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For our Environment

Report on the Environmental Economy 2011

Facts & Figures for Germany



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FOREWORD



Dear Reader,

The future will be shaped by close links between economy and ecology. Our future ability to thrive hinges on this combination. In view of climate change, our enormous consumption of finite resources and a steadily growing world population, merely continuing on the old path of industrial growth will lead to a dead end. But abandoning growth would also be a wrong turn. A society can only be based on solidarity if there is growth, and this is all the more true on a global scale. The key is not producing less, but producing intelligently. We need a type of growth that is no longer coupled to the excessive consumption of natural resources, but protects the climate and saves resources, thus improving our quality of life. This fundamental transformation process towards a green economy is an essential goal which the German government is pursuing with vigour.

The Report on the Environmental Economy 2011 shows that we have already made significant progress on this path to a new form of growth. Today we use much less resources, land and energy, and emit fewer pollutants than just ten years ago to obtain the same yield. Between 1990 and 2010, energy productivity increased by 38.6 percent and raw material productivity by 46.8 percent.

The current report contains a wealth of evidence to prove that environmental technologies and innovations are the future driving forces of our economy.

The global market in this sector already totals around 2 trillion euros. In the next ten years alone, this figure is forecast to double again. German companies lead the global environmental market with a share of more than 15 percent. Almost two million people in Germany already have green jobs. German businesses and employees will thus be benefitting from the expected boom. And we will do everything we can politically to further strengthen the innovative capacity of German companies on the key markets of the future.

With the transformation of our energy system, the Closed Cycle Management Act and the decision on a resource efficiency programme, the German government has already laid important foundations for a green economy. This is a joint national project which can make Germany a model of how to combine growth, resource efficiency, technological innovation and sustainability: future made in Germany!

A handwritten signature in black ink, reading "Norbert Röttgen". The signature is written in a cursive style.

Dr. Norbert Röttgen
Federal Minister for the Environment,
Nature Conservation and Nuclear Safety

FOREWORD

Dear Reader,

The Report on the Environmental Economy 2011, the second in this series of reports published by the Federal Environment Agency and the Federal Environment Ministry, presents a wide range of research results to highlight the economic importance of environmental protection. It shows once more that economic development and environmental protection do not have to be opposites. The increasing number of jobs in the environmental sector, dynamic growth on the green markets of the future and the high level of competitiveness of German companies on the global market for environmental goods are proof of the positive development in this regard.

Overall, we are managing our natural capital more efficiently today than we did ten years ago. However, this is not sufficient to achieve objectives like doubling energy and raw material productivity by 2020 or reducing land take.

The Report on the Environmental Economy shows that the transition towards a green economy provides enormous economic and employment opportunities. Studies prove that ambitious climate protection targets can create new jobs, for example through the expansion of renewable energies or energy upgrades for buildings. There is also great potential for job creation in saving resources. Increasing resource efficiency is a key factor in this. Efficient material and substance flows can help, for example, to cut the costs for material procurement, energy and water. Quite often, this goes along with cost savings due to lower waste or waste water volumes or lower costs for end-of-pipe environmental protection.



The path towards a green economy affords opportunities for both industrialised and developing countries to achieve prosperity in a way that respects ecological boundaries. In the industrialised countries, key areas of activity include the transformation towards a low-carbon economy, a reduction of resource consumption in absolute terms, and the conservation of biodiversity. This means that drastic efficiency gains will be required along with a consistent reduction of resource consumption. For newly industrialising and developing countries, the key challenge is to leapfrog the stage of the resource-intensive, high-emission economy prevailing in the industrialised countries and establish infrastructures right from the start that are geared to the requirements of climate and resource protection.

Shaping an ecologically sound economic system is one of the pivotal issues of this century. This is why the international community will meet in June 2012 – 20 years after the Rio Earth Summit – to discuss the transition towards a green economy.

A handwritten signature in black ink, appearing to read 'Jochen Flasbarth'.

Jochen Flasbarth
President
Federal Environment Agency



SUMMARY

Environmental protection is an important economic factor in Germany

Environmental protection has developed into an important factor in the German economy. This can be seen from the development of the environmental economy, a cross-sectoral industry comprising all businesses that supply environmental goods and services.

During the period 2006 to 2008, production of environmental goods in Germany displayed well above-average growth to reach new record levels in 2008 with a volume of nearly 76 billion EUR. Renewable energy was a major driving force behind this dynamic development. Even during the global economic crisis in 2009, production of goods in this sector increased despite the general downward trend. Since all forecasts are pointing to worldwide expansion of the markets in the years ahead, the economic importance of the environmental sector will continue to grow. Once again, renewable energy sources play a special role here.

A progressive environmental policy is essential for the dynamic development and competitiveness of the environmental economy. Nearly one third of all innovative companies said their environmental innovation activities had also been prompted by environmental legislation and regulations.

German companies continue to lead the environmental goods market at international level. With a 15.4 percent share of world trade in 2009, Germany again led the world in exports of environmental goods. It was followed by the US (13.6 percent) and China (11.8 percent), ahead of Japan, the United Kingdom and France.

In the environmental economy, research is extremely frequent, intensive and continuous. Nearly 80 percent of production in the environmental sector is particularly research- and knowledge-intensive. Environmental innovations also receive state assistance. The key elements here are research funding and the transfer and dissemination of new technologies. The aim is to ensure meaningful interaction of innovation policy and environmental policy, and at the same time to open up new markets for environmental technologies.

Environmental protection creates jobs

In 2008 there were nearly 2 million people employed in the environmental sector in Germany – a new record. This corresponds to 4.8 percent of all gainfully employed persons in Germany. There has thus been a further increase in the importance of environmental protection for the labour market in Germany compared with 2006. This growth in the number of jobs has been largely due to the expansion of renewable energy, Germany's success in exporting environmental goods, and environment-oriented services. By contrast, the importance of the classic environmental protection sectors such as investment in waste disposal, noise abatement, air quality control and water conservation has tended to decline.

Scientifically based estimates of the employment impacts of renewable energy sources up to 2010 are already available. They show that the strong upward trend in renewable energy is continuing. By 2010 the number of persons employed had already reached around 370,000. This is about 15 percent more than in 2008 (approx. 320,000 employees).

On balance, even allowing for the associated costs, environmental protection creates more jobs. This is because it tends to benefit labour-intensive sectors, for example energy-saving building modernisation. 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 or increased use of renewable energy sources that reduce consumption of fossil fuels such as oil or gas. Furthermore, model calculations show that in 2009 the expansion of renewable energy led to the creation of a net 70,000 to 90,000 jobs. The promotion of energy efficiency and resource efficiency and the continued development of the ecological tax reform also create jobs on balance. For example, improving material efficiency in businesses could lead to a net increase of almost 700,000 jobs.

Properly trained skilled employees are an important precondition for further growth of employment in the environmental protection sector. Lack of skilled specialists is already impeding development, e.g. in the field of energy-saving building modernisation. This problem will be exacerbated by demographic change. Greater attention should therefore be devoted to energy-saving issues during initial and further training in all construction trades – otherwise both climate and employment will suffer.

In other areas too, there is an urgent need to provide more content relevant to these issues in initial and further training and to integrate environmental requirements in vocational training and degree courses, in order to make the most of the opportunities that environmental protection offers for the domestic labour market.

Environmental protection pays off

Germany only spends about 1.4 percent of its gross domestic product on protecting the environment. Thus on a European comparison, Germany lies in the lower mid range when it comes to total national spending on environmental protection. 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 manufacturing sector.

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 and efficiency measures 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 favourable image of a region to attract qualified employees.

Because environmental protection helps to reduce environmental damage, it also gives rise to lower costs for society, e.g. as a result of air and water pollution or climate change. The transport sector alone causes environmental costs of around 40 billion EUR every year. The follow-up costs saved must therefore be considered in an overall economic assessment of environmental protection measures. For example, the expansion of renewable energy is already generating savings from avoided damage that are roughly equivalent to the additional costs they cause. This ratio will continue to improve as the production costs for electricity from renewable energy sources will rapidly decrease. Measures to protect biological diversity are also economically worthwhile in most cases, as shown by a number of examples.

Green Economy – the new principle of economic development

Fundamental to the concept of the Green Economy is the realisation that a management approach which destroys the natural basis of the economy cannot create long-term prosperity. Mega trends such as climate change, depletion of natural resources and loss of biodiversity underline how urgent the need is for transition to an economy that operates within the limits of environmental “guard rails”. Such a transition also has economic benefits. This is because the depletion of natural capital only creates short-term gains in prosperity – in the long term it is a threat to prosperity and the natural basis of life. Large-scale felling of forests, overfishing of the seas or over-utilisation of the atmosphere as a store for greenhouse gas emissions are all example of these connections.

The concept of Green Economy characterises an economy which

- ▶ continuously reduces harmful emissions and pollutant inputs into all environmental media,
- ▶ is based on closed-cycle management and reuses waste as far as possible,
- ▶ decouples economic growth and prosperity from the consumption of natural resources and the resulting environmental impacts,
- ▶ reduces resource consumption in absolute terms, especially by making more efficient use of energy, raw materials and other natural resources and by substituting renewable for non-renewable sources,
- ▶ protects the climate and strives for a long-term energy supply which is based entirely on renewable energy sources,
- ▶ generally seeks to act in harmony with nature and the environment, preserves biodiversity and restores natural habitats.

The transition to a green economy requires systematic support for environmental innovations. However it is much more than merely supporting individual environmental technologies or markets. Ultimately it requires a comprehensive ecological modernisation of the entire economy, because central requirements for a Green Economy such as improvements in resource efficiency can only be implemented successfully if all industries make their contribution.

Objectives and indicators for sustainable management

The objectives laid down in the National Sustainability Strategy are a first indicator of whether sustainable management is being practised in Germany. The analysis shows that progress has been made in many areas in recent years, but that in most cases the trend is not sufficient to achieve the environmental goals of the Sustainability Strategy.

Between 1990 and 2010, energy productivity increased by 38.6 percent and raw material productivity by 46.8 percent. And yet, the objective of the Sustainability Strategy - to double both energy and raw material productivity in Germany between 1990 and 2020 - will not be achieved at the current rate. To make this happen, the increase in energy productivity, for example, would have to more than triple every year compared to the last years. In this area, there is urgent need for action.

On the climate front, Germany has achieved the emission reduction laid down in the Kyoto Protocol. The reduction target of 40 percent by 2020, however, requires additional measures to protect the climate system. The expansion of renewable energies, expanding and upgrading the grid, energy-saving measures and an increase in energy efficiency are the key areas of action. By heralding the transformation of the German energy system, the German government has set the course for achieving climate policy objectives.

Land use for settlement and transport continues to increase - by a daily average of 94 hectares in recent years - although the rate has slowed somewhat since 2004. This means that Germany falls far short of the target to reduce daily consumption to 30 hectares by 2020.

In 2009 emissions of air pollutants were 56.4 percent down on 1990 - a welcome development. Between 2004 and 2009, however, the average annual reduction rate was a mere 1.5 percent. The objective of the Sustainability Strategy to reduce air pollutant emissions by 70 percent by 2010 compared to 1990 has thus not been fully achieved.

Development of environmental depletion by industry

The productivity of environmental consumption has improved steadily in recent years. Today the amounts of raw materials, land and energy consumed and pollutants emitted to generate the same earnings are considerably lower than ten years ago. However, labour productivity has increased considerably faster than material and energy productivity.

In the manufacturing sector today, material and resource costs as a share of gross production value are around 47 percent. The figure for personnel costs is only 18 percent. For economic reasons alone, it pays for companies to devote greater attention to material and energy costs, especially as the trend of rising prices for energy and raw materials is expected to continue. Numerous studies have shown that there is still large untapped potential for making more efficient use of materials and energy.

The energy intensity of production fell by 8.9 percent between 2000 and 2008. This was due in particular to the energy-intensive production sectors "Chemicals" and "Metal production". The total energy consumption of production over this period increased by 1.8 percent because gains in efficiency were cancelled out by economic growth.

Studies show that fears that climate-relevant emissions would be shifted abroad are unfounded. Model-based analyses for the countries with reduction commitments under the Kyoto Protocol come to the conclusion that the carbon leakage effects are relatively small: only 5 to 20 percent of the greenhouse gas reductions by the Annex I countries is cancelled out by additional emissions in states without reduction commitments.

In particular, the material-intensive sectors "Construction" and "Glass, ceramics, non-metallic minerals" have made savings in resource consumption. In the other production sectors there was little change.

Sustainable management as a challenge and opportunity for companies

The economic and financial crisis has focused attention on the issue of corporate risk management. Ecological aspects such as pollution, climate change, resource depletion and loss of biodiversity give rise to completely new risks for businesses. The public's expectations that businesses should behave in a socially responsible fashion, assume social and ecological responsibility and contribute to sustainable development have also grown enormously and become economically relevant. Businesses need to find new strategic, conceptual and operational answers to these risks and challenges.

This offers major economic opportunities for companies. That is because it gives rise to new, dynamically growing markets for "green" goods and services, and also great savings potential, especially through improvements in energy and material efficiency. Businesses can undertake strategic reorientation aimed at sustainable management and the assumption of social responsibility to enhance their competitiveness. Examples of guide documents are the United Nations Global Compact, the OECD Guidelines for Multi-national Enterprises, and ISO standard 26000:2010(E) "Guidance for social responsibility".

Systematic environmental management is a fundamental requirement for comprehensive and credible sustainability management. Suitable environmental management systems include DIN EN ISO 14001, the European Eco-Management and Audit Scheme EMAS, and the Energy Management standard DIN EN 16001 (future ISO 50001).

Production and consumption are responsible for a large proportion of today's environmental problems. State environmental policy therefore approaches product-related environmental protection with the aid of standards and specifications which lay down product requirements and prohibitions, e.g. of toxic substances. In addition, the Ecodesign Directive and the top-runner approach are used throughout the EU to make products more environmentally sound (especially as regards their impacts on energy and resource consumption). Labelling of ecologically ad-

vantageous product alternatives is relevant to the consumption of greener products, with the aim of providing practical guidance for buyers. With an annual purchasing volume of around 260 billion EUR, public procurement in Germany also has great potential for supporting environmentally sound products.

The future belongs to environmental and efficiency technologies

The growing global demand for goods and services can only be satisfied if we succeed in producing "more" with "less" – in other words decoupling economic growth from the consumption of natural resources. "Business as usual" would not be wise, either from an economic or an ecological point of view: UNEP estimates indicate that in a business-as-usual scenario, global GDP per capita in 2050 would be 14 percent lower than for a green investment scenario, but the burden on global resources would be 48 percent higher. Former World Bank chief economist 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 seven percent of the global social product by 2050. Moreover, raw materials will be less plentiful in future and hence probably much more expensive than today, and in many cases the capacity of our ecosystems to absorb pollutants is already exceeded.

Environmental and efficiency technologies will therefore play a key role in the 21st century. Especially on the "classic" markets – e.g. in the motor industry and mechanical engineering – the use of such technologies is becoming increasingly important and is a major factor determining a company's competitive strength.

Some green markets of the future have two major characteristics: 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. These markets include green energy generation, energy efficiency, resource and material efficiency, sustainable mobility, sustainable water management and closed cycle and waste

management. Environmental technologies which can be linked to these markets earned about 8 percent of Germany's gross domestic product in 2007, and by 2020 this share will increase to about 14 percent.

According to a study by Roland Berger Strategy Consultants, the global market volume of the six green markets of the future mentioned above will more than double from 1,400 billion EUR in 2007 to 3,100 billion EUR in 2020. This far exceeds the predictions in the study carried out two years earlier, which worked on the basis of a world market volume of 2,100 billion EUR in 2020. As shown, the biggest absolute increases in market volume between 2007 and 2020 can be expected in the fields of energy efficiency (+492 billion EUR), green energy generation (+460 billion EUR) and sustainable water management (+444 billion EUR).

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. The global share of German companies in the individual markets of the future was between 6 and 30 percent in 2007.

Germany shows particular strength in green energy generation and in waste and closed cycle management. German companies in these sectors account for a good quarter of the global market. Supported by the strong growth of the world market and their good competitive position on an international comparison, German companies have experienced a boom on the green markets of the future. Average growth rates (in terms of sales) have been particularly high on the markets for green energy, energy efficiency and resource and material efficiency.

The overall economic importance of the green markets of the future will continue to grow in the years to come. In the medium term, environmental protection will become an increasingly important sector for the classic industries as well, such as mechanical engineering and the construction industry, and also a driving force behind modernisation.

Increasing resource efficiency – a key challenge of this century

Natural resources are the Earth's natural capital and the basis for all economic activity. Without them we can neither meet our daily needs nor achieve prosperity. However, the use of natural resources has taken a course which is not viable in the long run – whether in ecological or economic terms. Estimates by the International Resource Panel expect that worldwide resource consumption will rise from the present 60 billion tonnes per year to 140 billion tonnes per year by 2050. A large proportion of natural resources are only available on a limited scale, however, and are not renewable. Even today, the economy is feeling the considerable burden of sharp rises and fluctuations in raw material prices. What is more, the extraction, processing, use and disposal of resources along the entire value chain gives rise to environmental impacts: energy consumption and release of greenhouse gases, pollution of air, water and soil, adverse effects on ecosystems and biodiversity.

Increasing resource efficiency is therefore a factor of central importance in order to safeguard prosperity in the long term, conserve the natural basis of our life for future generations and improve Germany's competitive position on an international comparison. The aim is to achieve greater economic output while at the same time reducing resource input – it is essential to “decouple” economic growth from resource input.

Possible means of increasing resource efficiency can be found all along the value chain: from sustainable resource extraction, via long-lasting and resource-conserving product design and material-efficient production processes and incentives for resource-efficient consumption, right through to closing substance cycles by reusing and recycling resources. Resource efficiency fosters innovation and competitiveness. But experience, e.g. from efficiency consulting for businesses, shows that even economically worthwhile efficiency measures are not implemented on their own merits, or at least not fast enough. The state is therefore called upon to create the right favourable framework conditions. Against this background, the German government has decided to develop a National Resource Efficiency Programme.

PART I: 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 developed into an important factor in the German economy. This can be seen from the development of the environmental economy, a cross-sectoral industry comprising all businesses that supply environmental goods and services. During the period 2006 to 2008, production of environmental goods in Germany displayed well above-average growth to reach new record levels in 2008 with a volume of nearly 76 billion EUR.

Renewable energy was a major driving force behind this dynamic development. After dipping briefly during the economic crisis in 2009, the environmental economy is taking a turn for the better again. Since all forecasts are pointing to worldwide expansion of the markets in the years ahead, the economic importance of the environmental sector will continue to grow. Once again, renewable energy sources play a special role here.

German companies continue to lead the environmental goods market at international level. With a 15.4 percent share of world trade in 2009, German again led the world in exports of environmental goods. It was followed by the USA (13.6 percent) and China (11.8 percent), ahead of Japan, the United Kingdom and France.

A progressive environmental policy is essential for the dynamic development of the environmental economy. Nearly one third of all innovative companies said their environmental innovation activities had also been prompted by environmental legislation and regulations.

In the environmental economy, research is extremely frequent, intensive and continuous. Nearly 80 percent of production in the environmental sector is particularly research- and knowledge-intensive. Environmental innovations also receive state assistance. The key elements here are research funding and the transfer and dissemination of new technologies. The aim is to ensure meaningful interaction of innovation policy and environmental policy, and at the same time to open up new markets for environmental technologies.

1.1 The environmental economy as a cross-sectional industry

The environmental economy comprises all companies that supply environmental goods and services. Through their goods and services, these companies make a contribution to preventing, reducing or eliminating harmful impacts on the environment. Their range covers such widely differing fields as waste management and recycling, water conservation and wastewater treatment, air quality control, noise abatement, renewable energy sources, environmentally sound products, efficient use of energy, climate protection, and instrumentation and control (I&C) technology.

The spectrum of goods manufactured is correspondingly broad: pumps, air filters, pipes, waste collection containers, silencers etc. are used in waste treatment, air quality control or noise abatement. Goods also include installations for generating electricity from renewable energy sources (e.g. wind energy and solar energy systems), and “smart meters” for controlling electricity consumption. Also of great importance are environment-related services: examples include energy consulting, trade in environmentally sound products, or product support services in the service and maintenance sector.

Recent years have seen a steady increase in the importance of integrated environmental protection within the environmental economy. This approach 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.

Unlike traditional branches of industry such as the automobile industry, there is no readily accessible statistical information on the environmental economy. The reason for this is that environmental protection is of a cross-sectional nature and relates to all sectors of the economy.¹ Until 2005 the Federal Statistical Office essentially recorded only figures on “end-of-pipe” techniques for environmental protection. In the reporting year 2006, it also started registering sales of integrated environmental protection technologies

and sales of goods and services in the climate protection sector, e.g. in the fields of renewable energy sources, energy saving and prevention of greenhouse gas emissions.

Other analyses take in goods which could by their nature – i.e. potentially – serve the interests of environmental protection. Since internationally comparable statistics are available on the production of and trade in potential environmental protection goods, this approach also makes it possible to examine the position of German industry in relation to the international competition. The information in this chapter is based largely on this potential-oriented approach.

What are potential environmental protection products?

Potential environmental protection goods can serve environmental protection purposes, but they may also perform other functions. They include such goods as pumps, pipes, and instrumentation and control equipment. The concept of potential environmental protection goods originates from a convention which was developed by research institutions in the 1990s in conjunction with the Federal Statistical Office. Since then it has been used for studies of the technological capacity of German industry. It is based on a list of goods that are (capable of being) used for environmental protection purposes. In 2006 this concept was expanded at the request of the Federal Environment Agency to include climate protection goods.²

1.2 Development of the production volume of potential environmental protection goods

After taking a brief dive during the economic crisis, the environmental economy is back on the growth trail again. All forecasts point to worldwide expansion of the markets in the years ahead. Climate protection goods have a special role to play here.

1 For this reason the Federal Environment Ministry and the Federal Environment Agency regularly award research projects aimed at analysing the size, composition and competitiveness of the environmental economy. These take a variety of statistical approaches to acquiring data on the environmental economy, thereby casting light on its many and various facets.

2 Cf. Legler et al (2006a).

Empirical basis for estimating production volume

The empirical basis consists of official data from production and foreign trade statistics. Using the lists available there on potential environmental and climate goods, it is possible to determine the monetary production, import and export volumes of industrial goods capable of being used for environmental protection purposes. In this field of potential environmental protection goods (including climate protection goods) it is possible to make an international comparison at the level of national economies. In the field of environmental protection services there is no internationally comparable basis of data. The results set out in this chapter therefore relate solely to the production of industrial goods.

Environmental and climate protection are becoming increasingly important for industry, and their share of industrial goods production is constantly growing (cf. Figure 1: Production of potential environmental protection goods broken down by environmental protection purposes (in billion EUR). Until 2005 this share was less than 5 percent. During the period 2006 to 2008, production of environmental protection goods in Germany displayed well above-average

growth to reach new record levels in 2008 with a volume of nearly 76 billion EUR – corresponding to 5.7 percent of total industrial production.³

In 2009 the production of environmental goods fell to 60.2 billion EUR as a result of the worldwide economic and financial crisis. This drop in production was thus in line with the average for German industry as a whole. Suppliers of climate protection goods, however, survived the crisis better, with a decline in production of only 7.1 percent. Production in the field of renewable energy sources actually rose slightly against the trend. This was due above all to the targeted state assistance under the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz – EEG) and the German government's ambitious climate policy.

The importance of climate protection for the environmental market has grown steadily in recent years. Whereas in 2007 only 20 percent of environmental goods was attributable to climate protection, this share increased to 26 percent by 2009. In the climate goods sector, renewable energy sources displayed the highest growth rates, powered in particular by the growth of solar cells (up to 2008) and the positive trend in wind energy that was maintained even during the crisis year.

Figure 1: Production of potential environmental protection goods broken down by environmental protection purposes (in billion EUR)

Environmental protection purpose	2002	2003	2004	2005	2006	2007	2008	2009
Waste		2.8	3.1	3.5	4.1	4.7	5.1	3.9
Wastewater		9.9	10.7	11.4	12.6	14.3	15.4	11.8
Air		14.6	15.5	15.8	17.8	19.7	21.3	16.1
Instrumentation and control		13.4	14.5	15.3	16.8	18.3	18.9	14.3
Climate protection ¹⁾	9.0	9.4	10.0	10.0	12.3	14.1	16.9	15.7
of which:								
Goods for efficient use of energy	6.0	6.4	6.3	6.4	7.2	7.9	8.3	7.1
Goods for efficient conversion of energy	1.2	1.0	0.9	1.0	1.3	1.4	1.6	1.5
Goods for use of renewable energy sources	1.7	2.1	2.8	2.6	3.8	4.8	7.0	7.1
Total ²⁾	47.4	48.5	52.6	54.6	62.1	69.5	75.9	60.2 ³⁾
For information:								
Share of total industrial production in percent	4.7	4.8	4.9	4.8	5.1	5.3	5.7	5.7
1) Excl. heat pumps.								
2) Incl. noise abatement, adjusted for multiple allocations.								
3) Fall in production as result of the economic and financial crisis.								

Source: Federal Statistical Office, Fachserie 4, Reihe 3.1, and special analyses for the Lower Saxony Institute for Economic Research (NIW); calculations and estimates by NIW

³ For the sake of simplicity, the following remarks mostly refer to environmental and climate protection goods, even where the potential approach is meant.

Figure 2: Production of potential environmental goods in Germany by branches of industry (in percent)

Branches of industry	Classic environmental goods	Climate protection goods	Potential environmental goods, total
Mechanical engineering	35.3	35.1	35.5
IT equipment, electronic and optical products	18.2	32.6	20.9
Repair and installation of machinery and equipment	17.5	–	13.4
Electrical equipment	6.9	5.8	6.8
Metal production and processing	6.3	–	4.8
Rubber and plastics	5.6	4.1	5.3
Metal products	3.3	4.4	3.4
Chemical products	2.4	1.2	2.2
Glass/glass products, ceramics, processing of non-metallic minerals	2.0	16.6	5.9
Textiles	1.0	–	0.8
Paper, board and resulting products	1.0	–	0.8
Total	100.0	100.0	100.0

Source: Federal Statistical Office, Fachserie 4, Reihe 3.1, and special analyses for the Lower Saxony Institute for Economic Research (NIW); calculations and estimates by NIW

1.3 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 generate a large proportion of their growth. Even if they are not active on the export front, they frequently compete with international rivals 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.

In the years leading up to the economic and financial crisis, the volume of global trade in environmental protection goods showed growth on a previously unparalleled scale: between 2002 and 2008 world

exports grew by an average of about 17 percent. By contrast, world trade in industrial goods averaged annual growth of only 14.4 percent. International trade in climate protection goods showed particularly dynamic development. From 2002 to 2008 this sector grew by an annual average of 19 percent, and in the case of renewable energy the figure was close to 33 percent (cf. Figure 3).

In the crisis year of 2009, the 18-percent decline in the export volume of environmental goods was less than the drop in processed industrial goods (around 22 percent). Trade in climate goods in the fields of efficient energy conversion and renewable energy sources recorded the smallest reductions.

Germany – Export champion in the environmental goods sector

With a 15.4 percent share of world trade in 2009, Germany again led the world in exports of environmental goods. It was followed by the USA (13.6 percent) and China (11.8 percent), ahead of Japan, the United Kingdom and France (cf. Figure 4).

Figure 3: Development of global trade in potential environmental protection goods

Environmental protection purpose	Average annual change in percent				
	1993-2008	1993-1998	1998-2002	2002-2008	2008-2009
Waste	10.7	8.5	-0.4	20.7	-28.9
Water	9.8	8.1	1.9	17.0	-18.5
Air	10.7	9.4	4.0	16.5	-19.6
Instrumentation and Control	9.6	9.0	4.1	13.8	-18.4
Noise	11.1	9.7	3.7	17.4	-20.0
Climate protection	11.6	8.7	5.0	18.9	-13.5
of which					
Efficient use of energy	9.3	9.1	1.3	15.1	-20.1
Efficient conversion of energy	9.8	6.9	9.7	12.3	-8.1
Renewable energy sources	18.5	10.1	9.8	32.6	-8.7
Environmental goods, total	10.5	8.6	3.6	17.1	-18.2
Processed industrial goods	9.4	8.2	3.6	14.4	-21.6

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

In many OECD countries, shares of world trade in potential environmental protection goods are on the decline, for example in the USA, the United Kingdom and France. This reflects the growing importance of the emerging economies. In recent years China in particular has displayed impressive development as an exporter of environmental goods. Its exports of environmental goods have shown an even more dynamic trend than China's industrial exports as a whole. Especially in the climate goods segment, China has taken up a strong position in the global market. This is primarily due to growth in the photovoltaic segment.

The share of industrial goods exports accounted for by potential environmental protection goods rose to 7.4 percent in 2009 (2008: 7 percent). It is not only in individual branches or regions that German environmental protection goods are in demand. German products sell particularly well in the fields of water and wastewater technology, instrumentation and control equipment, and climate protection goods. The German environmental economy is outstandingly competitive in all regions of the world.⁴ 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.

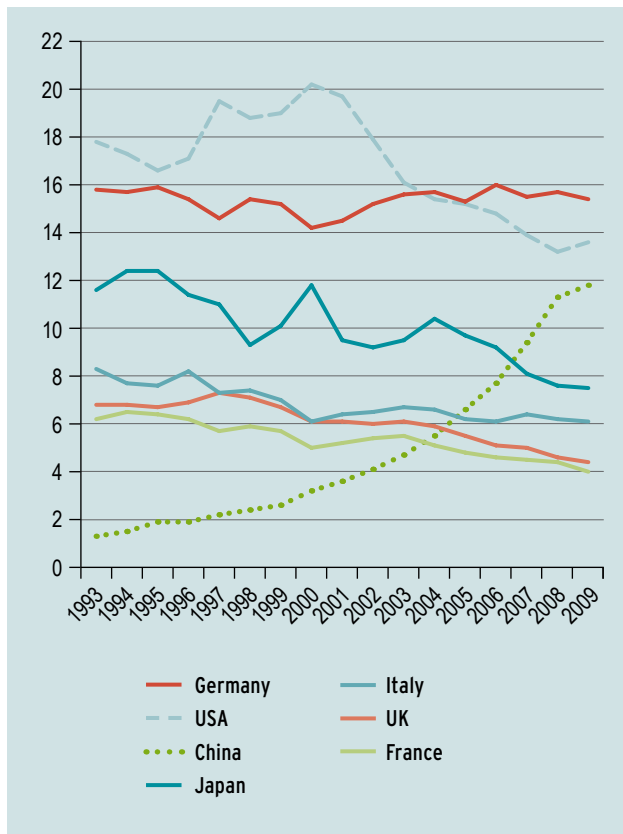
Ever since the 1970s and 1980s, a high level of environmental awareness and progressive environmental protection legislation have been major forces behind the development of a dynamic and competitive environmental economy. German suppliers have assumed a role as technological pioneers and translated this into a strong position on the international markets. Over the last 10 to 15 years the focus of demand for environmental goods has shifted from the developed industrialised countries to regions with emerging economies in Central and Eastern Europe and in Asia, especially China. German suppliers of potential environmental protection goods have made the most of this opportunity and secured substantial shares of those markets.

Competition in Germany – how imports have developed

Not only exports, but also imports are a relevant indicator when considering the international competitive position of a group of goods. This is because German companies' products have to compete with foreign suppliers within Germany too. Thus international competition also has an impact on the domestic market. Partly because of the growing international interlinking of markets, imports of environmental goods into Germany have shown an above-average rise in recent years. In 2009 they accounted for 6.1 percent

4 Cf. Schasse et al (2010).

Figure 4: World trade shares of the biggest suppliers of potential environmental goods 1993–2009
(Country's share of world exports in percent)



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

of total imports of industrial goods. However, since environmental protection goods as a share of industrial goods exports are considerably higher, at 7.4 percent, Germany is still in a strong competitive position even taking into account the growing demand for imports.

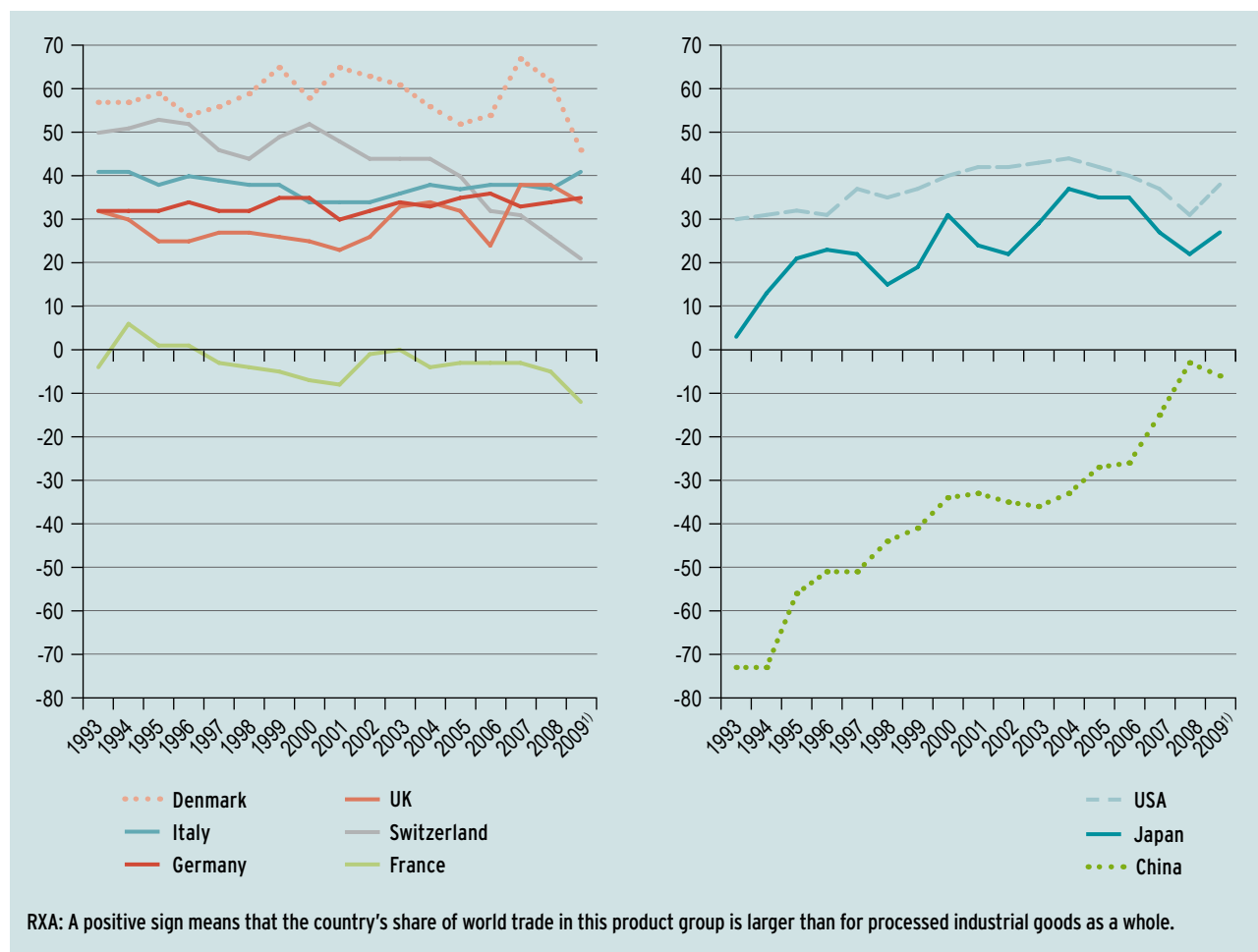
With the aid of an indicator of export specialisation (statistically measured as “relative world trade share”, RXA) it is possible to examine whether a country’s environmental economy occupies a better or worse position on international markets than the rest of the economy. A positive sign indicates that the product

group in question (in this case environmental goods) has a higher ratio of exports to imports than the average for industrial goods. This points to a strong position in international competition.

As can be seen from Figure 5, German companies enjoy a strong international position in the field of potential environmental protection goods. Germany’s relative share of world trade (RXA) in this range of goods is outstandingly high and has a stable track record. Much the same is true of other major economies such as the USA, Japan, the United Kingdom and Italy. But a number of smaller countries such as Sweden, Austria and Switzerland – though the latter has been falling off recently – have a high positive export specialisation in potential environmental goods. Denmark, thanks to its ambitious environmental policy, actually leads the field when it comes to specialisation in potential environmental goods. For some years now Norway, Poland and Hungary have also been achieving consistently high relative export advantages. Special note should however be taken of the development of China, with a very rapid rise in the export-import ratio. Today China’s environmental goods enjoy a similarly strong position on international markets to the other goods it exports.

German industry is especially competitive in the fields of waste technologies, water and wastewater engineering, instrumentation and control, and air quality control.⁵ In the climate goods segment – especially solar cells – imports have shown a sharp increase in recent years. This is an indication that German industry has become less competitive in this sector. There are countries with companies which display similar strength on the export front to German companies, but which have larger shares on their own 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 – which makes for greater competition on the domestic market and ultimately benefits the environment.

⁵ In these segments the ratio of exports to imports is much higher than the average, cf. Schasse et al (2010).

Figure 5: Specialisation of selected countries in potential environmental goods

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

1.4 In-depth study of the market for climate protection goods

In recent years the production of climate protection goods – especially in the renewable energy sector – has been steadily increasing. From 1993 to 2008, world trade in climate protection goods (expressed in US dollars) increased more than fivefold, with an average annual growth rate of 11.6 percent. It thus displayed much more dynamic development than trade in goods as a whole, which grew by 9.4 percent. The foreign trade picture for Germany is ambivalent: export successes on international markets contrast with massive increases in imports into Germany. Since 2004 the export/import ratio for climate protection goods has been lower than for industrial goods in general. In other words the proportion of climate protection goods imported is larger than the average

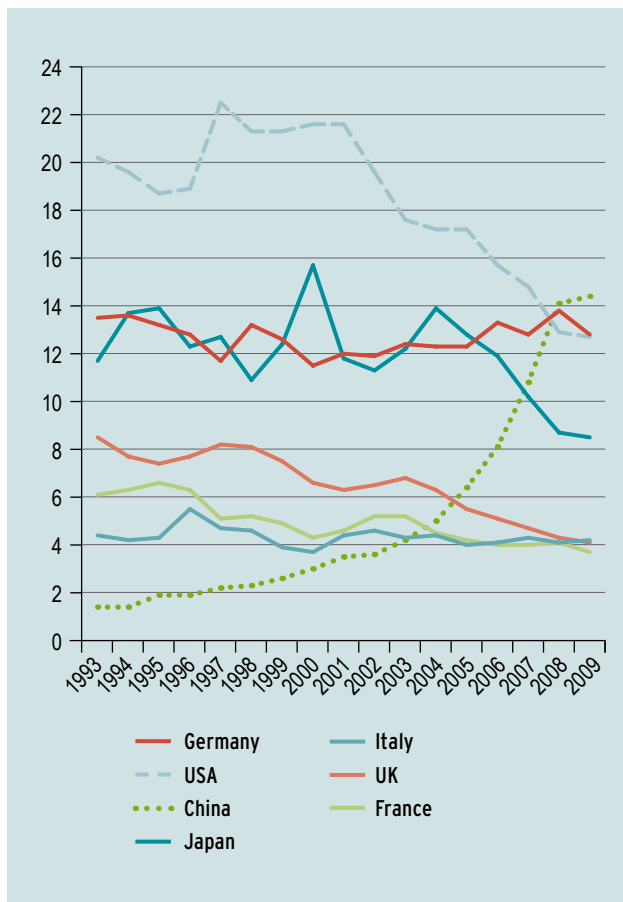
for industrial goods. It is therefore necessary to take a more differentiated look at this development.

During the crisis year of 2009, Germany exported potential climate protection goods to the value of more than 13.7 billion EUR. Although this was 16 percent down on 2008, the drop in climate protection exports in 2009 was much smaller than the figure for processed industrial goods as a whole. Thus with a 12.8-percent share of world trade, Germany remains the second-largest exporter of potential climate protection goods after China (14.4 percent), which took over the leading position from the USA in 2008. In recent years no other country has displayed such a dynamic development as China when it comes to exports of climate protection goods (cf. Figure 6). China gained world market shares from the USA and Japan in particular. Only Germany has succeeded in remaining stable at over 12 percent.

Renewable energy – the locomotive of dynamic development

Developments in the renewable energy sector have been particularly dynamic. The Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz – EEG) gave a strong boost to demand on the domestic market. After a certain time-lag, exports also showed a positive trend. In the course of the worldwide economic recovery it may be assumed that a large proportion of Germany's export losses in 2009 were made good during 2010. Goods for using renewable energy sources accounted for about 25 percent of imports of potential environmental goods into Germany in 2009 – compared with 8.5 percent in 2003. Above all, there has been a sharp rise in installations of photovoltaic systems in Germany in recent years, and domestic production capacity has been nowhere near able to meet this demand. Today, some 80 percent of the value of imports in the renewable energy sector

Figure 6: World trade shares of the largest suppliers of potential climate protection goods 1993–2009
(Country's share of world exports in percent)



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

is due to photovoltaic systems (largely solar cells), the remainder being accounted for by wind energy and hydro power installations and their components.

In the wind energy sector, growth in demand in Germany up to 2005/06 – encouraged by the assistance under the Renewable Energy Sources Act – was also so great that a sizeable portion of it had to be met by imports. After that, the expansion of domestic demand slowed down considerably – resulting in an export boom to make full use of the existing domestic production capacity.

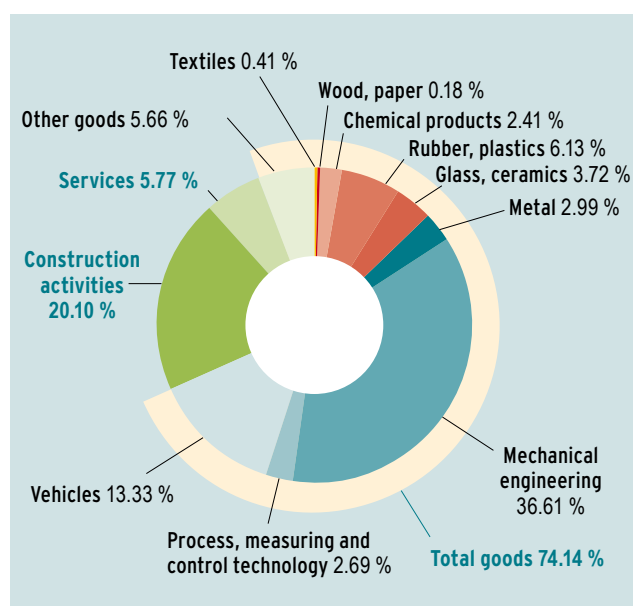
1.5 Industries and company sizes in the environmental economy

Breakdown by industry

In 2008 some 40 percent of businesses in the environmental economy in Germany belonged to the service sector. This is the finding of the official survey of goods, construction activities and services. Official surveys nevertheless indicate that sales of services account for only about 6 percent of the environmental protection market covered by those surveys (cf. Figure 7).

Empirical basis: The statistics on goods, construction activities and services

A survey conducted by the Federal Statistical Office since 1997 provides information about the production of goods, construction and services primarily intended for environmental purposes. Since 2006 it has also included the fields of renewable energy sources, energy saving, and prevention/reduction of climate-relevant emissions. The circle covered by the report was expanded considerably in 2006, which means the findings are hardly comparable with previous years. The following remarks relate to the latest results for the year 2008 and a special analysis by the NIW in collaboration with the Research Data Centre of the Statistical Offices of the Länder.

Figure 7: Sales shares of goods, construction activities and services for environmental protection 2008

Source: Federal Statistical Office, Fachserie 19, Reihe 3.3 (various years)

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. Product support services, by contrast, which probably play a particularly important role in export

business, are included in the sales of the goods. Moreover, environmental protection 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.

In the industrial goods sector, mechanical engineering currently boasts the largest share of sales at 36.6 percent. It is climate protection goods in particular that have contributed to the rapid growth of this segment of environmental goods.

Importance of small and medium enterprises (SMEs)

According to the findings of the Federal Statistical Office, the environmental economy in Germany has its main focus in the SME sector. About 94 percent of companies in the environmental sector have fewer than 250 employees, and as many as 70 percent actually have fewer than 50 employees (cf. Figure 8). A more differentiated examination shows that of the companies producing goods, the proportion of SMEs (up to 250 employees) operating in the environmental economy is, at 82 percent, smaller than is the case in the manufacturing industry with nearly 90 percent.

Figure 8: Size of businesses in the environmental economy (share of company size classes in percent)

Number of employees	0-49	50-99	100-249	250-499	500 and over	Total
All businesses in the environmental economy	70.6	12.7	10.8	3.6	2.3	100.0
Type of output						
Goods	41.7	16.3	24.4	10.0	7.6	100.0
Construction activities	69.9	17.8	9.7	2.1	0.5	100.0
Services	90.2	5.0	3.0	1.0	0.9	100.0
For information: Breakdown of businesses in manufacturing and construction industries as a whole by company size classes						
Manufacturing sector	48.2	23.6	18.1	6.2	4.0	100.0
Construction industry	97.2	1.9		1.0		100.0
Services (WZ 70 to 74) ¹⁾	92.2	4.0	2.5		1.4	100.0

1) Federal Statistical Office, structural survey in service sector, businesses with sales of more than €250,000 (FDZ).

Source: Federal Statistical Office, Fachserie 19, Reihe 3.3 and Fachserie 4 Reihen 4.2.1 and 5.1; Research Data Centre of the Statistical Offices of the Länder (Stuttgart and Berlin-Brandenburg); calculations by NIW

Figure 9: Sales of environmental protection goods by company size classes (in percent)

Number of employees	0-49	50-99	100-249	250-499	500 and over	Total
Environmental sector						
Waste	12.1	18.2	40.9	12.6	16.2	100.0
Water	25.3	19.7	30.4	14.7	9.9	100.0
Noise	8.1	9.7	16.1	4.8	61.2	100.0
Air	9.0	6.4	15.1	32.5	37.0	100.0
Climate protection	11.7	7.4	19.4	27.9	33.5	100.0
Nature conservation, soil remediation, cross-sectoral environmental services	42.6	21.4	19.2	15.7	1.0	100.0
Type of output						
Goods	7.8	7.0	22.5	23.2	39.5	100.0
Construction activities	23.6	18.6	20.8	34.7	2.3	100.0
Services	57.4	21.8	13.1	4.7	3.1	100.0
Total	13.8	10.2	21.6	24.5	29.9	100.0
For information: Breakdown of businesses in manufacturing and construction industries as a whole by company size classes						
Manufacturing sector	6.1	8.4	17.6	15.5	52.3	100.0
Construction industry	52.5	17.2		30.3		100.0
Services (WZ 70 to 74) ¹⁾	38.3	8.2	11.2		42.3	100.0

1) Federal Statistical Office, structural survey in service sector, businesses with sales of more than €250,000 (FDZ).

Source: Federal Statistical Office, Fachserie 19, Reihe 3.3 and Fachserie 4 Reihen 4.2.1 and 5.1; Research Data Centre of the Statistical Offices of the Länder (Stuttgart and Berlin-Brandenburg); calculations by NIW

Small and medium enterprises have – in terms of sales – a market share of 45.6 percent (cf. Figure 9). SMEs have an above-average share of sales when it comes to environmental protection services. Here they account for 92 percent of sales, whereas for services in general their share is only 58 percent. In the environmental goods production sector SMEs are also more active than in the manufacturing industries in general.

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 often only a peripheral business.

1.6 Research and innovation in the environmental economy

Great research and development intensity

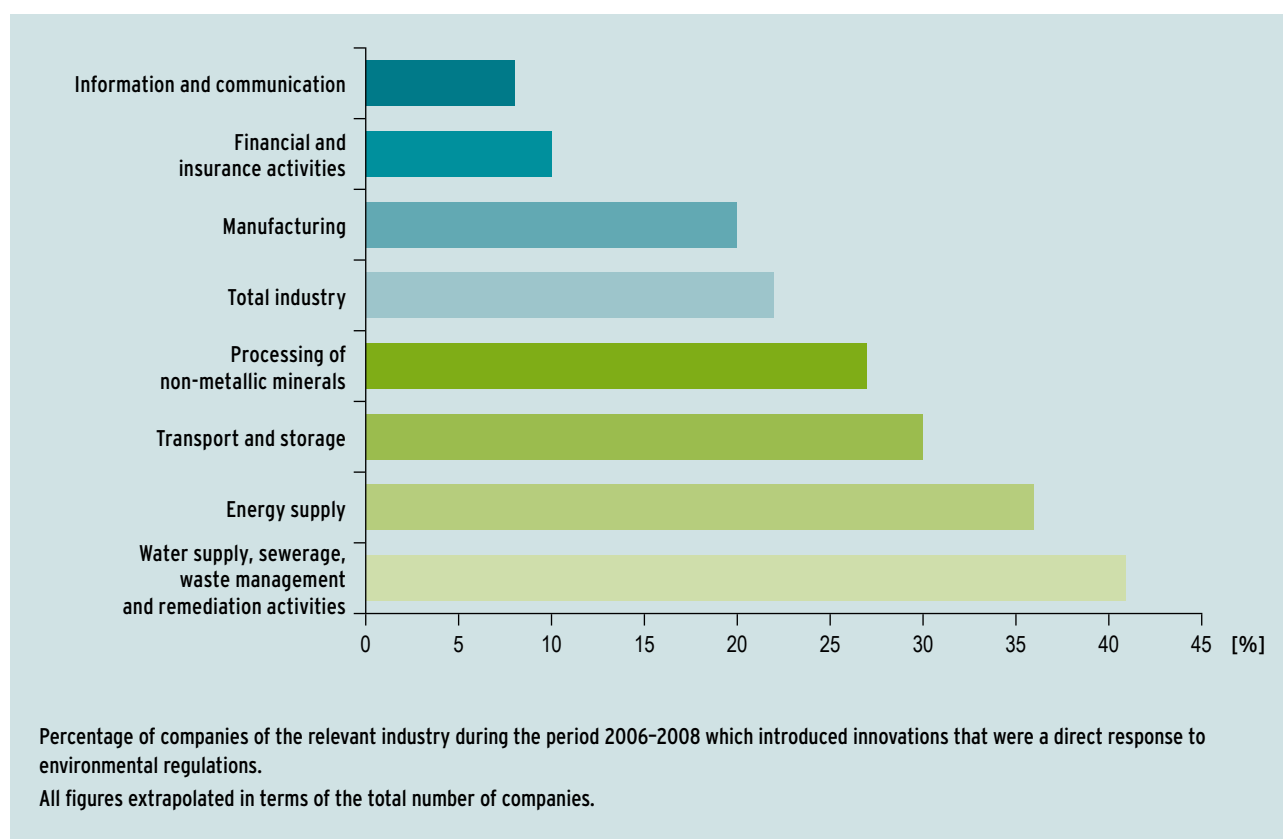
In the environmental economy, research is exceptionally frequent, intensive and continuous. Nearly 80 percent of production in the environmental sector is particularly research- and knowledge-intensive: mechanical engineering, instrumentation and control technology, electrical engineering, electronics and the chemicals, plastics and rubber industries 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.⁶ Qualification requirements for employees in the environmental economy are correspond-

ingly high. Thirty percent are graduates, compared to 20 percent in other sectors of industry.⁷ 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.

