biggest contributions to carbon dioxide reduction are made by the more stringent regulations for efficiency improvement and thermal insulation in new and existing buildings, and the promotion of renewable energy sources in electricity generation. Each of the two measures reduces greenhouse gas emissions by about 50 million tonnes carbon dioxide equivalent.[8]
- Smart metering of electricity utilisation, more efficient electrical appliances in households, and investment incentives for companies in trade, industry and services reduce the demand for heating fuels and electricity. This reduces CO_2 emissions by a further nearly 14 million tonnes.
- In the industrial sector the main impact comes from the reduction in emissions of fluorinated greenhouse gases (-17.5 million tonnes CO_2 equivalent). Investment incentives and assistance for advisory services also make an important contribution (-9 million tonnes CO_2 equivalent)[9]
- The Heat-Power Cogeneration Act *(Kraft-Wärme-Kopplungs-Gesetz)* helps to reduce emissions by a further 20 million tonnes CO_2 equivalent. This applies mainly to the industrial sector, but also creates incentives for trade and services companies and in district heating and local heating.
- In the transport sector cars make the largest contribution to CO_2 reduction (about 30 million tonnes). This is due to faster introduction of low-CO_2 vehicles and greater use of biofuels.[10]

As a rule, the reduction in greenhouse gases is due to the fact that non-renewable resources are replaced by renewable ones, that energy efficiency is improved and workflows in production and existing installations are better organised, maintained and repaired. The investments directly induced by the Meseberg

6 Cf. Jochem et al (2008).

7 The calculation does not include the small amounts of methane and N_2O emissions avoided due to the reduced quantities of heating fuel.

8 The calculations concerning the impacts of the expansion or renewable energy sources are based largely on the Renewable Energy Lead Study 2007 (Nitsch / DLR, 2007). Recent studies (Renewable Energy Lead Study 2008, publication in preparation) indicate that the volume of investment in renewable energy sources and the associated CO_2 emission reductions could actually be considerably higher.

9 The slight increase of 1.3 million t CO_2 equivalent in fluorinated greenhouse gases shown in Figure 12 is explained by the fact that the emission reduction of 17.5 million tonnes is more than offset by the growth in the reference case (+19 million tonnes).

10 This assumes a 14-percent share of total motor fuels in 2020.

Figure 12: Greenhouse gas reductions, induced investments and specific avoidance costs of the Meseberg and Meseberg-Plus programmes up to 2020

Emission basis 1990: 1,228.1 million t CO_2eq Emission basis 2007: 981.3 million t CO_2eq		Reduction 1990 to 2007: 20.1 %	
Measure	Emission reduction (million t CO_2eq)	Gross investment 2008 – 2020 (billion Euro)	Specific avoidance costs in 2020 (euro / t CO_2eq)
Cross-sectoral measures			
Measures in buildings sector	48.0	150.0	- 80.0
of which: Renewable Energy Sources Heat Act	15.0	39.0	73.0
Energy management industry	8.9	7.2	- 80.0
Energy management trade / commerce / services (TCS)	2.3	3.3	- 47.0
Heat-Power Cogeneration Act	20.0	- 0.3	- 0.3
Faster building refurbishment[2]	4.2	19.0	-10.0
Eco design and innovation offensive industry[2]	12.0	15.0	-15.0
Eco design and innovation offensive TCS[2]	3.0	5.2	-5.0
Material efficiency[2]	10.0	no data	no data
Private households, industry, trade, services			
Smart metering of electricity	3.4	5.0	- 150.0
Energy-efficient products	8.2	0.8	- 330.0
Incentives organic farming[2]	1.8	0.0	10.0
Measures in transport sector			
CO_2 strategy cars (with hybrid vehicles)	17.0	60.0	- 130.0
Expansion of biofuels	4.6	1.3	170.0
Change vehicle road tax to CO_2 basis	3.1	0.0	- 470.0
Consumption labelling for cars	3,5	0,0	- 450.0
Electromobility (excl. hybrid vehicles)	1.3	2.5	290.0
Improvements to HGV toll	0.5	0.5	78.0
Air transport (abroad: 1.9 million t)	0.4	2.7	- 95.0
Shipping (abroad: 0.5 million t)	-	0.4	- 390.0
Amendment to Company Cars Ordinance[2]	2.6	0,0	- 560.0
Low-friction oils compulsory (cars)[2]	2.5	11.0	- 190.0
Measures in industry			
Fluorinated GHG (effect 17.5 million t)	- 1.3	12.0	120.0
Non-fluorinated non-CO_2 GHG[2]	8.5	20.0	no data
Measures in conversion sector			
Electricity generation REG[11]	50.0	67.0	45.0
Biogas feed-in	3.5	1.1	55.0
Three modern lignite power plants[2]	7.4	2.3	15.0