Companies in the environmental protection sector are generally well networked. Their readiness to cooperate in networks with partners from industry,

Figure 10: Innovation as a result of environmental regulations 2006–2008



Source: Own diagram based on ZEW (results 2009)

6 Cf. Legler et al (2006b).

7 Cf. LÖbbe et al (1994); Horbach et al (2001); Gehrke et al (2002); Wackerbauer, Triebswetter (2005); Schönert et al (2007).

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 Centre for European Economic Research (Zentrum für Europäische Wirtschaftsforschung – ZEW), nearly one in three innovative companies said that their environmental innovation activities had also been stimulated by environmental regulations.⁸ The importance of environmental regulations for innovative activities varies between industries. In the manufacturing industry, environmental innovation was a direct response to regulations in about 20 percent of all companies. In some other industries this connection is even stronger (cf. Figure 10).

The connection between regulations and company innovation activities also depends on the regulated areas of environmental protection. Innovations in the field of noise abatement, where statutory requirements normally give rise to higher costs, are significantly stimulated by regulations. In other fields, such as materials and energy consumption, a reduction in consumption frequently makes sense at the level of the individual company, with the result that innovation processes are often initiated by market forces. Nevertheless, even where measures are taken to improve energy and material efficiency, market barriers may result in inadequate generation of innovations. Instruments such as environmental and energy management systems (e.g. under EMAS), dynamic energy efficiency standards for products or economic incentives in the form of promotion instruments or environmental charges can help to overcome such obstacles.⁹

State funding of environmental research at a glance

In 2009 some 3.3 percent of state R&D expenditure in Germany went into environmental research. This is around the average for the EU-15 and well above the average for the OECD (2.4 percent). However, these figures tend to underestimate the importance of environmental protection in state-funded research, as they only include programmes and projects where environmental protection is the main purpose (air, water, waste, soil, noise, radiation protection). The statistics do not register state financial support measures where progress in environmental protection comes about more or less as a by-product of research projects with a different principal purpose.

The main focus of state-assisted environmental research is in the field of climate protection/energy. Around 18 percent of research projects started since 1997 and about one third of the project costs can be classified under this heading.¹⁰ Classic environmental protection fields such as waste, soil and air quality control have declined in importance. This is true not only of the number of projects assisted, but also of their size and funding volume.

An analysis of state environmental research broken down by funding institutions, environmental sectors and observation periods shows that the increase in the strength of the climate/energy sector is due to growing expenditure by the federal ministries. The Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung – BMBF), the Federal Ministry of Economics and Technology (Bundesministerium für Wirtschaft und Technologie – BMWi) and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit – BMU) have all more than doubled their assistance in this field.¹¹

8 ZEW (2009).

9 Cf. ZEW (2011).

10 Analysis of the environmental research database of the Federal Environment Agency, cf. Schasse et al (2010).

11 Cf. Schasse et al (2010).

Figure 11: State budgets for environmental research in OECD countries 1991-2009

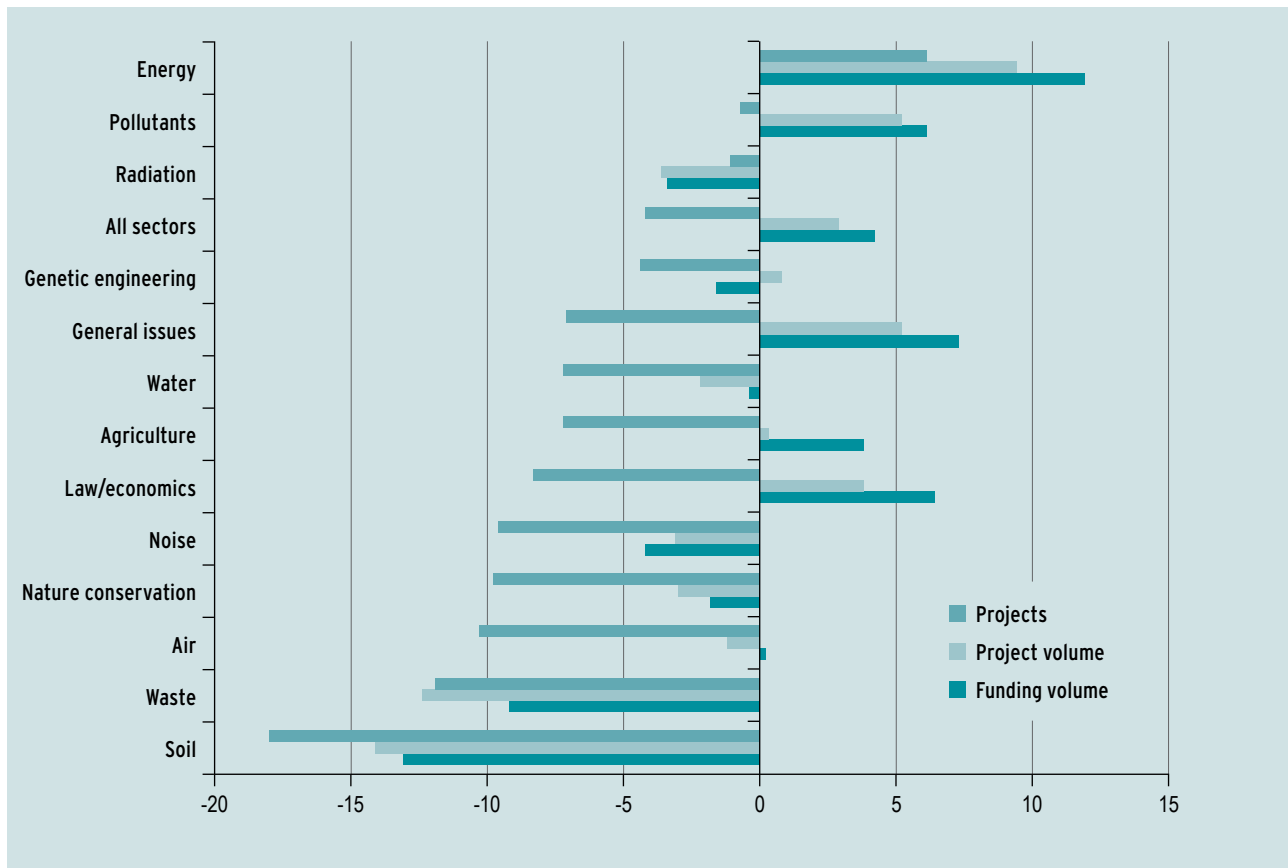
Country	Share of state expenditure on environmental research in total state expenditure for civil R&D in [%]											Average annual change of real R&D expenditure on environmental protection in [%]			Share of state environmental research expenditure in GDP in per mill	
	1991	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	1991-1999	1999-2008	2008-2009	1991	2008
GER	3.8	3.9	3.4	3.3	3.5	3.7	3.7	3.3	3.4	3.2	3.3	1.0	3.2	9.9	0.33	0.24
FRA	1.1	2.8	3.7	3.8	4.1	3.9	3.3	3.9	2.6	3.7	-	10.3	8.0	-	0.09	0.20
GBR	2.6	3.7	2.7	2.4	2.6	2.6	2.5	2.4	2.5	2.8	-	8.8	3.6	-	0.12	0.14
ITA	3.1	2.5	2.4	-	-	-	2.8	2.6	3.6	4.1	3.2	-0.7	9.9	-24.5	0.21	0.26
BEL	3.0	1.8	2.6	2.7	2.1	1.6	2.3	2.2	2.5	2.0	-	3.4	3.2	-	0.15	0.14
NED	3.3	3.8	3.3	3.1	2.9	1.9	1.2	2.1	0.7	0.5	0.4	5.2	-18.1	-8.1	0.31	0.03
DEN	3.2	4.4	2.4	2.3	1.9	1.9	1.7	1.7	1.9	2.5	2.7	6.7	2.0	18.4	0.21	0.21
IRL	1.0	1.4	1.7	2.4	1.9	1.1	1.7	0.9	1.2	1.3	1.5	13.9	14.1	19.3	0.03	0.07
GRE ^{2,3}	2.1	3.7	4.1	3.3	4.0	4.1	3.6	3.1	2.6	-	-	15.1	5.1	-	0.04	0.08
ESP	4.3	2.9	5.9	2.4	2.5	3.4	3.6	4.4	5.0	4.8	-	1.5	20.0	-	0.18	0.41
POR	3.0	4.5	3.7	3.6	3.4	3.9	4.0	3.4	3.7	3.7	-	15.5	9.8	-	0.11	0.37
SWE	4.3	3.0	1.1	1.3	1.9	2.2	2.7	2.1	1.7	1.7	2.0	-10.4	5.1	38.0	0.37	0.12
FIN	2.7	2.6	2.2	2.2	2.0	2.0	1.9	1.7	1.7	1.5	1.6	3.3	-0.6	12.3	0.25	0.14
AUT	2.4	2.5	1.4	1.3	1.7	1.4	1.6	1.6	1.6	1.6	2.5	-1.0	5.9	71.0	0.15	0.11
SUI ^{1,2}	1.1	1.4	-	0.3	-	0.3	-	0.1	-	-	-	-19.2	14.5	-	0.09	0.02
NOR	3.8	3.0	3.0	2.8	2.6	2.3	2.2	2.0	1.9	2.0	2.6	2.0	3.2	41.4	0.31	0.14
ISL	1.3	0.4	0.6	1.5	0.5	0.4	0.4	0.5	0.5	0.4	0.4	2.9	-2.9	13.6	0.07	0.03
CZE ²	-	-	-	4.1	4.3	4.3	3.1	2.8	2.3	2.7	2.5	-	1.6	11.3	-	0.15
POL ²	-	-	-	-	-	0.1	2.4	1.4	2.7	3.4	-	-	165.1	-	-	0.10
SVK ^{1,2,3}	-	2.3	-	3.0	1.8	2.9	1.1	4.2	4.6	3.1	2.9	-11.6	13.0	1.5	0.18	0.08
HUN ²	-	-	-	-	-	-	10.3	10.0	3.5	3.5	-	-	-26.2	-	-	0.15
CAN ^{2,3}	1.9	3.9	4.6	4.8	5.0	4.6	5.1	4.5	4.5	-	-	13.1	8.2	-	0.12	0.26
USA	1.7	1.7	1.3	1.2	1.1	1.2	1.1	1.1	1.2	1.2	-	2.9	3.1	-	0.07	0.05
MEX ^{2,3}	1.1	0.6	1.0	1.8	1.9	2.2	2.1	2.1	-	-	-	3.8	18.0	-	0.02	0.04
JPN	0.6	0.6	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	11.6	8.3	7.2	0.02	0.07
KOR	-	-	5.3	5.4	5.1	5.3	5.4	5.5	3.9	4.0	4.0	-	12.3	13.9	-	0.30
AUS	3.8	1.3	3.1	3.1	3.7	3.7	3.4	3.6	4.1	4.0	4.4	1.6	8.6	40.9	0.19	0.17
NZL ^{1,2}	3.4	3.4	-	-	-	-	-	16.2	10.3	13.4	-	-6.3	35.6	-	0.19	0.74
EU-15	2.9	3.3	3.2	3.4	3.6	3.6	3.0	3.1	3.1	3.2	-	3.0	6.1	-	0.16	0.21
OECD	2.2	2.4	2.3	2.4	2.4	2.4	2.3	2.3	2.4	2.4	-	4.3	6.8	-	0.12	0.13

1) For share of state R&D expenditure: SUI: 1992 and 1995 instead of 1991 and 1995. - SVK: 1994 instead of 1995.

2) Average annual change: SUI: 1992-2000 instead of 1991-1999 and 2000-2008 instead of 1999-2008; CZE: 2002-2008 instead of 1999-2008; SVK: 1993-1999 instead of 1991-1999; POL: 2004-2008 instead of 1999-2008; HUN: 2005-2008 instead of 1999-2008; GRE and CAN 1999-2007 instead of 1999-2008; MEX 1999-2006 instead of 1999-2008.

3) Share of state environmental research expenditure in GDP: GRE and CAN 2007, MEX 2006 instead of 2008; SVK 1993 instead of 1991.

Source: OECD, Research and Development Statistics; calculations and estimates by NIW

Figure 12: Annual average change in research projects by environmental sectors 1997-2009

Source: Federal Environment Agency, UFORDAT (search early April 2010); calculations by NIW

1.7 Central programmes at EU and national level

The High-Tech Strategy adopted in 2006 is an important framework for public funding of technology-oriented research in Germany. It currently comprises 17 priority areas, geared to the major global challenges such as climate change and resource conservation. For this reason there was also a special focus on support for environmental innovations.

A total of around 12 billion EUR was made available in Germany under the High-Tech Strategy from 2006 to 2009, including 420 million EUR specifically for environmental technologies (cf. Figure 13).¹² In addition to the environmental technology sector there are other high-tech sectors – such as energy technol-

ogies, vehicle and transport technologies, and production technologies – which include the promotion of environmental technologies. This makes it impossible to quote a precise figure for funding of environmental innovations.

In July 2010 the German Cabinet decided to continue pursuing the successful approach of the High-Tech Strategy and to focus on the big five areas of need – climate/energy, health/nutrition, mobility, security and communication. Priority themes in the sustainable development field of the new High-Tech Strategy 2020 are “CO₂-neutral, energy-efficient and climate-adapted cities”, “Intelligent restructuring of the energy supply system”, “Renewable resources as an alternative to oil” and “One million electric vehicles in Germany by 2020”.¹³

¹² Rennings et al (2008).

¹³ BMBF (2010).

Figure 13: Resources for the High-Tech Strategy 2006–2009 (in million EUR)

17 High-Tech Sectors	11,940
of which:	
- Nanotechnologies	640
- Biotechnology	430
- Microsystems technology	220
- Optical technologies	310
- Materials technologies	420
- Space travel technologies	3,650
- Information and communication technologies	1,180
- Production technologies	250
- Energy technologies	2,000
- Environmental technologies	420
- Vehicle and transport technologies	770
- Aviation technologies	270
- Maritime technologies	150
- Health research and medical technology	800
- Plants	300
- Safety research	80
- Services	50

Source: Rennings et al (2008)

In 2008 the Cabinet adopted the Environmental Technologies Master Plan. With this Master Plan, the Federal Environment Ministry and the Federal Ministry of Education and Research took a joint initiative to improve conditions for the development and use of new environmental technologies. Two key elements of the Master Plan were to provide assistance for research projects and to transfer and disseminate the application of new technologies. The aim was to ensure meaningful interaction of innovation policy and environmental policy, and thereby help German companies to open up new markets for environmental technologies. Work is to continue on developing and improving the Master Plan.

At the federal level three ministries – Education and Research, Economics and Technology, and Environment – are the biggest sources of assistance for research into environmental innovations. Figure 14

shows the fields which the Ministry of Education and Research (BMBF) will be funding from 2009 to 2015 under its framework programme “Research for Sustainable Development” (FONA), and the sums involved. It will make a total of 2 billion EUR available by 2015. Particularly large amounts of funding will be allocated to the sectors “Sustainable management and resources” and, under various project headings, to climate protection and energy technologies.

After the Federal Ministry of Education and Research, the Federal Ministry of Economics is the most important federal department for the design and implementation of the High-Tech Strategy. This ministry provides assistance for specific technology sectors, especially energy, aerospace, maritime, transport and information and communication technologies.¹⁴ But many of these also involve environmental innovations.

Since 2002 the Federal Environment Ministry has been responsible for project assistance in the field of research into renewable energy. The funds provided have risen steadily (cf. Figure 15).¹⁵ In 2009 a total of 118.4 million EUR was provided for newly approved projects. More than half this figure was due to photovoltaic energy (31.4 million EUR) and wind energy (28.2 million EUR).

Nearly 120 million EUR was allocated in 2010, and in 2011 research funding was stepped up to 128 million EUR.¹⁶ A new assistance programme initiated in spring 2011 for research into energy storage, with a funding volume of 200 million EUR, is jointly supported by the Economics, Research and Environment ministries.¹⁷

Through the Environmental Innovation Programme, the Federal Environment Ministry supports large-scale demonstration projects. These innovative projects are intended to demonstrate ways of implementing progressive methods for preventing or reducing environmental impacts. They have to go beyond the environmental protection requirements laid down in existing legislation.

The project findings must be transferable to other users of identical or similar installations to enable them to achieve comparable environmentally beneficial impacts. The Environmental Innovation Programme was stepped up in response to the Climate

14 Federal Ministry of Economics and Technology (BMWt 2011).

15 It was only because of an exceptional situation that a record sum of around 150 million EUR was approved for new projects in 2008.

16 BMU (2011a).

17 BMU (2011b).

Figure 14: Funds allocated by BMBF to Research for Sustainable Development 2009–2015

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
International										
Dialogues on sustainability			3 mill. EUR							
Era Net Eco-Innova				4 mill. EUR						
Centres of competence on climate change in Africa				95 mill. EUR						
International partnerships for environmental and climate technologies				60 mill. EUR						
Earth system										
Geotechnology programme					30 mill. EUR					
Underground CO ₂ storage					67 mill. EUR					
Key regions for Earth system					935 mill. EUR					
Dynamic Earth system modelling						6 mill. EUR				
Climate and energy										
Climate economics					12 mill. EUR					
Medium-term climate projections					20 mill. EUR					
Sustainable land management A: climate and ecosystem services					42 mill. EUR					
Sustainable management and resources										
Innovative SME										ca. 16 mill. EUR p.a.
Chemical processes and material recovery of CO ₂					100 mill. EUR					
Sustainable water management							200 mill. EUR			
Sustainable land management B: innovative systemic solutions					50 mill. EUR					
Society										
Social dimensions of climate protection and climate change				9 mill. EUR						
Sustainable consumption				10 mill. EUR						
Scientific networks of non-profit environmental institutes				2 mill. EUR						
Economics for Sustainability (WIN II)				9 mill. EUR						
Junior research groups on socio-economic issues					17 mill. EUR					

Source: BMBF (2009a)

Initiative. It now supports first-time use of innovative climate protection technologies. The investment assistance can be applied for by companies and local authorities.

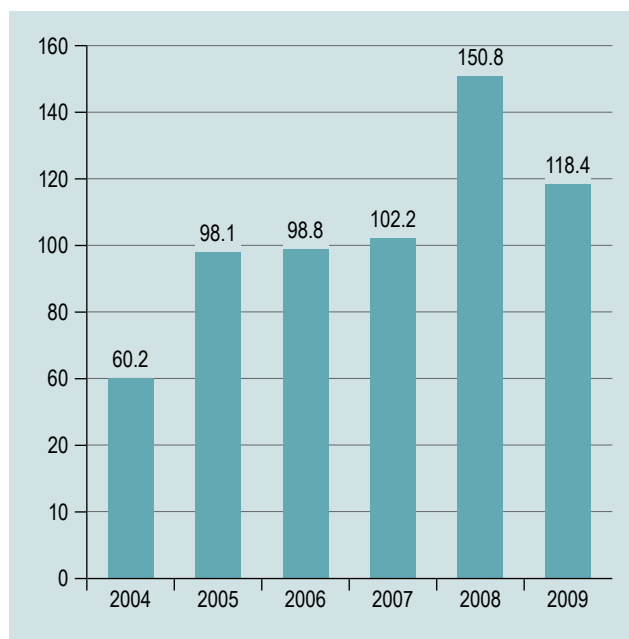
At EU level the Environmental Technologies Action Plan, ETAP, coordinates a variety of programmes for promoting environmental innovations and the use of environmental technologies. The aim of the plan adopted by the European Commission in 2004 is to

make Europe more competitive in this sector and at the same time promote effective protection of the environment.¹⁸ The most important EU funding instruments under the Action Plan include the Framework Programme for Research and Technological Development, the Competitiveness and Innovation Framework Programme (CIP), and also LIFE+, which aims to develop and implement the Community's environmental policy and environmental legislation.¹⁹

18 BMU (2010b).

19 EU COM (2010a).

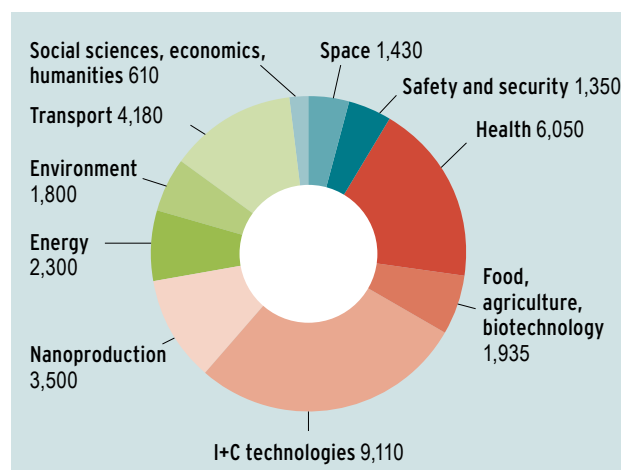
Figure 15: Development of new approvals of BMU research funding for renewable energies since 2004 (in million EUR)



Source: BMU (2010a)

The Framework Programme for Research and Technological Development is the European Union's

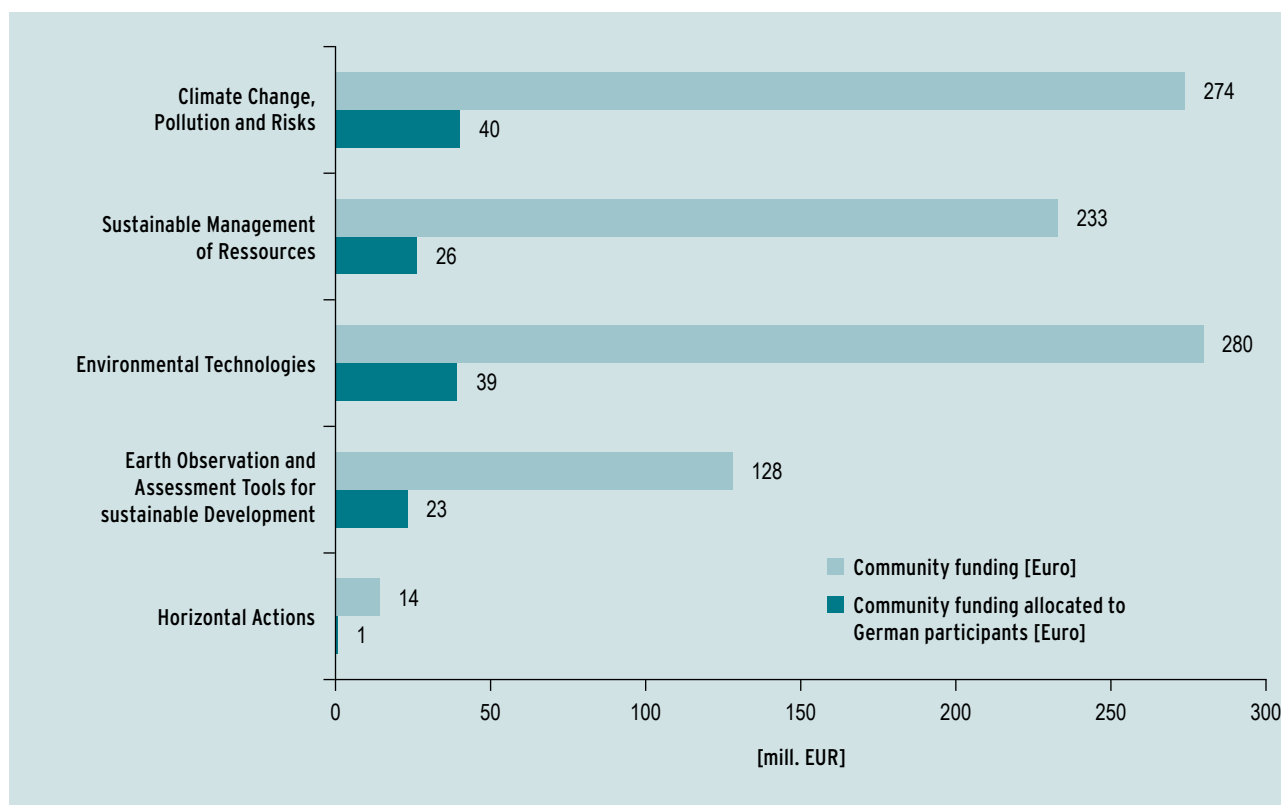
Figure 16: Allocation of funds under the "Cooperation" programme in the 7th Framework Programme (in million EUR)



Source: BMBF (2009b)

main instrument for promoting research in Europe. Among other things, the programme's projects help to achieve the objectives of ETAP. The 7th Research Framework Programme (FP7) runs from 2007–2013. It allocates 1.8 billion EUR to the environment under its "Cooperation" programme (cf. Figure 16). Promotion of environmental innovations also takes place in

Figure 17: Community funds allocated to environmental topics under the "Cooperation" programme 2007-2010



Source: DLR (2011)

other areas such as energy and transport, however, since a large proportion of environmentally relevant innovations emerge from traditional branches of industry.

Figure 17 shows the shares of the Community figure of 1.89 billion EUR for the environment that were allocated during the period 2007–2010 to various environmental segments as a whole, and to German participants.

The aim of the CIP Eco Innovation Programme is to foster the competitiveness of European companies. Its primary focus is on small and medium enterprises (SMEs). Over the period 2008–2013 it will make funds of around 200 million EUR available for supporting the first-time use and market launch of innovative products and processes that reduce environmental impacts or contribute to more efficient use of natural resources.²⁰ All in all, the EU accounts for around 11 percent of the funds paid out for environmental research²¹ in Germany between 2004 and 2009. Compared with the previous period (nearly 20 percent), however, the importance of EU funding has declined considerably.²²

A thorough evaluation of the ETAP Action Plan was undertaken in 2009. The EU Commission is seeking to create a follow-up plan in the form of an Eco Innovation Action Plan which would broaden the focus of ETAP from environmental technologies to include all forms of eco-innovation, e.g. institutional innovations.²³ In line with the strategic orientation of the EU 2020 Strategy and the new EU Innovation Strategy, and also the guidelines on a “resource-efficient Europe”, the Eco-Innovation Action Plan is to propose target operational measures which make it possible to achieve the objectives of these two documents.²⁴ The EU’s forthcoming 8th Framework Programme for Research and Innovation also needs to devote more attention than previous framework programmes to environmental and sustainability research and the application of its results.

In the interests of better networking of the actors in the field of environmental technology transfer and environmental innovations, the EU regional programmes under European Territorial Cooperation are used as a further instrument of collaboration with European countries. These include the regional cooperation networks SPIN and ACT CLEAN.

Promotion of environmental innovations and environmental technologies in small and medium enterprises in Central Europe and the Baltic Sea region

Since 2009 the Federal Environment Ministry (BMU) and the lead-managing Federal Environment Agency (UBA), along with partners from politics, industry and science in 13 EU Member States, have been taking part in the regional cooperation networks SPIN and ACT CLEAN. The aim of the projects is to ensure better utilisation of the environmental innovation potential of small and medium enterprise (SMEs) in production processes and better access to environmental technologies for producing SMEs – on a cross-border basis.

The backbone of SPIN and ACT CLEAN is transnational industry workshops with SME representatives and technology suppliers in fields such as energy efficiency and resource efficiency, sustainable construction, decentralised water management and use of bioenergy. The network provides a database containing environmental technology highlights from the partner countries in the Baltic Sea region and Central Europe, and also a toolbox. This puts SMEs in a position to identify improvement potential of internal environmental relevance for their processes and to assess alternative technological solutions. The transferability and applicability of the tools are tested by partners in the network.

At the same time the programmes analyse the framework conditions for transboundary transfer of environmental technologies and the development of environmental innovations, with a view to identifying obstacles and incentive structures for their use in SMEs. This leads to the development of specific action recommendations for the relevant macro-region. The focus here is on cross-sectional issues such as access to funding, promoting problem awareness and competence improvement in SMEs and administrations, especially in the new EU Member States, and greater assistance for regional networking of environmental innovators.

“SPIN – Sustainable Production through Innovation in SMEs” is supported by the EU Baltic Sea Region Programme 2007–2013. More information on activities and results is also available from www.spin-project.eu.

“ACT CLEAN – Access to Know-how and Technology for Cleaner Production in Central Europe” is co-financed by the Central Europe Programme 2007–2013. More information on partners, events and results can be obtained from www.act-clean.eu.

20 BMU (2010c).

21 This figure is confined to research programmes with environmental protection as their main purpose.

22 Schasse et al (2010).

23 EU COM (2010b).

24 EU COM (2010b).



2 Impact of environmental protection on employment

Key points at a glance

In 2008 there were nearly 2 million people employed in the environmental sector in Germany – a new record. This corresponds to 4.8 percent of all gainfully employed persons in Germany. There has thus been a further increase in the importance of environmental protection for the labour market in Germany compared with 2006. This growth in the number of jobs has been largely due to the expansion of renewable energy, Germany's success in exporting environmental goods, and environment-oriented services. By contrast, the importance of the classic environmental protection sectors such as investment in waste disposal, noise abatement, air quality control and water conservation has tended to decline.

Scientifically based estimates of the employment impacts of renewable energy sources up to 2010 are already available. They show that the strong upward trend in renewable energy is continuing. By 2010 the number of persons employed had already reached around 370,000. This is about 15 percent more than in 2008 (approx. 320,000 employees).

On balance, even allowing for the associated costs, environmental protection creates more jobs. This is because it tends to benefit labour-intensive sectors, for example energy-saving building refurbishment. 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 or increased use of renewable energy sources that reduce consumption of fossil fuels such as oil or gas. Thus in 2010 renewable energy sources alone avoided net energy imports of around 6 billion EUR. Furthermore, model calculations show that in 2009 the expansion of renewable energy led to the creation of a net 70,000 to 90,000 jobs. The promotion of energy efficiency and resource efficiency and the continued development of the ecological tax reform also create jobs on balance.

Properly trained skilled employees are an important precondition for further growth of employment in the environmental protection sector. Lack of skilled specialists is already impeding development, e.g. in the field of energy-saving building refurbishment. This problem will be exacerbated by demographic change. Greater attention should therefore be devoted to energy-saving issues during initial and further training in all construction trades – otherwise both climate and employment will suffer. In other areas too, there is an urgent need to provide more content relevant to these issues in initial and further training and to integrate environmental requirements in vocational training and degree courses, in order to make the most of the opportunities that environmental protection offers for the domestic labour market.

2.1 Impact of environmental protection on employment - an overview

Every two years since 2002 the Federal Environment Agency has had a survey of (gross) employment in the environmental protection sector conducted by research institutions using a standardised method. Because estimating employment effects is a very complex task, the methodological and empirical basis of the estimation method is evaluated regularly.²⁵ This ensures that the estimates are always based on the latest scientific findings. The most recent study estimates employment in the environmental protection sector as a whole in Germany for the year 2008.²⁶ Results up to 2010 already exist for the renewable energy sector.

The study indicates that in 2008 there were nearly 2 million people working in environmental protection. This amounts to 4.8 percent of all gainfully employed persons. This figure states gross employment in the environmental sector. That is the number of jobs necessary to produce the environmental protection goods and services as a whole. The importance of environmental protection for the labour market in Germany has grown steadily in recent years. Figure 18 shows what areas have generated jobs in the environmental sector and how the employment situation has developed since 2006.

Waste disposal, water conservation, noise abatement and air quality control are classic areas where jobs are created by environmental protection activities 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. A total of 333,000 employees are attributable to investments and material expenses in the environmental sector. By far the largest share of environmental protection employees is due to environment-oriented services, with around 1.2 million jobs. A particularly dynamic trend was displayed by exports of environmental protection goods, which accounted for 73,000 jobs in 2008, and employment in the renewable energy sector. In 2008 some 317,200 jobs were associated with expenditure on the construction and operation of renewable energy installations, while a further 4,900 jobs were due to research.

There have been constant improvements to the methodology and 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 data. The figure of nearly 2 million people employed in the environmental sector in 2008 therefore has to be regarded as the lower limit for actual employment in environmental protection.

Figure 18: Employment in environmental protection 2008

Employment effects due to	Employees		Difference 2008/2006
	2008	2006	
Investment in environmental protection ¹⁾	168,000	175,000	-7,000
Material expenses on environmental protection	165,000	175,000	-10,000
Exports of environmental goods	73,000	49,000	24,000
Personnel expenses and services for environmental protection ²⁾	1,205,700	1,132,400	73,300
Renewable energy	322,100	235,600	86,500
Total environmental sectors covered	1,933,800	1,767,000	166,800

1) Including thermal insulation of buildings (51,000 persons).

2) This figure includes R&D employees attributable to the renewable energy sector.

Source: Edler, Blazejczak (2010); calculations by DIW Berlin

25 Cf. Edler et al (2009).

26 Edler, Blazejczak (2010).

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. How many jobs actually depend on environmental protection is something that can only be estimated, because environmental protection is a cross-sectional task that creates jobs in nearly all sectors of the economy.

The facts and figures taken as a basis for the estimates originate from a variety of sources: official surveys, trade association statistics or expert estimates – for example when it comes to assessing the percentage of certain activities that is due to environmental protection.

Internationally established conventions and methods help to define the limits of the environmental economy. According to the criteria of the Organisation for Economic Cooperation and Development (OECD) and the European statistics authority Eurostat, the classic environmental protection sectors – waste management, water conservation, noise abatement and air quality control – have been joined by new environment-oriented services to the environmental economy which have only emerged clearly in recent years. Examples include energy management and facility management, eco tourism and environment-oriented financial services. Many companies offer activities that are only partly relevant to the environment – for examples, consultants who also give advice on energy saving, or construction trades that also insulate buildings. In such cases it is important to make a proper identification of the proportion of environmental protection activities.

The most reliable way of estimating the impacts on employment is to use a combination of two approaches:

- **Supply-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 employment impacts of environment-oriented services and, to some extent, those in the field of renewable energy.
- **Demand-oriented estimates** take data from the official statistics on domestic demand and on exports of environmental goods as a basis for calculating the employment effects. Model calculations based on input-output analysis are then used to identify the direct and indirect employment effects. The figures in Figure 1 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.

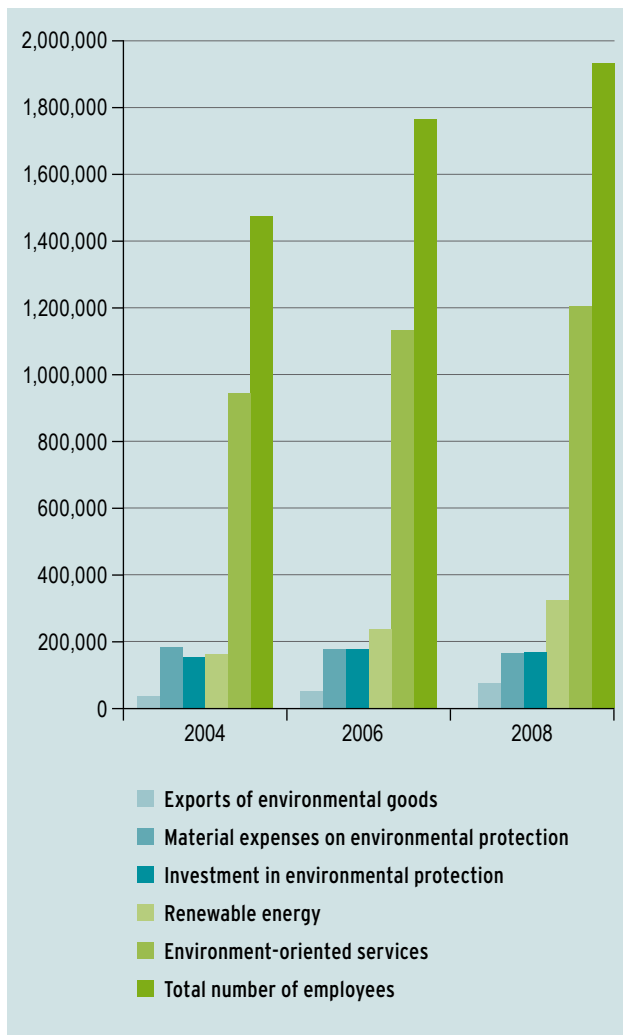
2.2 Employment in the environmental sector continues to increase

Compared with 2006 – the last time the survey was run – employment in the environmental sector is up by 166,800 persons or 9.4 percent. Thus employment in the environmental sector has developed better than the rest of the economy, since the total number of gainfully employed persons only increased by 3.1 percent from 2006 to 2008.²⁷

A look at the employment situation since the start of the millennium also reveals a clear positive trend. 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, employment due to investment in environmental protection and spending on materials in the classic segments of waste, water, noise and air shows a slight decline.

27 Federal Statistical Office (2010a).

Figure 19: Jobs in the environmental sector in Germany 2004-2008



Source: Edler et al (2009); Edler, Blazejczak (2010)

Renewable energy as a job generator

Renewable energy sources have displayed rapid growth in recent years. This is also reflected in the employment figures. Employment more than doubled from 160,500 in 2004 to 322,100 in 2008. Recent studies show that the strong upward trend is being maintained.²⁸ Even in the crisis year of 2009 there

was a slight rise in employment to around 339,500. For 2010, experts estimate employment to rise as high as 367,400 persons.

In 2010, however, there were clear differences in economic development between the individual renewable energy segments. Despite further cuts in payments for photovoltaic systems, installations in Germany reached a new record level. By contrast, the temporary stop in the market incentive programme for renewable energies (MAP) weakened the heat market. Wind energy too was unable to maintain the positive trend of recent years.

In 2010 employment due to the effects of the **Renewable Energy Sources Act (EEG)** amounted to around 262,100 persons. This is as much as 70 percent of all employees in the renewable energy sector. In 2004 the figure was around 60 percent. Thus the Renewable Energy Sources Act continues to make a major contribution to the positive trend in employment (cf. Figure 20).

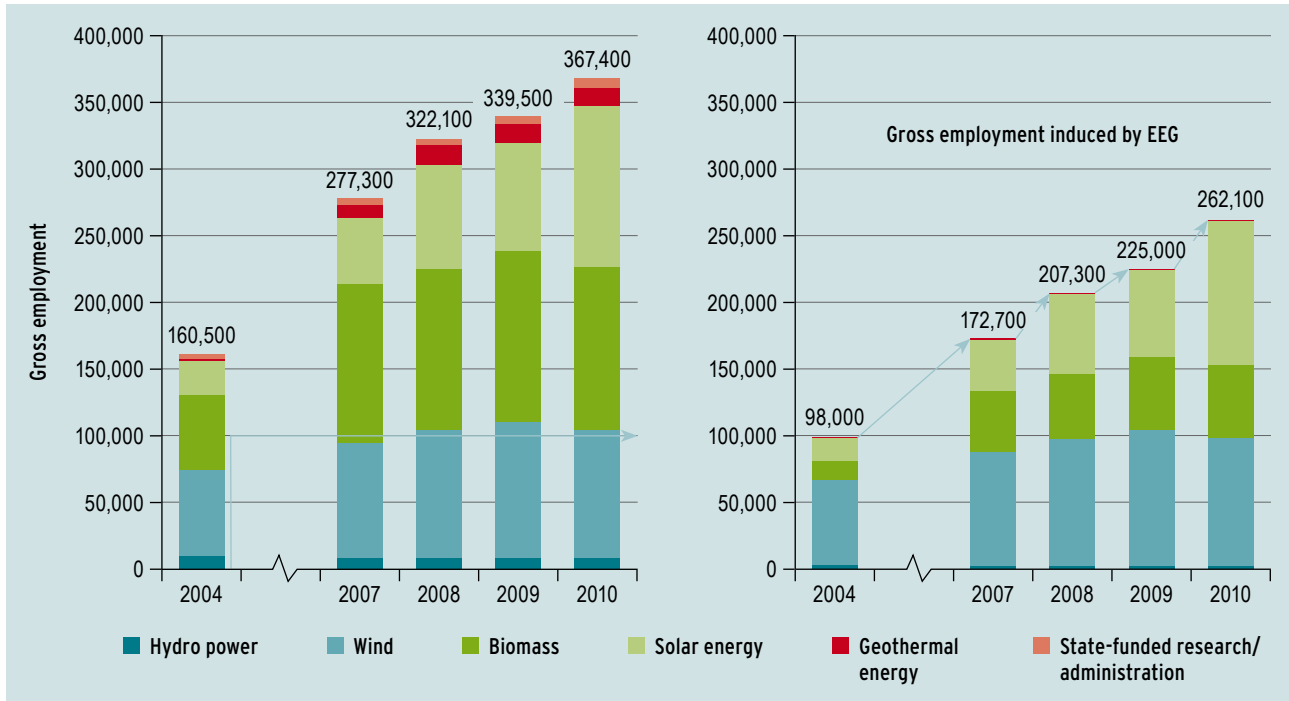
With the exception of hydro power, all renewable energy segments contributed to this growth. The largest share is due to biomass, which also includes biofuels and biomass heating fuels. Solar energy recorded the highest growth rate.

The future employment effects of renewable energy expansion in Germany depend on a variety of factors that are difficult to predict. Apart from trends in energy prices, these include the development of domestic sales – largely determined by future legal framework conditions – and continuing export successes by German companies in the renewable energy sector, which currently enjoy a strong position. Experts assume that the positive trend in employment can be maintained. According to a study published at the beginning of 2011, employment in the renewable energy sector in Germany can be expected to rise to between 500,000 and 600,000 by 2030.²⁹ In view of the German government's latest energy policy decisions, which are likely to lead to a further thrust in the expansion of renewable energy, these estimates seem realistic and could even be exceeded.

28 The employment effects of renewable energy sources are determined regularly for the Federal Environment Ministry, so more recent estimates are available for this sector, cf. DLR et al (2011).

29 Lehr et al (2011).

Figure 20: Employment in the renewable energy sector from 2004 to 2010 (in total and induced by the Renewable Energy Sources Act, EEG)



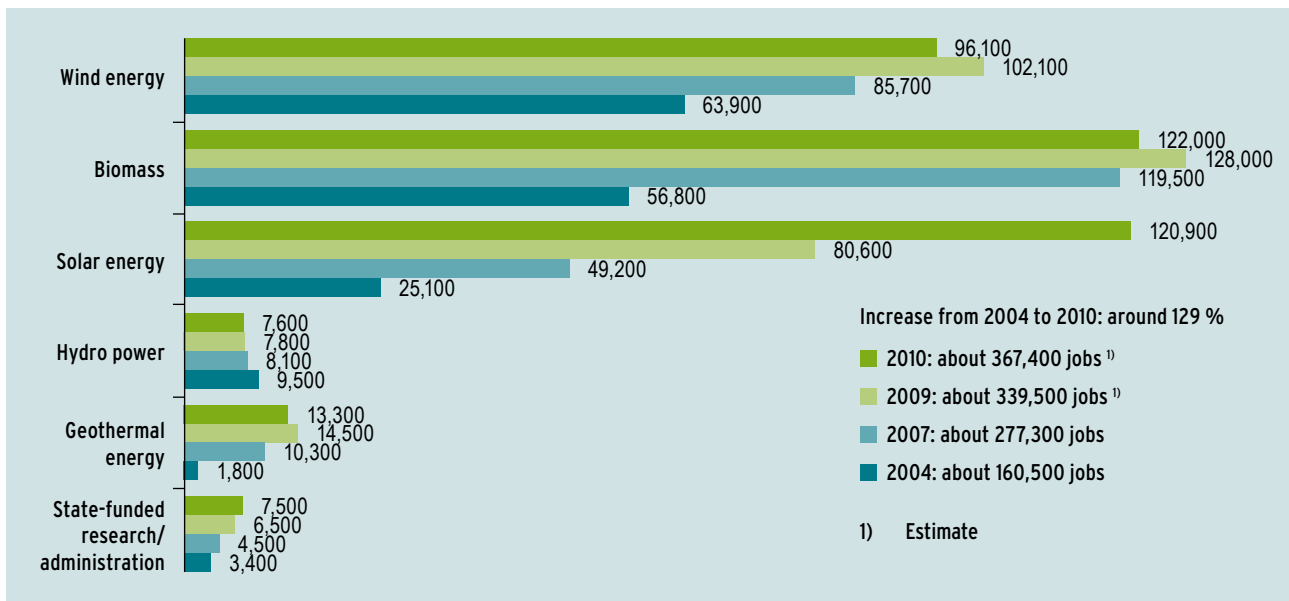
Source: DLR et al (2011), p. 5

More jobs through exports of environmental protection goods

Exports of goods and services for environmental protection are also increasingly creating 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 2008 figure of 73,000 employees who owe their job to exports hardly reflects this. Since integrated environmental protection is not covered adequately, the employment effects of environmental protection exports are probably considerably higher.

Figure 21: Employment impact of renewable energy sources



Source: DLR et al (2011), p. 11

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 (cf. details in Part 4). German companies are very well placed on the world market for environmental goods. They therefore have good prospects of being successful on the green growth markets of the future.

Environment-oriented services expanding

In 2008 almost two thirds of all jobs in the environmental sector were due to environment-oriented services. This reflects the great importance of services for the environmental economy. In all, more than 1.2 million employees provided environment-oriented services – for example in planning offices, environmental authorities, trade with eco products, and

environmental education. Environment-oriented service providers are found in all branches of industry, i.e. including those which according to official statistics belong to the manufacturing sector³⁰ or agriculture and forestry (cf. Figure 22). A comparison of employment in 2006 and 2008 shows a marked increase of around 73,300 persons (6.5 percent). There was a slight decrease in environment-oriented services in the manufacturing sector and the construction sector, and in energy supply and water supply, but a marked increase in employment can be seen in the other branches of industry.

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.

Figure 22: Gainfully employed persons in environment-oriented services

Branch of industry	Employees		Difference 2008-2006
	2008	2006	
Agriculture and forestry	110,700	103,900	6,800
Manufacturing industry and mining	100,700	115,900	-15,200
Energy and water supply	82,500	86,700	-4,200
Construction industry	47,000	46,100	900
Trade in and maintenance and repair of goods	216,900	195,100	21,800
Hotel and restaurant trade	6,200	5,900	300
Transport and communications	72,700	72,100	600
Banking and insurance	1,100	1,100	0
Services for companies	282,200	257,300	24,900
Public administration	70,000	62,600	7,400
Education	20,000	20,000	0
Other services	195,000	165,700	29,300
New sectors/white biotechnology	700	–	700
Total	1,205,700	1,132,400	73,300

Source: Edler, Blazejczak (2010), p. 11

30 The manufacturing sector includes the manufacturing industry plus mining, energy and water supply, and the construction industry.

Environmental service providers and their classification (examples)³¹

Original environmental services are directly related to the environmental economy. Such services are provided to a wide range of final customers. The spectrum ranges from private individuals through companies to institutions in the public sector. One example of the category of original service providers is an energy consultant who gives advice on energy efficiency to the various customer groups.

Industry-related environmental services support certain stages where value is added in the environmental economy. The service may be rendered in a development context prior to production, in a production context as a direct service connected with the manufacture of environmental products, or on a product-related basis after completion of the end product. For example, development service providers support the generation of product and process innovations, logistics experts facilitate production by making intermediate products available, and technicians carry out maintenance on the end product, e.g. a wind turbine.

Enterprise-related environmental services are provided as support for companies in the environmental sector – both for producers of goods and for service providers. Such services are provided for the company as a whole and are not confined to individual parts of the value-added chain. One example of an enterprise-related service is strategic advice for a company in the environmental sector on matters relating to exploiting new business fields for exports of environmental goods.

Types of environmental services

Original	Industry-related	Enterprise-related
Consulting firms in all lead markets - Energy consulting - Water management consulting - Waste management consulting - Environmental consulting - Expert opinions Project development (Energy) contracting Innovative business models - Sale of green electricity - Car sharing/bike sharing - Ecotourism - EV charging stations	Research and development - Basic research - Applied research and development Technical planning, consulting and inspections - Technical planning - Technical inspections Provision of raw materials and supplies - Energy supply - Water supply - Materials management services (wholesale) Logistics - Inbound logistics - Distribution logistics Sales - Commerce Operation and maintenance - Operation of technical installations - Monitoring of installations - Customer services, maintenance, repair Disposal and recycling	Financing - Banking - Private equity/venture capital Insurance Consulting - Strategic consulting - Personnel consulting - IT consulting - Process consulting Law firms Accounting firms Temporary employment/in-house training

2.3 Gross versus net – taking stock of the employment situation

The estimate of employees in the environmental sector in 2008 indicates what (gross) employment effects arise due to environmental protection. In a net approach it is necessary to deduct any potential job

losses from these employment figures – e.g. those due to displacement effects and to cost, price and competition effects. It is not possible to determine these net employment effects by statistical means. Estimating these effects requires scenario analyses which contrast an actual development (including the environmental measure) with a hypothetical situation

31 Cf. BMU (2009a).

(excluding the 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 estimated for environmental policy as a whole, but only for specific environmental policy measures or instruments.

Scientific studies show that environmental protection measures often have positive net effects on employment. This is due partly to the fact that labour-intensive sectors profit from environmental protection to an above-average extent. 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 or increased use of renewable energy sources that reduce consumption of fossil fuels such as oil or gas. Another example is investments designed to improve resource and material efficiency, thereby rendering raw materials imports – at least partly – unnecessary.

As the following examples show, climate protection and resource conservation in particular offer good prospects of linking environmental protection with employment. An ecological financial reform can also make a major contribution to realising environmental and employment objectives in parallel. This does not however mean that further developments in environmental protection should be confined to those fields that promote employment. After all, the primary aim of environmental protection is not to create as many jobs as possible, but to achieve environmental quality objectives as safely and efficiently as possible.

Employment effects of the energy revolution and climate protection

An energy revolution based on promoting renewable energy sources and energy efficiency improves the employment situation. Recent studies for the Federal Environment Ministry show that the promotion of renewable energy sources in 2009 created a net 70,000 to 90,000 jobs.³² In future this level could even be exceeded if Germany manages to maintain its strong position on the world market and if the positive development of the export markets continues. This could mean a further 180,000 to 250,000 more net jobs by 2030.³³

Various studies also show that ambitious climate objectives benefit the labour market. Experts have calculated that annual investment of around 30 billion EUR in climate-friendly technology and energy efficiency will be necessary to achieve the German government's climate protection target – a 40-percent reduction in Germany's greenhouse gas emissions compared with the base year 1990. More ambitious efforts in the climate protection field would make it possible to reach a million extra jobs by 2030.³⁴ Detailed analyses show that climate protection – as a result of improved energy efficiency in the transport sector, industry and building refurbishment – gives rise to positive effects on net employment. For example, a rigorous CO₂ reduction strategy in the transport sector could make 215,000 additional jobs possible by 2020.³⁵

For the EU as well, various studies confirm the positive employment effects of ambitious climate objectives. Simulation calculations show that if the EU as a climate pioneer were to implement a 25-percent reduction instead of 20 percent, this would create 1.5 million new jobs in the EU by 2020. Here the EU Commission is assuming that the proceeds of auctioning emission allowances and the revenue from CO₂ taxation of sectors not covered by emissions trading would be ploughed back into industry, partly to reduce labour costs.³⁶

A study coordinated by the Potsdam Institute for Climate Impact Research (Potsdam Institut für Klimafolgenforschung – PIK) actually arrives at considerably higher figures for the employment effects of EU climate policy, though this assumes a 30-percent reduction in greenhouse gas emissions by 2020 compared with the base year 1990.³⁷

On this basis up to 6 million extra jobs could be created in the EU by 2020. The economic output of the EU-27 would increase by a total of nearly 6 percent between 2010 and 2020, and the investment rate from 18 to 22 percent of GDP.