11 The calculations concerning the impacts of the expansion or renewable energy sources are based largely on the Renewable Energy Lead Study 2007 (Nitsch / DLR, 2007). Recent studies (Renewable Energy Lead Study 2008, publication in preparation) indicate that the volume of investment in renewable energy sources and the associated impacts, e. g. CO_2 emission reductions, could actually be considerably higher.

Emission basis 1990: 1,228.1 million t CO_2eq Emission basis 2007: 981.3 million t CO_2eq		Reduction 1990 to 2007: 20.1 %	
Measure	Emission reduction (million t CO_2eq)	Gross investment 2008 – 2020 (billion Euro)	Specific avoidance costs in 2020 (euro / t CO_2eq)
Plus CCS for the three lignite power plants[2]	13.0	5.7	50.0
HVDC Wind North Sea (additional 3 GW)[2]	9	6	29,0
Total Meseberg programme	173.0	314.0	-38.0
Total Meseberg-Plus programme	247.0	398.0	-34.0
Reduction Meseberg programme from 2008 (base 1990)	14.1 %		
Reduction 1990 - 2020 Meseberg programme	34.2 %		
Reduction 1990 - 2020 Meseberg-Plus programme	40.2 %		

1 Average avoidance costs were calculated using the total impact of this measure, 17.5 million t.
2 Measure proposed in Meseberg-Plus programme

Source: Calculations by ISI, BSR, PIK and ECF

programme total more than 310 billion euro between 2008 and 2020, and those prompted by the Meseberg-Plus programme add up to around 400 billion euro (cf. Figure 12).

All in all, the Meseberg decisions result in a substantial reduction in energy consumption in Germany. Compared with a scenario that does not include climate policy measures, calculations indicate that implementing the IECP reduces net energy requirements by eleven percent by 2020, and as much as 19 percent by 2030. This also means that thanks to the Meseberg decisions, technical progress on energy savings speeds up by one percent a year.

The analysis of the costs arising from the reduction in greenhouse gases reveals that: Taken over all investors together, the Meseberg programme brings an average economic advantage in the form of long-term cost relief amounting to 38 euro per tonne of CO_2 equivalent avoided (cf. Figure 12). The cost relief afforded by implementation of the minus-40-percent target is only around 34 euro per tonne CO_2eq avoided. This economic benefit estimated for 2020 does not include any side effects such as the improved sound insulation provided by multiple glazing or the better product quality resulting from improved temperature control of industrial processes. The specific avoidance costs are calculated by establishing a ratio between the annual overall costs – or total revenue – of the measure in question for 2020 and the greenhouse gas emissions avoided in the same year.[12]

If the measures are ranked in order of their expected specific avoidance costs (cf. Figure 13), we find that:
- About half of the necessary CO_2 reductions are potentially profitable in micro-economic terms;
- The other half of the measures involve costs of between 10 and 100 euro per tonne CO_2 avoided;
- Two measures involve unusually high avoidance costs of more than 150 euro per tonne: biofuels and electromobility. These are young and hence relatively expensive technologies.