Employment effects of increasing material and resource productivity

Positive economic effects make themselves felt in particular where improvements in the efficiency of production processes are implemented.

32 Lehr et al (2011).

33 Lehr et al (2011).

34 Cf. Schade et al (2009).

35 Cf. Schade et al (2009).

36 EU COM (2011a), p. 12; EU COM (2011b), p. 44.

37 Jaeger et al (2011).

In a project for the Federal Environment Agency, the Institute of Economic Structures Research (Gesellschaft für Wirtschaftliche Strukturforchung – gws) found that improving material efficiency in industrial companies not only saved raw materials and hence costs, but also increased the net number of jobs by around 700,000 (cf. details in Part IV).³⁸

Employment effects of an ecological financial reform

As long ago as 2001 the German Institute for Economic Research (Deutsches Institut für Wirtschaftsforschung – DIW), at the request of the Ministry of Finance, confirmed the positive employment effects of the ecological tax reform. The reform makes energy more expensive as a result of higher taxation, and at the same time reduces the burden on both employers and employees by lowering state pension contributions. The experts estimated a net increase in employment of around 250,000 jobs. The positive effect was due in particular to cutting the cost of labour by reducing the employer's contribution to the state pension scheme.

Existing estimates indicate that the European Commission's proposal for a reform of energy taxation in Europe also has positive employment effects³⁹: it would create nearly 700,000 additional jobs in the EU by 2020 and about 1 million by 2030. There would also be positive growth effects in almost all EU countries. An even more ambitious ecological financial reform which taxed not only energy, but also input of materials, and which at the same time reduced the tax burden on labour, would reinforce these positive employment effects. A total of around 6 million additional jobs could be created by 2020.⁴⁰

The examples show that many environmental policy approaches also benefit the employment market: energy saving, encouraging recycling and repair of products, refurbishing older buildings, promoting new technologies and innovations – all these create jobs and at the same time contribute to an environmentally sound and nature-oriented approach to economic management. The ones who profit from this are the suppliers of environment-friendly goods and services, and all those branches of industry whose environmental resource consumption is low. Environment-intensive industries and production processes, by contrast, are to a high degree faced with the challenge of improving their environmental efficiency,

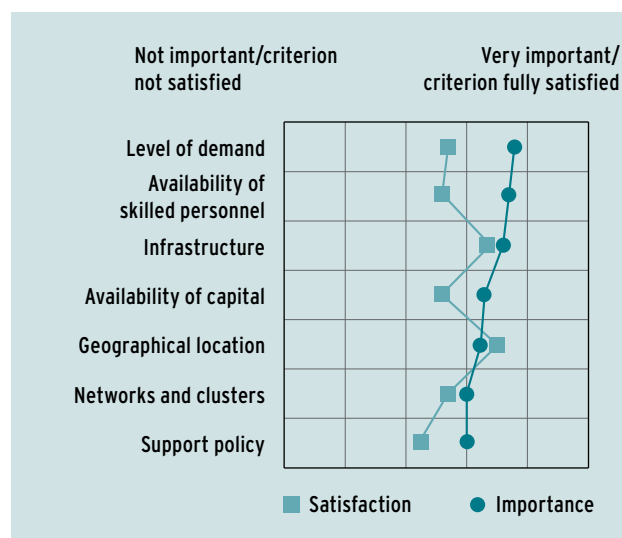
making appropriate changes to their production processes, and improving the environmental properties of their products.

2.4 Need for training and qualification in environmental protection

Numerous studies show that environmental protection offers high employment potential. If this potential is to be realised, employees with the necessary qualifications have to be available. An employer survey conducted by Roland Berger Strategy Consultants makes it clear that companies attach great importance to the availability of skilled personnel (cf. Figure 23). If there is a shortage of personnel trained in the specific skills needed, company innovation activities will start to fall off and the German environmental economy runs the risk of not being able to secure and expand its mostly very good competitive position.

Many companies already regard the shortage of skilled personnel as an obstacle to economic development. In the long term this trend will be reinforced by demographic change. Another factor is the necessary restructuring of the economy to a low-emission green economy, which will result in a greater need for environmental qualifications across all industries.

Figure 23: Importance and satisfaction of locational factors

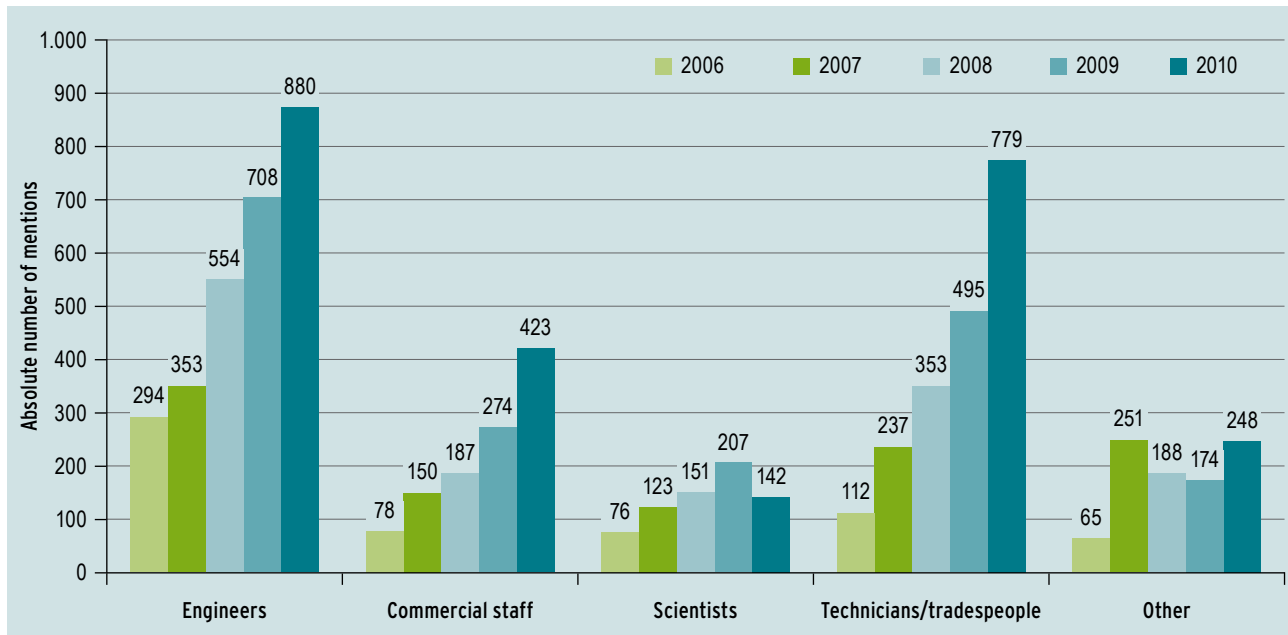


Source: BMU (2009b), p. 37

38 Cf. UBA (2010a).

39 EU COM (2011c).

40 Barker et al (2011). The figure quoted is based on modelling with the E3ME model, which was also used in the impact assessment for the revision of the EU Energy Taxation Directive.

Figure 24: Basic qualifications required (multiple responses possible) in job offers relating to renewable energy

Source: Ostenrath (2010)

Thus for economic reasons alone there is a need to step up efforts to provide environment-related training and qualification. However, such efforts are also an important precondition for Germany to achieve its environmental and climate objectives. In certain respects the situation in Germany is similar to that in other European countries: The great employment potential of environmental protection is increasingly being recognised, but the necessary development of qualifications has yet to be integrated extensively in environmental strategies and programmes.⁴¹

Changing qualification requirements

The qualification profiles required in the environmental protection sector are as varied as the jobs involved. For example, whereas the majority of jobs in the renewable energy sector call for a high level of qualification, most jobs in the recycling and waste management sector have a low profile of requirements.

One characteristic of many areas is constantly changing occupational requirements, because the environmental economy typically involves a high level of innovation. Here technological progress and growing

environmental challenges are giving rise to new requirements on the occupational front. This applies to the automobile industry, for example, where electric mobility will create new qualification requirements along the entire length of the value-added chain.⁴² This example also illustrates the fact that an “environmental protection qualification” is not confined to the classic environmental protection fields, but is finding its way into many occupations. To meet this challenge it is not enough simply to modify vocational and academic training for young people entering the labour market for the first time: it is also essential to promote life-long learning.

Example: Renewable energy

In recent years there has been a very sharp rise in demand for personnel in the renewable energy sector. An analysis of job offers relating to renewable energy⁴³ shows that it is largely technically oriented qualifications, i.e. engineers, technicians and construction trade personnel, that are being sought here (cf. Figure 24). This is partly due to the great demand for skilled personnel in the fields of installation and service. Moreover, the job offers also suggest that the industry is increasingly turning to (non-academic) technicians to make up for the lack of engineers.⁴⁴

41 Cedefop (2010).

42 Barthel et al (2010).

43 For the period 2006-2010, the “Wissenschaftsladen Bonn” (“Science Shop”) recorded and analysed job offers relating to renewable energy in the major newspapers and magazines and on internet job exchanges and company websites. In each case the analysis relates to the first quarter of the year in question.

44 Cf. Ostenrath (2010).

A survey of company representatives and experts on renewable energy⁴⁵ shows that the knowledge needed for work in the field of renewable energy should not be communicated primarily via new vocational training and degree courses, but by modifying existing vocational and degree courses, further training measures and supplementary qualifications (cf. Figure 25).

The training market has already responded to the increased demand for skilled personnel. For example, the number of degree courses relating to renewable energy more than doubled from 144 in 2007 to 300 in 2010.⁴⁶

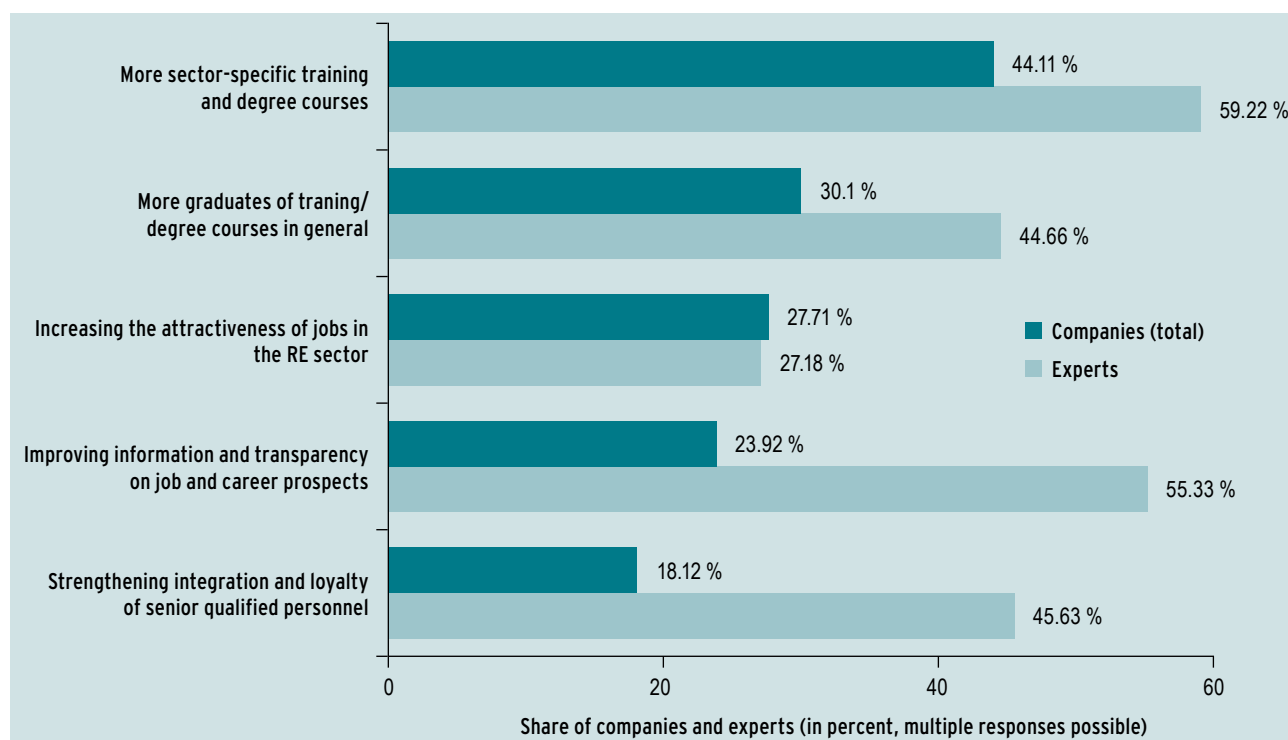
Example: Energy-saving building refurbishment

Energy-saving refurbishment of existing buildings offers great opportunities for climate protection and employment. Depending on the scenario in view, savings of between 30 and 70 percent of greenhouse gas emissions are possible in the buildings sector by 2030.⁴⁷ On average, however, only about one third of the economically worthwhile savings potential in the

buildings sector is currently being exploited⁴⁸. One reason for this is the lack of suitably qualified skilled personnel. Greater attention should therefore be devoted to energy-saving issues during initial and further training in all construction trades. Energy-saving building refurbishment also requires more space in the curricula of degree courses such as architecture or construction engineering. The construction sector has already recognised these signs of the times: around 80 percent of construction trade businesses and about 90 percent of consulting engineers see the future focus of their construction sector work in the field of building refurbishment.

A survey of experts from companies, associations and initial and further training institutions⁴⁹ confirms that the view that qualification should be brought about by modifying existing occupations also applies to the field of energy-saving building refurbishment. The survey also shows what qualification requirements are in special demand in the field of energy-saving building refurbishment. In addition to specialist knowledge about potential savings and energy efficiency measures, experts consider consulting skills

Figure 25: Efforts needed to secure the supply of new sector-specific qualified personnel



Source: Bühler et al (2007), p. 35

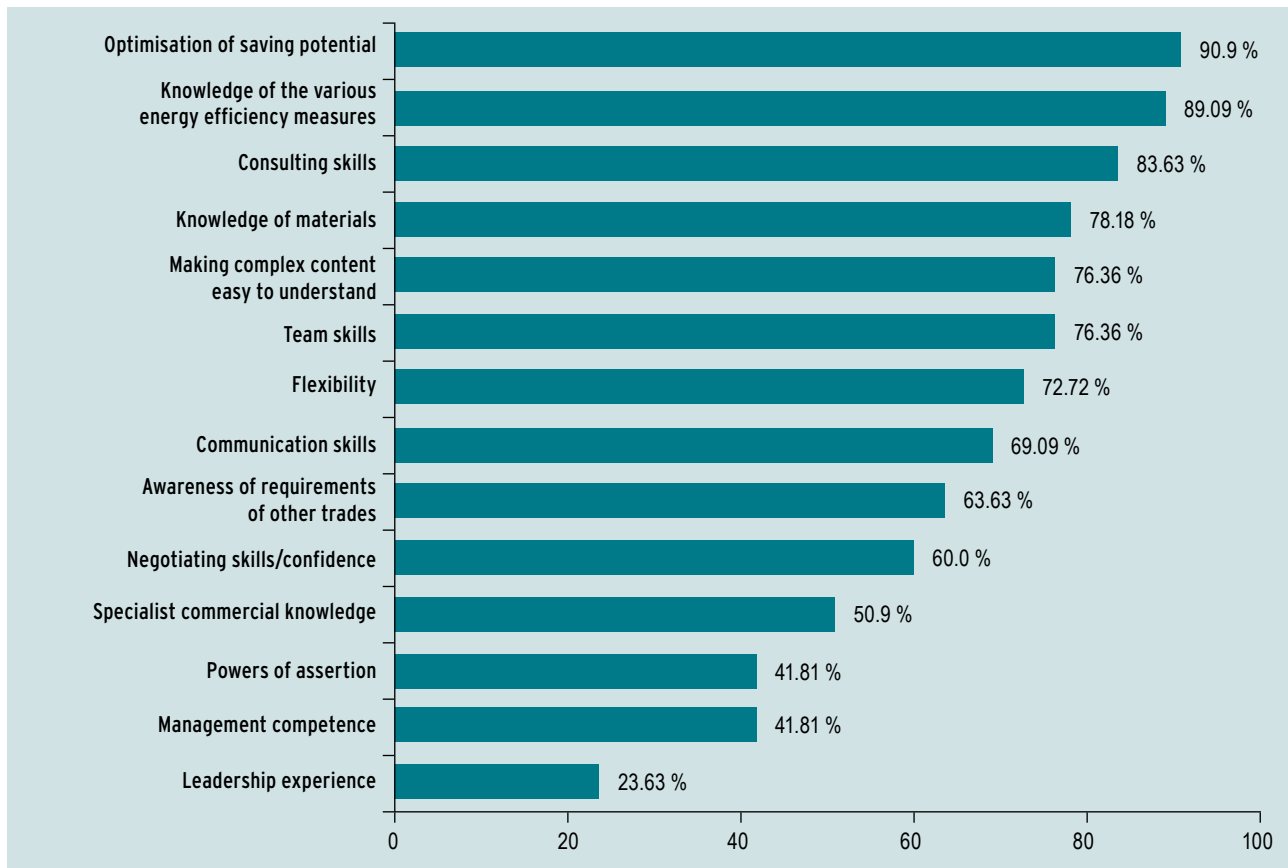
45 Cf. Bühler et al (2007). The experts were drawn from the fields of education, personnel development, consulting, administration, lobby groups, politics, research and development.

46 Wissenschaftsladen Bonn (2010).

47 Federal Environment Agency (UBA 2009a). This shows the reduction in greenhouse gas emissions compared with 2010.

48 Kleemann (2006).

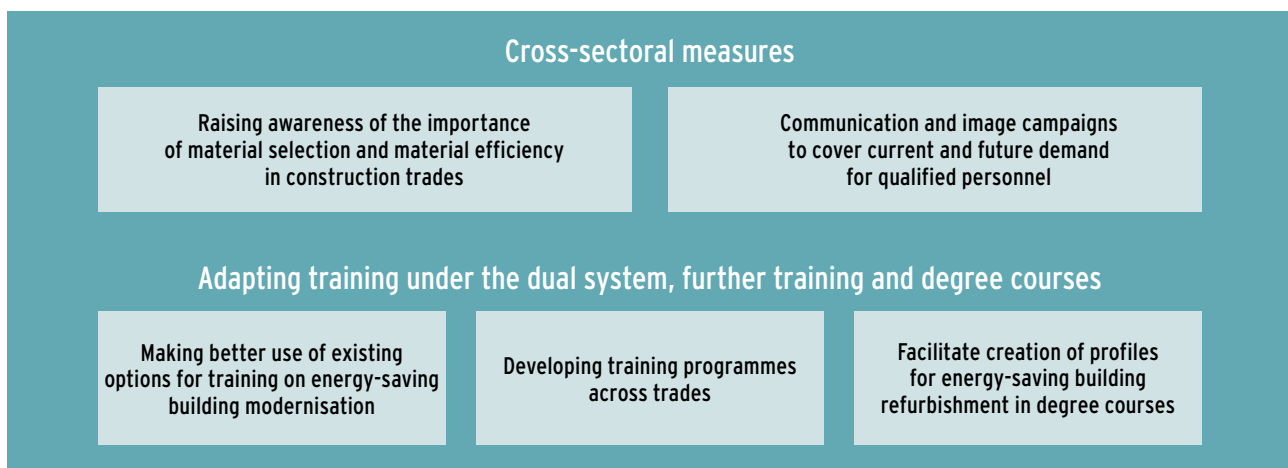
49 Mohaupt et al (2011).

Figure 26: Qualification requirements in the field of refurbishment/energy efficiency

Source: Mohaupt et al (2011)

and team skills to be particularly important. The experts also consider that an ability to “see things as a whole” and to coordinate the various construction trades plays an important part in the success of energy-saving building refurbishment. There should therefore be offerings in initial and further training which promote the interaction of planning and implementing trades. Furthermore, the choice of construction

materials should take account of the entire life cycle, i.e. including energy consumption and resource consumption in the manufacture of building materials or insulating materials and their recycling properties. Since the advice given by the planning and implementing trades influences the choice of materials, it makes sense to provide special qualifications in this field (cf. Figure 27).

Figure 27: Action recommendations in the field of energy-saving building refurbishment

Source: Own diagram based on Mohaupt et al (2011)



3 Costs and benefits of environmental protection

Key points at a glance

Germany spends about 1.4 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 manufacturing sector. From the mid-1990s, expenditure by the manufacturing sector on environmental protection was in decline, but since 2000 it has stabilised at a lower level. Thus on a European comparison, Germany lies in the lower mid range when it comes to total national spending on environmental protection.

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 and efficiency measures 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 favourable image of a region to attract qualified employees.

Because environmental protection helps to reduce environmental damage, it also gives rise to lower costs for society, e.g. as a result of air and water pollution or climate change. These “external costs” can also be quantified. For example, the expansion of renewable energy is already generating savings from avoided damage that are roughly equivalent to the additional costs they cause. Measures to protect biological diversity are also economically worthwhile in most cases, as shown by a number of examples.

3.1 What it costs to protect the environment

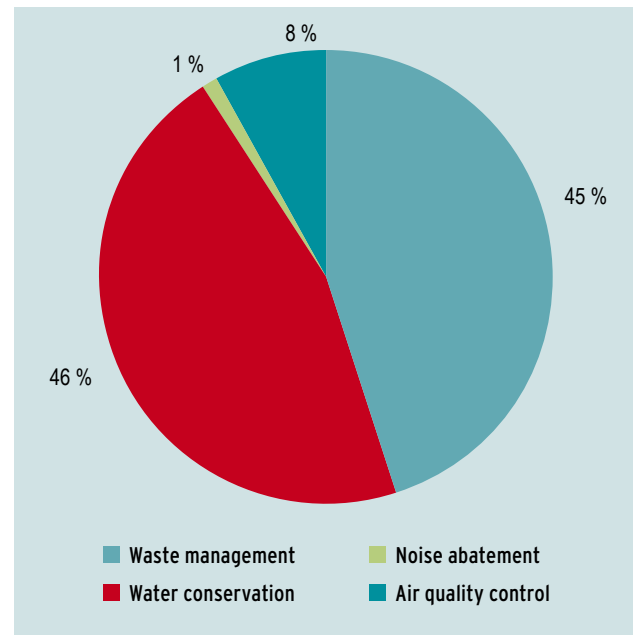
Total expenditure on environmental protection

In 2007, industry, state and privatised public disposal enterprises spent a total of 33.9 billion EUR on protection of the environment. This corresponds to a mere 1.4 percent of the gross domestic product. More than half of this figure is borne by the enterprises responsible for 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 20 percent is borne by the manufacturing 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 (cf. Figure 28). A further eight percent of expenditure is due to air quality control, and roughly one percent to noise abatement.

Expenditure on environmental protection comprises capital investment and the cost of materials for the ongoing operation of the installations. Since 2006 the statistics have also included capital expenditure and material costs by the manufacturing sector on climate protection (see later remarks below). The estimates by the Federal Statistical Office concerning

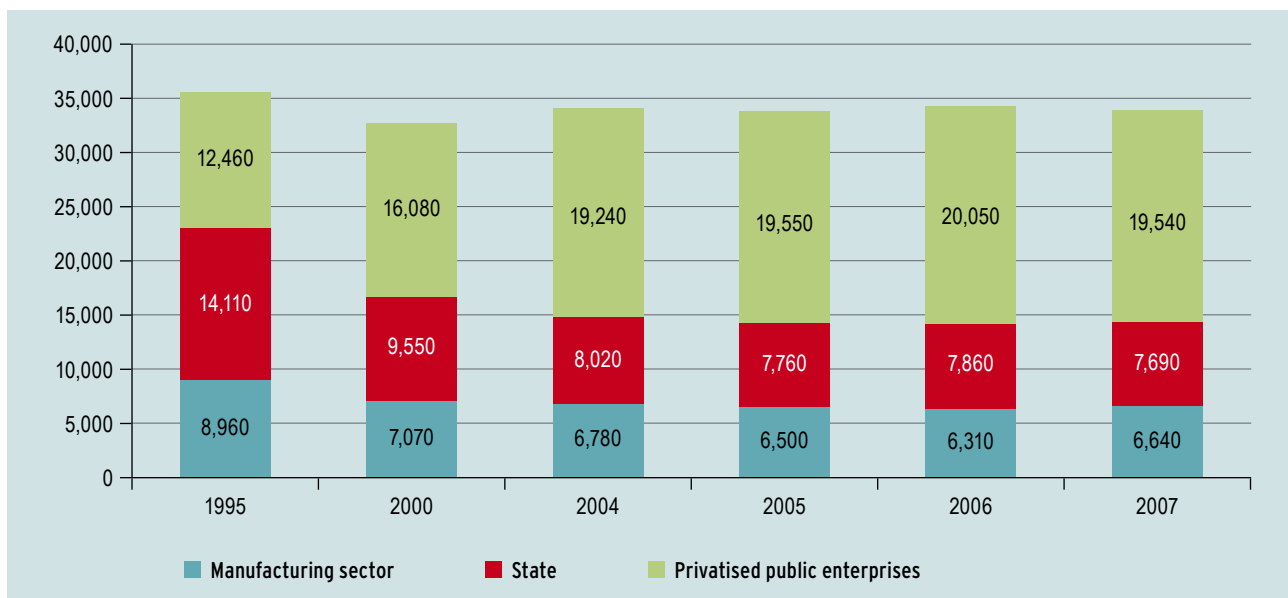
Figure 28: Environmental protection expenditure by environmental sectors 2007



Source: Own diagram based on Federal Statistical Office (2010b)

expenditure on climate protection as a whole, e.g. including state spending, are not yet available. In view of the growing importance of climate protection, therefore, the figures for spending on environmental protection represent a lower limit. In 2000 the state and industry spent about three billion EUR less on environmental protection than in 1995. Since then expenditure has remained at about the same level (cf. Figure 29).

Figure 29: Development of environmental protection expenditure (in million EUR)



Source: Own diagram based on Federal Statistical Office (2010b)

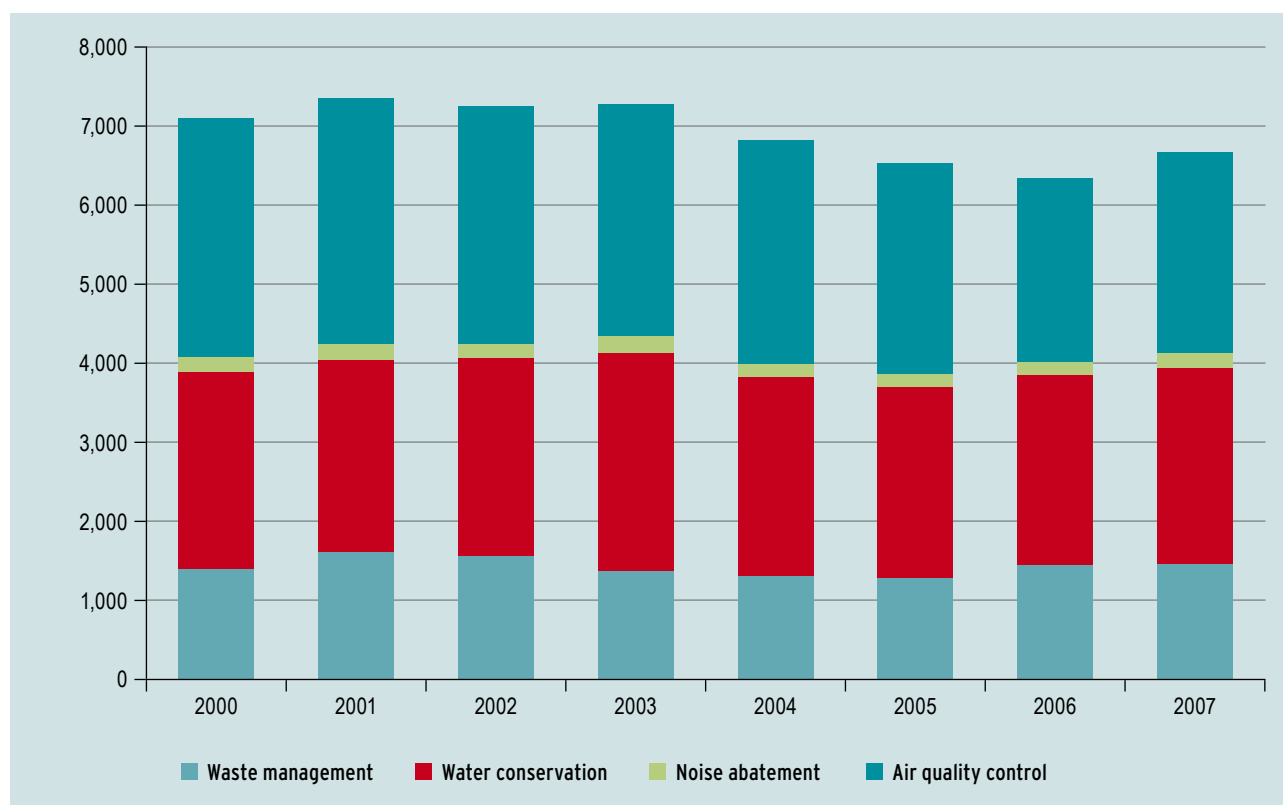
Underlying data⁵⁰

The Environmental Economic Accounts prepared by the Federal Statistical Office calculate total national expenditure on environmental protection on the basis of various statistical sources. The input data originate from the financial statistics (annual accounting statistics of the public sector) and from the statistics on environmental protection investments, and also on ongoing expenditure on environmental protection in the manufacturing sector. Data are also used from the statistics on the annual accounts of state-governed funds, institutions and enterprises. In view of a lack of data or non-availability at the time of publication, the results do not include environmental protection expenditure by certain segments. For example, data are not available for the agricultural and construction sectors, for parts of the services sector, especially for completely private waste and wastewater disposal enterprises, or for the private household sector. The estimates by the Federal Statistical Office to determine climate protection expenditure are not yet complete.

Environmental protection expenditure by industry

Expenditure by industry in the classic environmental sectors waste management, water conservation, noise abatement and air quality control declined slightly from 2003 onwards. Between 2006 and 2007 there was once again a slight rise of nearly 2 percent (cf. Figure 30). The share of national environmental protection expenditure that is borne by companies in the manufacturing sector fell from 25.2 percent in 1995 to 19.6 percent in 2007.

However, the statistics only register part of what industry actually spends on environmental protection. The role of 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. And, as mentioned above, the expenditure on climate protection is still not included in these figures.

Figure 30: Environmental protection expenditure by manufacturing sector (in million EUR)

Source: Federal Statistical Office, Environmental Economic Accounts

50 Cf. Federal Statistical Office (2010b).

Additive and integrated environmental protection investments

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. They prevent environmental impacts before they arise or during the process, and are therefore especially important from a resource conservation point of view.

breakdown of investment in environmental protection among the individual branches of industry and on investment in climate protection.⁵¹

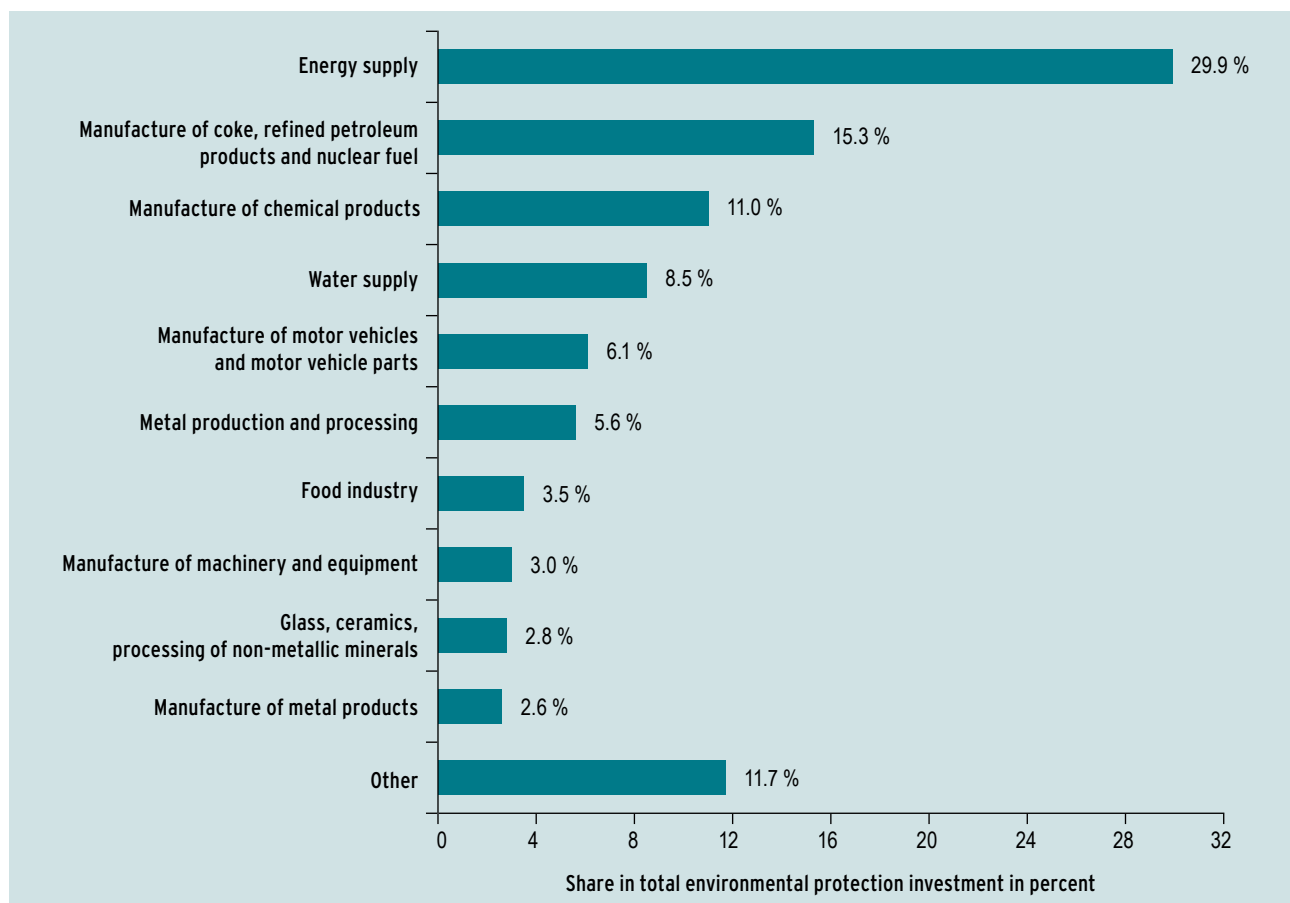
Expenditure on and investment in environmental protection

Expenditure on environmental protection comprises capital investment and the cost of ongoing operation of the environmental protection installations. Capital investment thus forms part of total expenditure. The information available on the manufacturing sector's capital investment in environmental protection is more differentiated than the information on overall spending on environmental protection. The results are an important building block in the Environmental Economic Accounts (EEA). There, total environmental spending by the national economy is calculated by taking the input data "Environmental investment" and adding "Ongoing environmental expenditure".

Investing in environmental protection and climate protection

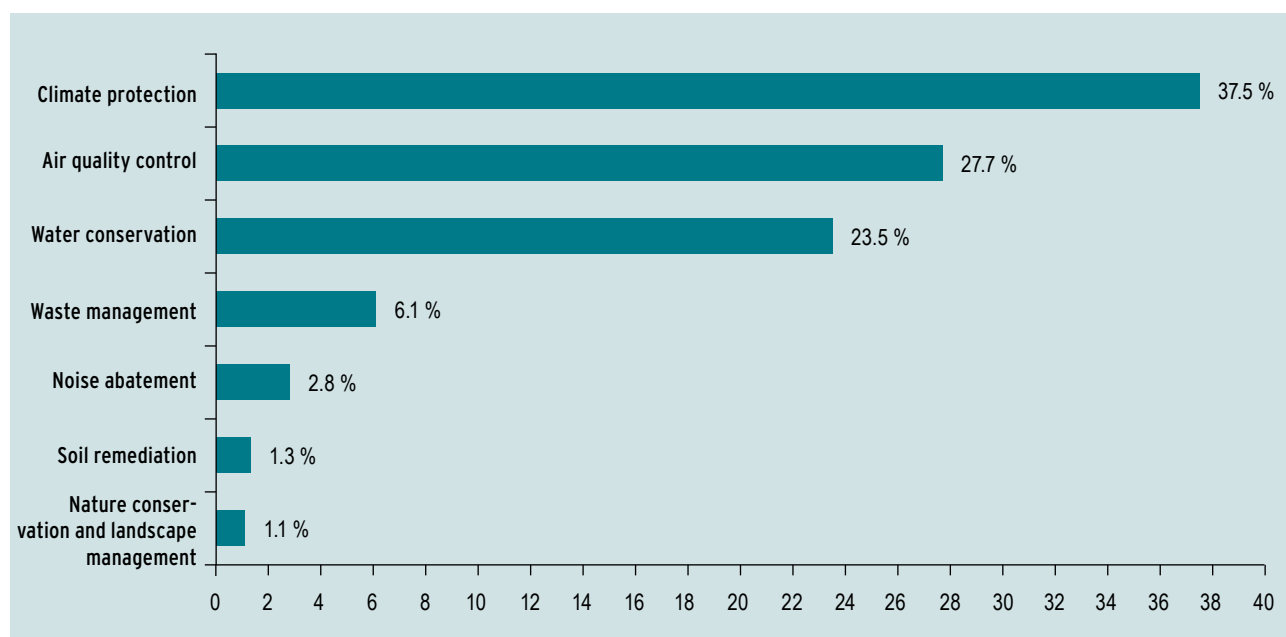
For the manufacturing sector, the environmental statistics provide more detailed information on the

Figure 31: Industries with the highest investment in environmental protection 2007



Source: Federal Statistical Office (2010c).

51 Cf. Federal Statistical Office (2010c).

Figure 32: Environmental investments by the manufacturing sector broken down by environmental sectors 2007

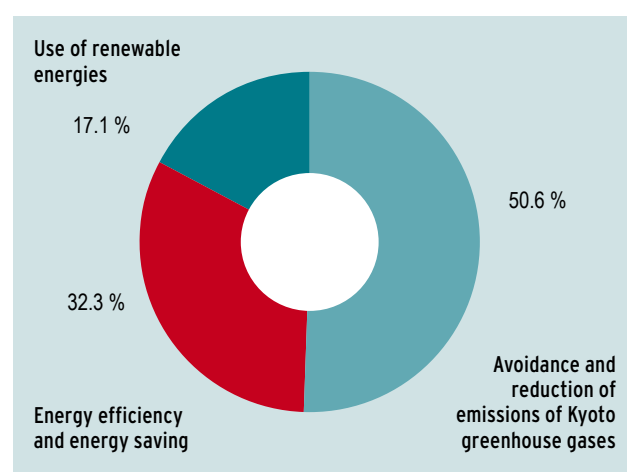
Source: Federal Statistical Office (2010c).

According to the environmental statistics, the manufacturing sector invested some 3 billion EUR in environmental and climate protection in 2007. Nearly 90 percent is concentrated in 10 branches of industry.

Energy supply, petroleum processing, chemicals and water supply were the industries with the highest capital investment in environmental protection in 2007. Nearly 30 percent of all investment in environmental protection is due to companies in the energy supply sector. A major item here is investment in climate protection, for example emission reduction measures. In overall terms too, these companies invest the most in climate protection measures, followed by air quality control and water conservation (cf. Figure 32).

The statistics also include a breakdown of climate protection investment among various measures. This indicates that roughly half of investment expenditure is due to emission reduction, about 30 percent to efficiency improvement and energy saving, and 17 percent to the use of renewable energy sources (cf. Figure 33).

According to provisional figures from the Federal Statistical Office, investment in environmental protection by the manufacturing sector in 2008 came to about 6.1 billion EUR. However, the industry classification was revised in 2008 with the result that the data for 2008 are not in general comparable with the data for 2007.⁵²

Figure 33: Climate protection measures by the manufacturing sector 2007

Source: Federal Statistical Office (2010c).

⁵² This change was due to a necessary and binding requirement for international harmonisation of classifications, cf. Federal Statistical Office (no year stated).

Financial assistance measures reduce spending by industry

Although companies spend money on environmental protection, e.g. when they have to satisfy certain requirements or comply with limit values, they can on the other hand take advantage of financial assistance for environmental protection that is available from national and regional authorities and the EU. In view of the large number of programmes it is not possible to quote a total figure for financial assistance provided for environmental protection. For example, under the heading "Environment and Nature Conservation" the funding database of the Federal Ministry of Economics lists 77 assistance programmes for companies, including 12 federal programmes. Energy efficiency and renewable energy are assisted by 110 programmes at federal and regional level. Further assistance is also available primarily in the climate protection sector, for example under the Federal Environment Ministry's Climate Initiative or a number of programmes run by the KfW banking group (Kreditanstalt für Wiederaufbau - KfW). Chapter 1.7 provides an overview of the assistance programmes.

Example: National Climate Initiative

The National Climate Initiative assists German industry through a number of projects and programmes. The aim is to make production processes in industry less expensive and more climate friendly. The Climate Initiative focuses on energy efficiency and thereby helps to reduce day-to-day energy costs. Companies have considerable opportunities to make more efficient use of energy. One example is the kick-off programme for commercial refrigeration installations. Merely using the technology already available on the market, it would be possible to save 11 billion kWh a year (two fossil-fuel thermal power stations) in Germany. The Environmental Innovation Programme also provides additional assistance funds for new technologies in the climate protection sector. Other examples of assistance measures under the Climate Initiative include innovation competitions, action weeks and information events.

For example, the figures for 2008 show a dramatic rise in capital spending on water conservation, whereas investment in climate protection is down in proportion. This is presumably due to the fact that the entire sector "Water supply; wastewater and waste management and disposal of environmental pollution" is now included in the manufacturing sector. In the comparable section of the "Manufacturing industries" and "Mining and quarrying", investment in environmental protection in 2008 was 5.3 percent up on 2007. It thus went up by less than overall investment (7.4 percent) by these industries.

Environmental protection expenditure on an international comparison

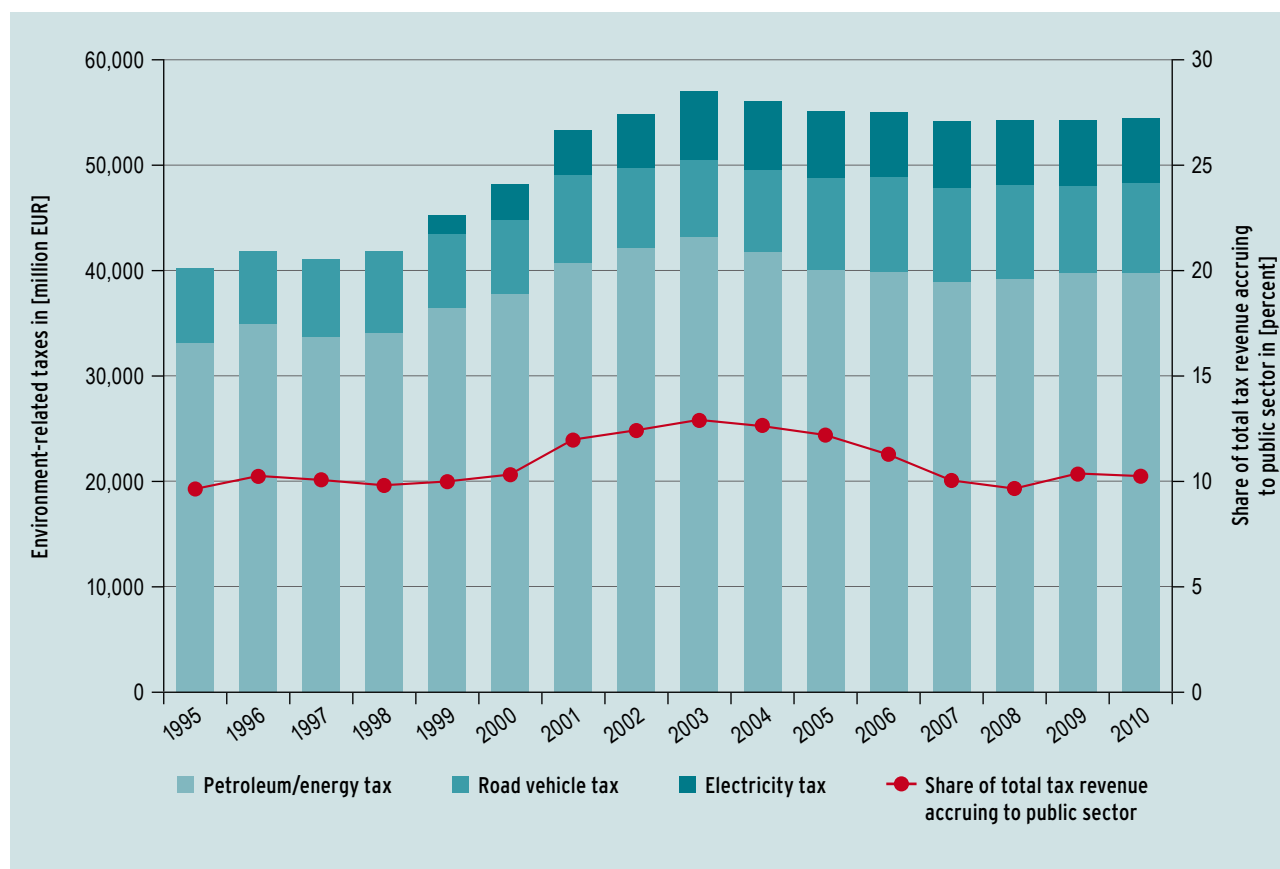
In 2006 the countries of the EU 25 spent an average of 1.8 percent of their gross domestic product on protecting the environment. With a share of 1.5 percent of GDP, Germany was in the lower middle range. The figures for industry are of a similar order. In terms of GDP, companies in the manufacturing sector throughout the EU spent about 0.4 percent on environmental protection, while the figure for Germany was barely 0.3 percent. The picture is probably different if one includes investment in climate protection, but as yet there are no comparative analyses available.

3.2 Environmental charges as a cost factor for industry and households

Environmental charges include environment-related taxes such as energy, electricity and road vehicle taxes, and charges for wastewater and waste disposal including street cleaning. The energy tax (formerly petroleum excise duty) accounts for by far the largest share of environment-related taxes in Germany. The ecological tax reform in 1999 introduced the electricity tax and raised the tax rates on motor fuels and heating fuels. Reduced tax rates for electricity, heating oil and gas apply to the manufacturing industries and to agriculture and forestry. For the manufacturing industries there is also the "peak equalisation scheme" for companies with a tax burden exceeding the reduction in state pension contributions. 90 percent of the revenue from the ecological tax reform goes into the state pension scheme. This reduces state pension contributions by about 1.7 percentage points. In view of the tax concessions for the manufacturing sector and the agricultural and forestry sectors, the effective tax burden on these sectors is lower than for the services sector and private households.⁵³

The burden due to environmental charges has diminished in recent years. In 2009 the share of total public-sector tax revenue accounted for by environment-related taxes came to about 10 percent. This corresponds to the level in 1999 – in other words when the ecological tax reform was introduced (cf. Figure 34). One major reason for this is the fact that environmental charges are volume-based taxes, which means that the real tax burden is constantly decreasing due to inflation.

53 Cf. Bach (2009).

Figure 34: Environment-related taxes in Germany 1995–2010

Source: Own diagram based on Federal Statistical Office (2010b)

For example, the energy tax on motor fuels would have to be 8.1 cents per litre higher today to offset the effect of inflation.⁵⁴ To counteract this effect, the European Commission has proposed that the (minimum) energy taxes be inflation adjusted at regular intervals.⁵⁵

In 2002, revenue from environment-related taxes in the OECD countries averaged 2.49 percent of their GDP. In 2008 the figure was only 2.18 percent (Figure 35). On an international comparison Germany is only middle-of-the-road when it comes to environmental taxes. Before the introduction of the ecological tax reform, environment-related taxes in Germany were actually below the average for the OECD.⁵⁶

3.3 Environmentally harmful subsidies

Whereas environmental charges lead to additional revenue for the state and provide economic incentives for environmental protection, the opposite is true of environmentally harmful subsidies. They distort competition to the disadvantage of environmental protection and thereby encourage environmentally harmful production and consumption practices. Therefore, they place a double burden on public-sector budgets: in the first place due to increased state expenditure and reduced state revenue, and later due to increased costs for dealing with the harm done to human health and the environment.

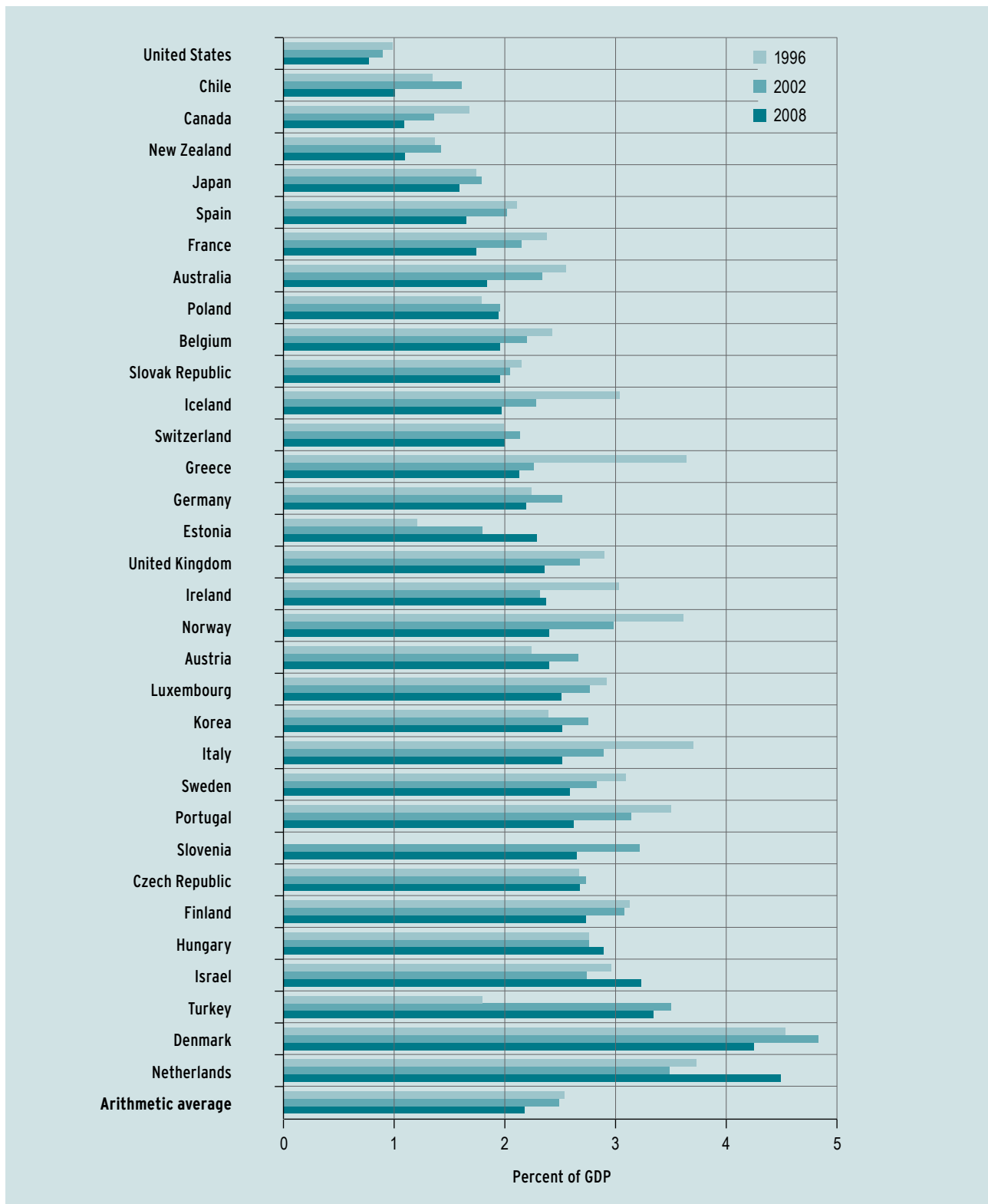
As early as 2001 the OECD, in its Environmental Performance Review for Germany, came to the conclusion that about 35 percent of subsidies in this country were potentially harmful to the environment.⁵⁷

54 Cf. Ludewig et al (2010).

55 Draft Energy Taxation Directive, cf. EU COM (2011g)

56 In 1996 environment-related taxes averaged 2.54 percent in the OECD and 2.24 percent in Germany.

57 OECD (2001a). The percentage of subsidies potentially harmful to the environment is based on the financial assistance and tax concessions described in the German Government's 17th Subsidies Report (1999). The figure relates to the volume of subsidies.

Figure 35: Revenue from environment-related taxes as a percentage of GDP in OECD countries 1996–2008

Source: OECD (2010), p. 33

In 2008 environmentally harmful subsidies amounted to over 48 billion EUR (cf. Figure 36).⁵⁸ This amount is only a lower limit, because it only includes the main federal subsidies. Assistance programmes at regional

and local level and subsidies through the EU budget are largely disregarded. Moreover, in some cases it is impossible to quantify the environmentally harmful component of the subsidy.

58 Federal Environment Agency (UBA 2010b).

Figure 36: Environmentally harmful subsidies in Germany in 2008

	mill. Euro (2008)	Environmental Asset						
		Climate	Air	Water	Soil	Biodiversity and landscape	Health	Resources
1 Energy supply and use								
Reductions of electricity tax and energy tax for the manufacturing industries and for agriculture and forestry	2,415	■	■	■	■	■	■	■
Peak equalisation scheme for eco tax in the manufacturing industries	1,962	■	■	■	■	■	■	■
Tax reduction for certain energy-intensive processes and techniques	886	■	■	■	■	■	■	■
Coal subsidies	2,454	■	■	■	■	■	■	■
Privileges for the lignite industry	min. 195	■	■	■	■	■	■	■
Energy tax reductions for coal	154	■	■	■	■	■	■	■
Manufacturer privilege for producers of energy products	270	■	■	■	■	■	■	■
Energy tax exemption for non-energy uses of fossil fuels	min. 1,600	■	■	■	■	■	■	■
Free allocation of CO ₂ emissions trading allowances	7,783	■	■	■	■	■	■	■
Subsidies for nuclear power	n. q.	■	■	■	■	■	■	■
2 Transport								
Energy tax reduction for diesel fuel	6,633	■	■	■	■	■	■	■
Distance-based income tax deduction for commuters	4,350	■	■	■	■	■	■	■
Exemption of kerosene from energy tax	7,232	■	■	■	■	■	■	■
Energy tax exemption for inland waterway transportation	118	■	■	■	■	■	■	■
VAT exemption for international flights	4,237	■	■	■	■	■	■	■
Flat-rate taxation of privately used company cars	500	■	■	■	■	■	■	■
Biofuels	n. q.	■	■	■	■	■	■	■
3 Construction and housing								
Home ownership grant	6,223	■	■	■	■	■	■	■
Promotion of saving for building purposes	467	■	■	■	■	■	■	■
Promotion of social housing	518	■	■	■	■	■	■	■
Joint Agreement for the Improvement of Regional Economic Structures	n. q.	■	■	■	■	■	■	■
4 Agriculture and forestry, fisheries								
Agricultural subsidies of the European Union	n. q.	■	■	■	■	■	■	■
Joint Agreement for the Improvement of agricultural structures and coastal protection	n. q.	■	■	■	■	■	■	■
Tax rebate for agricultural diesel	135	■	■	■	■	■	■	■
Exemption of agricultural vehicles from vehicle road tax	55	■	■	■	■	■	■	■
Subsidies for production of spirits	80	■	■	■	■	■	■	■
Fisheries subsidies of the European Union	n. q.	■	■	■	■	■	■	■
Total	48,267							

n.q. = not quantifiable

■ Primary effects

■ Secondary effects

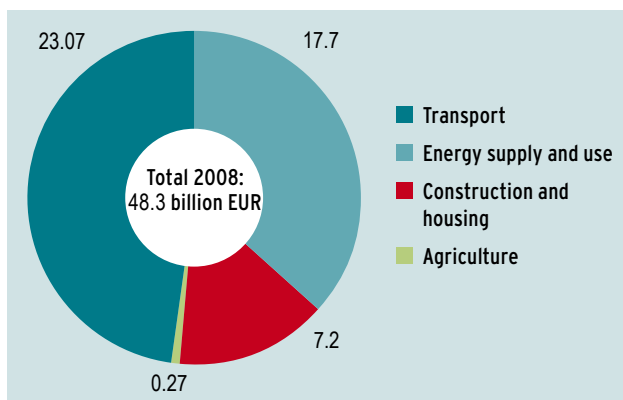
Source: Federal Environment Agency (UBA 2010b)

Environmentally harmful subsidies are a burden on nearly all environmental assets: from harmful effects on water, soil or air, to increased land take and loss of biological diversity. It is important to distinguish between direct and indirect environmental impacts due to subsidies. For example, the electricity and energy tax reductions for the manufacturing industries have a direct negative effect on the climate because they increase the use of fossil fuels (primary effects). The increased extraction of fossil fuels gives rise to indirect negative impacts, e.g. on the environmental assets water, soil and biodiversity (secondary effect). All in all, roughly half the environmentally harmful subsidies directly favour fossil fuels and thereby frustrate efforts to protect the climate.

A comparison with 2006 shows⁵⁹ that on an overall view there has not been any progress with the reduction of environmentally harmful subsidies: The total figure for environmentally harmful subsidies rose from nearly 42 billion EUR in 2006 to over 48 billion EUR in 2008. There was a particularly sharp rise in the energy and transport sectors.

Subsidies of 17.7 billion EUR are provided to assist energy supply and use (cf. Figure 37). This applies not only to extraction of the energy sources (e.g. coal and lignite), but also to energy generation. The subsidies lower the price of energy and thereby reduce the incentive to make economical and efficient use of energy. This results in higher energy consumption, combined with energy-induced environmental pollution.

Figure 37: Environmentally harmful subsidies - Breakdown by sectors (in billion EUR)



Source: Own diagram based on UBA (2010b)

In the transport sector, subsidies amounting to 23 billion EUR contributed to environmental pollution in 2008. Nearly half the environmentally harmful transport subsidies, 11.5 billion EUR, were due to air transport. They distort competition at the expense of the railways and other greener means of transport.

The construction and housing sector received environmentally harmful subsidies totalling 7.2 billion EUR in 2008. The subsidies reduce the cost of building new housing or developing new industrial, commercial and transport areas. The state funds usually make no distinction between previously used land and newly developed "greenfield" sites.

EU and international level

When it comes to reforming environmentally harmful subsidies, Germany is also bound by international obligations. In its proposal on the "Europe 2020" strategy the European Commission calls upon the Member States to phase out all environmentally harmful subsidies.⁶⁰ Under the G20 decisions adopted in Pittsburgh in September 2009, Germany also undertook to phase out subsidies for fossil fuels in the medium term.

3.4 Cost savings through corporate environmental protection

Environmental protection measures within companies make a considerable contribution to reducing costs. Improving resource efficiency is a matter of central importance here (cf. details in Part IV). For example, efficient flows of materials and substances can reduce expenditure on materials procurement, energy or water. This frequently gives rise to cost savings through reduced levels of waste or wastewater, or reduced expenditure on end-of-pipe environmental measures. Such savings are based on a variety of approaches, such as use of innovative environmental technologies, greater use of integrated environmental protection, management techniques based on optimising resource flows, or optimisation of process workflows and product design.

59 Cf. UBA (2008a) for the data for 2006.

60 EU COM 2010c.

Systematic tapping of cost-reduction potential has been made possible for companies and all types of organisations through the introduction of the European Eco-Management and Audit Scheme. By mid 2011 there were more than 7,900 registered EMAS sites in the EU. Resource-intensive companies in the manufacturing sector in particular have achieved significant reductions in their material and energy consumption as a result of EMAS. A survey carried out by the Bavarian Office for the Environment (LfU) in 2006 revealed that 61 percent of the companies questioned were able to achieve a lasting reduction in costs with the aid of their environmental management scheme⁶¹ This was confirmed in 2009 by a

BMU survey: 85 percent of the companies questioned were able to significantly improve their eco-efficiency through EMAS.⁶²

State assistance programmes can make it easier to identify and finance environmental protection measures that reduce costs. A number of Länder offer suitable programmes for establishing an environmental management system under EMAS.⁶³

Companies seeking to optimise their use of resources can also obtain low-cost advisory services from efficiency agencies.

Saving costs by improving efficiency⁶⁴

- **Systematic energy management in a car factory:** Following the principle "Use energy only when necessary", factory management – with active assistance from the employees – introduced an energy management system and improved the ventilation, cooling and waste heat utilisation of a large German car factory. This is saving a total of 11 percent of energy consumption and more than 70,000 tonnes of CO₂ per year. This pays in economic terms as well. Even in the first year, the energy cost savings of nearly 10 million EUR exceeded the initial investment of 4.6 million EUR. This works out at 210 percent return on investment.
- **New lighting system in a warehouse:** The redesigned lighting system in a factory warehouse improved the lighting quality and reduced energy costs. The capital expenditure of 98,600 EUR results in annual electricity savings of 72,200 EUR. This relieves the burden on the climate by 448 tonnes of CO₂ a year and represents a return on investment of 73 percent.
- **Improved heating and cooling system:** Since the rebuilding of a production facility, the waste heat from the machines has been used to heat adjacent parts of the building. Moreover, the necessary pumps conform to energy efficiency class A. The energy savings of 748 MWh per annum required an investment of 1 million EUR; the return on investment is 145 percent.
- **Lighter concrete floors:** A new technology incorporates hollow spheres of recycled plastic in concrete floors. Thanks to ingenious design, the load-bearing capacity does not suffer, but the floor is lighter. This makes it possible to save up to 35 percent concrete and 20 percent reinforcement steel. It also reduces the associated greenhouse gas emissions.
- **The soft centre:** In the past, cavities in cylinder heads and engine blocks have been drilled into the rough casting. This costs time and material. A foundry has developed a process in which these cavities are created during casting with the aid of tubular aluminium inserts and a reusable filling material. In the case of a gearbox casing, for example, this can save about 60 percent of the weight of raw material.
- **Less tinplate for tin cans:** Optimising combinations when stamping out blanks in a tinware factory makes it possible to reduce annual consumption of tinplate by 220 tonnes.

61 Cf. LfU (2006).

62 Cf. BMU (2009c).

63 Cf. Environmental Verification Committee (Umweltgutachterausschuss 2010).

64 Cf. Dena (2010).

3.5 Environmental protection reduces follow-on costs for the national economy

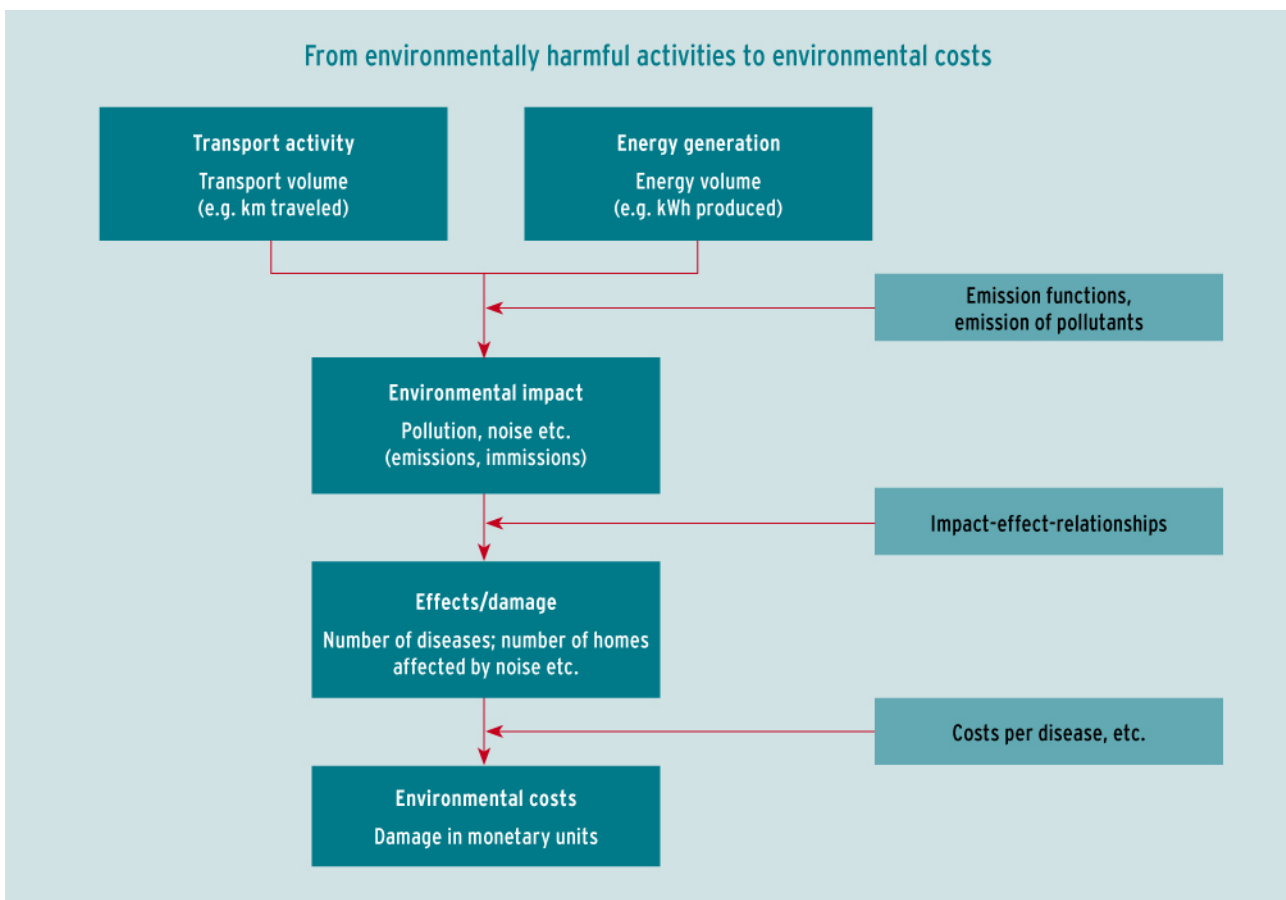
Poor air quality causes respiratory diseases, noise can result in sleep problems, polluted soils and water have to be cleaned – many economic activities give rise to environmental and health costs that are borne not by the polluter, but by the general public.

Environmental pollution costs of this kind – also known as external (environmental) costs – can range as far as climate effects that do not occur until the distant future. Conversely, if environmental measures reduce environmental impacts, this benefits the people affected and society as a whole. For example, a reduction in fine particulate emissions reduces the incidence of respiratory disorders. This in turn leads to lower health costs, thereby relieving the burden on the entire national economy. 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.

Example: Air pollution has harmful effects on health

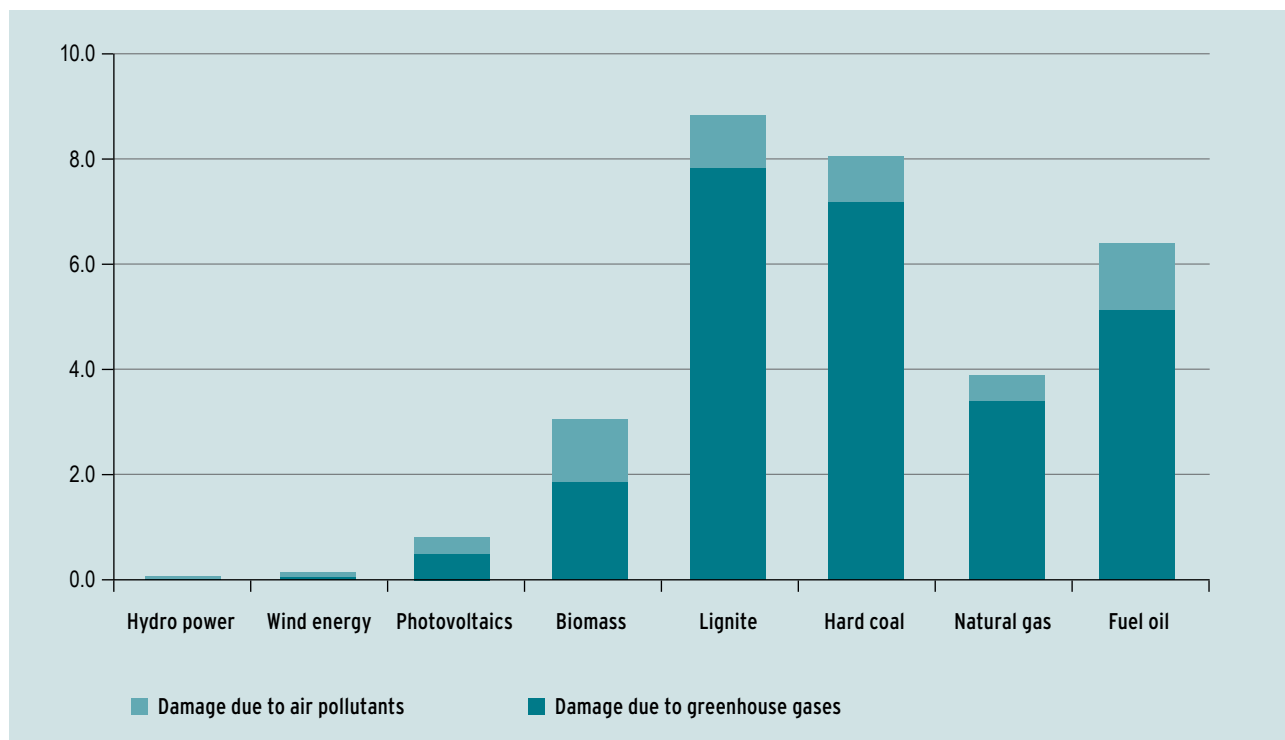
Man-made pollution of the atmosphere with soot particles and other pollutants gives rise to an increased risk of disease and death. Numerous scientific studies have demonstrated the connection between air pollution and health damage. These epidemiological studies observe the health of a very large number of people over long periods and compare the data with the level of air pollution that these people are exposed to. They have shown that soot particles increase the risk of various diseases: respiratory disorders such as asthma and bronchitis, lung cancer, cardiovascular diseases. For example, an additional particulate exposure of 10 g/m³ increases the risk of lung cancer by more than 1 percent. These health effects result in a number of costs for the national economy: costs for hospital treatment and medication, intangible costs due to loss of quality of life, and loss of production due to absence from work. Programmes designed to reduce air pollution thus reduce the cost to the economy.

Figure 38: Example of impact path method: General systematics of calculating environmental costs



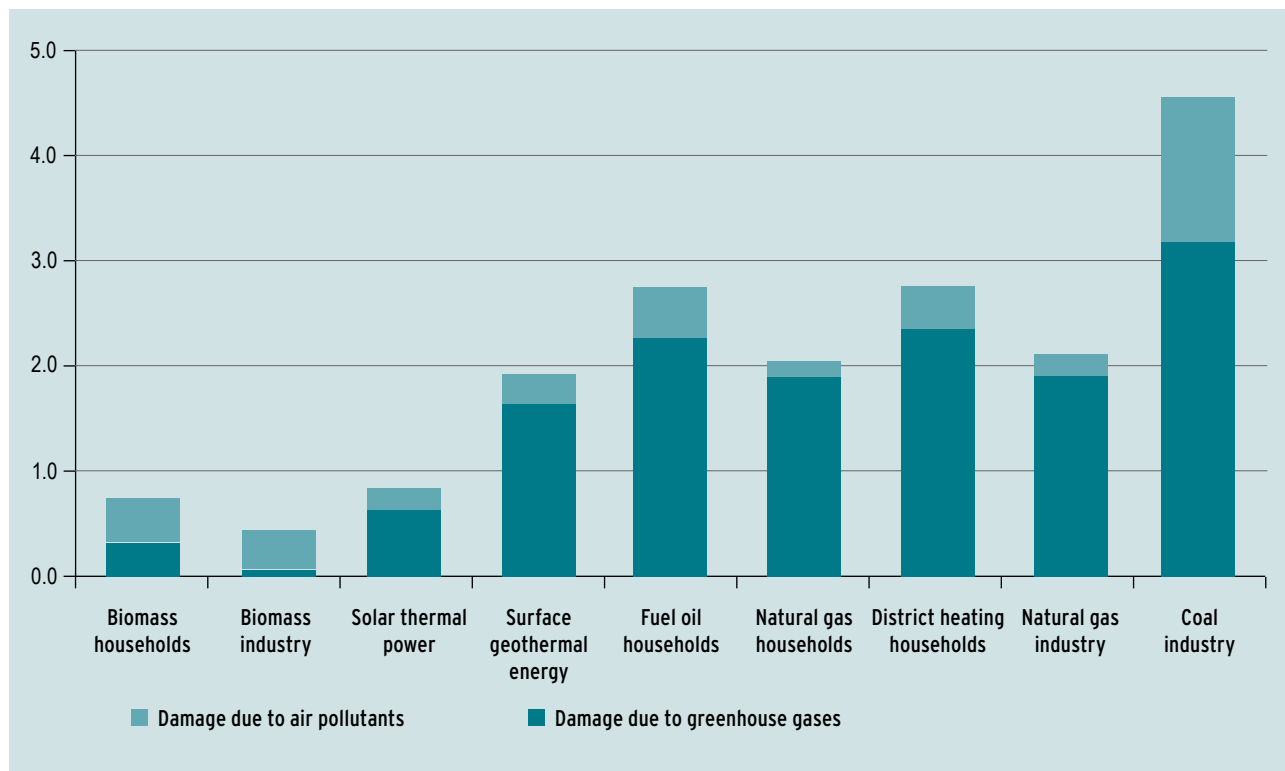
Source: Maibach et al (2011)

Figure 39: External costs of electricity generation 2010 (in cent/kWh)



Source: BMU (2011j)

Figure 40: External costs of heat generation 2010 (in cent/kWh)



Source: BMU (2011j)

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.

The biggest factors responsible for environmental costs include generation of power from fossil fuels, and motorised transport. Fossil fuels are responsible for about seven cents per kilowatt-hour, whereas for electricity from renewable energy sources the figure averages less than one cent (cf. Figure 39). In the case of heat generation, the environmental costs are between 0.4 and almost 5 cents per kilowatt-hour (cf. Figure 40).

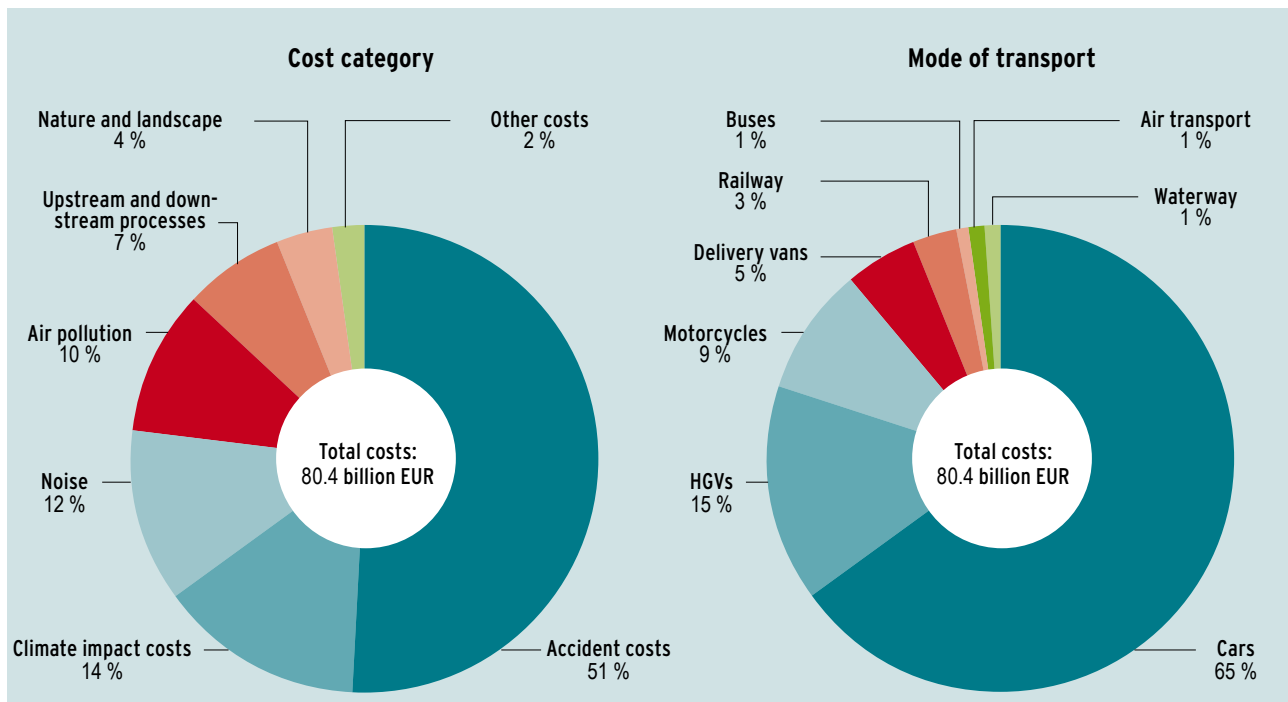
Of course it is often impossible to avoid environmental costs entirely, and this cannot be an objective of environmental policy. What is important, however, is that such costs are included in any overall economic assessment. Against this background, greater energy efficiency and the expansion of renewable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

The external costs of transport in Germany add up to about 80 billion EUR. According to an analysis for 2005 by the Zurich-based research institute Infrac, 96 percent of these costs are due to road traffic. Roughly half the external costs are environmental follow-on costs.

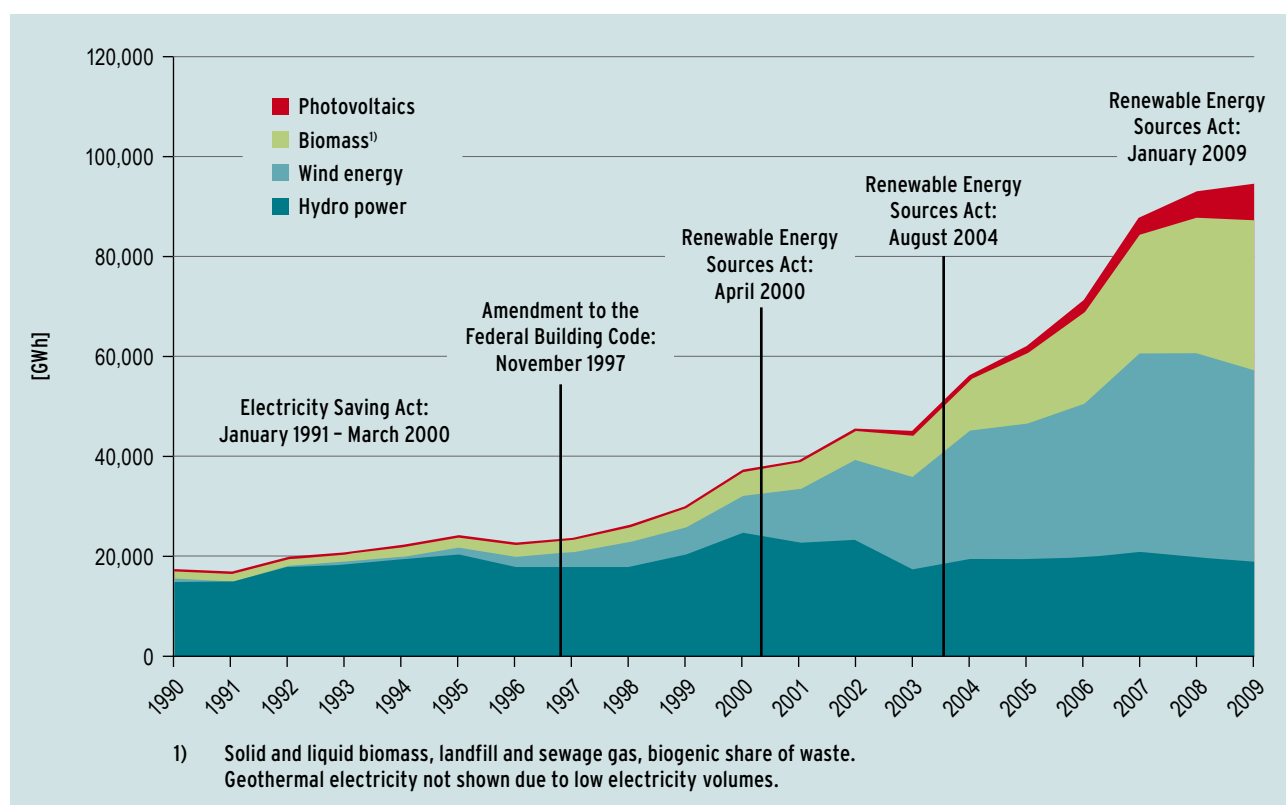
The three largest environmental cost blocks in the transport sector are climate costs, noise costs and costs due to air pollution. Other costs arise in the nature and landscape sectors, and as a result of upstream and downstream processes such as the production of motor fuel or electricity.

External environmental costs of transport are an important indicator. They show in money terms the benefits that environmental protection yields in the transport sector. 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 investment 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 (cf. Figure 41).

Figure 41: External cost of transport in Germany 2005



Source: Infrac (2007)

Figure 42: Contribution of renewable energy to electricity generation in Germany

Source: BMU (2011c)

3.6 Benefits and costs of promoting renewable energy sources

Greater expansion of renewable energy under the EEG

Experts agree that the German government's ambitious climate protection targets can only be achieved if renewable energy takes over the greater part of electricity generation in the long term. On the other hand, many renewable energy technologies for generating electricity are not yet competitive on the market. For this reason Germany promotes them under the Renewable Energy Sources Act (EEG), by means of fixed feed-in payments for the electricity produced. The EEG has proved extremely successful: in Germany as much as 102 billion kilowatt-hours of electricity came from renewable sources in 2010, or 16.8 per cent of total electricity consumption.⁶⁵

How and why the EEG surcharge has increased

Since the feed-in payments are higher than the market price of electricity, this gives rise to additional costs – “differential costs” – which are passed on to electricity consumers via the EEG surcharge.⁶⁶ Particularly electricity-intensive companies and railways are largely exempted from this. Whereas the EEG surcharge for tariff customers was 1.3 cent/kWh in 2009, it increased to 2 cent/kWh in 2010 and 3.53 cent/kWh in 2011 (cf. Figure 43).

There are many different reasons for the marked increase in the EEG surcharge in the last two years.⁶⁷ In addition to the rapid expansion of electricity generation from biomass and photovoltaics, the economic crisis also contributed to the increase in the surcharge. In 2009 the drop in prices on the elec-

65 BMU (2011c).

66 The method of calculating the differential costs changed considerably in 2010 with the entry into force of the EEG Equalisation Scheme Ordinance (EEG Ausgleichsmechanismus-Verordnung). Cf. details in BMU (2011e).

67 Cf. UBA (2011a), p. 3ff and BMU (2011e).

Figure 43: Cost of renewable energy expansion

		2009	2010 ¹⁾	2011 ¹⁾
Total EEG payment (less grid fees avoided)	bill. EUR	10.8	12.7	16.7
Differential costs	bill. EUR	5.3	8.2	12.4
Back payment (differential costs) from previous year	bill. EUR			1.10
Average EEG surcharge for non-privileged electricity consumers (e.g. households, trade, commerce)	cents/kWh	1.3	2.0	3.5
Cost per average household	EUR per month	3.8	6.4 ²⁾	10.3
	% of electricity bill	6	9 ²⁾	14

1) Forecasts. These figures do not include any retroactive corrections in the light of new data.

2) Sources: Federal Environment Agency (UBA 2011a) and BMU (2011e).

tricity exchange resulted in an unexpectedly sharp rise in the differential costs and hence in the EEG surcharge.⁶⁸ Moreover, from 2010 onwards the cost of 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 is also apportioned via the EEG surcharge.

The importance of the EEG surcharge for the development of electricity prices

Electricity prices for tariff customers (especially private households) have risen considerably in recent years (cf. Figure 44). As shown, however, it was only in the first two years that the EEG surcharge made an appreciable contribution to this. On a longer-term view, the price has been pushed up mainly by

increases in the cost of electricity generation, transmission and distribution and by a higher rate of value-added tax.

It also has to be borne in mind that the expansion of renewable energy leads to falling prices on the electricity exchange. This is because the priority feed-in for EEG electricity tends to increase the supply of electricity. Offers by the most expensive conventional electricity suppliers are pushed off the market – which results in falling exchange prices (merit order effect). In 2009 the reduction in electricity prices due to renewable energy sources averaged about 0.6 cent/kWh. This resulted in a – theoretical – reduction of about 3.1 billion EUR for German electricity consumers.⁶⁹ It is however questionable whether the tariff customers profit from this effect.

Figure 44: Breakdown of the monthly electricity bill of a model household

	2000	2002	2004	2006	2008	2009	2010	2011
Electricity bill €/month (3,500 kWh/a)	40.67	46.99	52.48	56.63	63.00	67.70	69.10	72.78
Generation, transport, distribution	25.15	28.32	31.56	34.53	37.95	41.17	40.53	39.58
EEG	0.58	1.02	1.58	2.20	3.25	3.83	5.97	10.30
CHP Act	0.38	0.73	0.91	0.90	0.55	0.70	0.38	0.09
Concession fee	5.22	5.22	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	5.97	5.97
VAT	5.61	6.48	7.24	7.81	10.06	10.81	11.03	11.62
In 2005 prices	43.87	49.00	53.28	55.74	59.10	63.27	63.87	66.47

Source: BMU (2011e)

68 For the calculation of the EEG surcharge in 2010 an exchange price of 5.3 cent/kWh was assumed, in 2009 the figure had been nearly 7 cent/kWh.

69 Sensfuß (2011).

What is more likely is that – as the RWI (Rheinisch-Westfälisches Institut für Wirtschaftsforschung) has found – electricity suppliers are mostly not passing these cost advantages on to the final customer.⁷⁰ This would be a problem of lack of competition, and from a macroeconomic point of view it would not be efficient. But regardless of who ultimately profits from this effect, it is a reduction in electricity procurement costs that is due to the expansion of renewable energy.

Cost increasing and reducing effects for electricity-intensive companies

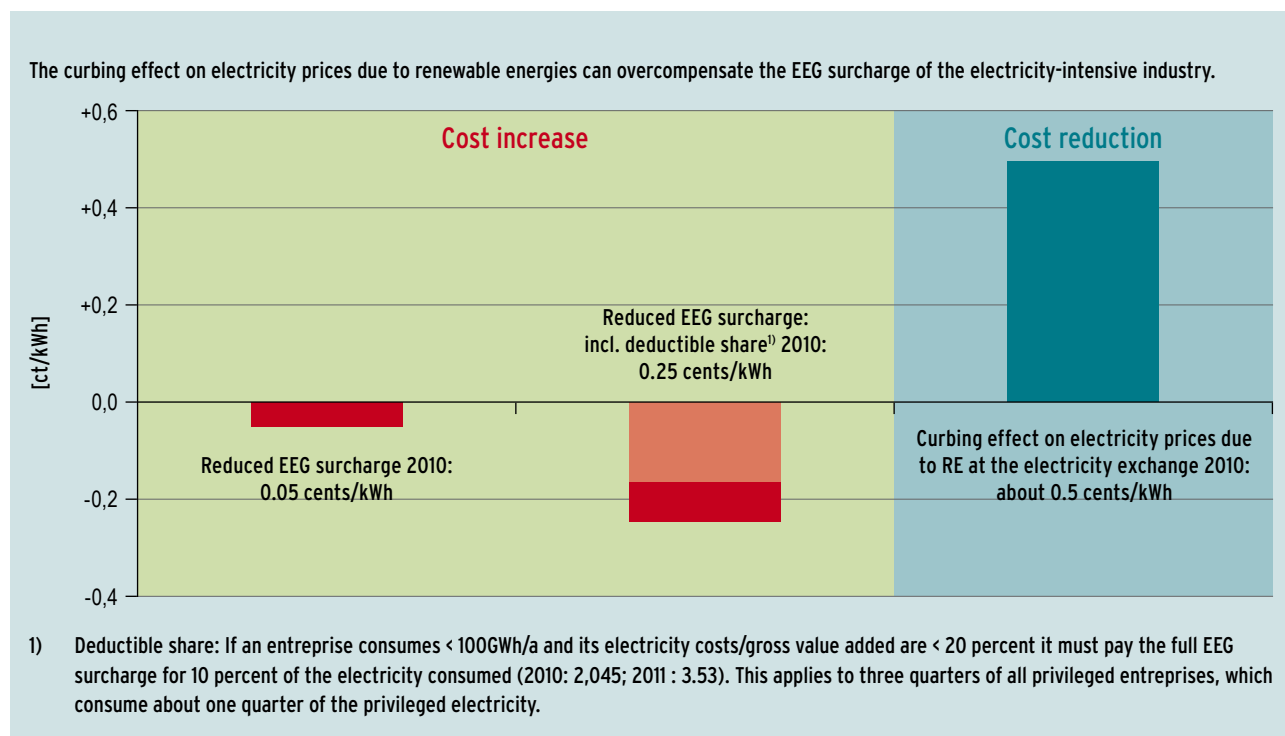
For electricity-intensive companies the EEG surcharge has been very extensively restricted by the “special equalisation scheme” laid down in the EEG since 2003. In 2010 it was only 0.05 or 0.25 cent/kWh, depending on electricity consumption and intensity. This provision was created to avoid endangering the international competitiveness of these companies. Comparing the remaining EEG surcharge with the possible relief due to the fall in electricity exchange prices resulting from the merit-order effect (see

above), it becomes apparent that on balance the expansion of renewable energy may even have reduced the burden on electricity-intensive industries in 2010 (cf. Figure 45).⁷¹ By contrast, the preferential treatment of electricity-intensive companies had the effect of raising the EEG surcharge by around 18 percent for all those who do not benefit from the reduced surcharge.⁷²

Future costs of promoting renewable energy through the EEG

The future costs of promoting renewable energy will be influenced by a variety of factors (e.g. support regime, expansion rate, energy price trends) and are very difficult to predict. This is illustrated, for example, by the forecasts on the development of the EEG surcharge and EEG tariffs submitted regularly by the four transmission system operators.⁷³ In the medium and long term, electricity generation based entirely on renewable energy by the year 2050 has substantial cost advantages over conventional electricity generation on the basis of fossil fuels (cf. Figure 46). The main driving forces behind this trend will be falling

Figure 45: Cost increasing and reducing effects of renewable energy for industry 2010



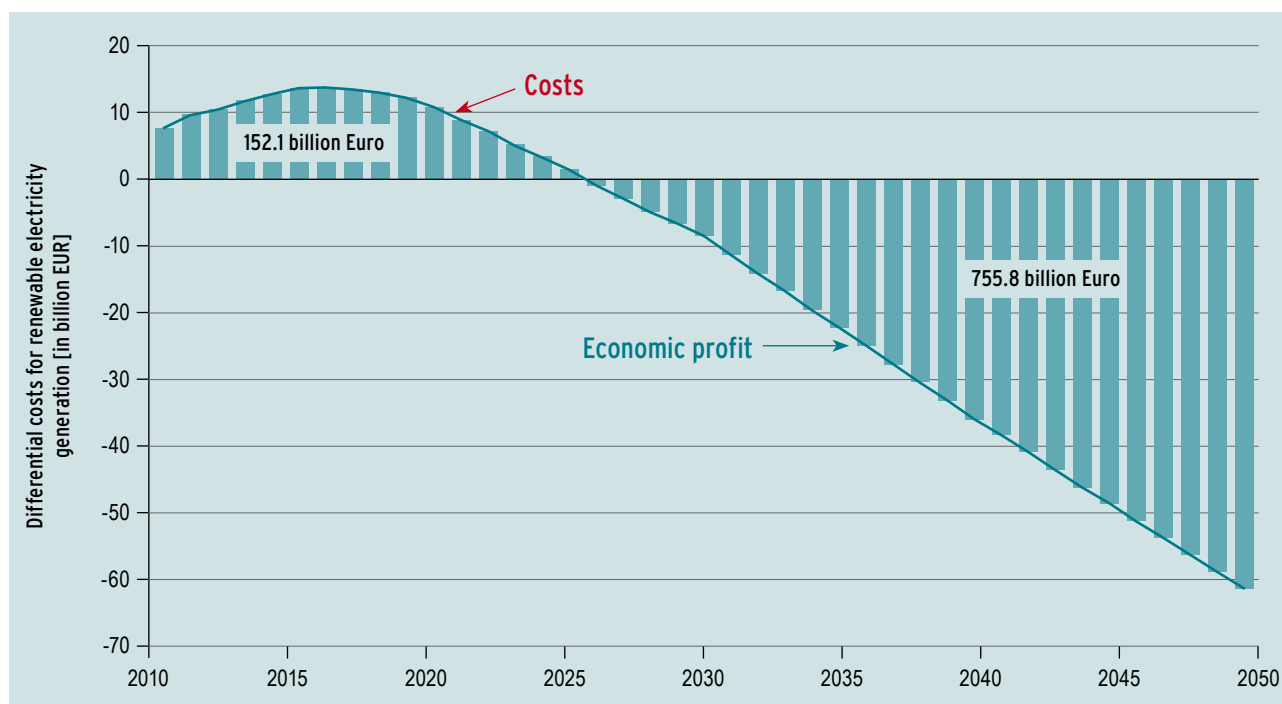
Source: Renewable Energy Agency (Agentur für erneuerbare Energien) (2011)

70 Cf. Frondel et al (2010), p. 13.

71 Renewable Energy Agency (Agentur für Erneuerbare Energien) (2011).

72 Wenzel, Nitsch (2010).

73 Cf. www.eeg-kwk.net, references to scientific studies can also be found here.

Figure 46: Development of differential costs for renewable electricity generation in Germany from 2010 to 2050⁷⁴

Source: ZSW (2011)

generation costs for renewable electricity, rising prices for fossil fuels, and the predicted rise in CO₂ allowance prices. Thus the expansion of renewable energy also makes economic sense.

Overall economic benefits of expanding renewable energy

The costs of renewable energy have to be seen in the light of substantial overall economic benefits. For example, the expansion of renewable energy avoids climate-damaging emissions and air pollutants. Estimates indicate that the electricity paid for under the EEG reduced CO₂ emissions by around 58 million tonnes in 2010 alone.⁷⁵ This leads to lower follow-on costs for society as a result of harmful effects on health and the environment. Figure 47 shows the costs and benefits quantified to date that

can be attributed to EEG electricity. On this basis the quantified costs and benefits of renewable energy expansion are already more or less equal today.

Figure 47: Costs and benefits of promoting renewable energy expansion (in billion EUR)

	2008	2009
Differential costs electricity ⁷⁶	4.7	5.3
Cost of control and balancing energy	0.6 (2007)	0.4
Grid expansion ¹⁾	0.02	0.02
Transaction costs ¹⁾	0.03	0.03
Total: Cost of renewable electricity	5.35	5.75
Total: Benefits of renewable electricity⁷⁷	5.9	5.7

1) estimate for 2007

Source: IZES et al (2010a)

⁷⁴ The estimates of the differential costs are based on updated figures for the energy concept of the Renewable Energy Research Association (FVEE), which achieves full electricity supply on the basis of renewable energy sources by 2050, cf. (FVEE 2010).

⁷⁵ BMU (2011c).

⁷⁶ This balance, which is oriented to the national economy, is calculated using "system analysis differential costs". These vary slightly from the differential costs based on the EEG. Cf. details in IZES et al (2010a).

⁷⁷ Of this figure, only about 1 billion EUR was internalised through emissions trading in 2009, cf. IZES et al (2010b).

The expansion of renewable energy also reduces imports of energy resources, increases domestic value added and thereby creates additional jobs. In 2009 the increased use of renewable energy sources made it possible to save imports of fossil fuels to the value of about 6 billion EUR.⁷⁸ This tended to produce positive macroeconomic effects, because the imports were to a large extent replaced by domestic output. It also makes for greater security of supply.

The positive effects on the international competitive strength of German companies are also an important favourable factor. German companies occupy an outstanding position on the global market for renewable energy, and the promotion of renewable energy under the EEG – as well as research-related and project-specific assistance – has made a major contribution to this development.

The doubts that are nevertheless continually being raised about the sense of providing assistance for renewable energy are partly due to the fact that under the EEG the cost of this assistance is very transparent, whereas subsidies for other forms of electricity generation tend to make the costs more obscure. For example, nuclear power is only profitable on a microeconomic view because it receives explicit and implicit subsidies running into the billions. The risk of damage, for example, is largely borne by society. Moreover, if the external environmental costs of fossil power generation were charged to the originators in full, the cost of electricity generation from nuclear power and fossil fuels would already be higher in many cases than for renewable energy sources.⁷⁹

3.7 Benefits of biodiversity and ecosystem services

Intact ecosystems and ecosystem services – goods and services supplied free of charge by nature – are indispensable to human well-being and a foundation for the existence of economic activity. But they do not appear in public budgets or company balance sheets. As a result, ecosystems are over-utilised, damaged and destroyed. Because of the lack of systematic evaluation, we are often unaware of the amount of natural wealth we are destroying. Individual analyses indicate that the value and opportunities which ecosystem services of natural and near-natural biotopes provide to society, and indeed to individual companies, are considerable.

Ecosystem services and biological diversity – Locational factor for regional development

Ecosystem services such as conserving soil fertility and providing clean groundwater as a drinking water resource are essential requirements for sustainable management. In order to ensure that forms of management which protect water and soil resources and which create preconditions for maintaining biological diversity are worthwhile in economic terms as well, they are – where they exceed the statutory minimum level – given financial assistance. For example, cooperation models exist between farmers and water supply companies or agri-environmental programmes; these are jointly financed by the EU and national and regional authorities. In many rural

Figure 48: Economic effects of tourism in major protected areas

	Berchtesgaden National Park (2002)	Altmühltal Nature Park (2005)	Müritz National Park (2004)	Bayrischer Wald National Park (2004)
Gross turnover in mill. EUR	49 mill. EUR (9.3) ¹⁾	20.7 mill. EUR	13.4 mill. EUR (5.6) ¹⁾	27.8 mill. EUR (13.5) ¹⁾
Employment equivalent (full-time jobs)	1,457 (272) ¹⁾	483	506 (210) ¹⁾	904 (439) ¹⁾

1) only visitors who have come specifically because of the status "National Park"

Source: Job et al. (2009)

⁷⁸ Federal Environment Agency (UBA 2010a).

⁷⁹ Federal Environment Agency (UBA 2007a).

areas the relevant payments are an important component of the economic basis. In 2007 payments for agro-environmental programmes amounted to 603 million EUR and applied to 28 percent of agricultural land.

Another mainstay of rural regions is tourism. Protected areas such as national parks, biosphere reserves and nature parks attract the public. The approximately 50.9 million people that visit German national parks every year generate a gross turnover of about 2.1 billion EUR, which corresponds to an income or employment equivalent of about 69,000 persons (cf. Figure 48).⁸⁰

Ecosystem services and urban development

Urban biotopes such as parks, roadside trees or roof and facade plants provide local recreation facilities, improve air quality and have an equalising effect on the urban climate. An attractive urban environment is an important locational factor for investment decisions. The positive health effects of urban biotopes help to avoid health costs.

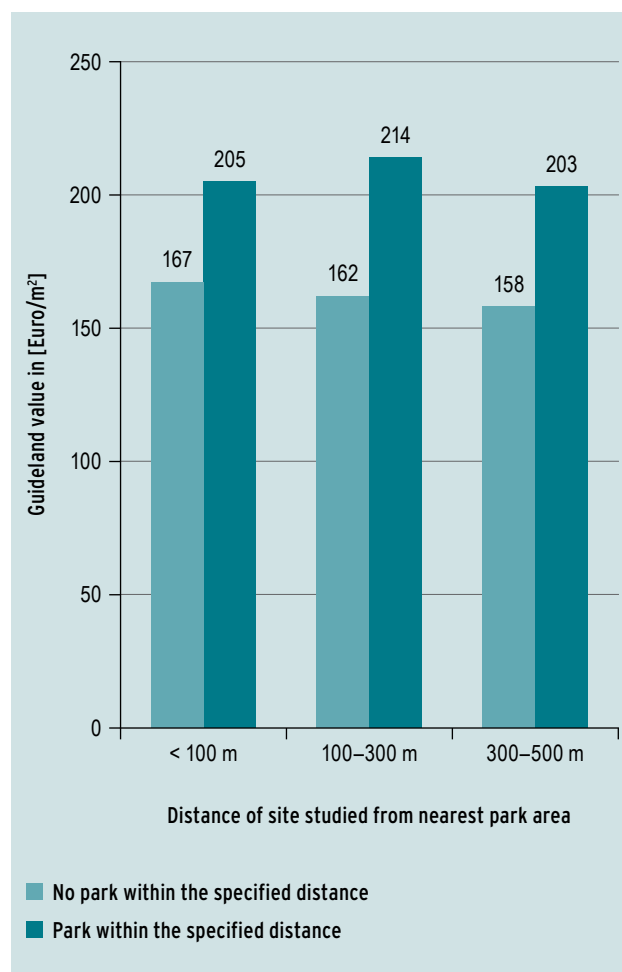
To date, no detailed studies are available on the economic significance of such effects. Initial findings are however known regarding the positive effects of green areas on the value of property. One study shows that in German cities with a moderate level of land prices, sites that are not more than 500 metres from a park are worth an average of 45 EUR per m² more than sites located further away (cf. Figure 49).⁸¹ In densely populated urban districts, the sum of all green factors investigated (parks, roadside trees, back and front gardens, decorative areas) explains as much as 36.7 percent of the value of the site.

Nature conservation and carbon markets

Many nature conservation measures also have a positive effect on economically important ecosystem services. Examples include the flood control effects of restoring near-natural water meadows, and the reduction of climate-relevant gases by bog renaturing measures.