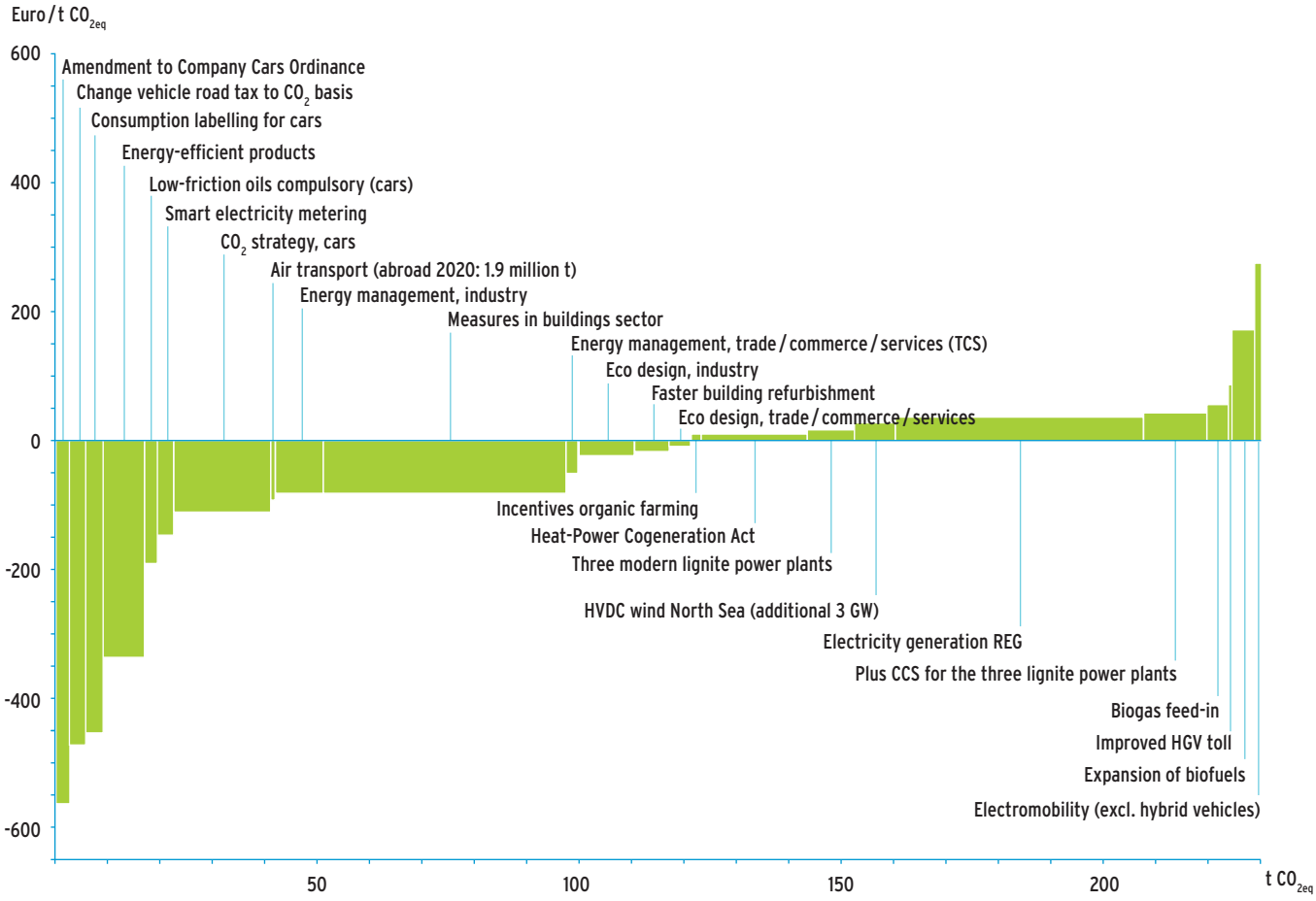
3.2 THE 40-PERCENT TARGET AND MESEBERG PLUS – ADDITIONS TO THE IECP

With a reduction of around 34 percent in carbon dioxide emissions, the instruments in the Meseberg programme are not in themselves sufficient to achieve the German government's target of a 40-percent reduction by 2020. Further measures are under discussion, however. If they were all implemented, a CO_2 reduction of more than 70 million tonnes by 2020 would be possible. The 40-percent target could thus be met.