Grossmann et al (2010) calculated that by relocating dykes further from the river to reclaim 35,000 hec-

Figure 49: Effects of green spaces on property values



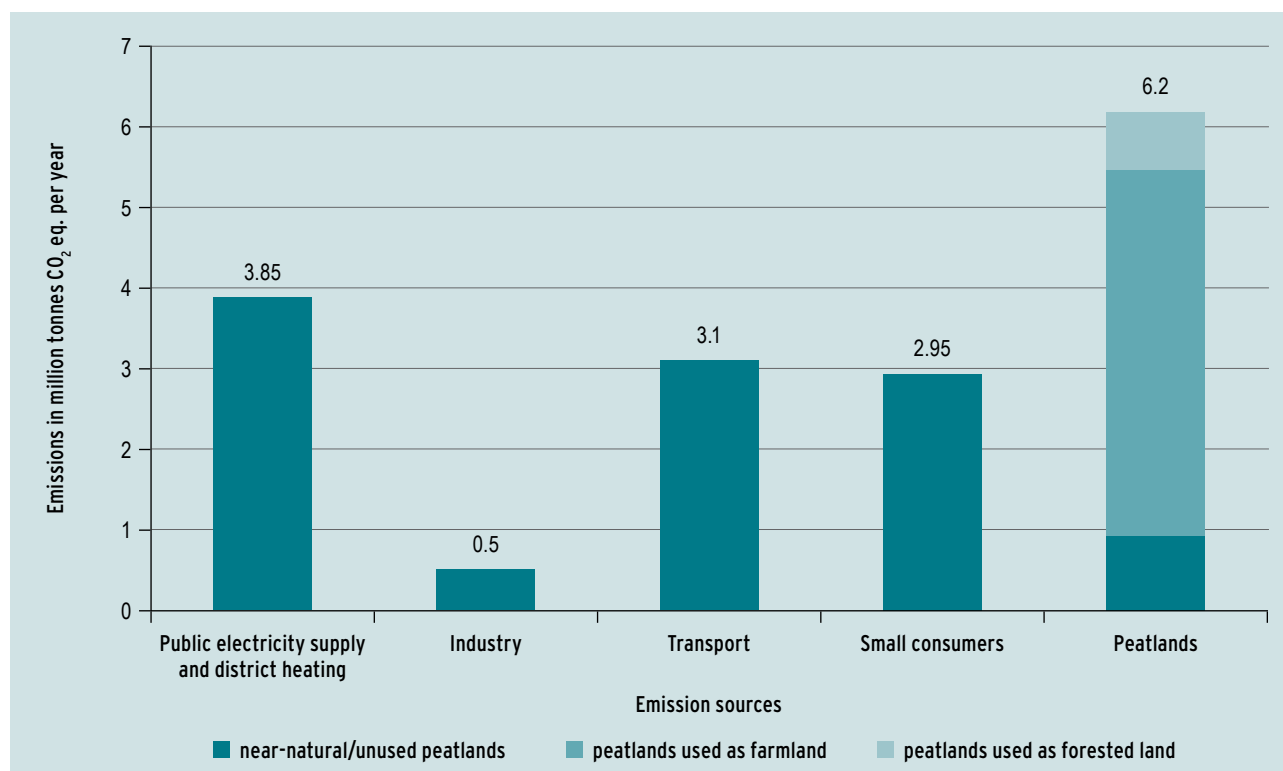
Source: Hoffmann, Gruehn (2010)

tares of near-natural flood areas along the Elbe it would be possible to avoid an average of 6 million EUR per year in flood damage. The reclaimed alluvial meadows would at the same time reduce harmful nutrient inputs into the water and would thereby obviate the need for alternative measures to achieve the objectives of the Water Framework Directive, costing a further 16 million EUR a year.

The extensive areas of former peatland soil which are found in Northern Germany in particular are one of the main sources of climate gas emissions in Germany. In Mecklenburg/Western Pomerania these emissions are twice as high as emissions by the road traffic sector (cf. Figure 50).

80 Job et al. (2009).

81 Hoffmann, Gruehn (2010).

Figure 50: Emissions from former peatlands used as farmland compared with other relevant sources in Mecklenburg-Western Pomerania

Source: Ministry of Agriculture, Environment and Consumer Protection, Mecklenburg-Western Pomerania

The peatland protection measures in Mecklenburg/Western Pomerania over the period 2000 to 2008, covering an area of 30,000 hectares, resulted in a macroeconomic benefit worth nearly 30 million EUR in the form of avoided greenhouse gas emission damage.⁸² Peatland protection measures are an inexpensive variant for reducing greenhouse gas emissions. In favourable cases (development of alder swamp forests) the avoidance costs amount to only 0–2 EUR per tonne of CO₂.⁸³

Ecosystem services and biodiversity as entrepreneurial opportunities

A worldwide study headed by the economist Pavan Sukhdev (The Economics of Ecosystems and Biodiversity, TEEB) has estimated that the welfare loss due to ongoing worldwide loss of biodiversity will be 7 percent of global consumption by 2050. For the present

period this corresponds to about 50 billion EUR per year.⁸⁴ Important sectors of the economy are directly dependent on biological diversity. The worldwide market for pharmaceuticals from genetic resources had already reached a volume of 75–150 billion US dollars by 1999⁸⁵. For Germany, the market value of agricultural products dependent on pollination services is estimated at 2.5 billion EUR.⁸⁶

Companies are increasingly coming to realise that the Earth's natural resources also hold promise of business opportunities and profit prospects. Major trade companies like Migros (Switzerland), Hofer (Aldi Austria) and REWE are developing product labels for which biodiversity-oriented production is an essential criterion.

Companies will only be able to satisfy future market requirements if they integrate a sustainable biodiver-

82 Schäfer (2009).

83 Barthelmes et al (2005).

84 TEEB Interim Report (2008).

85 Jessel et al. (2009).

86 aid-Informationdienst (2011).

sity management system in their corporate strategy. To this end, TEEB suggests⁸⁷ that companies adopt concepts such as “No Net Loss”, “Ecological Neutrality” and “Net Positive Impact”. It also calls for better accounting for – positive and negative – impacts of company activities on biological diversity, to bring about changes in corporate investment decisions and business operations. With this in view, TEEB recommends that trade associations and environmental accounting experts develop new instruments such as joint standards and common indicators for business.

At international level various guides are now available for companies, containing recommendations for systematic integration of biodiversity in business decisions and including practical examples. One example for Germany is the “Handbuch Biodiversitätsmanagement” (“Biodiversity Management Handbook”) of June 2010, compiled at the request of the Federal Environment Ministry and in cooperation with the “Business and Biodiversity Initiative” of the Centre for Sustainability Management (CSM) at the Leuphana University of Lüneburg. The Federal Environment Ministry is also cooperating with companies and associations in work on indicators and further guides to biodiversity management by business.

TEEB Germany: Helping to understand ecosystem services

The TEEB study initiated by Germany during its G8 presidency in 2007 jointly with the EU Commission shows that a nature-friendly and resource-saving approach to business management makes economic sense. Investment in nature conservation and environmental protection does not compete with economic development, but actually contributes to global economic development and the fight against poverty.⁸⁸

The book “Produktivkraft Natur” (“Nature as a Production Factor”), published in 2009 and based on extensive research for the Federal Environment Ministry/Federal Agency for Nature Conservation, makes it clear why investing in the conservation of biodiversity pays off.

More information can be found on the website www.wirtschaft-und-natur.de

Investing in nature conservation and environmental protection pays off

Planting and protecting nearly 12,000 hectares of mangroves in Vietnam cost 1.1 million US dollars, but at the same time this saved 7.3 million US dollars for coastal protection measures (e.g. cost of maintaining dykes). The fact that the mangrove protection project also secured the existence of the “nursery grounds” for many fish species and hence the basis for coastal fishing is a positive side effect (in economic terms as well) which was not even included in the calculations!⁸⁹

According to TEEB estimates, placing 20 to 30 percent of the oceans under protection could create a million jobs and result in fishing yields of 70 to 80 billion US dollars per annum and ecosystem services amounting to 4.5 to 6.7 trillion US dollars. If overfishing continues, however, the collapse of the fishing industry is inevitable, giving rise to serious social problems.

At the end of 2010 the Federal Environment Ministry decided to prepare a study for Germany on the economic significance of biodiversity and ecosystems. A number of reports between 2012 and 2015 are to quantify as far as possible and illustrate the value of nature conservation measures, biodiversity and ecosystem services for climate protection, water conservation and flood control, conservation of soil fertility, recreation, health, economic development etc.

The project will also analyse approaches to integrating economic values of ecosystem services in the Environmental Economic Accounts and welfare measurements, and also in the range of environmental policy instruments (planning instruments, economic instruments etc.).

The aim is to show that, in economic terms as well, it pays to conserve nature and ecosystems. Quite apart from this, however, the moral obligation to conserve nature as an asset in its own right remains the central motive for a policy designed to conserve nature and biological diversity.

87 Bishop et al (2010).

88 The findings of the study, which was conducted with the collaboration of hundreds of experts around the world under the auspices of the United Nations Environment Programme UNEP, can be found at www.teebweb.org.

89 TEEB for Policy makers (2009)

PART II: SUSTAINABLE MANAGEMENT



1 Objectives and indicators for sustainable management

Key points at a glance

A management approach is sustainable if it meets the needs of present generations while maintaining the options available to future generations. In view of worldwide population growth and the economic growth of the emerging economies in their race to catch up, this calls for very much more efficient use of environmental resources. Mega trends such as climate change, depletion of natural resources and loss of biological diversity demonstrate the urgent need for transition to a Green Economy, in other words an economy that operates within the limits of ecological “guard rails”. The objectives laid down in the National Sustainability Strategy provide a first indication of criteria for assessing sustainability. The analysis shows that in most cases the trend is not yet sufficient to achieve the environmental objectives of the National Sustainability Strategy.

Energy and raw materials productivity are certainly moving in the right direction, but the trend is far from sufficient to achieve the targeted doubling by 2020. The measures adopted by the Federal Government for improving energy efficiency in existing buildings are important incentives for increasing efficiency. On the climate front, Germany has achieved the emission reduction envisaged in the Kyoto Protocol. Further climate protection measures are however necessary to achieve the reduction target of minus 40 percent by 2020. The key elements are: expansion of renewable energy, grid expansion, energy-saving measures, and improving energy efficiency. Land use for settlement and transport continues to increase, although the rate has slowed somewhat since 2004. Air pollution levels showed a reduction of as much as fifty percent in the first half of the 1990s. However, from 2004 to 2009 the annual reduction averaged only 1.5 percent.

1.1 Sustainable management - overview and principles

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 the following:

Definition of sustainable development

To bring together environmental protection, economic efficiency and social responsibility in a manner which ensures that decisions are viable in the long term from all three points of view. Maintaining the Earth's viability represents the absolute utmost limit; this is the framework within which the various political objectives have to be optimised.⁹⁰

In this sense, sustainable development is 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 so that they also take account of long-term impacts and shortages.

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:⁹¹

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).
- 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 reaction capacity of relevant natural processes in the environment (time rule).
- Dangers and unreasonable risks to human health due to anthropogenic influences are to be avoided.

At the level of the national economy the German government's sustainability strategy adopted in April 2002 can be taken as a yardstick. Apart from the sustainability management rules, its core elements are 21 objectives and the relevant indicators. These are intended to show whether society and the economy are developing sustainably. Since 2006 indicator reports every two years by the Federal Statistical Office have provided information on progress.

Intergenerational equity, quality of life, social cohesion and international responsibility are the four guidelines at the centre of the sustainability strategy. Clear quantitative targets and priority fields of action are to help get closer to the vision of sustainable development.

The National Sustainability Strategy is to continue evolving within the framework of a broad sustainability dialogue.⁹² One important instrument for this purpose is the progress reports on the Sustainability Strategy, which take account of statements by the public and stakeholder groups. The strategy and the subsequent reports provide an in-depth account of the guidelines, processes and a wide range of topics.

For economic players this means: "Sustainable management within the framework of a market economy simultaneously pursues economic success, social cohesion, the protection of the natural basis for life, and the exercise of international responsibility. It aims to create a viable long-term equilibrium between these goals and thereby increase the prosperity of society as a whole. Sustainable management is based on responsible use of all resources such as air, water, soil, biodiversity and ecosystems, raw materials, labour and capital." (Draft of Progress Report 2012)

90 Federal Government (Bundesregierung 2011b).

91 Deutscher Bundestag (1998).

92 Cf. www.dialog-nachhaltigkeit.de

1.2 Green Economy - the new blueprint for economic development

The term Green Economy was introduced into the environmental and economic policy debate in 1989 by David Pearce, Anil Markandya and Edward Barbier in their publication “Blueprint for a Green Economy”.⁹³ Since about 2007 there has been a political revival of this discussion, at international level as well, though with various different shades of emphasis.

Fundamental to the concept of the Green Economy is the realisation that a management approach which destroys the natural basis of the economy cannot create long-term prosperity. Mega trends such as climate change, depletion of natural resources and loss of biodiversity underline how urgent the need is for transition to an economy that operates within the limits of environmental “guard rails”. Such a transition also has economic benefits. This is because the depletion of natural capital only creates short-term gains in

prosperity – in the long term it is a threat to prosperity and the natural basis of life. Large-scale felling of forests, overfishing of the seas or over-utilisation of the atmosphere as a store for greenhouse gas emissions are all example of these connections.

Against this background, UNEP characterises a Green Economy as a “low-emission society” which uses its resources in an efficient and nature-friendly way and which keeps substance cycles closed as far as possible.

This strategic approach is characteristic of an innovation-based economy that

- continuously reduces harmful emissions and pollutant inputs into all environmental media,
- is based on closed-cycle management and reuses waste as far as possible,
- decouples economic growth and prosperity from the consumption of natural resources and the resulting environmental impacts,

The international discussion about a Green Economy

The concept of the Green Economy is playing an increasingly important role in the United Nations organisations. In particular, the United Nations Environment Programme (UNEP) introduced the concept of the Green Economy into the global political debate. Until 2010 the focus was on “green” design of economic programmes for overcoming the economic and financial crisis. UNEP called for a “global green new deal”, in the sense of a stimulation of industry and employment through state programmes promoting investment for the benefit of environmental protection.⁹⁴ This strategy was successfully implemented in a large number of countries. On this basis, UNEP started up a comprehensive Green Economy Initiative with the aim of developing, at global level, strategies for transition to a Green Economy. One central result of these analyses is the Green Economy Report published at the beginning of 2011.⁹⁵ The UN perspective is a broad one: Green Economy is placed in the context of sustainable development and poverty alleviation. The General Assembly of the United Nations has tabled Green Economy as one of the principal topics for the UN Conference on Sustainable Development in 2012. This underlines the importance of this concept today at international level.

In discussions within the OECD (Organization for Economic Cooperation and Development) the focus is on development of a Green Growth Strategy, though there are also connections with the discussion about a Green Economy. The Strategy defines specific instruments and incentives that are close to the market and makes recommendations about efficient design of the framework conditions for sustainable and environmentally sound growth. A central element here is the need to integrate environmental protection in all sectors of the economy and to take advantage of the resulting environmental protection opportunities for growth and employment.⁹⁶ The Green Growth Strategy is primarily a growth-based economic policy concept for the industrialised countries.

93 Cf. Pearce et al (1989).

94 Cf. UNEP (2008).

95 Cf. UNEP (2011a).

96 Cf. OECD (2011a).

- reduces resource consumption in absolute terms, especially by making more efficient use of energy, raw materials and other natural resources and by substituting renewable for non-renewable sources,
- protects the climate and strives for a long-term energy supply which is based entirely on renewable energy sources,
- generally seeks to act in harmony with nature and the environment, preserves biodiversity and restores natural habitats.

The transition to a Green Economy makes it necessary to establish and strengthen green markets of the future (cf. Part III) and provide systematic assistance for environmental innovations. Such assistance is necessary at all levels of the innovation process – from research and development to market diffusion in Germany and technology transfer to other countries.

However, the concept of the Green Economy goes far beyond promoting individual environmental technologies and markets. Ultimately it requires a comprehensive ecological modernisation of the entire economy, because central requirements for a Green Economy such as improvements in resource efficiency

can only be implemented successfully if all industries make their contribution. This also includes designing new business models and continuously improving employee qualifications so that their abilities can be tailored to the needs of the Green Economy. There is also a need for new financing instruments, to ensure a faster and easier flow of capital into environmentally sound applications.

Environmental policy plays a key role on the transformation path to a Green Economy. An environmental policy with ambitious targets that sets out a clear framework for action and thereby provides orientation is essential for speeding up advances in environmental technology and investing in new, environmentally sound products and production methods.

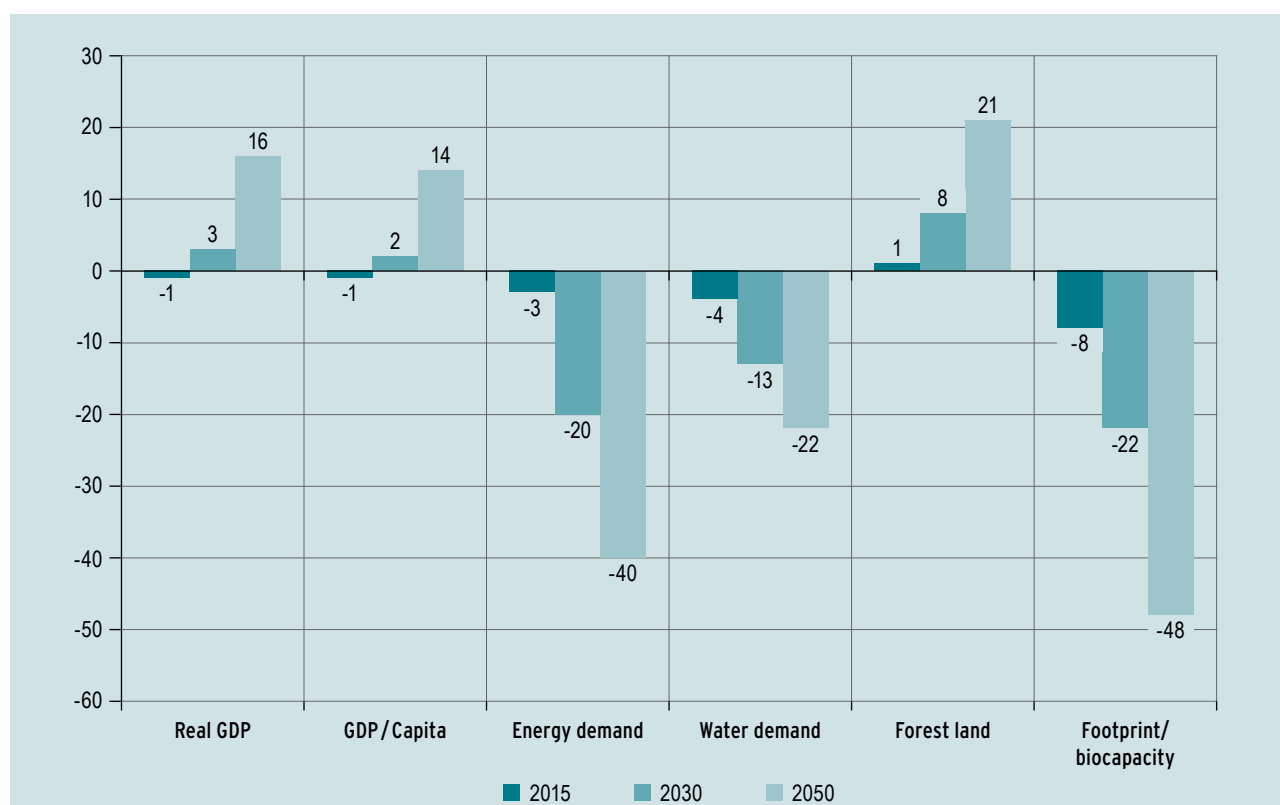
For Germany, the transition to a Green Economy requires environmentally oriented further development of the social market economy, to make it possible to anticipate the mega trends of the future and the resulting economic opportunities for environmentally sound and resource-efficient management approaches. It promises long-term economic success, safeguards the natural basis of life, and at the same time lives up to Germany's international responsibility for sustainable economic development.

Benefits of green transformation of the economy

UNEP takes the view that at least 2 percent of the worldwide gross domestic product should be channelled into green investments, in order to ensure the transition to a Green Economy in the long term. The economic and ecological impacts that such a strategy could have by 2050 have been estimated by UNEP on the basis of scenario analyses. The assumptions of the Green Investment scenario include greater investment in improving energy efficiency in buildings, industry and the transport sector, and greater investment in the use of renewable energy, waste prevention, afforestation and improvements in water supply.

The result: Compared with the business-as-usual scenario, global growth would be increased by an additional 16 percent by 2050 (see Figure 51). In 2050 the demand for energy would be 40 percent less and the demand for water 22 percent less than in the business-as-usual scenario. Moreover, global warming due to climate change could be limited to 2 degrees Celsius. In the business-as-usual scenario, by contrast, energy-related CO₂ emissions would increase from the present 30 to around 50 gigatonnes in 2050.

The economic growth modelling in the business-as-usual scenario did not include the economic risks and damage due to increased climate change, water shortage and the loss of ecosystem services. This means the economic benefits of the Green Investment scenario would be considerably greater than indicated by the UNEP estimates.

Figure 51: Impacts of the Green Investment scenario compared with the Business-as-usual scenario (in percent)

Source: UNEP (2011b), p. 25

1.3 Objectives and indicators for sustainable management

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 the Report on the Environmental Economy. The following remarks therefore concentrate on the economic and environmental dimension of sustainability in the sense of a “Green Economy”, focusing on trends in the use of the environment and efficiency in the production of goods and services. The objectives laid down in the National Sustainability Strategy provide a first indication of criteria for assessing progress. For this reason the following section first provides an overview of the objectives and indicators of the National Sustainability Strategy and on progress towards achieving the objectives. Since the strategy only contains objectives up to the year 2020, this is followed by information about longer-term objectives and the need for further development of the sustainability indicators.

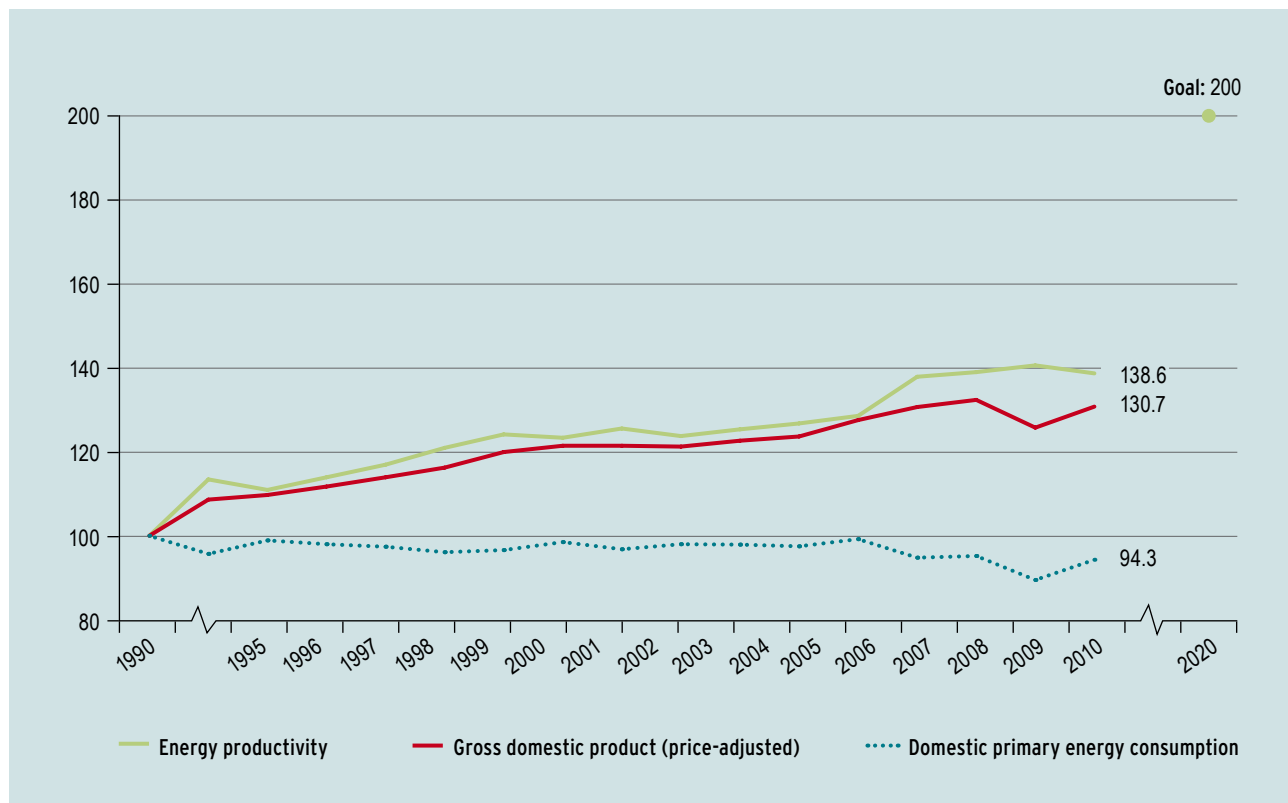
Energy productivity

Indicator

Nearly every 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. Energy productivity is calculated from the ratio of gross domestic product to primary energy consumption. It increases if the same added value (measured as gross domestic product) can be produced with less primary energy input.

Goal

The National Sustainability Strategy seeks to double energy productivity by 2020 compared with 1990.

Figure 52: Energy productivity and economic growth (Index 1990=100)

Source: Federal Statistical Office (2011a)

Progress

Between 1990 and 2010, energy productivity in Germany increased by nearly 38.6 percent (cf. Figure 52). The average increase between 2000 and 2010 was only 1.1 percent per year. To achieve the goal of doubling energy productivity by 2020, energy productivity will have to increase by an average of 3.7 percent per annum in future, in other words three times as fast as the present trend. Germany can only achieve this energy productivity objective if further measures are taken.

The decision to transform the energy system taken in the wake of the Fukushima reactor disaster envisages that Germany should become one of the world's most energy-efficient economies.⁹⁷ At the same time, primary energy demand is to fall in absolute terms, with a drop of 50 percent by 2050. Since 40 percent of energy is currently used for homes, there are specific targets for this sector in view of its outstanding importance. The heat requirements of existing buildings are to be reduced by 20 percent by the year 2020. Buildings in Germany are to be almost climate neutral by 2050, in other words the energy required is to come solely from renewable energy sources.

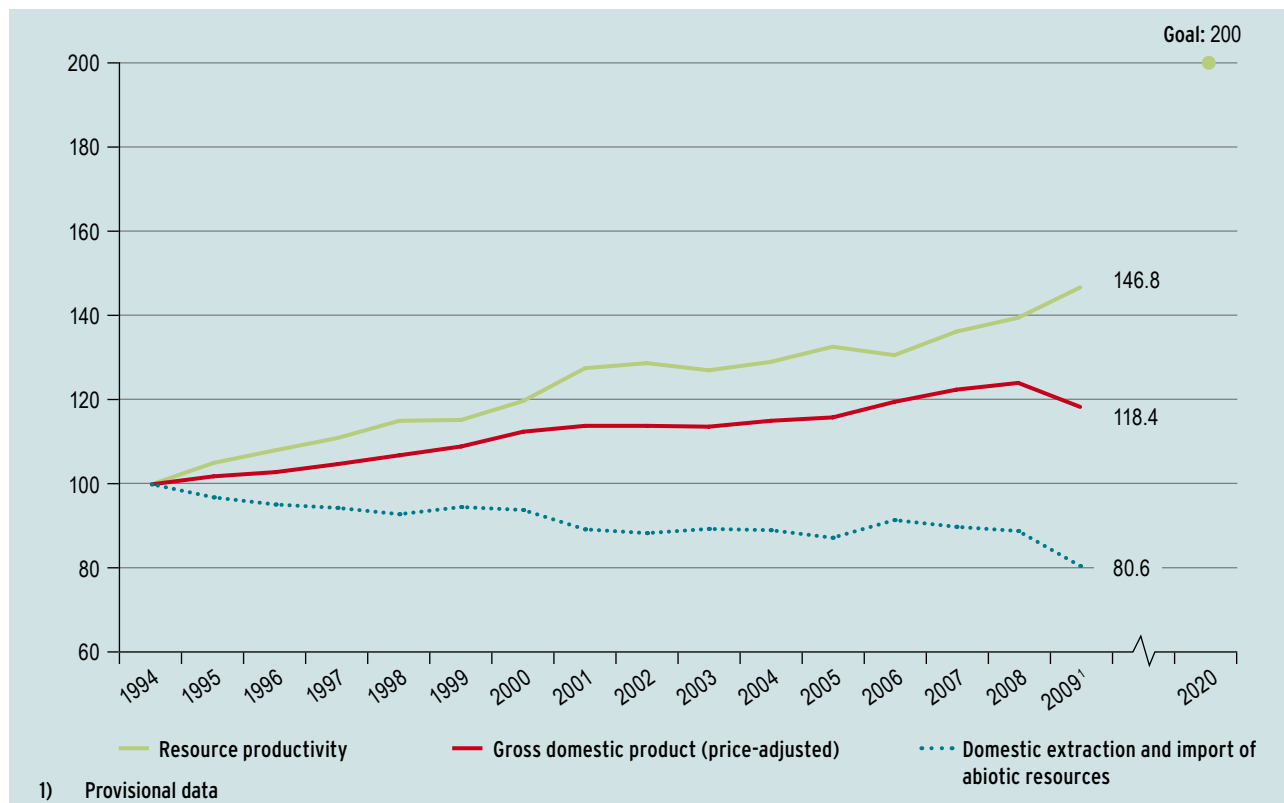
The incentives adopted by the German government with the aim of increasing energy-saving refurbishment of residential buildings and stepping up energy-efficiency standards in buildings are important steps on the way to achieving the long-term savings objectives in the buildings sector.

Raw material productivity

Indicator

The extraction and use of resources always involves consumption of land, material and energy, migration of substances and emission of pollutants. The major flows of substance quantities that are found, for example, in the construction sector (construction of roads, industrial, commercial and residential buildings) and energy generation (coal and lignite production), therefore create a substantial burden on the environment. Furthermore, non-renewable natural resources that are consumed today are no longer available to future generations. For these reasons we must make more sparing and more efficient use of raw materials.

97 With regard to the following cf. Federal Government (Bundesregierung 2011a).

Figure 53: Resource productivity and economic growth (Index 1990=100)

Source: Federal Statistical Office (2011a)

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 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”. Resource productivity is defined as the ratio of gross domestic product (in EUR, 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. It increases if the same added value (measured as gross domestic product) can be produced with less input of materials.

Goal

The National Sustainability Strategy pursues the aim of doubling resource productivity by 2020 compared with the base year 1994.

Progress

Between 1994 and 2009 resource productivity increased by 46.8 percent: with input of materials

falling (minus 19.4 percent), gross domestic product rose by 18.4 percent (cf. Figure 53). After a slight fall in productivity from 2005 to 2006, a marked upward trend has been observed again since 2007. On the whole, the indicator is moving in the right direction. However, the trend of the last five years is not sufficient to achieve the target, which means that additional measures are necessary to increase resource productivity.

Various strategies can be used to achieve further increases in resource productivity. For example, one important goal is to increase the useful life of products and design them so that the material can be reused.

A contribution to increasing resource productivity is also made by closed-cycle management, in that every reuse or supplementary use of products and materials reduces the consumption of primary raw materials. This is a source of considerable further potential for saving resources, for example in the construction sector by stepping up the use of recycled concrete material as a substitute for primary mineral resources. Numerous examples exist in many other branches of industry (cf. Part IV for details).⁹⁸

98 Cf. Federal Environment Agency (UBA 2010a).

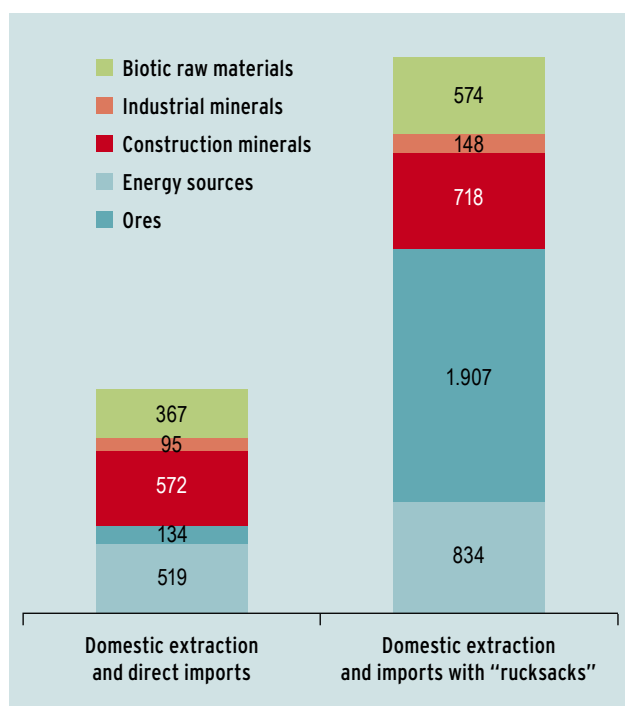
Further development of the resource productivity indicator

The resource productivity indicator used in the National Sustainability Strategy does not take account of the raw materials needed to produce imported products. Its information value is therefore limited. For example, if resource-intensive production stages are shifted abroad, the indicator rises although there is no improvement in resource productivity.

Taking account of intermediate products produced abroad, the picture for German resource inputs is as follows.

The left side of the diagram shows domestic extraction and imports of raw materials (DMI⁹⁹). The right side shows the direct material input (DMI) with raw material equivalents for imported goods. This includes all indirect material inputs arising outside Germany from the production of the goods. The findings of the Federal Statistical Office indicate that the weight of imports increases by a factor of five if one includes foreign resource inputs. In some production sectors the significance of the ecological rucksacks is actually considerably higher than that.

Figure 54: Raw materials input by resource groups 2008
(in million tonnes)



Source: Federal Statistical Office (2010) – press conference on the Environmental Economic Accounts

For example, Germany imports about 8 million tonnes of motor vehicles and relevant components. Their production requires nine times as much input of raw materials. Two million tonnes of imported textiles cause resource inputs totalling as much as 69 million tonnes.¹⁰⁰

If one takes account of the ecological rucksacks borne by imported goods when calculating resource productivity, it emerges that progress on productivity between 2000 and 2008 was only around 6.9 percent. It thus works out considerably lower than the present indicator for the Sustainability Strategy with a plus of 17.1 for the same period.

Resource productivity has improved in recent years, but not nearly enough. Even the doubling of resource productivity targeted for 2020 can only be an interim step.

As with energy consumption, long-term reduction targets are necessary to provide a guide for industry. They should take account of ecological rucksacks and be geared to absolute minimisation of resource consumption. In the long term, by 2050, efforts should be made to cut resource consumption by a factor of ten.¹⁰¹

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. Non-energy production processes and consumer behaviour also play a role here. The principal greenhouse gases caused by man are carbon dioxide (CO₂), methane (CH₄), nitrous oxide/laughing gas (N₂O), 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.

99 DMI (Direct Material Input) comprises direct inputs of raw materials for the German economy. It is the base quantity for the German sustainability indicator.

100 Federal Environment Agency (UBA), Federal Statistical Office (Statistisches Bundesamt 2009).

101 This demand is also found in EPA network (2006).

Goal

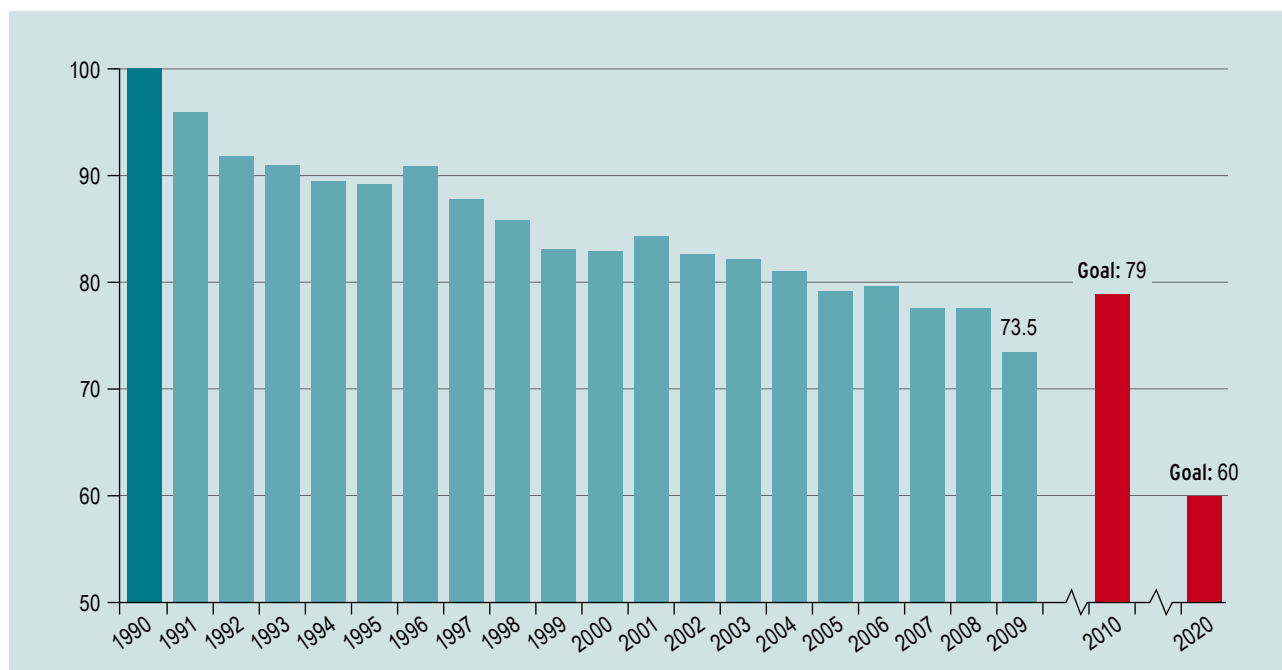
In ratifying the Kyoto Protocol, Germany undertook to reduce its emissions of greenhouse gases by 21 per cent compared with 1990 between 2008 and 2012. Worldwide greenhouse gas emissions are still growing. In the long term, by 2050, they need to be cut drastically and at least halved by the year 2050 compared with 2000, in order to limit mean global warming to 2 degrees Celsius compared with pre-industrial times. In view of their special historical responsibility and their economic capacity, the industrialised countries should reduce their greenhouse gas emissions by 80–95 percent compared with 1990. But the emerging and developing economies are also called upon to reduce their greenhouse gas emissions below the reference figure. This is the only way to ensure a reasonable probability of achieving the 2-degree target.¹⁰²

In view of this, the German government has set itself ambitious climate protection targets. According to the principles paper on energy adopted in June 2011, there is to be a 40-percent cut in greenhouse gas emissions by 2020, a 55-percent cut by 2030, a 70-percent cut by 2040 and a cut of 80 to 95 percent by 2050, in each case compared with 1990.¹⁰³

Progress

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 85.7 percent. Compared with 1990, greenhouse gas emissions recalculated as CO₂ equivalent fell 26.5 percent by 2009 (cf. Figure 55). On this basis Germany has already achieved the reduction laid down in the Kyoto Protocol. According to an estimate by the Federal Environment Agency, the economic recovery resulted in emissions rising in 2010 by 4.3 percent compared with 2009¹⁰⁴, though at 960 million tonnes this is still well below the figure for 2008. Figure 56 shows that in the case of the trend simply continuing the long-term target of a reduction in greenhouse gas emissions in Germany by 80 to 95 percent by 2050 (compared with the base year 1990) will not be reached. Additionally, further efforts are needed to achieve the targeted 40-percent reduction by 2020. Estimates indicate that the Integrated Energy and Climate Programme adopted by the German government would lead to a 30 to 33-percent reduction in greenhouse gas emissions by 2020.¹⁰⁵

Figure 55: Greenhouse gas emissions in Germany (emissions of six Kyoto gases as CO₂ equivalent, 1990 = 100)



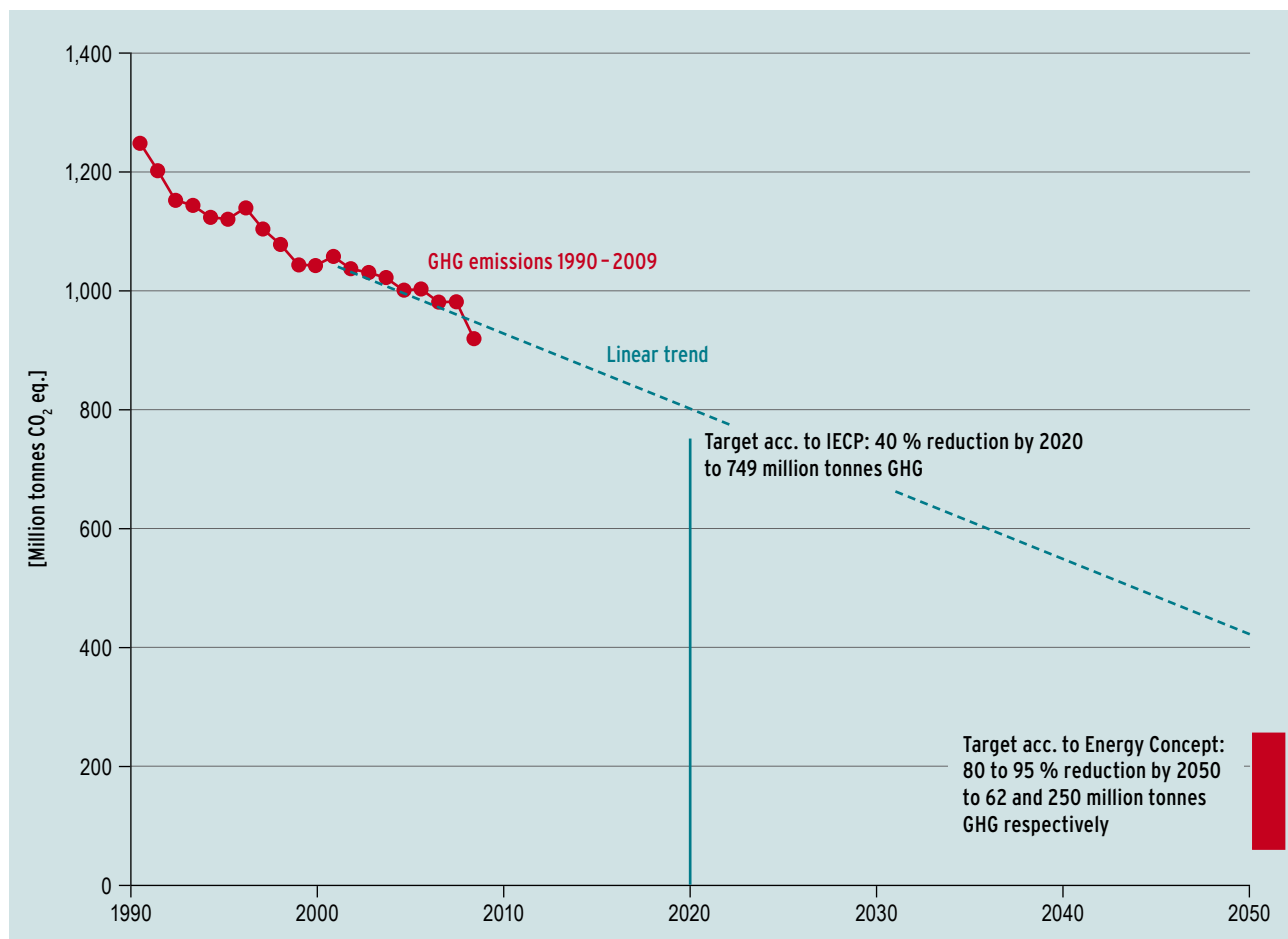
Source: Federal Statistical Office (2011a) and Federal Environment Agency (2011b)

102 The reductions necessary for the 2-degree target can be deduced from the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, cf. IPCC (2007a), p. 15 and p. 776.

103 Federal Government (Bundesregierung 2011a).

104 Federal Environment Agency (UBA 2011b).

105 Federal Environment Agency (UBA 2011c).

Figure 56: Greenhouse gas reduction targets according to IECP and Energy Concept

Source: UBA (2011c), p. 16

In its Energy Concept approved in June 2011, the German government laid down important key elements for achieving the climate protection objectives and the transformation of the energy system. Central elements here are the further expansion of renewable energy and grid expansion, the provision of better assistance for co-generation of heat and power, increased assistance for energy-saving building refurbishment, and further measures to improve energy efficiency.

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.

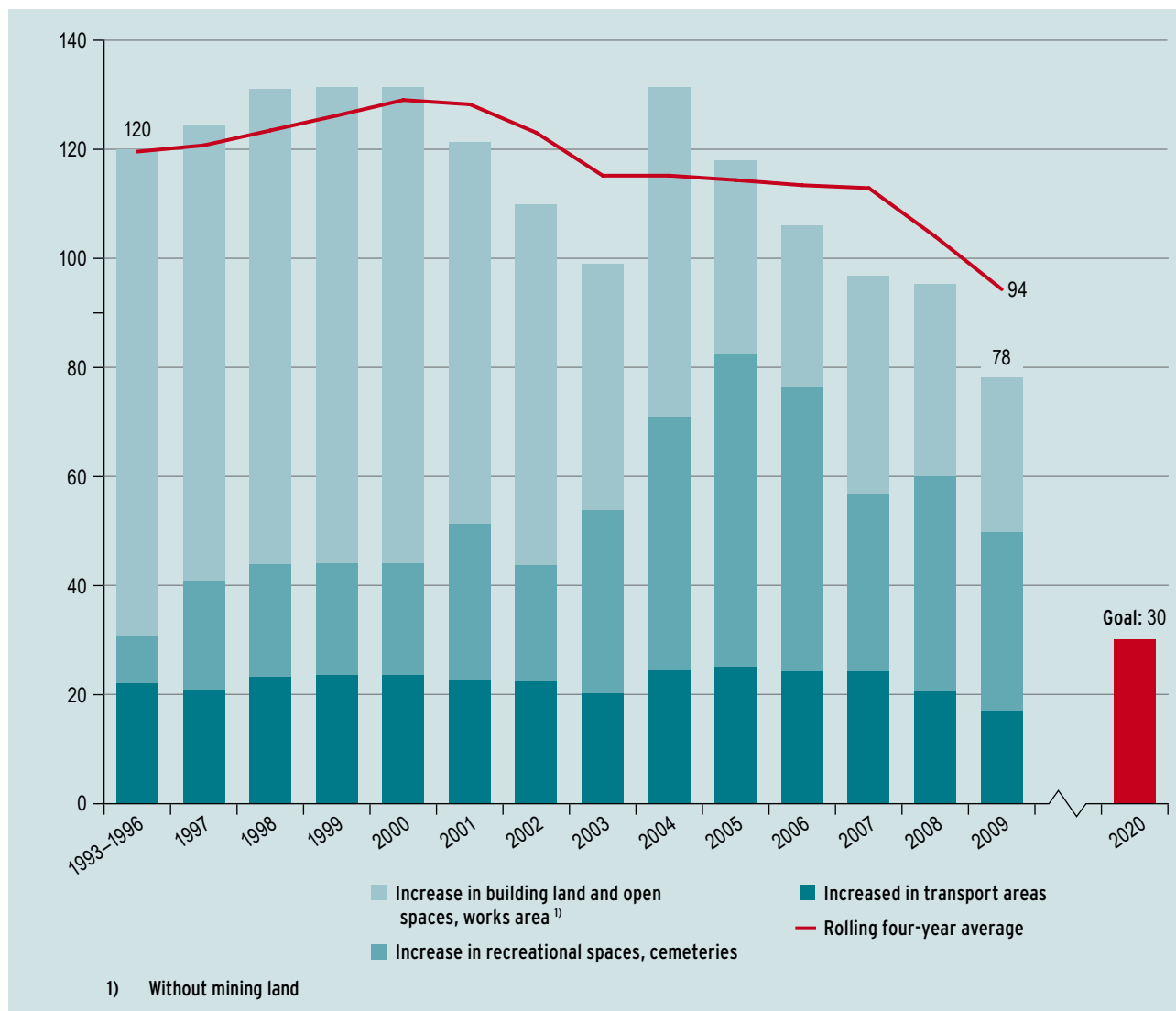
The German government has therefore included in the Sustainability Strategy an indicator of land use for housing and transport purposes. It shows how many additional hectares of land per day are used for settlement and transport (cf. Figure 57).

Goal

The target of the National Sustainability Strategy is that by 2020 not more than 30 hectares of new land per day are to be taken for housing and transport purposes.

Progress

The total area used for housing and transport purposes is continuing to increase rapidly. In recent years the amount of new land taken for housing and transport purposes has averaged 94 hectares per day.

Figure 57: Land take in Germany (increase in land used for housing and transport purposes in hectares per day)

Source: Federal Statistical Office (2011a)

Estimates indicate that about 43 to 50 percent of this land surface is sealed. Although the rate of growth of land used for housing and transport has slackened in recent years, the speed of this decline is not sufficient to meet the specified target.

Air pollution

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 sys-

tems in power plants. Further efforts are nevertheless required. The indicator "Air Pollution" groups four major pollutants: sulphur dioxide (SO₂), oxides of nitrogen (NO_x), ammonia (NH₃), and volatile organic compounds (NMVOC).

Goal

The aim of the National Sustainability Strategy is 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 set a new target.

Progress

In 2009 emissions of air pollutants were 56.4 percent down on 1990 – a welcome development. However, most of the sharp drop took place in the first half of the 1990s: by then the emissions of air pollutants had been almost halved. In the last five years up to 2009,

the annual reduction in these emissions has only averaged 1.5 percent (cf. Figure 58). The trend is not sufficient to reach the target.