A considerable contribution could be made by reducing methane and N2O emissions in areas such as coal mining, natural gas distribution, and the industrial and agricultural sectors. Reducing such non-CO_2 greenhouse gases largely in the industrial sector would cut emissions by 8.5 million tonnes of carbon dioxide equivalent. A reduction on a similar scale

12 In the case of capital costs, the specific avoidance costs are based on a measure-specific interest rate of between four and ten percent. The energy prices for assessing the energy quantities avoided and substituted are taken from the study "Politik-Szenarien für den Klimaschutz IV" ("Policy scenarios for climate protection IV") (Fraunhofer-ISI et al. 2008b).

Figure 13: Avoidance costs currently expected for various measures*[13]



* The calculations on the impacts of expanding renewable energy sources are based largely on the Renewable Energy Lead Study 2007; Nitsch, DLR (2007). The latest studies (Lead Study 2008) indicate that the renewable energy investment volumes and the associated impacts, e. g. CO_2 avoidance, could actually be considerably greater.

Source: Calculations by PIK

(7.5 million tonnes CO_2 equivalent) would be achieved by replacing three to four old lignite power plants by modern plants. Offshore wind energy systems with an additional capacity of three gigawatts would also help to reduce CO_2 emissions by nine million tonnes. If the use of low-friction oils were prescribed for cars, carbon dioxide emissions could be reduced by a further 2.5 million tonnes. Speeding up building refurbishment would result in a cut of 4.2 million tonnes CO_2 equivalent.

Since these measures going beyond the Meseberg decisions cover a very wide range, the individual instruments can be used on a targeted and flexible basis – depending also on cost-reduction potential and export opportunities. As a rule, the cost of such additional measures is moderate (cf. Figure 12). In individual cases they even result in additional revenue.

The cost benefit averages 21 euro per tonne carbon dioxide equivalent, i. e. not quite as high as for the preceding Meseberg measures.

3.3 POSITIVE IMPACTS ON GROWTH AND EMPLOYMENT

Fears are sometimes voiced that climate protection will put the brakes on economic growth. In fact, the opposite is true. The overall economic analysis reveals that the gross domestic product could increase by around 70 billion euro between 2008 and 2030 as a result of climate protection investments.[14] During the same period, at least 900,000 additional jobs can be expected. Implementing the minus-40-percent target is in itself enough to create 500,000 new jobs by 2020 (cf. Figure 14).

13 The illustration does not show the measures "fluorinated greenhouse gases", "material efficiency" and "non-fluorinated nonCO_2 greenhouse gases", because they cannot be depicted in this form.

14 The overall economic analysis is performed using the economic ASTRA model (Assessment of Transport Strategies), a tool for assessing long-term policy strategies.

Spending on climate protection investments has direct impacts on the economy as a whole. It leads in turn to new investments in response to cost savings made elsewhere; it makes a contribution to long-term reductions in expenditure on energy requirements; and it reduces imports of energy from fossil fuels.

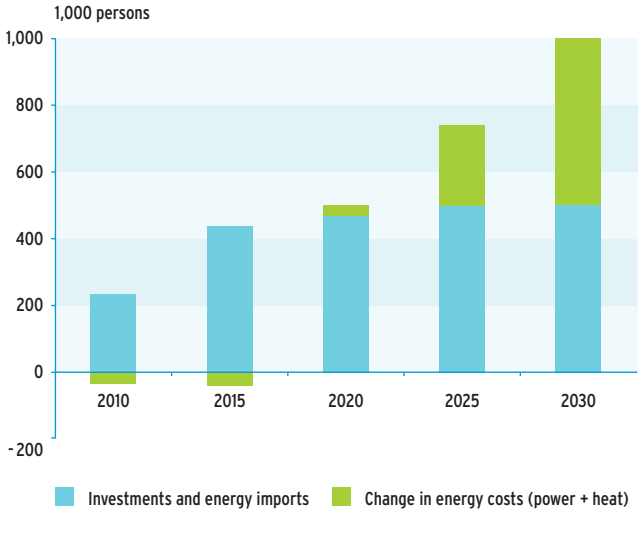
But the investments triggered by the German government's climate protection package also lead to indirect economic effects. The numerous intermediate inputs that become necessary in other industries influence the structure of the individual sectors of the economy. In Germany these structural effects can be expected to have positive impacts, since the necessary investments tend to favour industries which – like the construction industry and the capital goods industry – are based in Germany and are labour intensive. All this has effects on growth, consumption and employment.