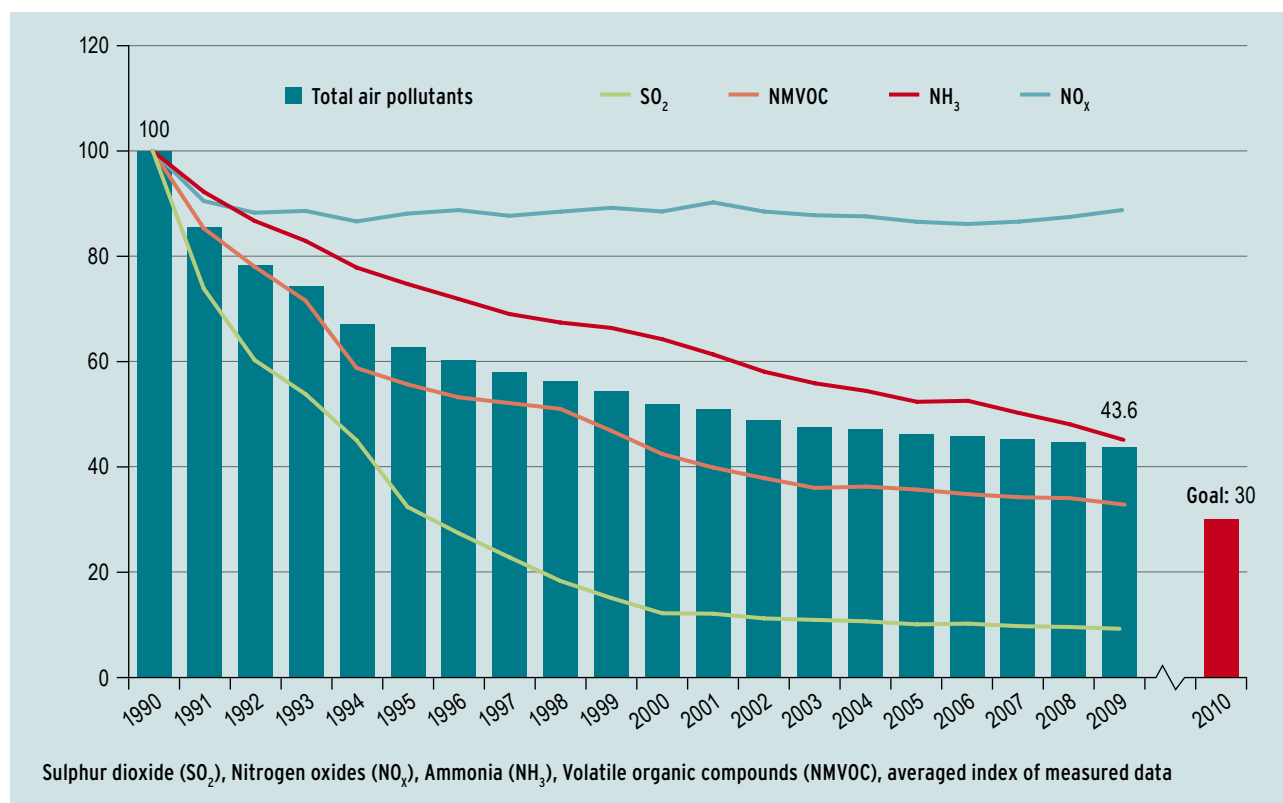
The individual emission types make different contributions to the trend. The biggest drop was in sulphur dioxide emissions, with a decrease of 90.6 percent. Factors contributing to this development were the desulphurisation of power plant flue gases, the partial replacement of high-sulphur German lignite 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 66.1 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 12.6 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.

Conclusions

Use of natural resources is an indispensable element of economic activity. This chapter shows that use of the environment has displayed a tendency to decline, and 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 environmental 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, for example 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) and makes an in-depth analysis at the production level.

Figure 58: Air pollution (Index 1990=100)



Source: Federal Statistical Office



2 Development of environmental depletion by industry

Key points at a glance

The productivity of environmental consumption has improved steadily in recent years. Today the amounts of raw materials, land and energy consumed and pollutants emitted to generate the same earnings are considerably lower than ten years ago. However, labour productivity has increased considerably faster than material and energy productivity. In other words, the long-term trend is characterised by falling labour input combined with growing national product. In the manufacturing sector today, material and resource costs as a share of gross production value are around 47 percent. The figure for personnel costs is only 18 percent.

The energy intensity of production fell by 8.9 percent between 2000 and 2008. This was due in particular to the energy-intensive production sectors "Chemicals" and "Metal production". There has been no sign of a structural change - i.e. a reduction in the share due to energy-intensive production - in recent years.

The fall in CO₂ emissions in the years 2000 to 2008 is due above all to private households. The CO₂ intensity of production decreased, primarily due to the expansion of renewable energy sources.

Studies show that fears that climate-relevant emissions would be shifted abroad are unfounded. Model-based analyses for the countries with reduction commitments under the Kyoto Protocol come to the conclusion that the carbon leakage effects are relatively small: only 5 to 20 percent of the greenhouse gas reductions by the Annex I countries is cancelled out by additional emissions in states without reduction commitments.

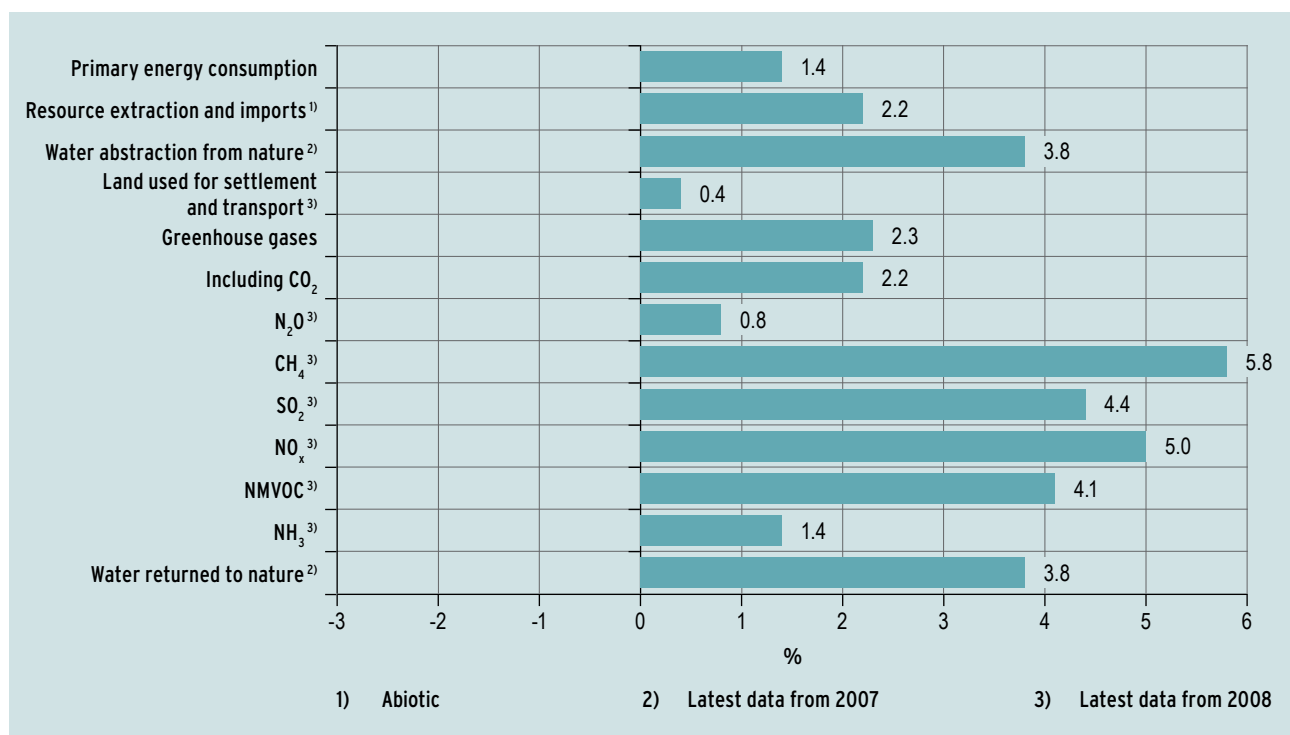
In particular, the material-intensive sectors "Construction" and "Glass, ceramics, non-metallic minerals" have made savings in resource consumption. In the other production sectors there was little change.

2.1 Efficient use of the environment - taking stock

The productivity of environmental consumption in the national economy has, without exception, improved in recent years (cf. Figure 59). Today the amounts of raw materials, land and energy 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 improvements in the efficiency of environmental consumption are frequently associated with an improvement in economic performance.¹⁰⁶ Companies that produce more efficiently than their competitors have a competitive lead – especially at times of rising energy and raw materials prices.

Figure 59: Trends in productivity of environmental resource utilisation
(average annual change 2000–2009 in percent)



Source: Federal Statistical Office (2010b)

Productivity and intensity - indicators of efficiency

The productivity of an input factor such as energy, land or CO₂ 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 thus 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.

¹⁰⁶ 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.

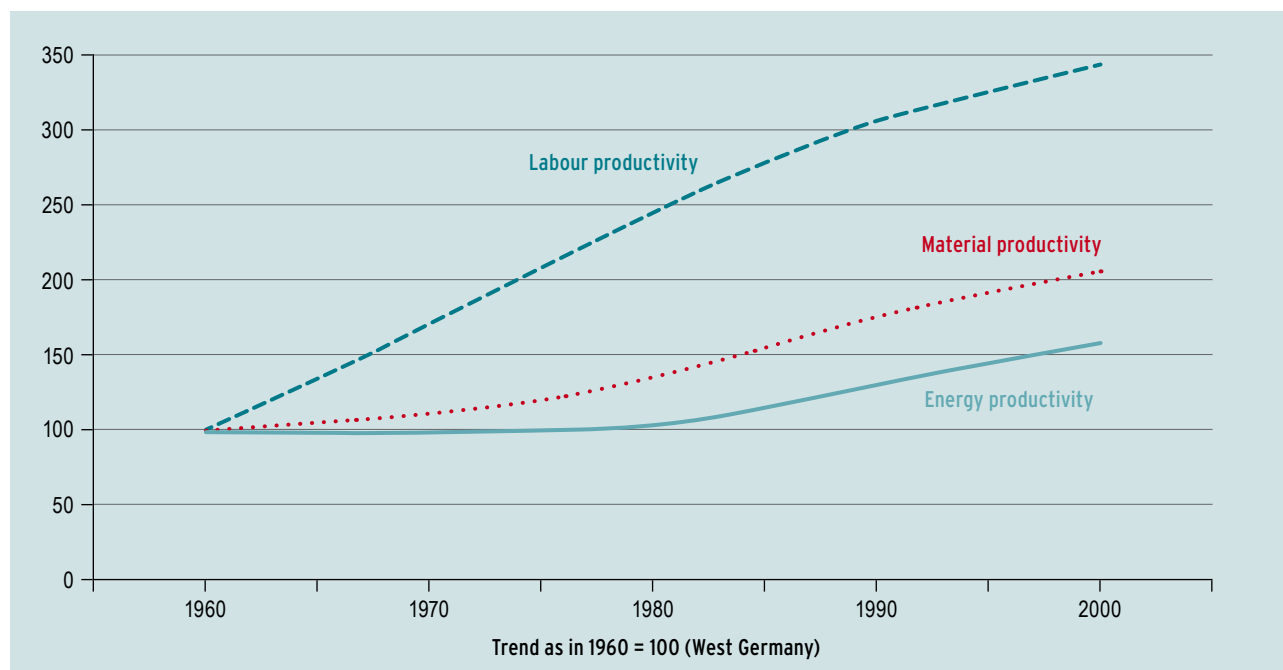
On a long-term view, the factor with which companies have achieved most of their productivity increases has been labour. From 1960 to 2000 labour productivity increased by three and a half times, whereas materials productivity only doubled in the same period and energy productivity actually rose by only about fifty percent (cf. Figure 60). Despite the considerable relevance of material costs for businesses, resource productivity has hardly increased in relation to labour productivity, even in recent years (cf. details in Part IV). 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.¹⁰⁷

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 productiv-

ity 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 the environment.

Simply for economic reasons, it pays companies to devote greater attention to material and energy costs: in the manufacturing industry, average material and resource consumption costs are as high as 47 percent of gross production value, whereas wage costs only account for around 18 percent (cf. Figure 61). In a number of industrial core areas the cost of material accounts for more than half of the gross production value.¹⁰⁸ For example, the metal industry, the food industry and mechanical engineering are particularly dependent on raw material prices. In 2008 material costs in these industries accounted for 61 percent, 59 percent and 44 percent respectively.¹⁰⁹ The trend of rising energy and resource prices means that in all probability this dominance will continue to increase.

Figure 60: Labour, material and energy productivity



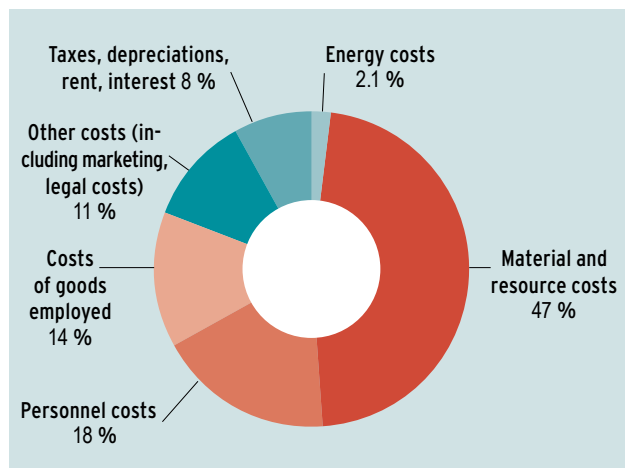
Source: BMU et al (2006)

107 Cf. McKinsey (2007a), p. 6.

108 It should however be noted that the material costs themselves include labour costs in cases where the material takes the form of semi-finished and finished products used for production.

109 Cf. Federal Statistical Office (Statistisches Bundesamt 2010d), p. 377.

Figure 61: Cost shares of gross production value in the manufacturing sector 2008



Source: Federal Statistical Office (2010d)

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. 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 on the rapidly expanding green growth markets.

2.2 Energy consumption and energy intensity of production¹¹⁰

Energy consumption broken down by economic activities

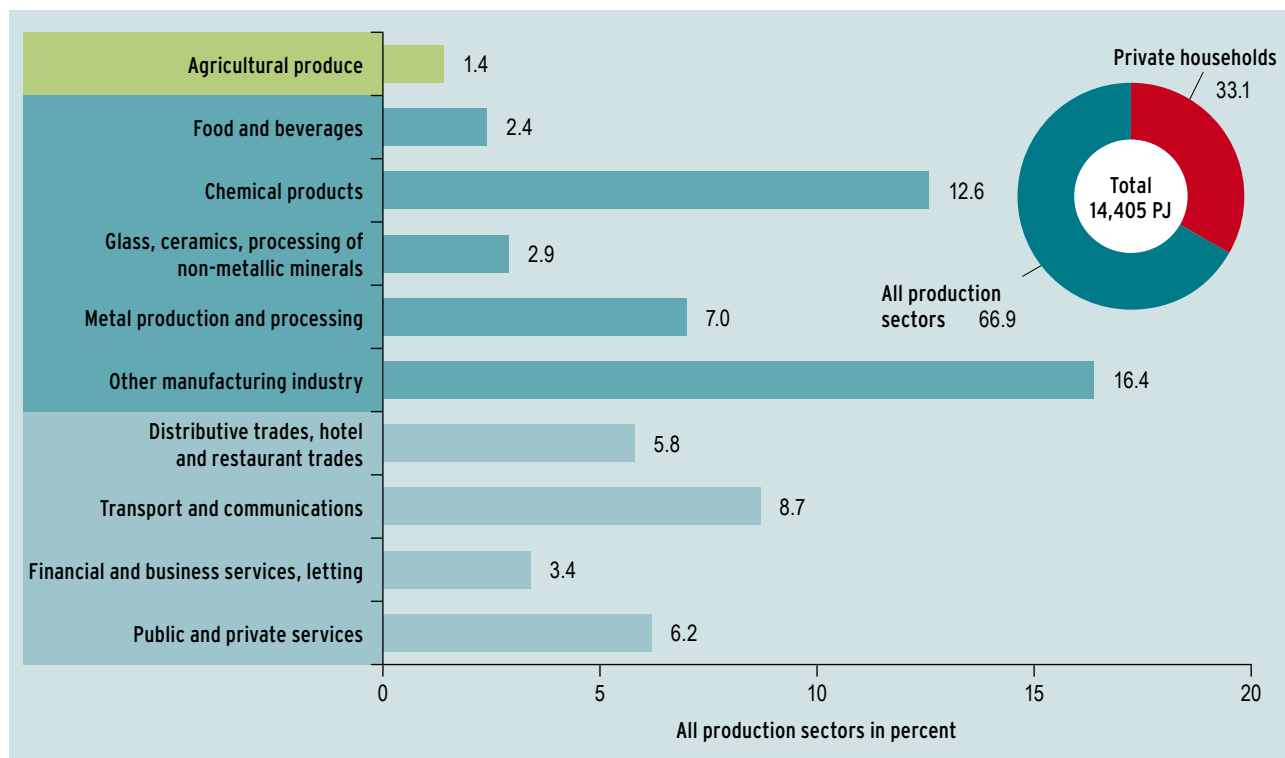
Primary energy consumption in Germany has been decreasing slightly since the early 1990s. The main driving forces here are renewable energy and the efficiency improvements in fossil power plants.¹¹¹ In 2010 it was 14,057 petajoules (PJ), which was thus 4.7 percent higher than the year before. In 2009, the primary energy consumption of 13,428 PJ reached the lowest level in Germany since the early 1970s. A decisive factor here was the major economic slump and the resulting drop in economic output. Production decreased in the energy-intensive branches of industry in particular, with the result that energy consumption showed a sharper drop than economic output.

The breakdown of energy consumption among branches of industry in Figure 62 is based on special analyses of the Environmental Economic Accounts. Since these are only available for the period 2000 – 2008, they do not show the most recent trends.

In 2008 two thirds of the energy used was accounted for by production, and one third by private households. The most energy was used by the chemicals sector (over 12 percent), the steel industry (7 percent) and the service sector “Transport and communication” (8.7 percent). The total share of energy consumption of the service sectors came to around 24 percent.

¹¹⁰ The analyses of the Environmental Economic Accounts by the Federal Statistical Office show the breakdown of energy and resource consumption by the economic sectors responsible. The latest figures available here are for 2008.

¹¹¹ Cf. Federal Environment Agency (UBA 2011d).

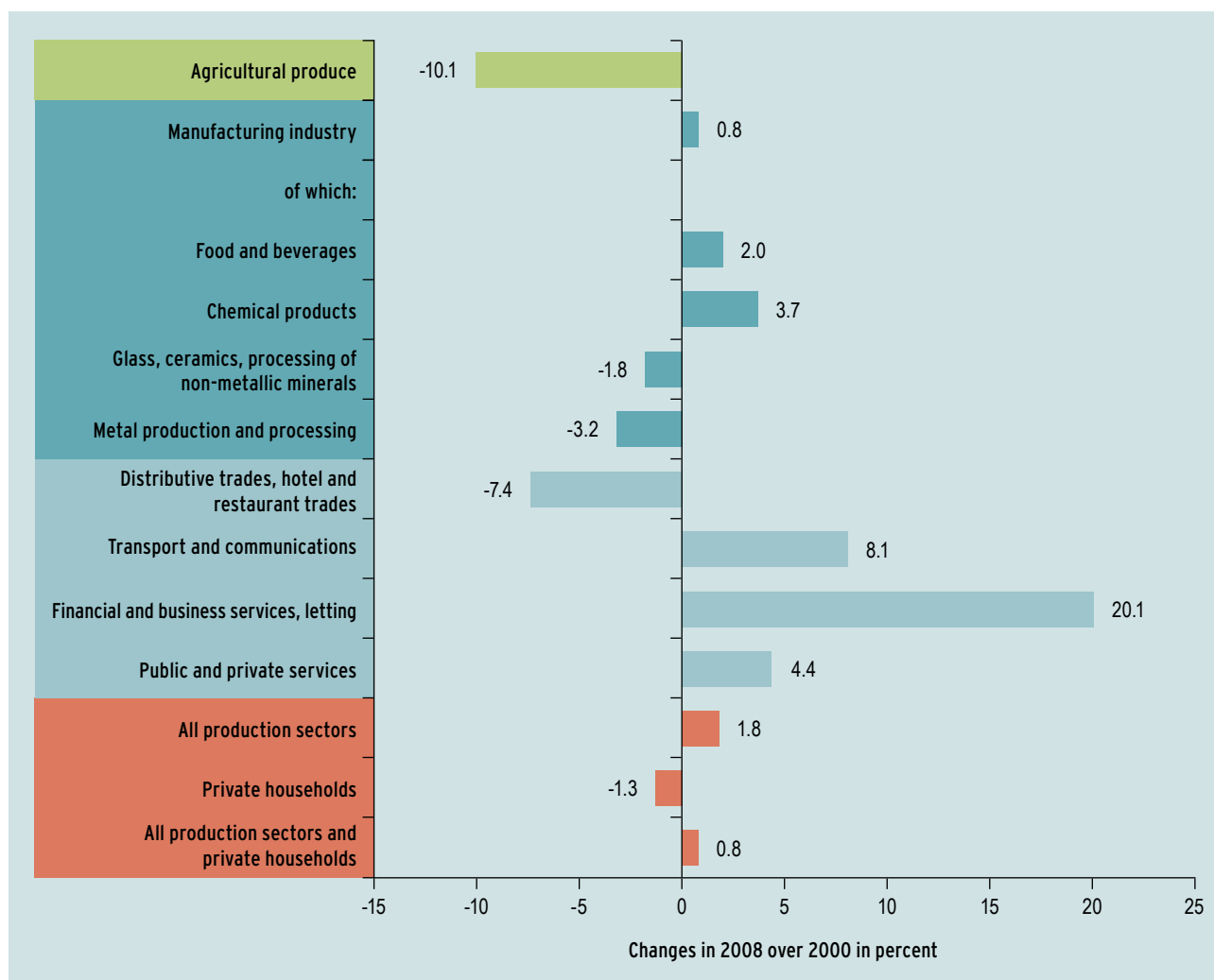
Figure 62: Primary energy consumption by economic activities 2008

Source: Federal Statistical Office: Environmental Economic Accounts (2011)

Trend in energy consumption

From 2000 to 2008, primary energy consumption in Germany increased by 0.8 percent. The trend was affected by fluctuations, however, for example as a result of energy price developments and annual temperature fluctuations. The energy-intensive sectors “Metal production and processing”, and “Glass, ceramics, processing of non-metallic minerals” succeeded in reducing their energy consumption slightly (cf. Figure 63). In the “Distributive trades and hotel and restaurant trades” there was actually a marked drop in consumption of 7.4 percent. Increases in energy consumption can be observed in the service sectors in particular (total of +4.4 percent). More energy than in 2000 was also consumed in certain areas of the manufacturing sector, e.g. “Chemical products” and “Food and beverages”.

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. Conversely, 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.

Figure 63: Trend in primary energy consumption by economic activities 2000–2008

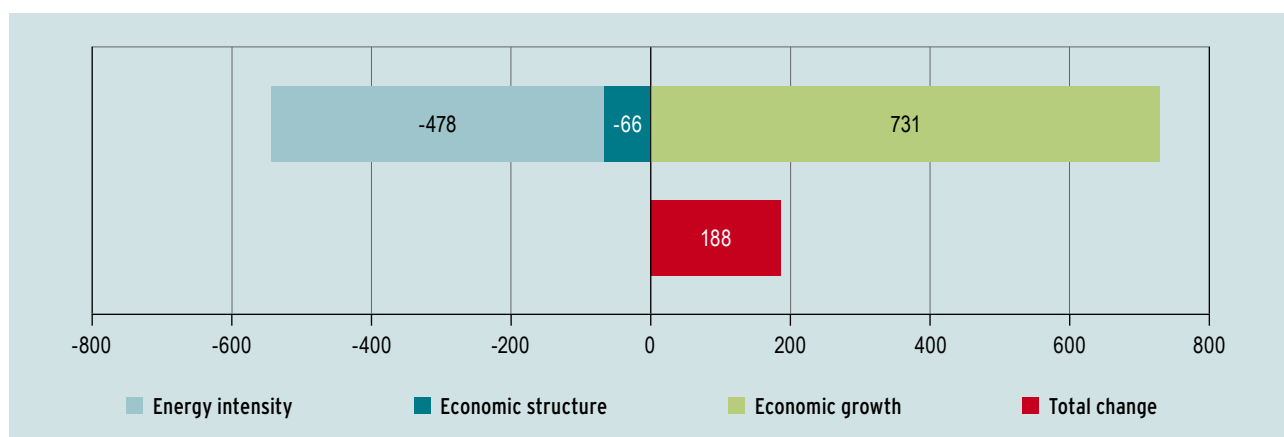
Source: Federal Statistical Office: Environmental Economic Accounts (2011)

The analysis (cf. Figure 64) shows that with conditions otherwise unchanged, economic growth in the years

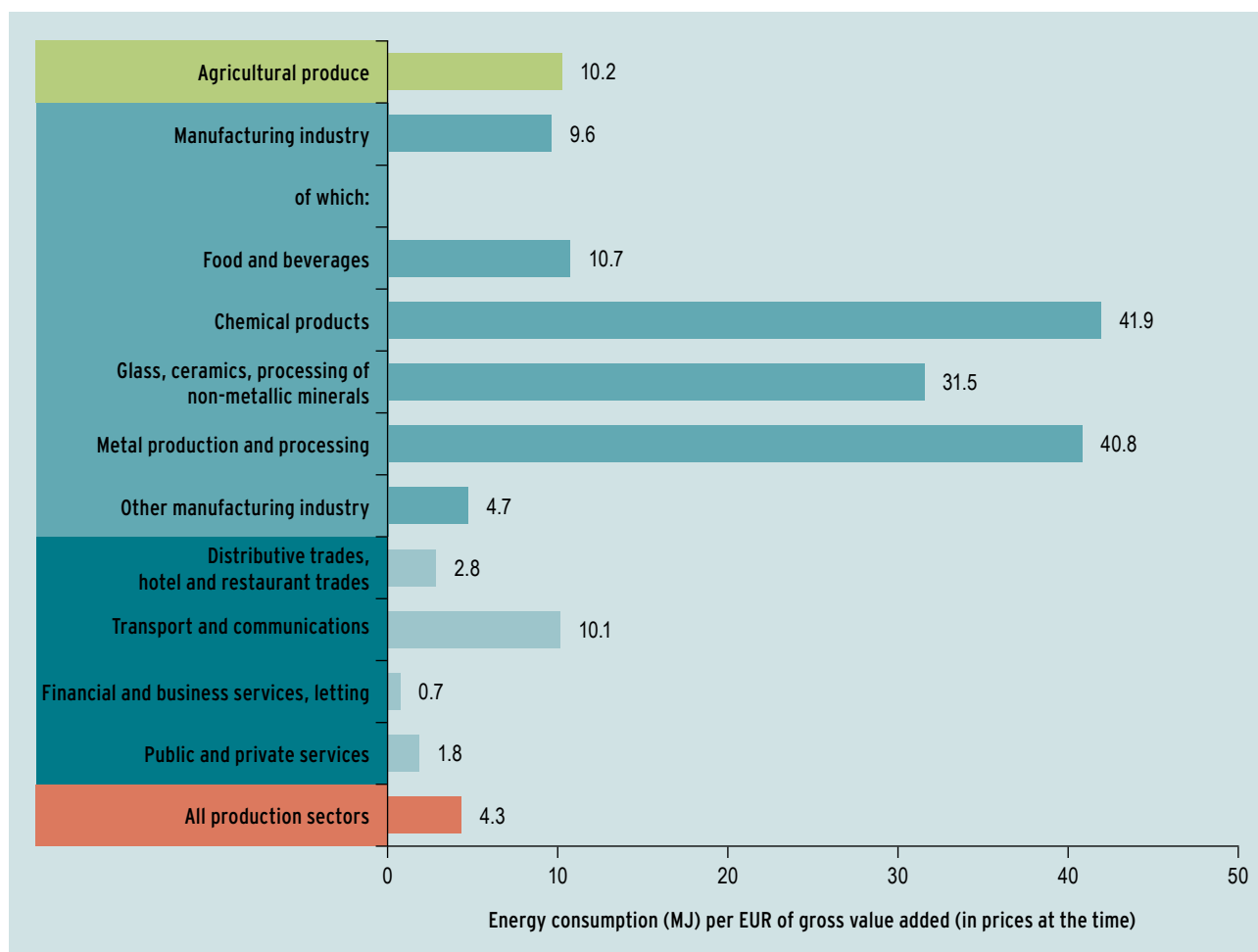
2000 to 2008 would have resulted in energy consumption increasing by 731 petajoules.

Figure 64: Factors responsible for the trend in energy consumption

(change 2000–2008 in petajoules, broken down by influencing factors)



Source: Federal Statistical Office (2011), special analyses for the Federal Environment Agency

Figure 65: Energy intensity by production sectors 2008

Source: Federal Statistical Office: Environmental Economic Accounts (2011)

Changes in economic structure produced only a slight reduction in energy consumption, namely 66 petajoules. This means that the share due to energy-intensive production sectors hardly changed during the period 2000 to 2008. Falling energy intensity had a marked reducing effect on consumption, which means production as a whole became more efficient. Taken together, these opposite trends resulted in a slight increase in energy consumption at the level of the national economy over the period 2000 to 2008.¹¹²

Energy intensity in the production sectors

Energy intensity in the various production sectors presents a very varied picture. On average, the manufacturing sector consumes nearly 10 megajoules (MJ) per euro generated. The chemicals sector with

42 MJ/euro and metal with nearly 41 MJ/euro are particularly energy-intensive. In absolute terms as well, these two sectors are among the biggest energy consumers in the manufacturing sector in Germany. Services, on the other hand, have a much lower average energy intensity (Figure 65).

Trends in energy intensity in the production sectors

The energy intensity of all production sectors fell by an average of 8.9 percent between 2000 and 2008 (Figure 66). At the same time – as explained above – energy consumption as a whole increased slightly, which means that there was a slight decoupling of economic growth and energy consumption.

¹¹² The decomposition analysis is based on a special analysis by the Federal Statistical Office which is only available for the year 2008.

Falling energy intensity and hence rising energy efficiency have been achieved in recent years by the energy-intensive chemicals and metal production sectors in particular. The situation with regard to glass, ceramics and non-metallic minerals is a special case. Here the large percentage increase in energy intensity is mainly due to a change in the method of statistical data acquisition.¹¹³ 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 ongoing 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 CO₂ intensity of production

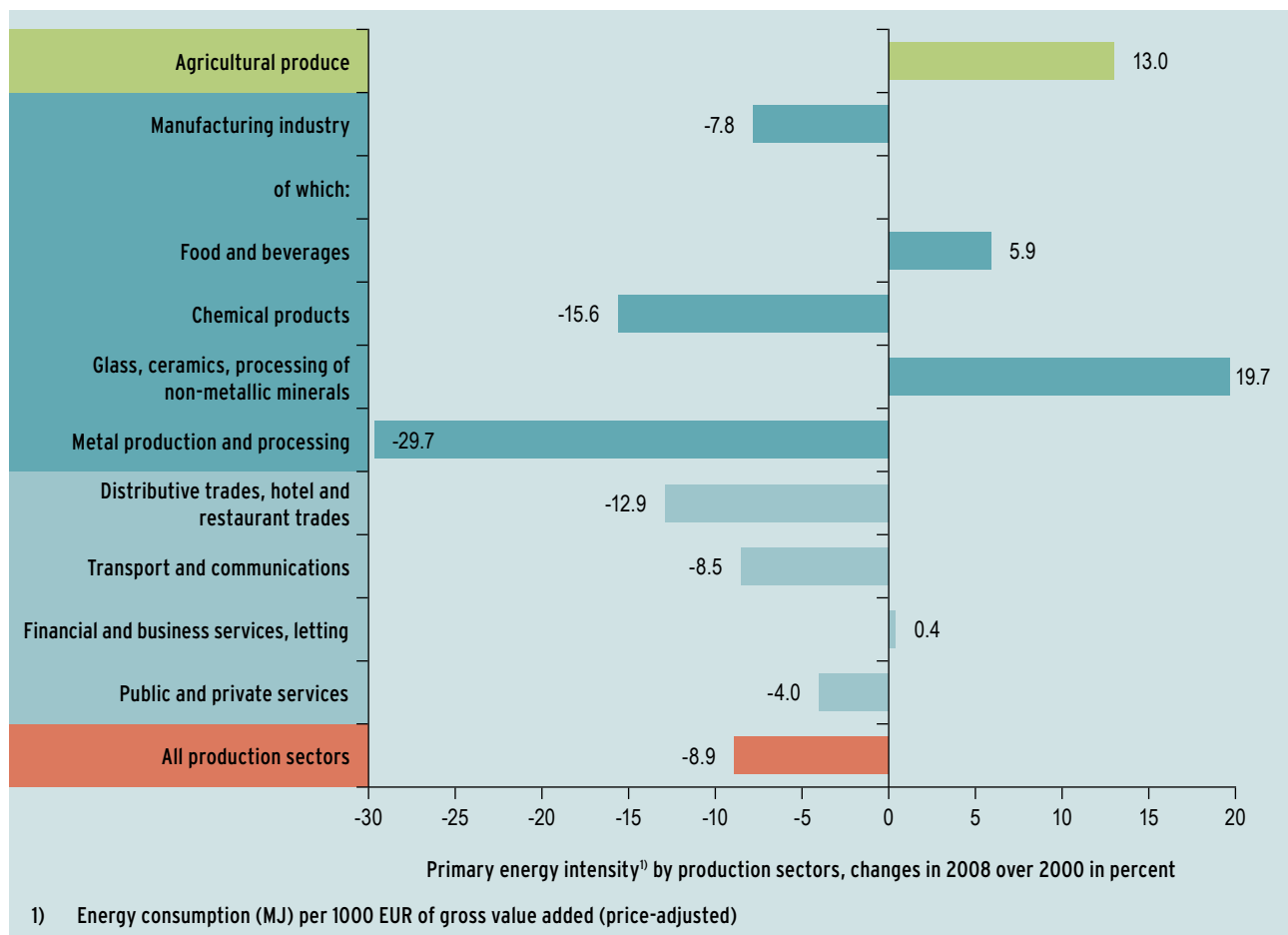
CO₂ emissions broken down by economic activities

Greenhouse gas emissions by the economy as a whole amounted to 960 million tonnes of CO₂ equivalent in 2010.¹¹⁴ Carbon dioxide emissions, at around 86 percent, accounted for by far the largest share (cf. Figure 67).

A differentiated picture of CO₂ emissions broken down by economic activities is available for the years 2000 to 2008 (cf. Figure 68).¹¹⁵

Nearly 77.2 percent of direct CO₂ emissions in 2008 were due to production, 22.8 percent to consumption

Figure 66: Trends in energy intensity 2000-2008



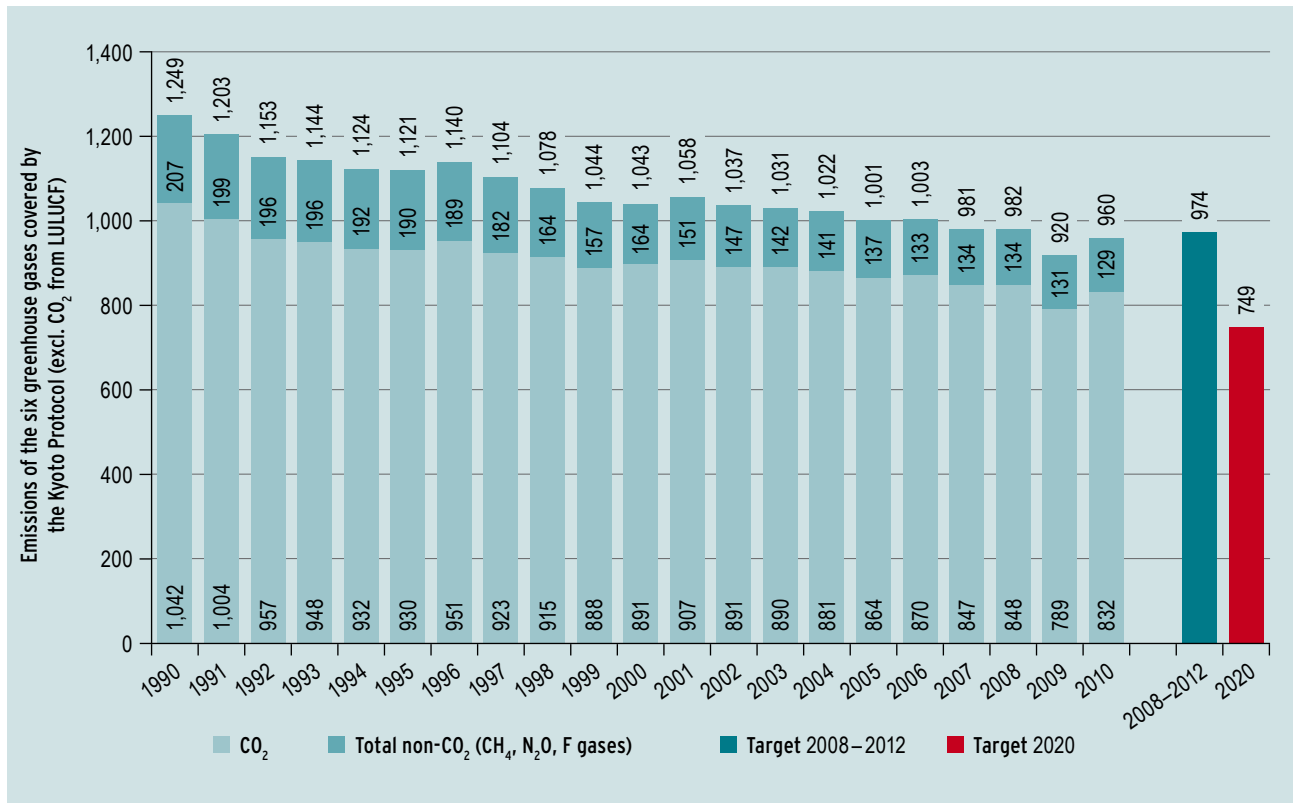
Source: Federal Statistical Office: Environmental Economic Accounts (2011)

113 Cf. Federal Statistical Office (2008a).

114 Federal Environment Agency (UBA 2011e).

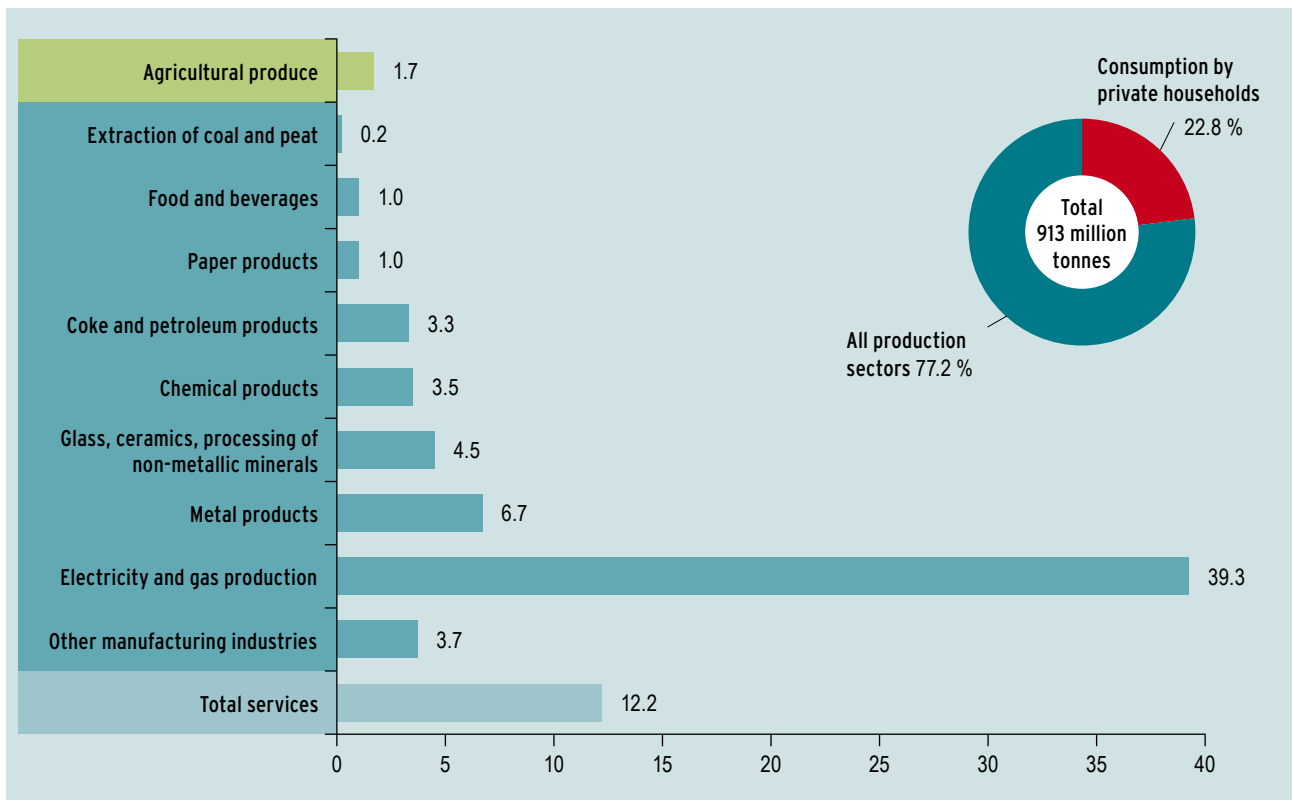
115 Cf. Federal Statistical Office (2010b).

Figure 67: Development of greenhouse gas emissions in Germany (in megatonnes CO₂ equivalent)



Source: Federal Environment Agency

Figure 68: Direct CO₂ emissions by economic activities in 2008 (in percent)



Source: Federal Statistical Office (2010b), p. 59

by private households (cf. Figure 68). The biggest polluters here, at 39.3 percent, are the electricity and gas suppliers – primarily because they supply electricity to the other production sectors and to households.¹¹⁶ Production of services was responsible for 12.2 percent of CO₂ emissions.

Development of CO₂ emissions

Germany is one of the few countries that have succeeded in reducing their carbon dioxide emissions in the last decade (Figure 69). During the period 2000 to 2008 it succeeded in reducing CO₂ emissions by 6.4 million tonnes. Direct CO₂ emissions by private households in Germany, e.g. as a result of transport

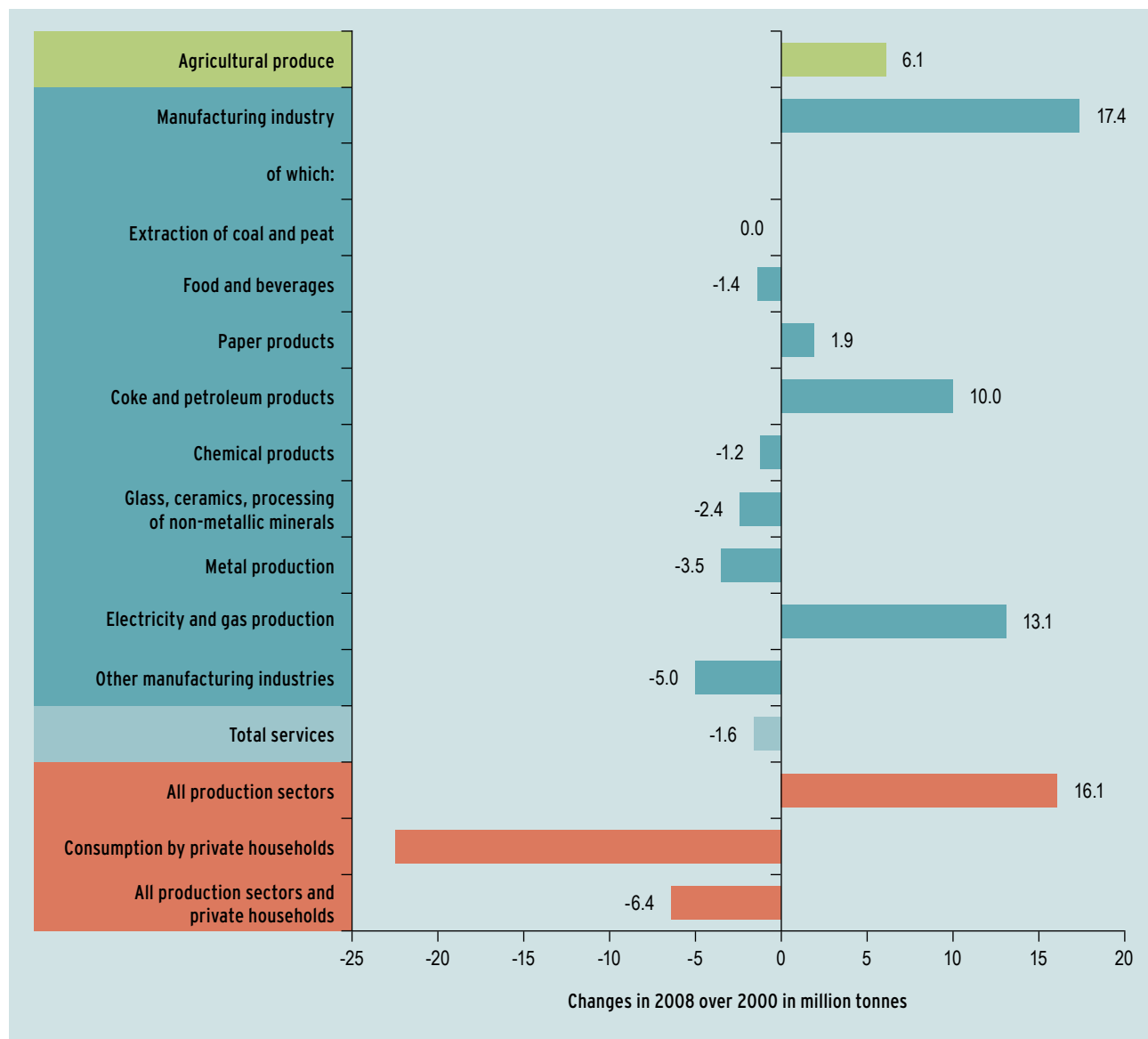
and heating, fell by 22.5 million tonnes during this period. In the domestic production sector, by contrast, CO₂ emissions rose by 16.1 million tonnes.

Although a number of production sectors and the services sector managed to reduce their CO₂ emissions between 2000 and 2008, this trend was cancelled out by the increase in emissions in the major sectors “Coking and petroleum products” and “Electricity and gas production”.

CO₂ intensities in the production sectors

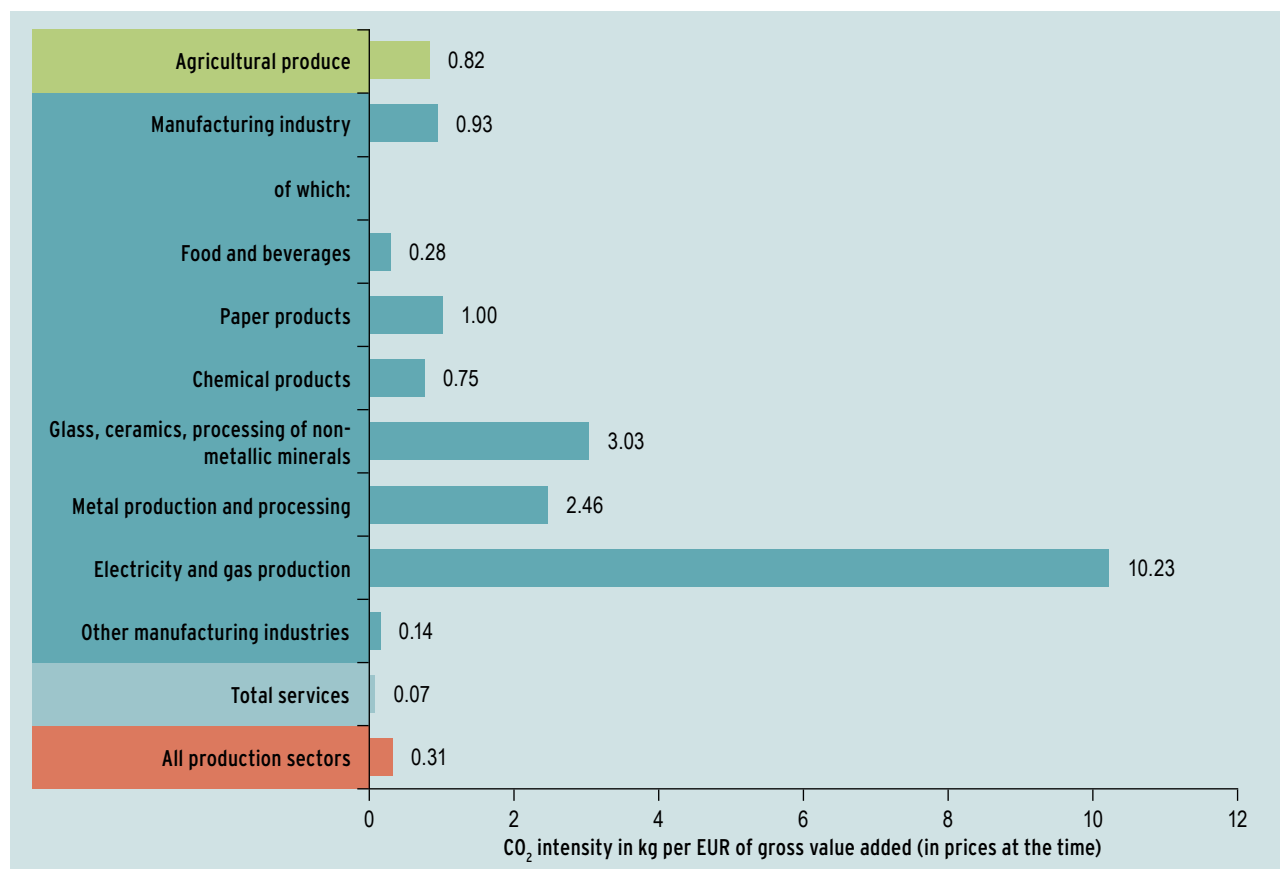
The CO₂ intensity indicator shows the level of CO₂ emissions per unit of value added. The most CO₂-

Figure 69: Development of direct CO₂ emissions, broken down by economic activities 2000-2008



Source: Federal Statistical Office (2010b)

¹¹⁶ As well as the presentation of direct emissions used here, the emissions caused by power generation were also allocated to end consumers.

Figure 70: CO₂ intensity by production sectors 2008

Source: Federal Statistical Office (2010b)

intensive branches of industry are metal production, electricity and gas production, and processing of non-metallic minerals (cf. Figure 70).

CO₂ intensity figures have declined steadily in recent years. Several factors contributed to this: not only the increasing shift to lower-carbon fuels, but also the growing share of electricity generation accounted for by renewable energy sources, improved efficiency in new plants, and numerous energy-saving measures.

2.4 Carbon leakage - does climate policy shift CO₂ emissions abroad?

In the public debate, people frequently voice the fear that energy-intensive companies will shift their production to countries with less stringent climate protection requirements if advanced climate policies have the effect of raising production costs. This would

reduce climate-relevant emissions in Germany, but increase them abroad. If such carbon leakage occurs, it will tend to curb the success of climate protection policy.¹¹⁷ It would also reduce production and employment in Germany.

Carbon leakage can also arise from indirect effects, if an ambitious climate policy lowers the demand for fossil fuels and this reduces energy prices on the world market. As a result, the demand for and consumption of such fuels might go up in other parts of the world with less ambitious climate objectives.

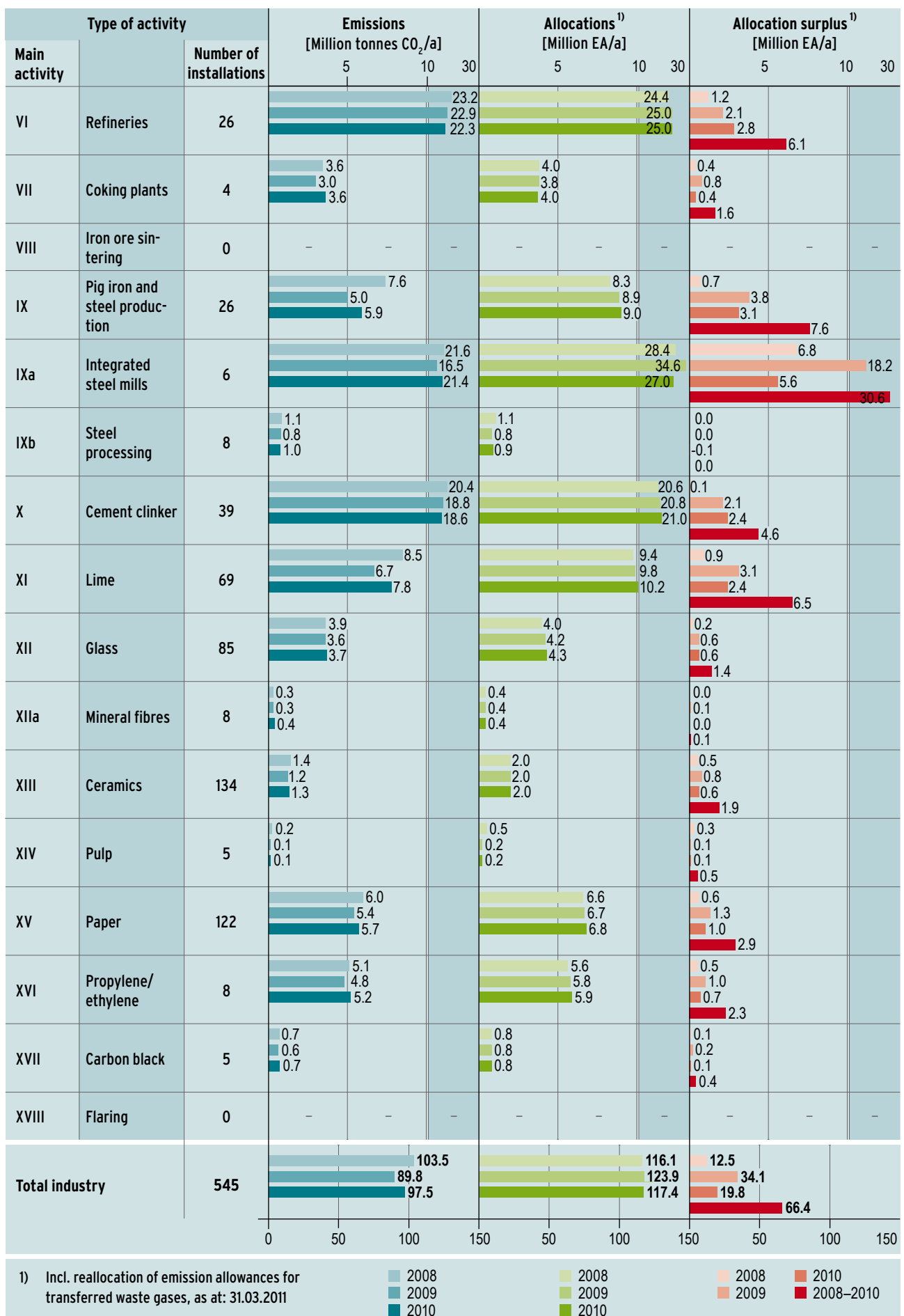
Model-based analyses for the countries with reduction commitments under the Kyoto Protocol come to the conclusion that the carbon leakage effects are relatively small: only 5 to 20 percent of the greenhouse gas reductions by the Annex I countries is cancelled out by additional emissions in states without reduction commitments.¹¹⁸ It seems likely that the greater part of any leakage takes place via raw materials markets and not via product markets.¹¹⁹

117 However, relocation of production abroad does not inevitably result in higher greenhouse gas emissions. For example, if the energy mix is less CO₂ intensive than in Germany – possibly because the country has great hydro power potential – emissions might even fall on balance as a result of the production shift.

118 Cf. IPCC (2001a), p. 12.

119 Cf. IPCC (2001b), p. 622.

Figure 71: Emissions and allocations of industrial activities subject to the emissions trading scheme during the period 2008 to 2010. Allocation surplus in Germany 2011



Source: German Emissions Trading Authority (DEHSt 2011), p. 61

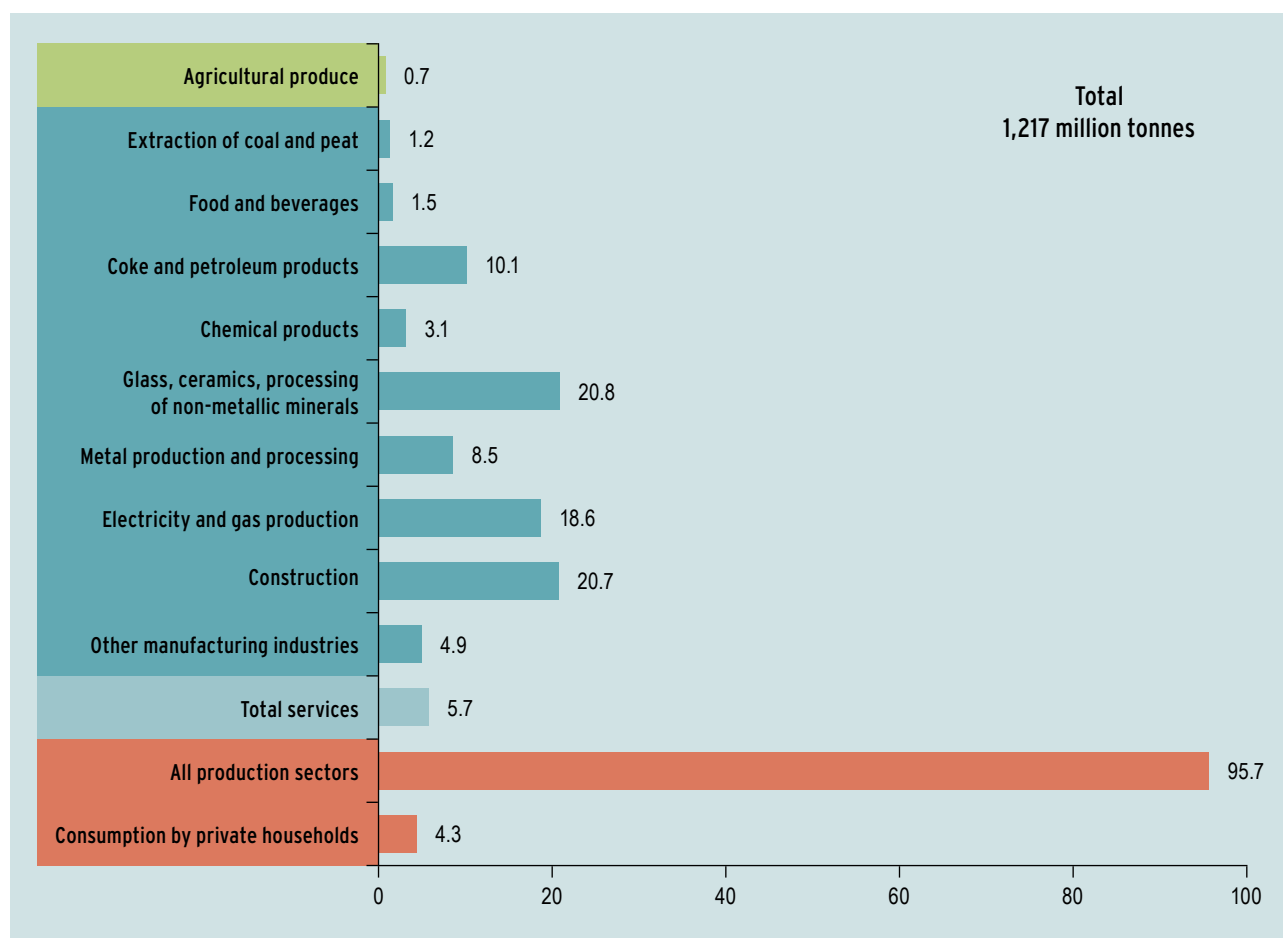
A study for the Federal Environment Ministry and the Federal Environment Agency analysed the risk for Germany of carbon leakage resulting from EU emissions trading.¹²⁰ It emerged that only the pig-iron and steel industry, the fertiliser industry, parts of the chemical industry, paper and board manufacturers, and the aluminium industry were at risk of leakage. This is due to the fact that these production sectors are not only exposed to strong international competition, but also have a potentially high burden of costs as a result of the emissions trading scheme. In total, these production sectors are responsible for considerably less than one percent of Germany's gross domestic product.

The study not only took account of the direct burden of costs arising from the purchase of emission allowances, but also the indirect costs due to increases in the price of electricity. It also assumed that all emission allowances were auctioned, and hence that industry has to pay for all the emission allowances it

requires. The statements about the leakage risk industries are thus based on a scenario that assumed the maximum possible burden of costs. In fact, the burden on industry due to emissions trading is far less than assumed in this "worst case scenario". This is because, in order to avoid leakage effects, industry is allocated a considerable portion of the emission allowances free of charge in the new emissions trading period 2013–2020 as well.

To date, German industry has in fact profited considerably from emissions trading. Analyses of allocations and verified emissions within the EU emissions trading scheme show that in the years 2008 to 2010 the German industrial sectors were allocated more emission allowances free of charge than they actually needed for their emissions. The cumulative allocation surpluses of industrial installations (Figure 71) currently have a market value of around 1.1 billion EUR.¹²¹

Figure 72: Use of non-renewable raw materials by economic activities 2008 (in percent)



Source: Federal Statistical Office (2010b)

120 Cf. Graichen et al (2008).

121 Cf. German Emissions Trading Authority (DEHSt 2011).

2.5 Resource utilisation and resource productivity in production

Resource utilisation broken down by economic activities

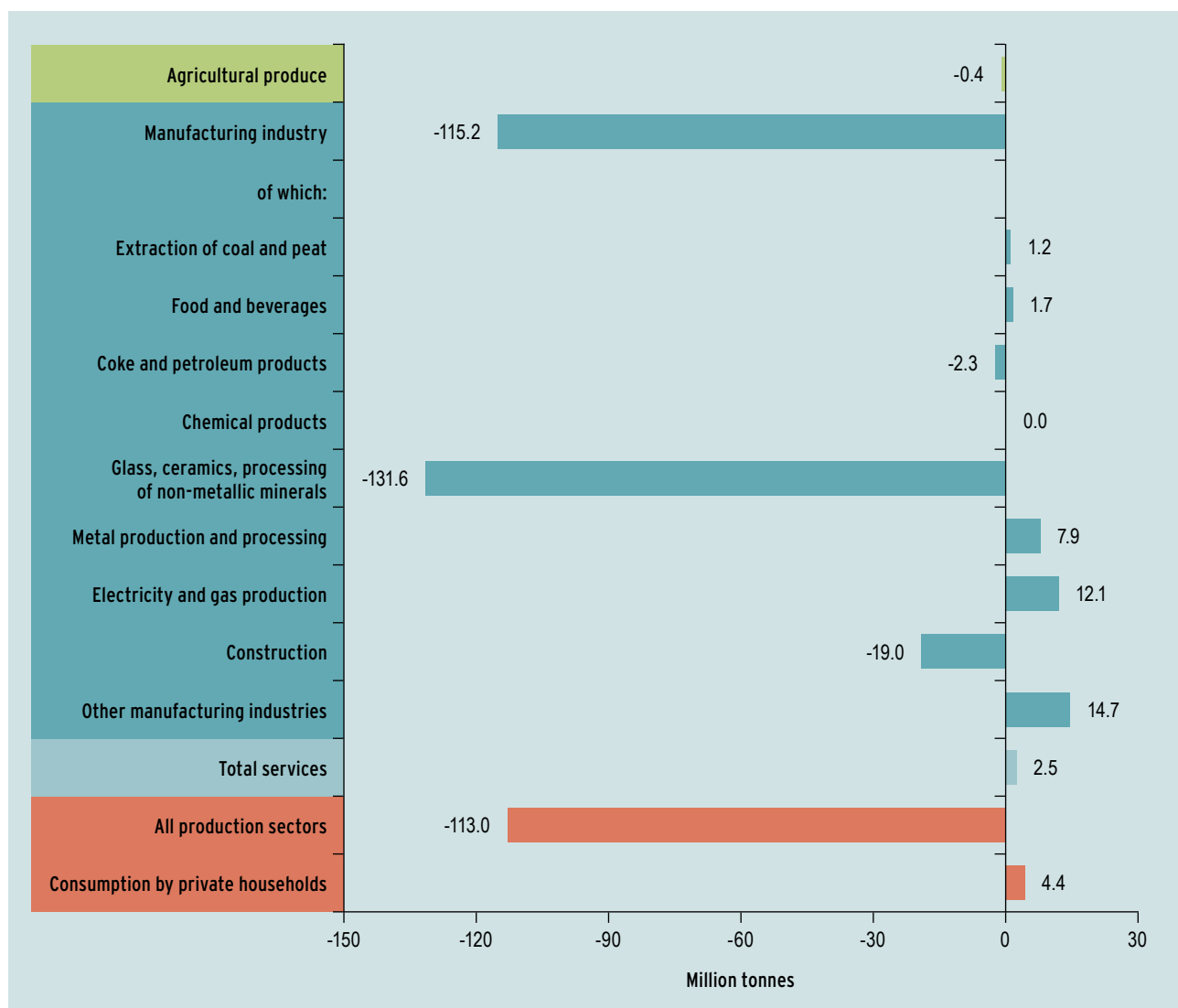
In 2008 some 1217 million tonnes of non-renewable resources – within the meaning of the resource indicator¹²² – were consumed as intermediate products in production and for consumption by households (cf. Figure 72). This is more than 15 tonnes per capita of the population. Nearly 96 percent of raw materials are needed for production, and a good four percent for consumption by private households. The largest share of raw materials is consumed by the manufacturing sector (89.2 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 2008 consumption of raw materials by the production sector was considerably lower than eight years before. The most substantial reduction was in the most material-intensive sector – glass, ceramics, non-metallic minerals – followed by construction (cf. Figure 73). In all other production sectors the changes were relatively slight. As with energy consumption, there may be a variety of reasons for the decline in resource consumption – for example a decline in production volume – and it is not necessarily possible to draw direct conclusions about more efficient use.

Figure 73: Trends in consumption of non-renewable raw materials 2000-2008



Source: Federal Statistical Office (2010b)

122 Cf. Part II, Chapter 4.

To be able to draw such conclusions, it is also necessary to include the development of production volume in the analysis.¹²³

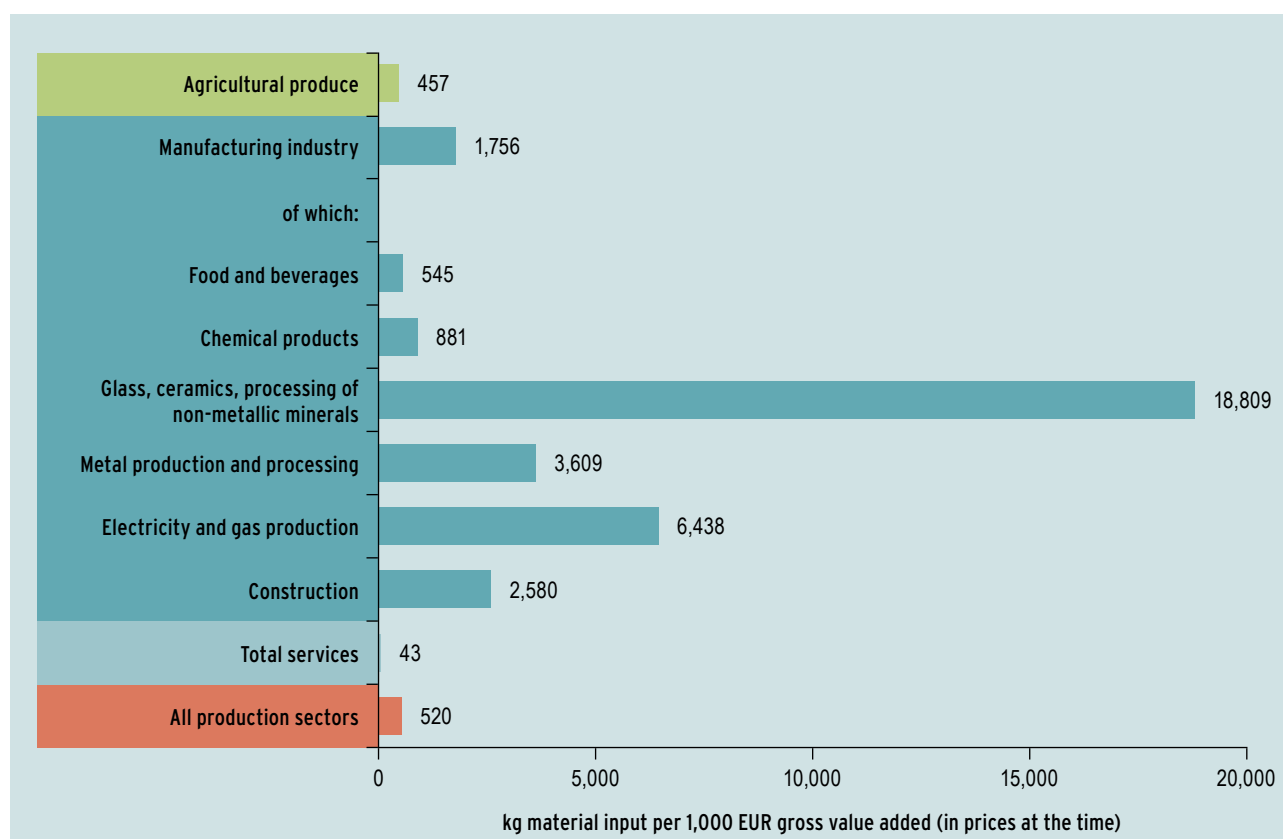
Material intensity in the production sectors

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 is investigated by the Federal Statistical Office with the aid of the material intensity indicator. This indicator is defined as material input per gross value added and therefore

corresponds – at the level of the production sectors – to the reciprocal of resource productivity. Thus the greater the productivity or material efficiency of production, the lower the material intensity.¹²⁴

The comparison of industries reveals great variations. Whereas the most material-intensive production sector – glass, ceramics, non-metallic minerals – consumes 18,809 kilograms of raw materials per 1,000 EUR gross production value, the services sector only needs an average of 43 kg (cf. Figure 74). The cross-industry average for the production sector is around 1,756 kg/1,000 EUR.

Figure 74: Material intensity by production sectors 2008



Source: Federal Statistical Office (2010b)

123 At present there is no up-to-date statistical analysis available on the reasons for the trend in resource consumption.

124 The analysis shown here relates to material input as defined for the purpose of the resource indicator. At the level of the production sectors, the statistical term “material input” is commonly used instead of “resource input”, cf. Federal Statistical Office (Statistisches Bundesamt 2010b), p. 40ff.



3 Corporate sustainability management

Key points at a glance

The economic and financial crisis has focused attention on the issue of corporate risk management. Ecological aspects such as pollution, climate change, resource depletion and loss of biodiversity give rise to completely new risks for businesses. The public's expectations that businesses should behave in a socially responsible fashion, assume social and ecological responsibility and contribute to sustainable development have also grown enormously and become economically relevant. Businesses need to find new strategic, conceptual and operational answers to these risks and challenges.

Environmental protection not only involves risks and new challenges, but also offers substantial economic opportunities. This is because it gives rise to new, dynamically growing markets for "green" goods and services, and also great savings potential, especially through improvements in energy and material efficiency.

Businesses can undertake strategic reorientation aimed at sustainable management and the assumption of social responsibility. Examples of guide documents are the United Nations Global Compact, the OECD Guidelines for Multinational Enterprises, and ISO standard 26000:2010(E) "Guidance for social responsibility".

Systematic environmental management is a fundamental requirement for comprehensive and credible sustainability management. Suitable environmental management systems include DIN EN ISO 14001, the European Eco-Management and Audit Scheme EMAS, and the Energy Management standard DIN EN 16001 (future ISO 50001).

3.1 New challenges, risks and opportunities for businesses

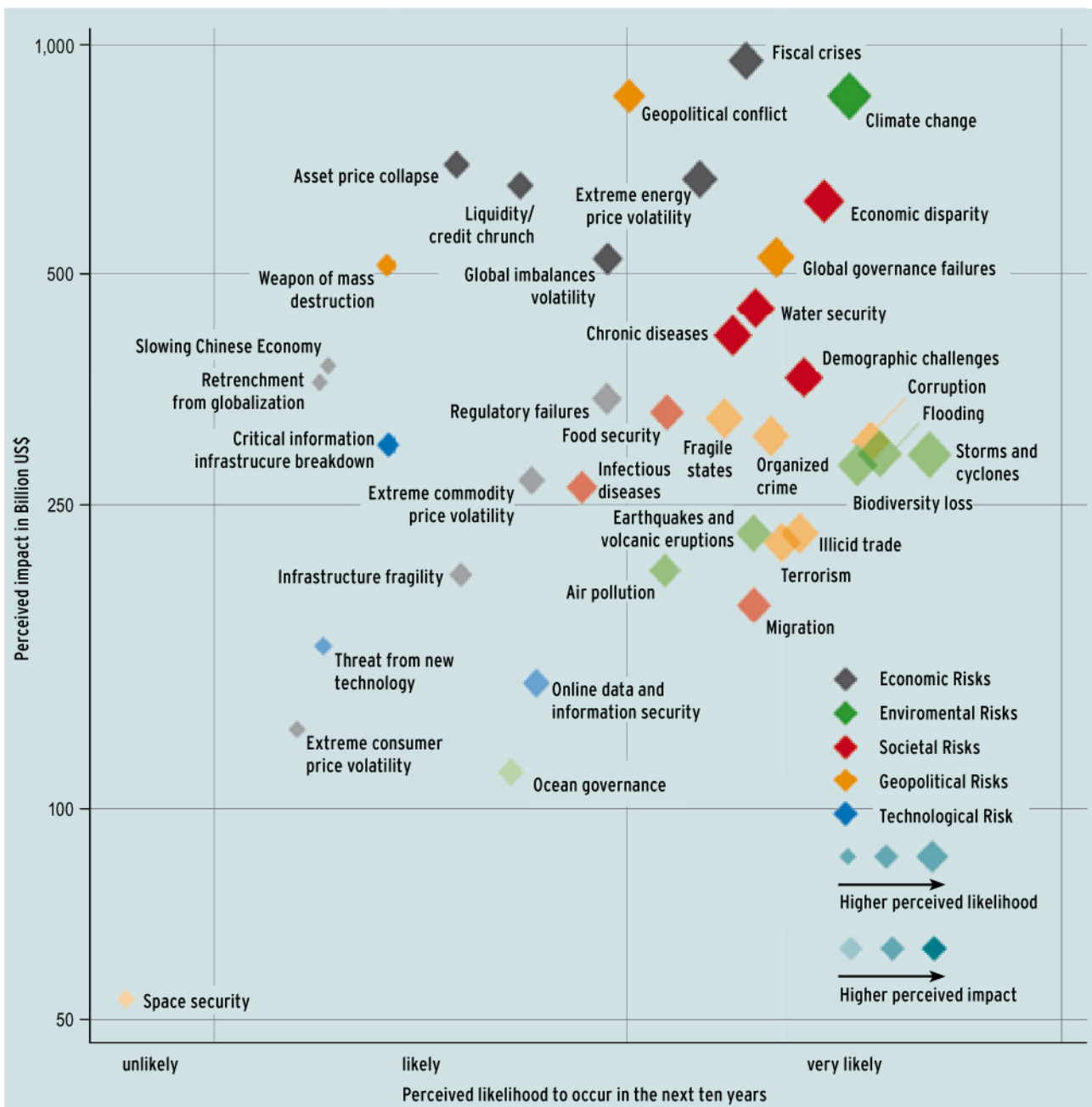
The economic and financial crisis has heightened awareness of risks in the financial sector and made it clear that a management approach which focuses solely on short-term profit and fails to address the public interest can bring the world to the brink of disaster. Corporate sustainability management is therefore a key issue. It presents great challenges for businesses, because in developing new corporate strategies they will have to take account of all rele-

vant risks and environmental and social challenges and find strategic answers to them.

There have been fundamental changes in corporate risks

In recent years there has been a marked increase in economic and political instabilities, geopolitical conflicts, energy crises, global population growth and demographic change. As a result, the international risk landscape for companies has undergone fundamental changes.

Figure 75: Worldwide risks 2011



Source: BMU (2011g), p. 7

The focus is increasingly shifting to challenges such as ecological mega trends which have existed for a long time but have tended to play a minor role in risk assessments, although their effects are no less pressing, radical and structure-changing.

Impacts of ecological mega trends

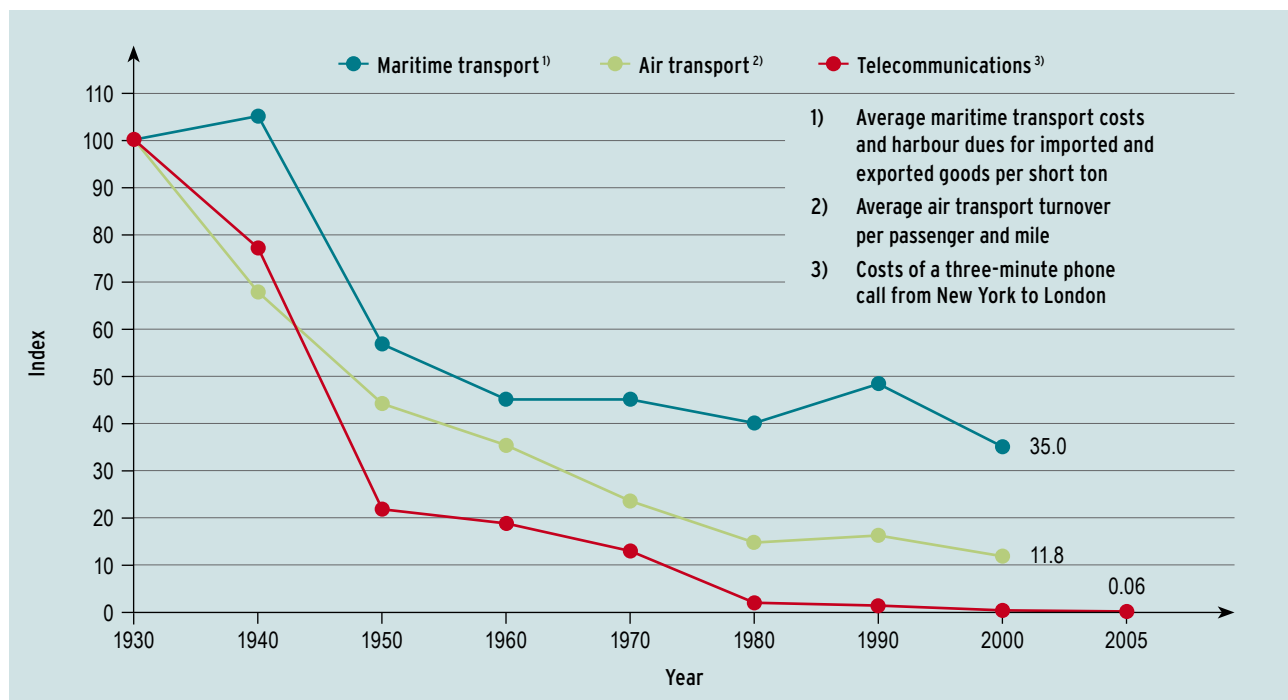
Environmental pollution, climate change, resource scarcity and loss of biodiversity, together with the rapid growth of the world's population, are totally changing the initial conditions for businesses. These mega trends and their economic, ecological and political impacts can have a "boomerang effect" if companies do not address them in good time. They will have a strong influence on the framework conditions for corporate activities and will increasingly determine a company's competitive strength. Examples include new environmental product demands by consumers, environmental regulating for factoring in environmental costs, rising energy and resource prices, and the impacts of climate change (e.g. floods, desertification) on production locations. Companies that anticipate the global mega trends and gear their corporate policy to them – e.g. by improving their energy and resource efficiency or by stepping up their engagement in green markets of the future (cf. Part III) – will therefore gain competitive advantages.

Acceleration of economic globalisation

The division of labour associated with economic globalisation has speeded up even further, as has the reduction in transport and communication costs. This makes it possible to supply high-quality products quickly and at low cost. In certain industries whole production sectors are farmed out to countries with low labour costs. Among other things, this has structural impacts on national economic and social systems and also on the environment, for example if regulatory frameworks are not implemented adequately in the destination countries.

Supply chains are becoming increasingly complex because of the growing interdependence of the global economy. This results in control problems and challenges when drawing up contracts with suppliers. Public attention and rapid electronic dissemination of information renders companies vulnerable if they fail to make adequate checks on environmental protection issues and working and social conditions (loss of image, drop in sales).

Figure 76: Development of transport and communication costs (Index 1930 = 100)



Source: bpb (2009)

New global competition

The confrontation with new global competitors – especially from the emerging economies – results in an intensification of competition on prices and costs and steps up international rivalry for scarce resources and energy. This increases demands on competitive strength and the pressure to innovate.

Society's increasing expectations of business

The public's expectations that businesses should behave in a socially responsible fashion, assume social and ecological responsibility and contribute to sustainable development have grown enormously and become economically relevant. In a recent survey by management consultants Ernst & Young, more than two thirds of the respondents from the general public said they thought that corporate environmental protection and sustainability were very important. They regarded environmental protection as the second most important task that companies had to perform. Only the task of creating jobs received a slightly higher rating.¹²⁵

Against the background of public loss of confidence – as a result of corporate scandals and misconduct by corporate decision makers – critical media and increasingly well informed organisations in civil society are calling for greater corporate responsibility and accountability, e.g. through credible reporting. Today people are more aware of the fact that corporate decisions have social and ecological consequences and that corporate decision contexts are much more complex and much more firmly embedded in society.

The question is no longer – as it was at the start of the 20th century – how businesses mould society, but how the new, dynamic framework conditions and societal expectations mould corporate activities. Companies have to provide new and sustainable answers to this question. Purely reactive behaviour on a company's part is not rewarded by shareholders or stakeholders. Forward-looking action and “proper conduct” are a strategic necessity for companies today.

New opportunities for businesses

As well as risks and new challenges, the mega trends offer considerable economic opportunities:

Emergence of new markets for goods and services

Today it is possible to identify at least six lead markets for the future in which ecological and economic challenges are very closely interlinked: environmentally sound energy generation, energy efficiency, resource and material efficiency, closed-cycle management, sustainable water management, and sustainable mobility (cf. Part III).

Resource and energy efficiency measures determine the competitive strength of businesses

Companies that traditionally approach efficiency measures from the “labour costs” angle could easily find they are using the wrong “roadmap”. Energy and resource efficiency have become strategic factors of corporate management. Those who make sparing use of energy and resources improve their competitive strength – and can pay good wages and create jobs with a viable future. Improving energy and resource efficiency is therefore a key to strategic corporate management. In sectors that are particularly dependent on raw material prices, like the automobile or mechanical engineering industry, material costs already account for more than 50 percent of the gross production value. This offers enormous potential. For example, the German Materials Efficiency Agency (Deutsche Materialeffizienzagentur – demea) estimates on the basis of practical consulting experience that SMEs in the German manufacturing sector could save an average of at least 20 percent of material costs by improving the efficiency of their production workflows. On a conservative extrapolation, that would work out at around 100 billion EUR per annum for the economy as a whole. Exploiting resource efficiency potential and the associated cost savings would substantially increase the competitive strength of SMEs in particular on domestic and foreign markets.¹²⁶

125 Ernst & Young (2011).

126 BMU (2011h), cf. Part IV.

Responsible corporate activity is more than a buzz word

The mega trends not only call for adjustments, but also promote a new kind of corporate policy geared to sustainability. The object of the enterprise is governed by socially relevant goals and values and seeks to make a contribution to win-win-win solutions for company, environment and society. The viable business model for the future – in economic terms too – is not short-term profits, but long-term perspectives with answers to social and ecological demands and issues.

3.2 Starting points for sustainable management

In the light of the challenges and the new economic opportunities, companies can undertake a strategic reorientation towards sustainable management and the assumption of social responsibility (Corporate Social Responsibility – CSR). It soon becomes clear that economics and sustainability are not opposites, but two sides of the same coin. 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 business partners. They also do it in their own self-interest: they are preparing themselves to cope with the challenges of the future. The future will therefore belong to those companies which make an active contribution to ethical and sustainable corporate leadership in their own country, and also at their international locations. A sustainable approach to corporate management which caters for social, ethical and ecological aspects can in the long term achieve above-average financial success, even though it may not always be possible to quantify the effects in monetary terms. Examples of strategic approaches and benefits of sustainable corporate management include:

- Developing integrated, holistic business strategies to reduce and avoid risks,
- Building up reputation and improving image, establishing brand value through credible and plausible action,
- Avoiding and reducing environmental pollution, making sparing use of natural resources, replacing non-renewable resources, initiating substitution processes,
- Installing faster, targeted innovation processes,
- Improving employee motivation, identification and performance,
- Developing the linear value chain into win-win strategies in which many actors profit from each other and which all actors can continue developing on the basis of common values and visions,
- Increasing customer loyalty and strengthening customer trust through employee training, safeguarding consumer rights,
- Ensuring better cooperation and fair competition with other companies and organisations,
- Engaging in dialogue with stakeholder groups to strengthen legitimacy of activities (“licence to operate”),
- Making a positive contribution to sustainable development of society,
- Reducing costs and risks,
- Increasing turnover, profit margins,
- Making organisational and operational changes to increase efficiency,
- Ensuring better access to sources of funding.

3.3 Guides to responsible corporate management

Standards, industry-specific and cross-sectoral codes of conduct, voluntary initiatives, guidelines and principles for responsible corporate management have increasingly been institutionalised in recent years by state and/or private actors at a social level. Special mention must be made of the following as central guide documents:

- the United Nations Global Compact with its ten universal principles,
- the OECD Guidelines for Multinational Enterprises and
- the standard ISO 26000:2010(E) “Guidance for social responsibility”, May 2010.

United Nations Global Compact

The idea of a Global Compact¹²⁷ was first raised by the then Secretary General of the United Nations, Kofi Annan, in an address to the World Economic Forum on 31 January 1999. The operational phase was initiated at the United Nations headquarters in New York on 26 July 2000.

The Global Compact is a voluntary initiative for companies. It asks companies to embrace, support and enact, within their sphere of influence, a set of core values (principles) in the areas of human rights, labour standards, the environment, and anti-corruption. The ten 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.

Principles of the Global Compact¹²⁸

Human rights

Principle 1: Businesses should support and respect the protection of internationally proclaimed human rights within their sphere of influence 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 and

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

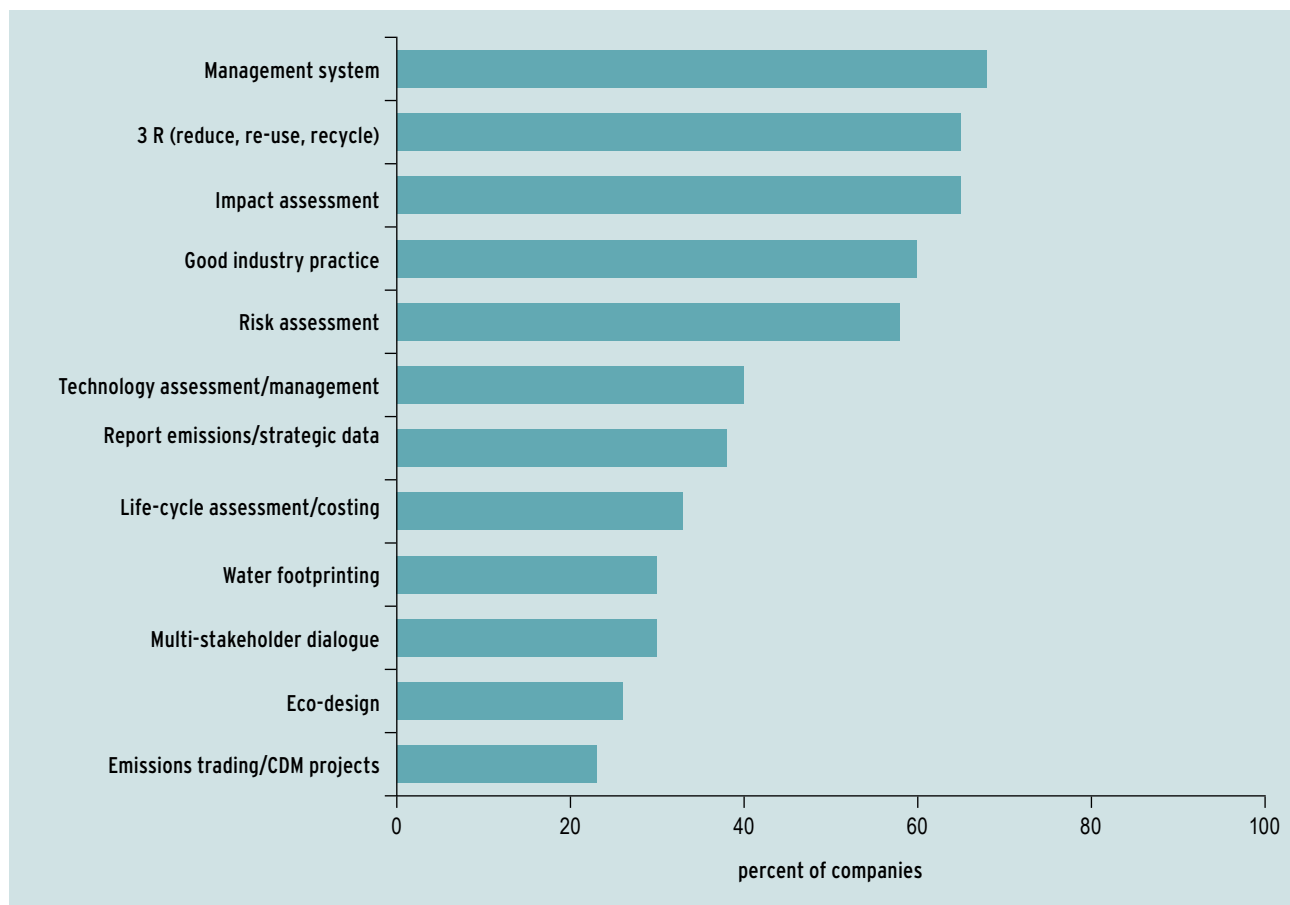
Principle 10: Businesses should work against corruption in all its forms, including extortion and bribery.

To safeguard integrity and credibility it was agreed in 2004 that the voluntary initiative would introduce quality assurance mechanisms and proof of progress. For this reason every member joining the Global Compact undertakes to report on its progress towards implementing the ten principles (CoP – Communication on Progress).¹²⁹

127 Cf. United Nations Global Compact (2011a).

128 Cf. DGCN.

129 Cf. United Nations Global Compact (2011b).

Figure 77: Environmental measures by the Global Compact members

Source: United Nations Global Compact (2011b), p. 25

For the environmental sector, the Annual Report 2010 finds that members made significant progress compared with 2009, especially in the fields of environmental management systems (+15 percent), closed-cycle management measures (+6 percent) and reporting on greenhouse gases (+5 percent).

The Global Compact currently has more than 6,000 participating companies worldwide and 2000 employee, human rights, environmental and development organisations in 140 states.

National networks have been established as dialogue platforms in many countries. Today (June 2011) the German Global Compact network comprises 162 businesses and 54 organisations from civil society, science and politics. It is actively supported by the German government, especially through funds from the Federal Ministry for Economic Cooperation and Development (BMZ).

OECD Guidelines for Multinational Enterprises

The Guidelines for Multinational Enterprises of the Organisation for Economic Cooperation and Development (OECD) set out a comprehensive, universally valid action framework with voluntary principles and standards for responsible corporate management. They were drawn up in cooperation with representatives of employers and employees and of non-governmental organisations (NGOs).

Unlike other codices, the Guidelines set out recommendations by governments to businesses. The signatory states (comprising the 34 OECD members plus Argentina, Brazil, Egypt, Latvia, Lithuania, Morocco, Peru and Romania) undertake to implement appropriate measures to promote the Guidelines.

OECD Guidelines for Multinational Enterprises

Basic obligations and general policies of enterprises (Chapters I and II)

Contribute to economic, environmental and social progress with a view to achieving sustainable development, comply with national and international law, promote local development etc.

Disclosure (Chapter III)

This covers two fields:

1. Reporting on the company's strategic orientation, operational activities, financial situation and corporate governance structure, and forward-looking information about strategies and market positions, investments and research activities.
2. Disclosure of information on socially and environmentally relevant risks and issues that need to be communicated.

Human rights (Chapter IV)

Respect for human rights belongs to the global standard that enterprises are expected to maintain. Observation of human rights means that in the context of their own activities, enterprises should avoid infringing human rights or tolerating such infringement by others. By means of due diligence, which should be integrated in the risk management system, the enterprise should avoid adverse impacts on human rights.

Employment relations (Chapter V)

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

Environmental policy (Chapter VI)

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

Combating corruption (Chapter VII)

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

Consumer interests (Chapter VIII)

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

Science and technology (Chapter IX)

Protection of intellectual property, know-how transfer

Competition (Chapter X)

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

Taxation (Chapter XI)

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

The revised version of the OECD Guidelines adopted on 25 May 2011¹³⁰ includes a number of significant substantive improvements.

Special mention must be made of the following:

- The Guidelines apply to businesses in all sectors of the economy.
- The Guidelines can basically be applied by all businesses, not only those with multinational operations. Small and medium enterprises can also use them as a guide. The Guidelines are to be understood as “good practice”.
- With their activities, businesses should contribute to sustainable development.

130 Cf. OECD (2011b).

- Businesses are to contribute to transparency by means of correct and timely reporting on their organisation and activities and the impacts of these activities, and about probable risks. In view of climate change, for example, businesses are recommended to reduce their greenhouse gas emissions and communicate information about such emissions.
- A new Chapter IV on human rights has been added to the Guidelines. This introduces the due diligence principle (duty of businesses to check that human rights are in fact observed).
- Chapter V “Employment relations” is brought into line with the ILO Tripartite Declaration and makes recommendations on best possible wages for employees.
- The chapter on the environment recommends the introduction of an environmental management system and continuous improvements in environmental performance. Businesses should assess the environmental impacts of their activities and basically prevent such impacts, and also compensate for unavoidable impacts.

The Guidelines also include a grievances mechanism. All adhering countries have set up National Contact Points (NCPs) to which infringements of the Guidelines by enterprises operating internationally can be reported. Such cases are then discussed with the relevant enterprise as part of an arbitration procedure. If the NCP finds that there has been an infringement of the Guidelines, this is published in an announcement.

ISO 26000 “Guidance for Social Responsibility”

On 1 November 2010, after nearly six years’ preparation, the International Organization for Standardization (ISO) published the “Guidance Standard on Social Responsibility – ISO 26000”¹³¹. The German Standards Organisation (Deutsches Institut für Normung – DIN), following a resolution by the German national subcommittee that took part in the international negotiations, adopted the standard and published it in January 2011 as DIN ISO 26000 “Social Responsibility of Organisations”.¹³² As a guide, DIN ISO 26000 differs from other standards in that it offers the user support and guidance in developing an individual approach to the issue of “social responsibility”, instead of merely laying down requirements.

Since the first official international working meeting in 2005, more than 600 interested persons, including 443 as voting experts and 214 as advisory observers, from 99 countries worked to draw up the Guidelines on the basis of the existing ISO rules.

The strength of this guide lies in the fact it represents a viable international consensus on principles and procedures for assuming social responsibility. The standard describes the topics covered and the questions that an organisation needs to answer if it is serious about addressing the issue of social responsibility. It defines universally valid approaches and refrains from laying down detailed binding requirements. It can be used for organisations of all kinds.

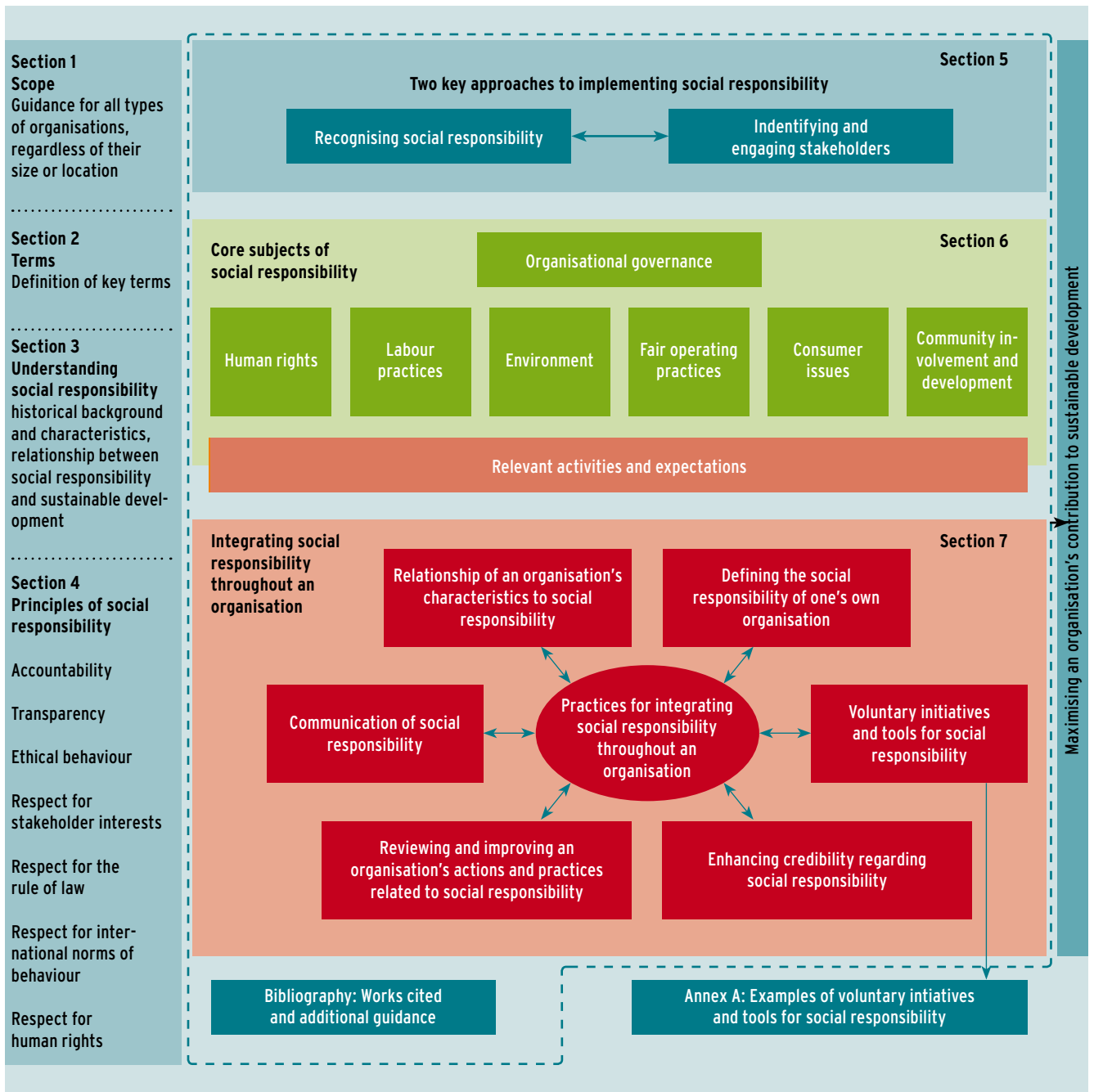
This is in fact the challenge when using the standard – it makes it necessary to take the instructions in the standard and adapt and apply them to the individual organisation. The standard therefore makes it clear that it is not suitable for certification, because the assumption of responsibility has to be understood as an ongoing task that is constantly changing and developing. This view is in line with that of the German government, which has stressed in a joint declaration with industrial associations and trade unions that DIN ISO 26000 is not a basis for certification, and there can be no formal or technical justification for certification under ISO 26000.¹³³

131 Cf. ISO (2010).

132 Cf. DIN (2011).

133 For the full text of the joint declaration on non-certifiability, see the website of the Federal Ministry of Labour and Social Affairs (Bundesministerium für Arbeit und Soziales – BMAS): http://www.csr-in-deutschland.de/portal/generator/15262/property=data/2010_11_15_stellungnahme_nichtzertifizierung_guidance_sr.pdf.

Figure 78: Structure of DIN ISO 26000



Source: DIN (2011), p. 12

The breakdown of the complex into generic principles and core subjects makes it possible to organise an intensive, step-by-step approach to the various issues relating to social responsibility. The aim is to develop an overall understanding of the organisation's social responsibility and integrate it in the implementation of the various aspects. The guide makes it clear how the various core subjects depend on and interact with each other. It is only by taking

all core subjects together that one obtains a complete picture of the exercise of social responsibility. It is basically important to make a careful check on the relevance of each issue for the organisation. Deliberately addressing the individual issues is essential to see things from a different angle; in particular, it makes it possible to understand hitherto unknown risks and avoid them better.

Figure 79: Overview of core subjects and issues

Core subject: Organisational governance
Core subject: Human rights
Issue 1: Due diligence Issue 2: Human rights risk situations Issue 3: Avoidance of complicity Issue 4: Resolving grievances Issue 5: Discrimination and vulnerable groups Issue 6: Civil and political rights Issue 7: Economic, social and cultural rights Issue 8: Fundamental principles and rights at work
Core subject: Labour practices
Issue 1: Employment and employment relationships Issue 2: Conditions of work and social protection Issue 3: Social dialogue Issue 4: Health and safety at work Issue 5: Human development and training in the workplace
Core subject: Environment
Issue 1: Prevention of pollution Issue 2: Sustainable resource use Issue 3: Climate change mitigation and adaptation Issue 4: Protection of the environment, biodiversity and restoration of natural habitats
Core subject: Fair operating practices
Issue 1: Anti-corruption Issue 2: Responsible political involvement Issue 3: Fair competition Issue 4: Promoting social responsibility in the value chain Issue 5: Respect for property rights
Core subject: Consumer issues
Issue 1: Fair marketing, factual and unbiased information and fair contractual practices Issue 2: Protecting consumers' health and safety Issue 3: Sustainable consumption Issue 4: Consumer service, support, and complaint and dispute resolution Issue 5: Consumer data protection and privacy Issue 6: Access to essential services Issue 7: Education and awareness
Core subject: Community involvement and development
Issue 1: Community involvement Issue 2: Education and culture Issue 3: Employment creation and skills development Issue 4: Technology development and access Issue 5: Wealth and income creation Issue 6: Health Issue 7: Social investment

3.4 Environmental management systems as core instruments of sustainable management

Systematic environmental management is the basic requirement for setting up a comprehensive and credible corporate sustainability management system. The following are suitable sustainability management systems:

- the environmental management standard DIN EN ISO 14001,
- the European Eco-Management and Audit Scheme (EMAS) and
- in relation to energy aspects the energy management standard DIN EN 16001 (in future ISO 50001).

Environmental management standard DIN EN ISO 14001

The standard DIN EN ISO 14001 “Environmental management systems – Requirements with guidance for use” lays down globally recognised requirements for an environmental management system. In particular, it focuses on a process of continuous improvement. ISO 14001 is suitable for worldwide use by all economic sectors and organisations. The standard, in force since 1996, was revised in 2004.¹³⁴

In terms of content, the standard first requires the formulation of a corporate environmental policy. This is followed by the process of planning how the corporate environmental policy can be put into practice. Finally the environmental management system is introduced. Verification 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 is certified by accredited ISO certifiers under a private contract. The period for repeat certification is not explicitly laid down, but a three-year interval is usual.