The overall economic impacts of the Meseberg programme and the additional measures can be classified into two phases (cf. Figure 15). In the first phase the gross domestic product is primarily driven by direct investment in climate protection: In 2020 the largest contribution to growth, at around 60 percent, comes from these investments, of which nearly two thirds go directly into climate protection and one third is also triggered by second-round effects. In the second phase from 2020 onwards there is a growth in the importance of consumption, which by 2030 is contributing about 60 percent to the additional GDP.

A similar development takes place on the employment market. Whereas until 2020 it is clearly investments and import savings that create new jobs, from then on falling energy costs become an increasingly important engine for employment. By contrast, the importance of investments for the labour market starts stagnating in 2015 (cf. Figure 14).

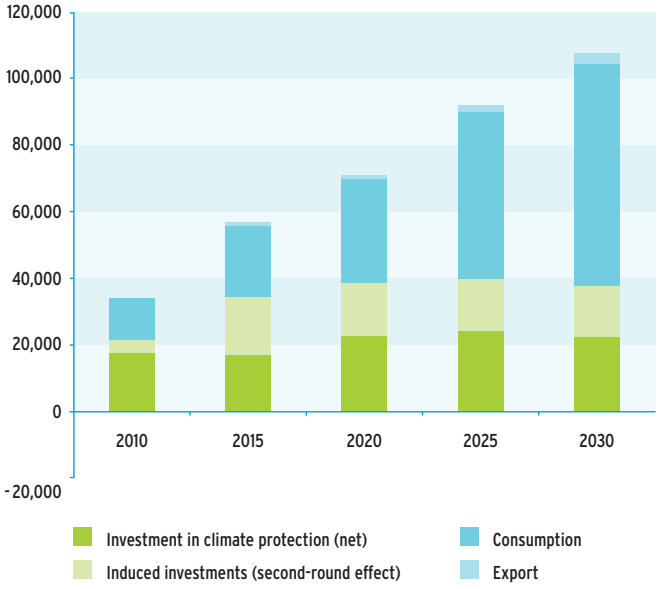
The importance of environmental technologies is growing on the world market too. Recent analyses indicate that the global market for environmental technologies can be expected to increase to around 2,200 billion euro by 2030, and by 2020 as much as 1,700 billion euro of this will already be due to climate protection technologies – including transport.[15] Thus climate protection goods and environmental technologies are becoming increasingly important for German industry (cf. Part 3 – The markets of the future are green).

Figure 14: Increase in employment over time, differentiated by driving forces
(investments and energy imports, and change in energy costs)



Source: Calculations by ISI using the ASTRA model

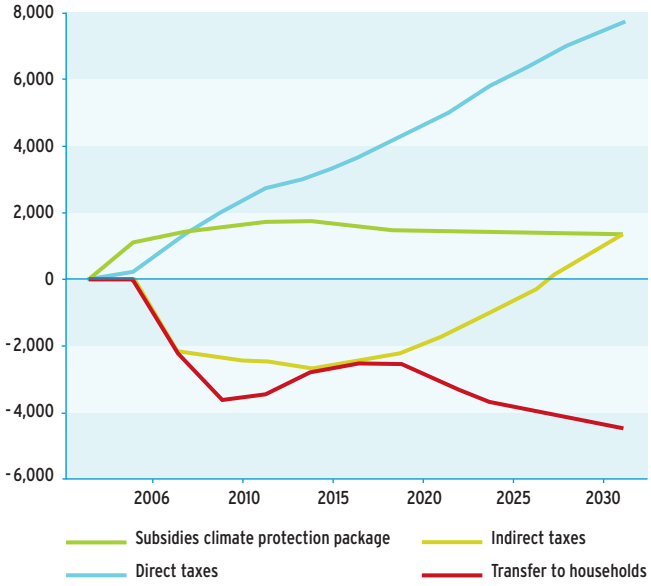
Figure 15: Development of growth contributions of GDP components
(in million euro)



Source: Calculations by ISI using the ASTRA model

15 Cf. Roland Berger Strategy Consultants (2007).

Figure 16: Change in major components of state budget
(in million euro)



Source: Calculations by ISI using the ASTRA model

Accelerated propagation of climate protection technologies as driven by an ambitious climate protection policy helps to ensure that German companies specialise in innovative technologies at an early stage and thereby strengthen their competitive position. Given its establishment as an international pioneer on the world market for environmental technologies, Germany is thus outstandingly well placed. Today German companies already occupy a strong position on the world market for climate protection technologies – and this is true in three respects: firstly, their world trade share of exports of climate protection technologies is already at least 15 percent; secondly, when it comes to foreign trade Germany has a strong focus on climate protection goods; and thirdly, Germany's share of international patents is already around 20 percent. Thus as the international demand for climate protection goods grows, companies in Germany will be in an excellent position to do well in competition thanks to their existing specialisation and their innovation lead.

As this has an impact on the world market, foreign trade will push up demand for German climate protection technologies by a further 17 billion euro by 2020. This means that GDP would show a further average increase of over 20 billion euro per year between 2020 and 2030. Between 2015 and 2025 an export surge of this kind could result in some 200,000 additional jobs.

The state budget also profits from the climate protection package. In spite of falling revenue from indirect taxes – e. g. as a result of reduced revenue from petroleum excise duty – the nearly two billion euro a year of subsidies needed to achieve the minus-40-percent target will be more than made good by growing revenue from direct taxes and falling social security payments due to increased employment (cf. Figure 16). The bottom line is that in 2030 national debt will be about 180 billion euro lower than if Germany failed to pursue a climate protection policy.

4. INNOVATION FOR CLIMATE PROTECTION – LOOKING BEYOND 2020

The climate problem can only be solved by looking beyond the horizon of current forecasts and targets. The Meseberg decisions take us to 2020, but it is vital to look beyond this – especially as regards developments in the emerging economies.

Up to now, efficiency losses in the production, distribution and use of energy in the industrialised countries have been massive. It is safe to assume that only about one third of primary energy input is actually used for mobility, production, heating and services. The investigations by the Bundestag Committee of Inquiry into "Protection of the Earth's Atmosphere" as long ago as 1990, and more recent studies show that within the next six to eight decades it may be possible to reduce our primary energy requirements by more than 80 percent, i.e. by a factor of five – photovoltaic systems, passive houses, biotechnology and light metals are only a few of the examples. In Switzerland the term "2000-watt society" has been coined for the vision of a highly efficient industrialised society at the end of this century. This kind of massive increase in energy efficiency is an indispensable precondition for any forward-looking climate and energy strategy.

Renewable energy sources have the potential to provide more than 50 percent of total final energy consumption in Germany – which will then be lower.[16] This is in line with the German government's recently reaffirmed long-term objective from the Sustainability Strategy. In the field of straight energy generation, the potential of renewable energy sources will then be as high as 80 percent.

Recent studies show that along this route there will be substantial changes in the importance of the individual renewable energy sources in the coming decades. The relative importance of biomass, which currently accounts for about 2/3 of all energy from renewable sources, will decline. By contrast, wind power and solar energy in particular have great innovation and growth potential, the latter especially in European and non-European networks (North Africa). Geothermal energy also has considerable potential for expansion and cost reduction, especially in the field of hydrothermal applications.

Coal still accounts for a large proportion of electricity generated in Germany – and worldwide. Research into means of capture and storage of carbon dioxide from large thermal power plants is therefore of special climate policy relevance. If they prove to be viable for large-scale use, and especially if safe storage facilities of sufficient size are available, these technologies could be used from about 2020 onwards. By 2050 they could help to make economic growth and CO_2 reduction compatible in the second half of the century. Research and pilot projects are necessary to explore this potential.

In the forthcoming modernisation of the energy system, it will be necessary to take account of interactions between the electricity and heating sectors. For example, the growing share of renewable energy sources will result in a temporary increase in demand for **natural gas** for electricity generation. To counter this, the present very high level of natural gas used for heat supply must be reduced – for example by means of better thermal insulation of buildings and more efficient building services technology, and also through more efficient generation of heat in **combined heat-and-power plants**. With heat requirements falling in the buildings sector and CHP shares rising in the electricity production sector, there will in particular be a need to expand **heating networks**.

16 Cf. for example Nitsch 2007.

The need for bold new ideas: Lighthouse projects with innovation potential

Outmoded ways of thinking will not be enough to overcome the enormous challenges of global climate change. Instead of old recipes, there is a need for bold innovations and rapid technology leaps. Five examples of lighthouse projects indicate what is possible. Successful implementation of the Meseberg programme depends on these and many other such projects. An innovation competition would stimulate further ideas and concepts for new climate-friendly ideas.

Example 1: Local energy efficiency learning networks help to reduce consumption in industry. Those responsible for energy in company networks share their experience, initiate expert presentations and receive all the information they need to improve efficiency in their operations. There are currently about 70 such energy efficiency or climate protection networks in Switzerland and ten in Germany. They reduce annual energy consumption by two to three percent compared with the average of one percent for the industry – a highly efficient mechanism for improving energy productivity in industry.[17]

Example 2: High-voltage direct current (HVDC) power lines are a first step towards a pan-European decentralised "SuperSmart Grid", which considerably facilitates the integration of energy from renewable sources.[18] Transmission losses in HVDC lines are only about half as much as with the present alternating current technology. This makes it possible to transmit power efficiently even from fairly remote production locations to the place where it is consumed. This would for example allow solar energy from the Mediterranean region or wind power from the Atlantic and the North Sea or Baltic Sea to be used throughout Europe.

Example 3: Infrastructure for electric vehicles in urban agglomerations is a precondition for the successful introduction of electrically powered vehicles. For example, in cooperation with Israel and Renault-Nissan, the company "Project Better Place" headed by former SAP director Shai Agassi has launched a large-scale pilot project to promote solar-powered electric vehicles; a similar project based on wind energy has been initiated in Denmark. In Germany cities could promote the use of electric vehicles in urban and commuter traffic by creating car parks with facilities for recharging the batteries. This would make it possible to accumulate experience with electronic control of charging processes in distributed networks – a starting point for the use of renewable energy via "SuperSmart Grid" (cf. Lighthouse project 2). A very important point to bear in mind is that electromobility will require the creation of additional renewable energy capacity

Example 4: Pilot projects for geological storage of CO_2: Tests investigating geological storage of CO_2 provide information on whether it is possible in future to develop coal-fired power plants with much lower CO_2 emissions. It appears to be basically possible to capture the carbon dioxide produced in fossil-fuel power plants and store it in geological formations.[19] What is not clear, however, is the availability of sufficient safe storage facilities that ensure permanent reliability and environmental compatibility. Estimates of the cost involved also vary considerably. There is now an urgent need for pilot CO_2 storage projects on a scale of several 100,000 t per annum, to permit investigation of the technical feasibility, cost-effectiveness, environment impact and safety of CO_2 storage.[20]

Example 5: A German Climate Fund could promote innovative solutions in Germany and abroad. With the support of public-private partnerships and suitable instruments at international level, such a fund would form an important building block in worldwide financing of climate policy in the 21st century. A crucial factor here would be to allocate to the fund a substantial portion of revenue from the auctioning of emission rights.[21]

17 Cf. Jochem et al (2007).
18 Cf. Czisch (2006).
19 Carbon dioxide Capture and Storage (CCS).
20 Cf. Wilson et al (2008).
21 Cf. Jaeger et al (2008).

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