EU Eco Audit (EMAS)

The ISO 14001 requirements for an environmental management system are a core element of the European Eco Audit Regulation (EMAS).¹³⁵ However, EMAS has much more demanding requirements than ISO 14001 and is therefore more ambitious. Before validation and entry in the EMAS register, EMAS 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 are 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.¹³⁶

¹³⁴ Cf. DIN (2009).

¹³⁵ Cf. OJ L 114 p. 1, of 24.4.2001, see under: <http://www.emas.de>.

¹³⁶ Cf. Environmental Verification Committee (Umweltgutachterausschuss 2010).

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. A systematic inventory is a precondition for identification of any kind of improvement potential. For this reason the 2009 revision of the EMAS Regulation¹³⁷ expressed the existing requirements in the form of standardised indicators with uniform reference quantities (Annex IV C). This permits clearer and more standardised presentation of the environmental performance of organisations in their environmental statements. The core indicators relate to the fields of energy efficiency, material efficiency, water, waste, biological diversity, and emissions.

There are numerous practical guides on how to use EMAS:

- 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.¹³⁸
- 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 people. It also contains model systems for registering corporate energy and resource utilisation.¹³⁹
- The office of the Environmental Verification Committee offers an extensive list of target-group-specific practical guides to EMAS.¹⁴⁰

Diffusion of environmental management systems

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 7,934 sites throughout Europe currently take part in EMAS. For comparison: two years ago the figure for Europe was about 1,200 lower. The number of participants in Germany has been stable for about three years, and currently totals 1,876 sites (April 2011). In Europe as a whole, 68 percent of the sites are SMEs, and the same applies to Germany. The manufacturing 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. In Germany a total of 5,865 companies and establishments are certified under ISO 14001.¹⁴¹

DIN EN 16001 (Energy management)

In Germany EN 16001 was published on 1 July 2009 as a national standard under the title “DIN EN 16001:2009 Energy management systems – Requirements with guidance for use”. In four chapters and a user guide, the standard describes the introduction and implementation of energy management systems in a process of continuous improvement.¹⁴² DIN EN 16001 is a classic management standard, comparable to EMAS, ISO 14001 and ISO 9001 (quality management).

137 Regulation (EC) No. 1221/2009 of the European Parliament and of the Council of 25 November 2009 allowing voluntary participation by organisations in a Community eco-management and audit scheme and repealing Regulation (EC) No. 761/2001, and Commission decisions 2001/681/EC and 2006/193/EC (OJ L 342, p. 1).

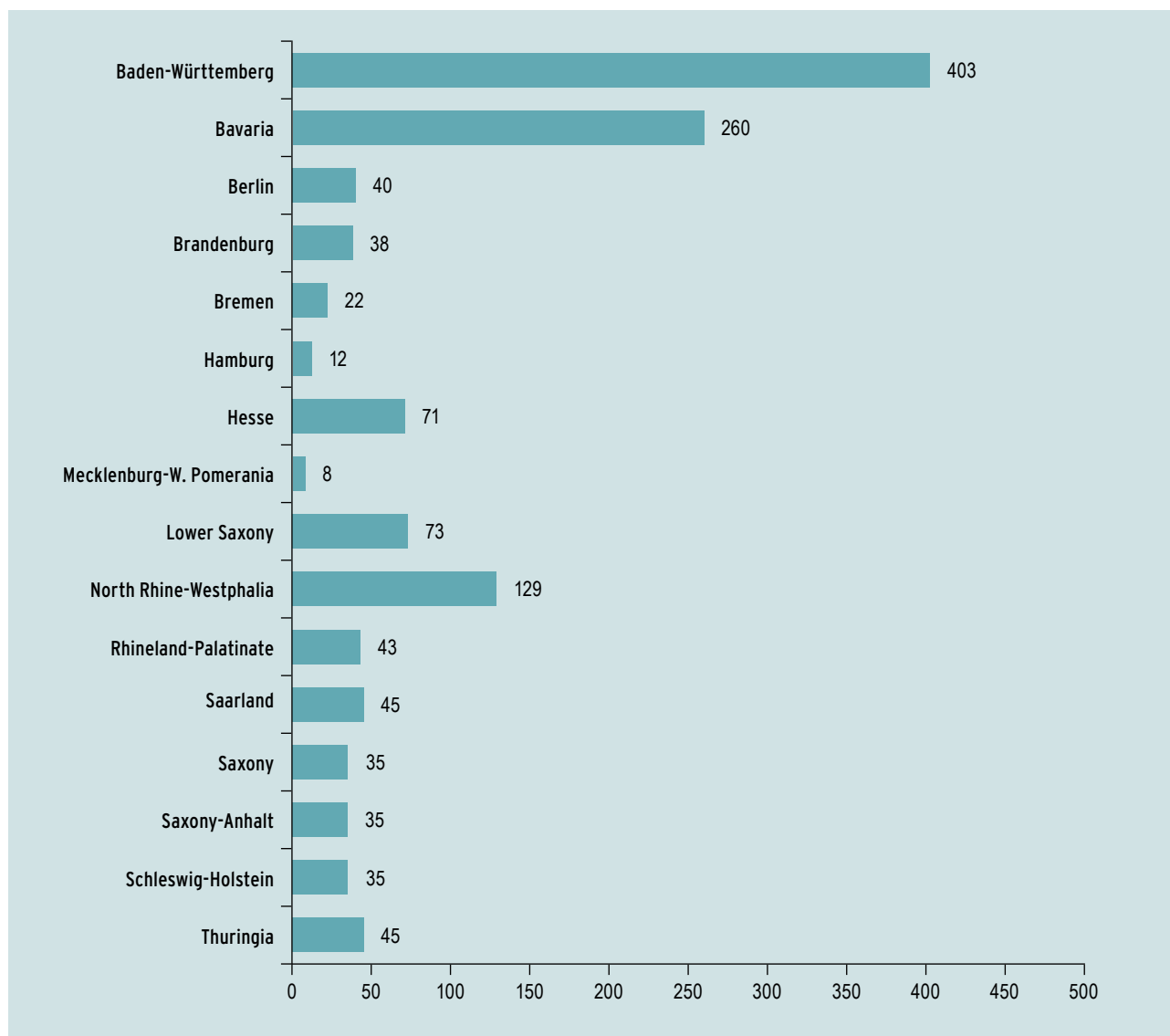
138 EU COM (2004).

139 For further information, see www.emas-easy.de.

140 For further information, see www.emas.de.

141 ISO (2009).

142 Cf. BMU, UBA (2011).

Figure 80: Number of EMAS registered companies/organisations in the German Länder (Figures: May 2011)

Source: Federal Environment Agency based on DIHK figures

Thus for the large number of enterprises and organisations that have already implemented EMAS or ISO 14001 in particular, the introduction of DIN EN 16001 merely means integrating the additional energy-related requirements in the existing management system. The design of the standards is deliberately coordinated.

In June 2001 there were 37 companies in Germany – the largest number in any country – certified under EN 16001. Some of these companies also have an

environmental management system under EMAS or ISO 14001. At this point in time, 206 companies worldwide were certified under EN 16001.

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:¹⁴³ Examples in the field of organisation are:

- Introduction of environmental cost accounting
- Inclusion of environmental components in the employee suggestions scheme,
- Initiation of processes for developing environmental targets and measures,
- Environmental benchmarking, life cycle assessments,
- Introduction of environmental R&D criteria,
- Use of target 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 ecological process innovations include measures for energy-saving and resource-saving production processes, recycling and proper disposal, sustainable management of supply chains, involvement of stakeholder groups, and 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.

EMAS is a modern environmental management system, but its potential in businesses 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.

3.5 What are the elements of credible corporate policy?

The guides and environmental management systems mentioned can heighten corporate awareness of the organisation's social role and support the necessary further development of the core business processes. Essentially, the following thematic areas should be included:

Vision and mission statement

If sustainable management and social responsibility are to be more than image maintenance and reputation management, there is a need to integrate company-specific environmental, social and ethical values 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.

143 Cf. Rennings et al (2006); Hoffmann et al (2006).

Systematic control and integrated management

A comprehensive, credible 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.

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 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 organisation 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 employees

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 human relations 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. Investment in qualification and initial and further training is the basis for successful innovation, research and development and the international competitiveness of companies.

Responsibility in the supply chain

As well as the economic criteria, it is also important to take into account 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. 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 are increasingly reacting 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.

Dialogues with stakeholder groups strengthen trust in the company

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.

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.

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. 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.

As of June 2011, some 219 enterprises and organisations in Germany had published a sustainability report or corporate social responsibility (CSR) report on a voluntary basis. Of these, 52 are EMAS registered, 102 are certified under ISO 14001 and 97 enterprises and organisations¹⁴⁴ based their report on the requirements of the Global Reporting Initiative¹⁴⁵ (GRI).

144 Note: The total of this breakdown is greater than the number of reports, since a number of companies use two or more of EMAS, ISO 14001 and GRI.

145 For further information on the Global Reporting Initiative, see <http://www.globalreporting.org/Home>.



4 Sustainable management and consumers

Key points at a glance

Production and consumption are responsible for a large proportion of today's environmental problems. State environmental policy therefore approaches product-related environmental protection with the aid of standards and specifications which lay down product requirements and prohibitions, e.g. of toxic substances. In addition, the Ecodesign Directive and the top-runner approach are used throughout the EU to make products more environmentally sound (especially as regards their impacts on energy and resource consumption). Labelling of ecologically advantageous product alternatives is relevant to the consumption of greener products, with the aim of providing practical guidance for buyers. Furthermore, public procurement in Germany has great potential for supporting environmentally sound products.

4.1 Product-related environmental protection

Product-related environmental protection finds expression, for example, in specific standards and specifications laying down the requirements that a product has to meet and properties that are prohibited, e.g. toxic substances. In addition, the Ecodesign Directive and the top-runner approach are used throughout the EU to make products more environmentally sound (especially as regards their impacts on energy and resource consumption).

Ecodesign Directive and the EU top runner approach

The EU Ecodesign Directive permits the specification of product group specific requirements for environmentally sound design of certain products – with the result that particularly inefficient products are banned from the European market. At the same time benchmarks are determined for the best available technology found on the market. The Directive is implemented through measures taken by the European Commission or self-regulation by businesses.

A first measure for implementing the Ecodesign Directive is the “Standby Regulation” (No. 1275/2008), which entered into force at the beginning of 2009. Among other things, it lays down binding limits for maximum permitted standby and off mode power consumption by household and office equipment; the limits will gradually be tightened.

A revised version of the Ecodesign Directive entered into force at the end of 2009. This extends the scope of the Directive to cover products of relevance to energy consumption, in other words products which do not themselves consume energy but which have an influence on energy consumption (e.g. windows, thermal insulation materials or car tyres).

A system of dynamic, phased tightening of the energy efficiency figures gives industry the opportunity for continuous improvement and adaptation of its products. The Ecodesign Directive is thus one of the

instruments for implementing the “top-runner approach”, which was originally developed in Japan, in the EU internal market. The aim is to promote penetration of the markets by technologies that are environmentally sound and/or resource or energy efficient.

The Ecodesign Directive¹⁴⁶, in combination with the European energy consumption labelling system (A-G energy label), forms the basis for a consistent EU top-runner approach which removes “energy wasters” from the market and creates incentives to buy efficient and greener equipment. This approach is supplemented by voluntary eco labelling and the demand effect of public procurement. This combination of instruments has resulted in a sharp drop in stand-by losses of electrical equipment – with benefits for the environment and for the consumer’s pocket.

Figure 81: Product groups for which Regulations are already in force under the Ecodesign Directive

Regulation	Product group
1275/2008/EC	Standby and off mode
107/2009/EC	Simple set-top boxes (television sets)
244/2009/EC	Household lamps (light bulbs, energy-saving lamps)
245/2009/EC	Discharge lamps (street lighting, office lighting)
278/2009/EC	External power supplies
640/2009/EC	Electric motors
641/2009/EC	Pumps for heating systems
642/2009/EC	Televisions
643/2009/EC	Household refrigeration appliances
1015/2010/EC	Household washing machines
1016/2010/EC	Household dishwashers
327/2011/EC	Fans
n.a.	Room air-conditioners and comfort ventilators

4.2 Consumer-oriented environmental policy

Consumer demand is also a factor of considerable importance: Which products are in demand, and in what quantities, is relevant to environmental consumption. The consumer sectors with the greatest impacts on the environment are building and living, mobility and food. They involve considerable inputs of energy, substantial flows of materials, and serious adverse effects on the environment.¹⁴⁷

Here there are a number of possible courses of action that not only offer benefits for the environment, but can also lead to savings for consumers. They include changes of habits such as “loanership, not ownership”, for example sharing a lawnmower with the neighbour, or car sharing. Changes in habits also demand new approaches on the part of businesses. Car sharing, originally set in motion by small groups of enthusiasts, has now reached the major car makers, who are offering their own concepts.

146 For more information on the Ecodesign Directive, see www.eup-network.de.

147 Federal Environment Agency (UBA 2007b).

Another possible option is to buy greener products. Here the use of labels to identify especially green products is of great importance. They identify the ecologically better product alternative on the basis of defined criteria and thereby provide practical guidance for buyers, making it considerably easier for consumers to select and decide which product to buy. The labelling also heightens public awareness of the environmental impacts of products and at the same time opens up market opportunities for new products and services for manufacturers and distributors.

Examples of product labelling include the “Blue Angel”, the European organic logo or the energy efficiency classes. Awareness of these labels is very considerable, and in many households they contribute to the purchase decision (cf. Figure 82).

Figure 82: Awareness of product labels and influence on purchase decision

Figures in percent	Known	Influence on purchase decision
Energy efficiency classes	87	68
Organic logo	87	43
Blue Angel	76	39

Source: BMU, UBA (2010)

“Blue Angel” eco label

With some 11,500 products from more than 900 manufacturers, the “Blue Angel” is the world’s first and most successful eco label. It was started in 1977 by the Federal Ministry of the Interior, which was responsible for environmental issues at that time, and the Federal Länder. For more than 30 years now the German “Blue Angel” eco label has been a valuable and indispensable instrument of environmental policy which – rather like an ecological lighthouse – has shown consumers the way to ecologically better products.¹⁴⁸

In particular, consumers are familiar with the symbol from recycled paper and from paints and

varnishes. But the spectrum of products is very much broader. It ranges from wallpapers and paper products, furniture, floorings and wood panels, PCs and printers to complex IT equipment, heating systems, many building products and even ocean-going ships.

The Blue Angel offers industry and the distributive trades a platform for serious advertising of their ecologically beneficial products on the market. This also applies to those product groups for which a Blue Angel, although it exists, is not used by the manufacturers. For example, consumers are still waiting in vain for mobile phones with a “Blue Angel”, although this would be possible. The manufacturers would only have to apply for it.

The Blue Angel is awarded by an independent jury, whose honorary members are drawn from environmental and consumer associations, trade unions, industry, commerce, the craft trades, local authorities, media, churches and two (varying) Federal Länder.

Technical preparation for the development of award criteria is handled by the Federal Environment Agency in Dessau, which also functions as the administrative office. Contractual details of the use of the symbol are dealt with by RAL (Deutsches Institut für Gütersicherung und Kennzeichnung) in St. Augustin.

Since the beginning of 2009 the Blue Angel has also been used to identify especially energy-saving and climate-friendly goods and services. The Blue Angel with the new ‘Protects the climate’ suffix in the logo ensures easy and reliable consumer identification of top climate-relevant products with especially low energy consumption. This places the decision to make an important contribution to climate protection in the consumers’ own hands.

The most important item in all award criteria is much lower power consumption than traditional products. Merely by updating the 10 main household appliances such as refrigerator, washing machine, dishwasher etc., it would be possible to save up to 40 percent in energy costs compared with standard appliances. In addition, the appliances in question must also meet high standards for other environmental properties. For example, espresso machines must have an auto shut-off system (preferably short), plas-

148 For more information, see www.blauer-engel.de.

tic components must not contain any critical substances, and there are stringent limit values for the release of nickel and lead after descaling. The eco label for washing machines is to be used to identify appliances that not only have low power consumption, but also use as little water as possible at the various wash temperatures and can also wash at a temperature of 20 degrees Celsius.

Within three years, award criteria are to be developed for up to 100 new product groups, so that the Blue Angel can be awarded for as many climate-relevant and energy-efficient products as possible.



In future, the Blue Angel also aims to inform consumers better about other aspects in addition to climate protection and to help them with their purchase decisions by using a clear message to emphasise the product's contribution to specific topics in the field of environmental and health protection. For this reason the Federal Environment Ministry, together with the Federal Environment Agency and the eco-label jury, has decided to set clearer priorities within the product portfolio of the Blue Angel.

Initially the Blue Angel will exist in the following categories:



This classification is not final, however. More categories may be added in the future.

Public procurement

The biggest consumer, with the greatest demand power, is the public sector. With an annual purchasing volume of around 260 billion EUR, public procurement in Germany has great potential for supporting environmentally sound products.

The European Commission set a target that by 2010 some 50 percent of all procurement processes in the Member States should take account of environmental criteria. A monitoring exercise is now to be performed to determine whether the Member States have achieved this target. On the basis of these findings, further relevant initiatives can be expected from the European Commission.

In its “Sustainability Measures Programme” adopted in December 2010, the German government has already set itself a number of ambitious targets for “greener” design of procurement procedures. The regional (Länder) and local authorities are also to take similar action. Wherever possible, for example, life cycle costs are to be taken into account when determining the “most economically favourable offer”. Environmentally sound products sometimes involve higher costs for initial investment, but lower costs during the use phase which either pay for the higher initial costs or more than cancel them out. The disposal costs for such products are generally lower than for comparable “conventional” products. Prevention of consequential damage, e.g. climate change, and the need for complex resource production processes can also be considered in the assessment. First concrete regulations on award procedures have been laid down in the transposition of the EU Directive on “Clean and energy-efficient road transport vehicles” into German law. This example shows how the public sector can do much to ensure that the external costs associated with these activities are taken into account in its own procurement procedures.

PART III: GREEN MARKETS OF THE FUTURE



1 Overview

As we have seen in the first part of the Report on the Environmental Economy, the environmental economy is already an important and growing 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 and mechanical engineering – the use of such technologies is becoming increasingly important and is a major factor determining a company’s competitive strength.

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” – in other words decoupling economic growth from the consumption of natural resources.

“Business as usual” would not be wise, either from an economic or an ecological point of view: UNEP estimates indicate that in a business-as-usual scenario, global GDP per capita in 2050 would be 14 percent lower than for a green investment scenario, but the burden on global resources would be 48 percent higher.¹⁴⁹ Former World Bank chief economist Lord 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 seven percent of the global social product by 2050.¹⁵⁰ Moreover, raw materials will be less plentiful in future and hence probably much more expensive than today, and in many cases the capacity of our ecosystems to absorb pollutants is already exceeded.

149 UNEP (2011b).

150 Institute for European Environmental Policy (2008).

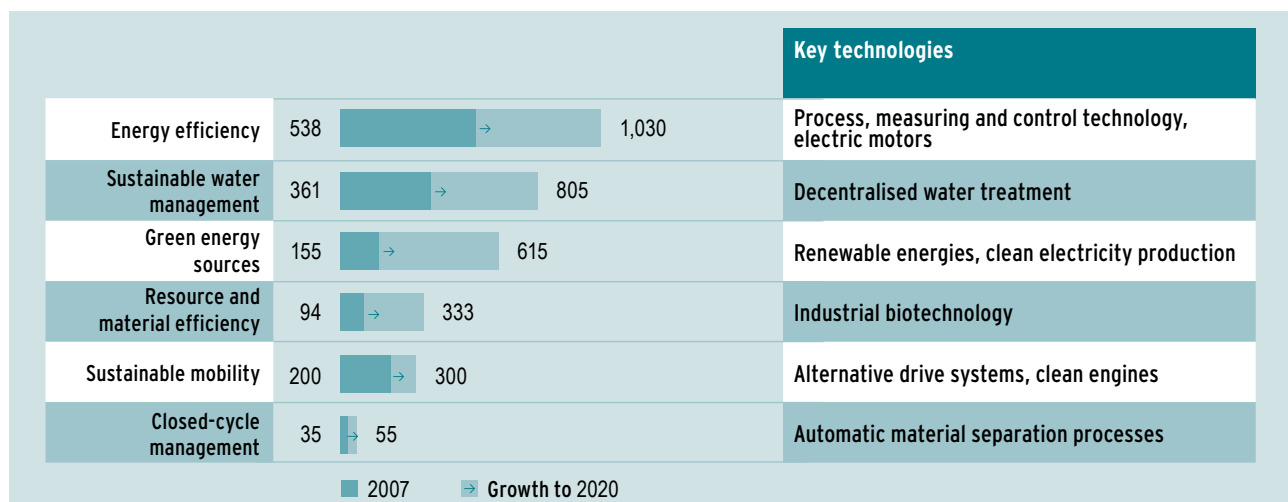
This section looks at six green markets. These are the markets for green energy generation, energy efficiency, resource and material efficiency, sustainable mobility, sustainable water management, and closed substance cycle and waste management. They are characterised by the fact that firstly, they play a key role in safeguarding the existence of human beings and satisfying their basic needs, and secondly, they are of special economic importance. Environmental technologies earned about 8 percent of Germany's gross domestic product in 2007, and by 2020 this share will increase to about 14 percent.¹⁵¹

The analysis of these markets is based on numerous studies performed 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 survey of more than 200 research institutes and 1,300 companies from the identified green markets of the future.¹⁵² 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 1,400 billion EUR in 2007 to 3,100 billion EUR in 2020.¹⁵³ This far exceeds the predictions in the study carried out two years earlier, which worked on the basis of a world market volume of 2,100 billion EUR in 2020.

As Figure 83 shows, the biggest absolute increases in market volume between 2007 and 2020 can be expected in the fields of energy efficiency (+492 billion EUR), green energy generation (+460 billion EUR) and sustainable water management (+444 billion EUR).

Figure 83: Growth of market volume in the green markets of the future (in billion EUR)



Source: BMU (2009b)

151 BMU (2009b).

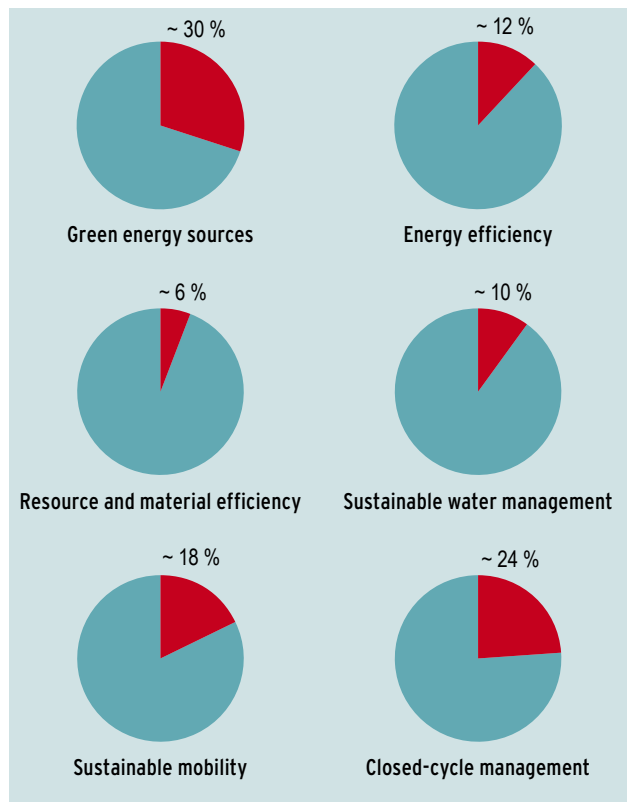
152 The studies from 2007 and 2008 are published (in German) in the series "Umwelt, Innovation, Beschäftigung" (UIB) (Ed. BMU/UBA).

153 BMU (2009b).

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 6 and 30 percent on these individual markets of the future (cf. Figure 84). Germany shows particular strength in green energy generation and in waste and closed cycle management. German companies in these sectors account for a good quarter of the global market.

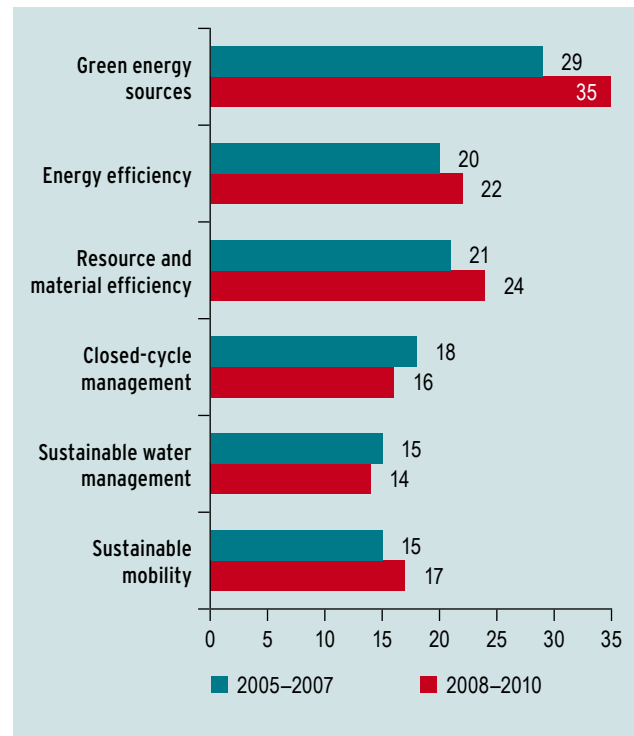
Supported by the strong growth of the world market and their good competitive position on an international comparison, German companies have experienced a boom on the green markets of the future. Average growth rates (in terms of sales) have been particularly high on the markets for green energy, energy efficiency and resource and material efficiency (cf. Figure 85).

Figure 84: German shares of world markets for green technologies 2007



Source: BMU (2009b), p. 19

Figure 85: Sales growth of German companies on green markets of the future (in percent)

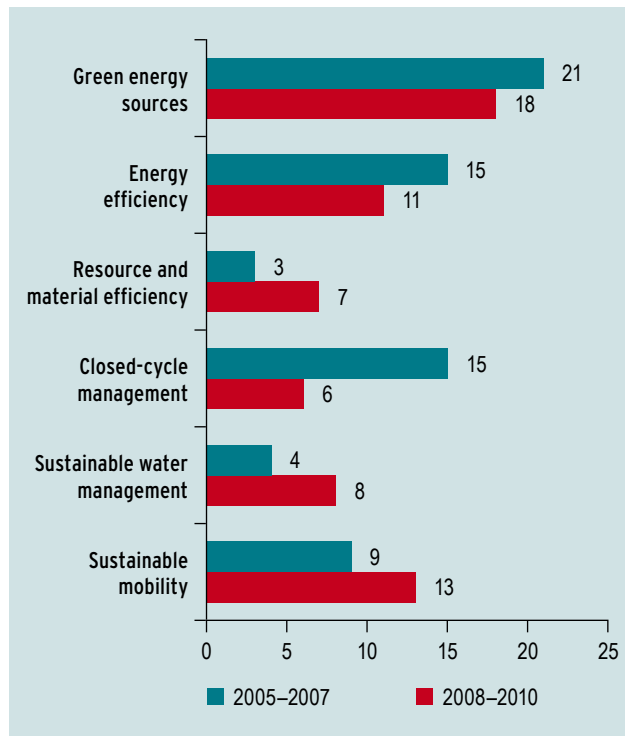


Source: BMU (2009b), p. 19

The rapid sales growth has been accompanied by a marked increase in employment. Personnel numbers at the companies surveyed rose by an average of 14 percent between 2005 and 2007 (cf. Figure 86). From 2008 to 2010 the companies expected their workforce to grow by 10 percent. These figures are 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. In the medium term, environmental protection will become an increasingly important sector for the classic industries as well, such as mechanical engineering and the construction industry (cf. Figure 87), and also a driving force behind modernisation.

Figure 86: Growth of personnel numbers in green markets of the future (in percent)



Source: BMU (2009b), p. 21

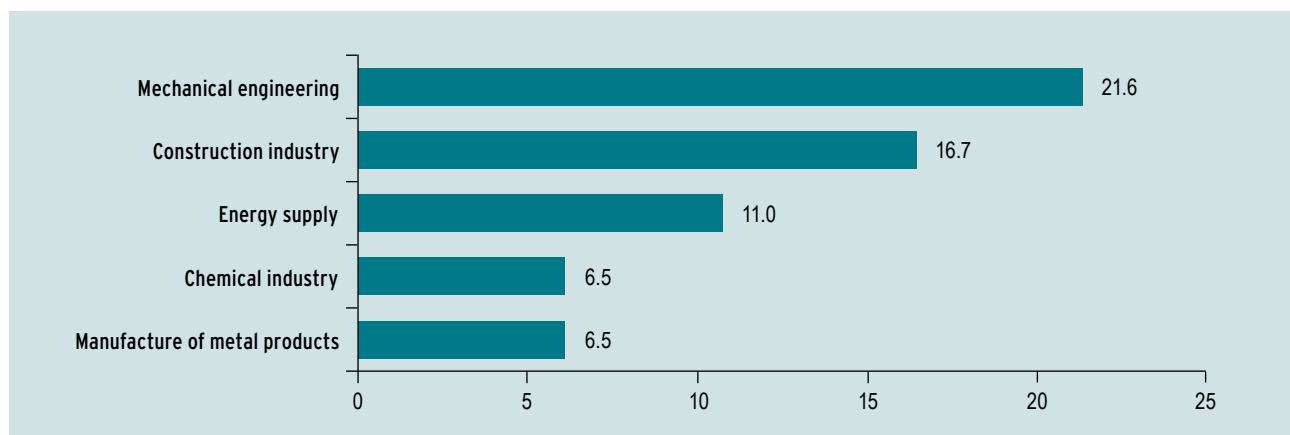
The economic opportunities afforded by the green markets of the future are increasingly being identified by other countries as well. One example is South Korea: during the financial crisis the country started an economic stimulus programme that was more than 80 percent “green” in character. Under the

“Five-Year Green Growth Plan” from 2009 to 2013, two percent of gross domestic product is to be used for investments in climate protection and energy, sustainable transport and the development of green technologies.¹⁵⁴ China too is very active in the environmental protection sector and in its efforts to establish an internationally competitive environmental economy. Today Chinese companies are already market and technology leaders in a number of fields of environmental technology, for example photovoltaic systems (cf. Part III, Chapter 2).

In view of the growth prospects, the international race for leading positions on the green markets of the future has long been in full swing, and competition is getting keener. This is also indicated by the survey conducted by Roland Berger Strategy Consulting: Nearly all the 1,300 companies questioned expect the competition situation to become more intense by 2020. Germany and the EU will have to make additional efforts to defend their leading positions on many markets of the future and not get left behind.

→ **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.greentechatlas.de>.

Figure 87: Original sectors of companies that have diversified into environmental technology (in percent)



Source: BMU (2009b), p. 31

154 UNEP (2011a).



2 Green energy generation

2.1 Challenges for green 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 around 47 percent between 2008 and 2035 if the policy measures already adopted are maintained.¹⁵⁵ 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 88).

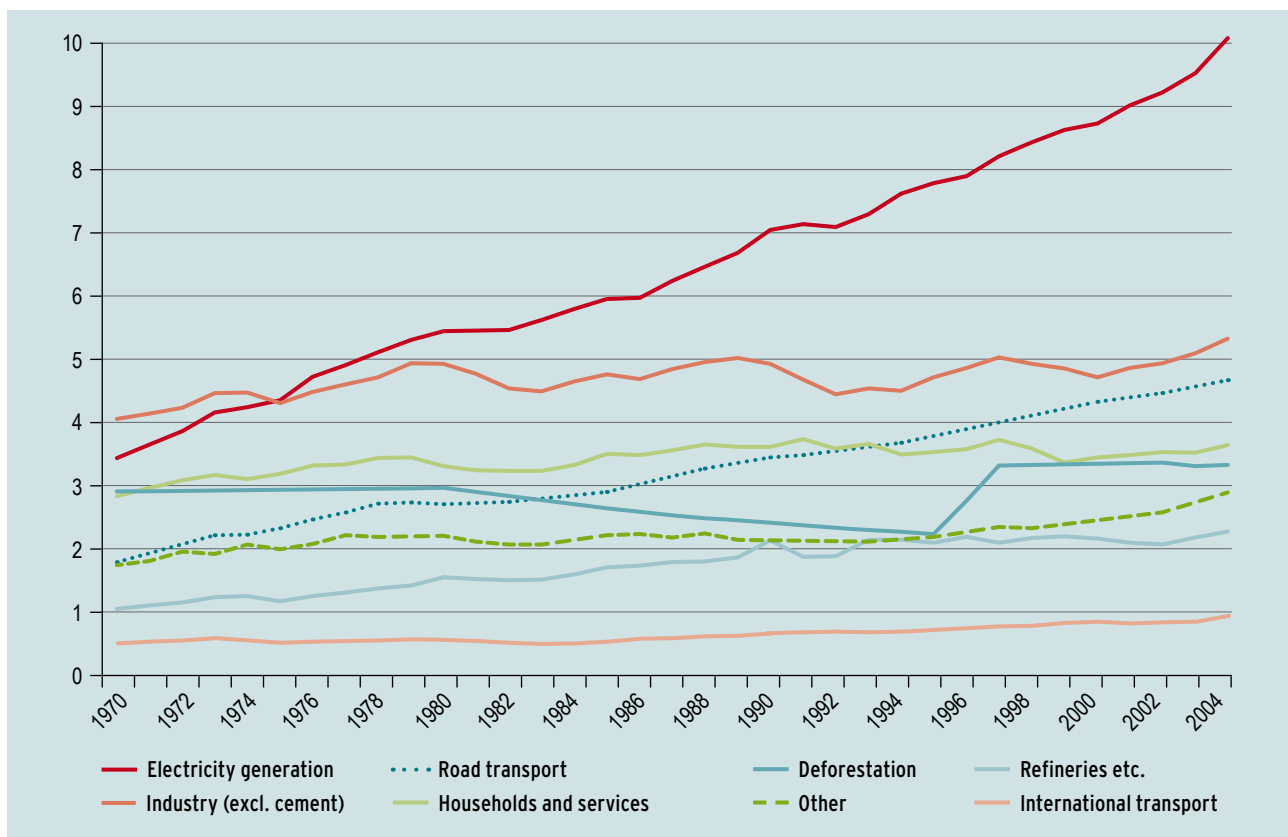
To limit the scale of climate change, there needs to be a drastic reduction in global CO₂ emissions.¹⁵⁶ And this – in view of the economic backlog in the developing countries – applies particularly to the industrialised countries. The EU Council of Ministers

has therefore decided to cut the EU's greenhouse gas emissions by 30 percent compared with 1990 by the year 2020, provided other countries make comparable efforts. Apart from this, the EU has undertaken to reduce emissions by at least 20 percent in the same period. Renewable energy sources as a share of final energy consumption are to be stepped up to 20 percent by 2020, and energy consumption is to be reduced by 20 percent compared with a reference trend by increasing energy efficiency. The energy efficiency target is the only target to date that is not binding.

Under the Energy Concept, Germany has again undertaken to reduce its greenhouse gas emissions by 40 percent by the year 2020, and by at least 80 to 95 percent by 2050, in both cases compared with 1990. To achieve this, the German government has adopted not only the Energy Concept, but also the

¹⁵⁵ IEA (2010).

¹⁵⁶ Cf. IPCC (2007a). To ensure a good probability of limiting global warming to 2 degrees Celsius, it is necessary to reduce global greenhouse gas emissions by 50 to 85 percent by the year 2050 (compared with 2000).

Figure 88: Sources of global CO₂ emissions 1970–2004 (Gt CO₂ per year)

Source: IPCC (2007), p. 104

Integrated Energy and Climate Programme, which comprises a total of 29 measures.¹⁵⁷ The biggest contribution to reduction is to be made by energy generation technologies. In the first place there is the further expansion of renewable energy sources in the electricity sector. But efficiency improvements in fossil power plants and co-generation of heat and power are also to make significant contributions to the targeted reduction in greenhouse gas emissions.

The European Union has introduced European emissions trading at company level as the most important instrument for meeting its emission reduction commitment in the energy sector. In Germany emissions trading covers around half of CO₂ emissions as a result of the inclusion of installation in the energy sector and CO₂-intensive industries.

2.2 Products and technologies for green energy generation

There are two central levers for gradually reducing CO₂ emissions in the energy production sector: reducing emissions caused by combustion of fossil fuels, and making greater use of renewable energy sources.

The market of the future for green energy generation therefore consists mainly of the following product groups:

- **Renewable energy sources** such as hydro power, solar thermal energy, photovoltaics, wind power, geothermal energy, biogas and biomass systems;
- **Efficient power plant technologies** such as gas and steam plants, low-CO₂ coal-fired power plants or combined heat and power systems, e.g. CHP plants;

157 Cf. BMU (2009d).

- **Energy storage technologies** such as chemical, compressed air, magnetic, underground or hydrogen storage;
- **Hydrogen technologies and fuel cell applications.**

Moreover, the energy infrastructure issue is becoming increasingly important. Grid expansion, smart metering and smart grids are coming more and more to

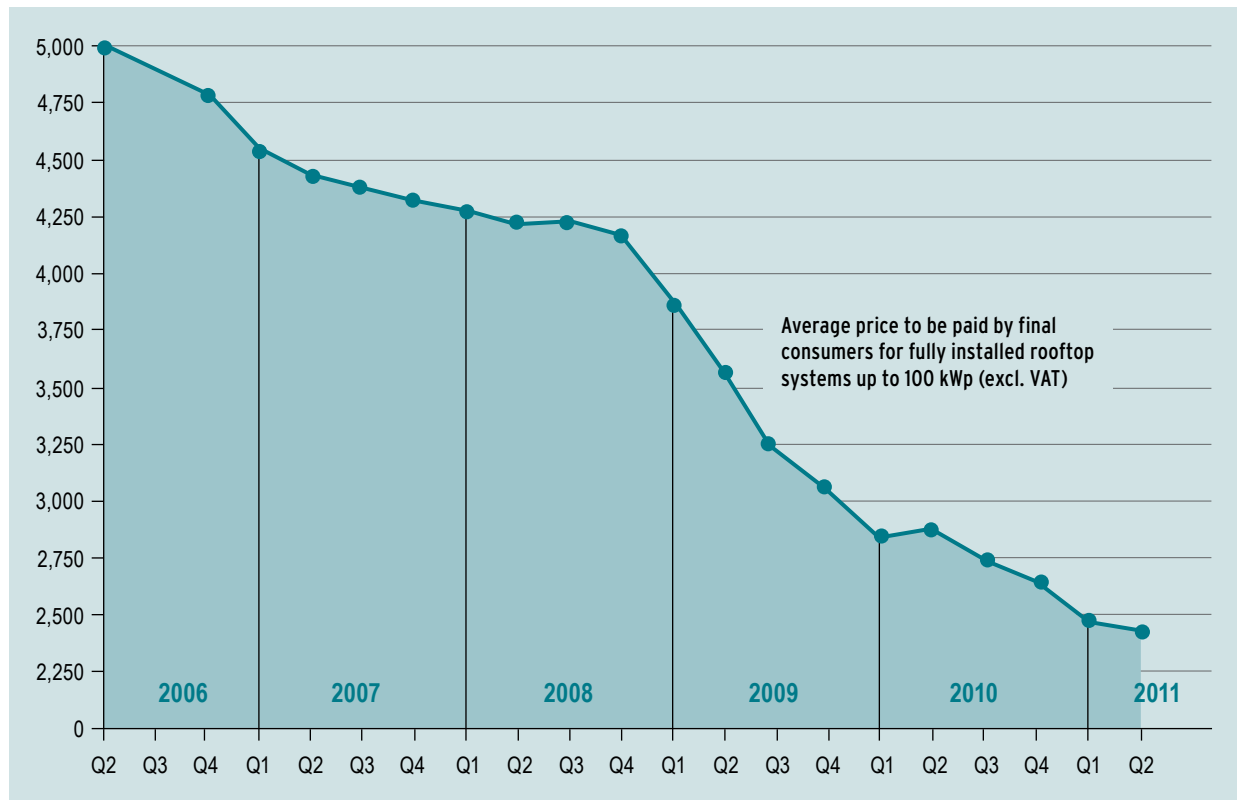
the fore with the ongoing expansion of renewable energy. Which means the growth prospects are excellent in these fields too.

As 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.

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

The cost of most technologies for using renewable energy sources has fallen considerably over the last 20 years. In particular, the cost and price situation in the photovoltaic (PV) sector reflects a remarkable success story. In the early 1990s a PV system fully installed on the roof of a building cost around 15,000 EUR/kWp. By the beginning of 2006 the price had fallen to about 5,000 EUR/kWp. Since then it has halved again. In 2009 alone, prices fell by a third (cf. Figure 89).

Figure 89: Development of prices for photovoltaic power systems (EUR/kWp)



Source: German Solar Industry Association (BSW-Solar) 2011. Independent, representative survey of 100 installers by EuPD Research

2.3 Market potentials

Fact file: Green energy generation ¹⁵⁸		
Size of world market	2007	155 billion EUR
	2020	615 billion EUR
Germany's share of world market	2007	~ 30 %
Sales growth	2005 to 2007	29 %
	2008 to 2010	35 %
Growth in personnel numbers	2005 to 2007	21 %
	2008 to 2010	18 %

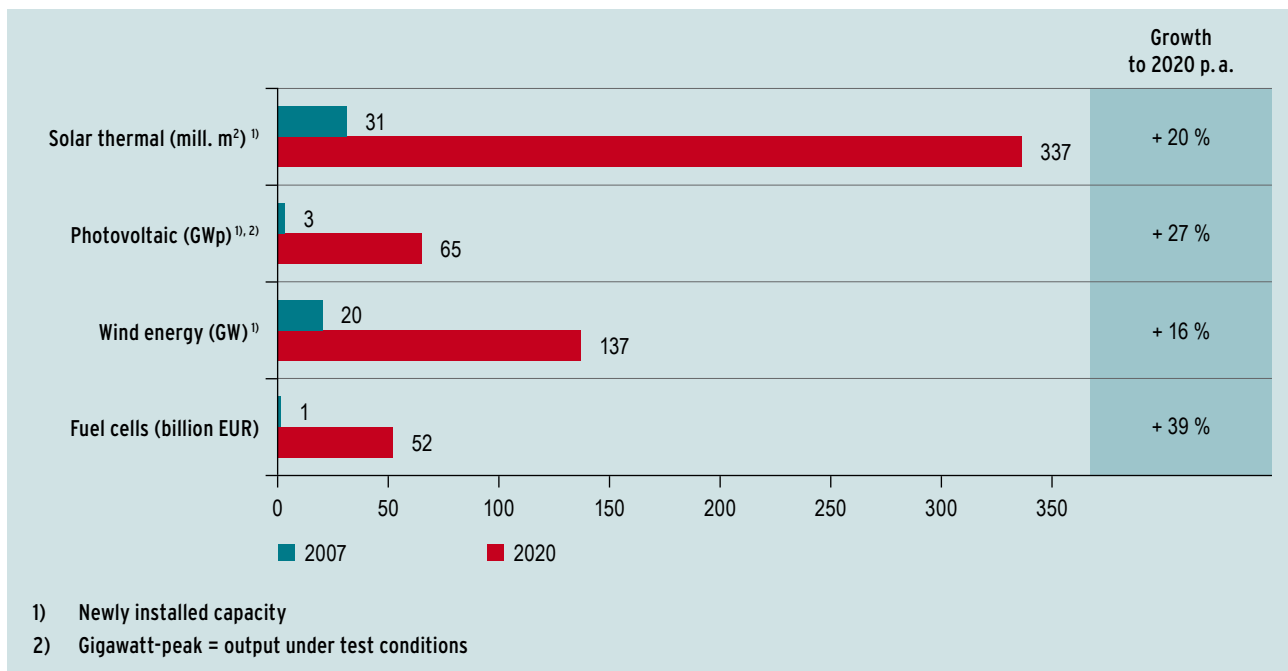
In 2007 the world market for green energy generation stood at around 155 billion EUR. In spite of the economic and financial crisis, worldwide annual investment in clean energy technologies rose to around 162 billion US dollars in 2009, roughly a third of which was due to developing and emerging economies.¹⁵⁹ According to a forecast by Roland Berger Strategy Consultants the world market volume is like-

ly to grow to 615 billion EUR by 2020, which means it will almost quadruple.¹⁶⁰

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, biogas and wind energy systems, and also fuel cells, with worldwide annual sales growth of 15 to over 30 percent (cf. Figure 90: World market projections for green energy generation). Solar energy provides an example of the dynamic worldwide development of the markets in the renewable energy sector. Production of solar cells rose by 119 percent from 2009 to 2010 (cf. Figure 91).¹⁶¹

Between 2021 and 2030, according to scenario evaluations by the IPCC, up to 7,180 billion US dollars will be invested worldwide in the expansion of power generation from renewable energy sources alone.¹⁶² The world market for renewable energy technologies will more than quadruple between 2007 and 2030 – from 132 billion EUR to nearly 590 billion EUR.¹⁶³

Figure 90: World market projections for green energy generation



Source: BMU (2009b), p. 63

158 BMU (2009b).

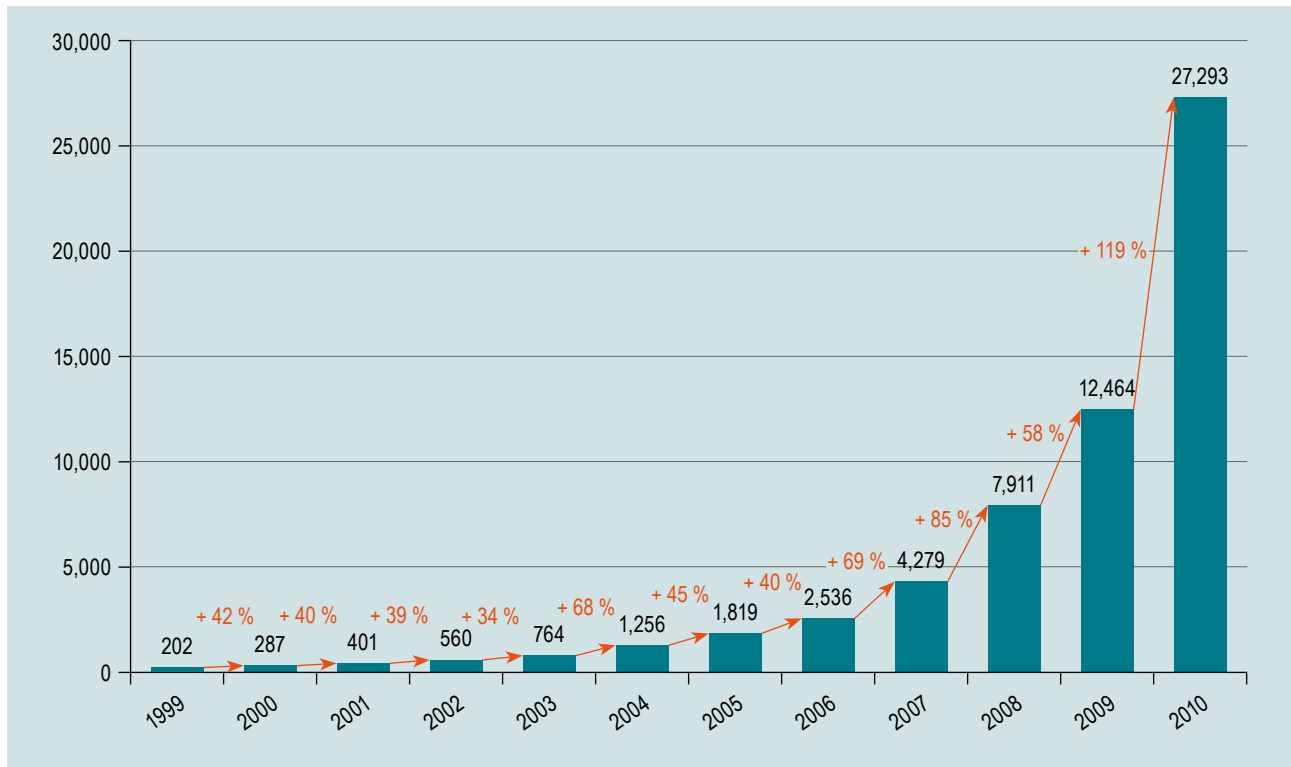
159 WBGU (2011).

160 BMU (2009b).

161 Photon (2011a).

162 IPCC (2011).

163 Lehr et al (2011). Money amounts in real prices 2005.

Figure 91: Worldwide solar cell production from 1999 to 2010 (in MW)

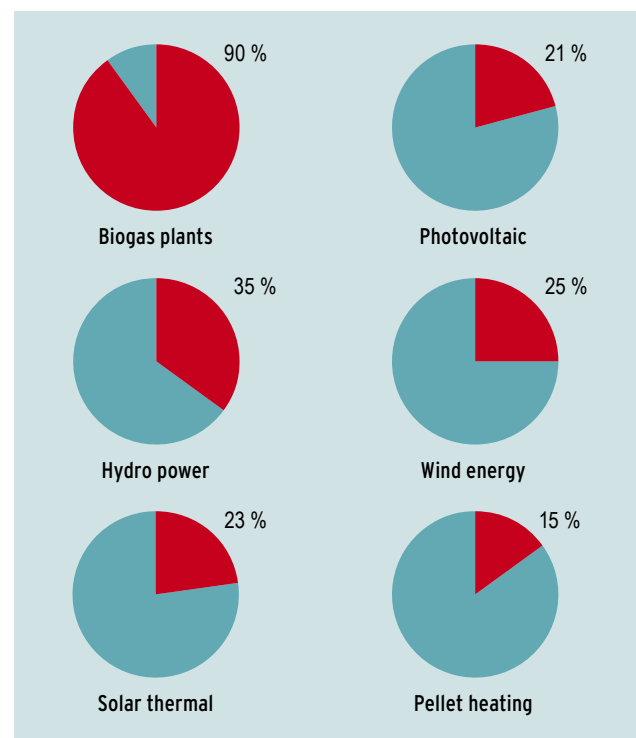
Source: Photon (2011a)

2.4 Position of German companies

Shares of world market and world trade

In many technologies for green 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 2007 German manufacturers had around 90 percent of the world market for biogas installations, 25 percent of wind energy, 23 percent of solar thermal energy, and 21 percent of photovoltaic systems (cf. Figure 92).

German companies' shares of world trade¹⁶⁴ present a similar picture. In technologies for wind energy, collectors and biomass, their world trade shares in 2007 were as much as 27, 26 and 20 percent.¹⁶⁵ Germany's share of world trade in products for using renewable energy sources averaged more than a quarter.

Figure 92: World market shares of German companies in the field of green energy generation 2007

Source: BMU (2009b), p. 64

164 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.

165 Lehr et al (2011).

In the long term it is likely that new producers will enter the growing world market, which could result in a drop in Germany's share of world trade. However, since the markets for renewable energy technologies are growing very rapidly, a sharp rise in exports can be expected even in the event of a smaller share of world trade.

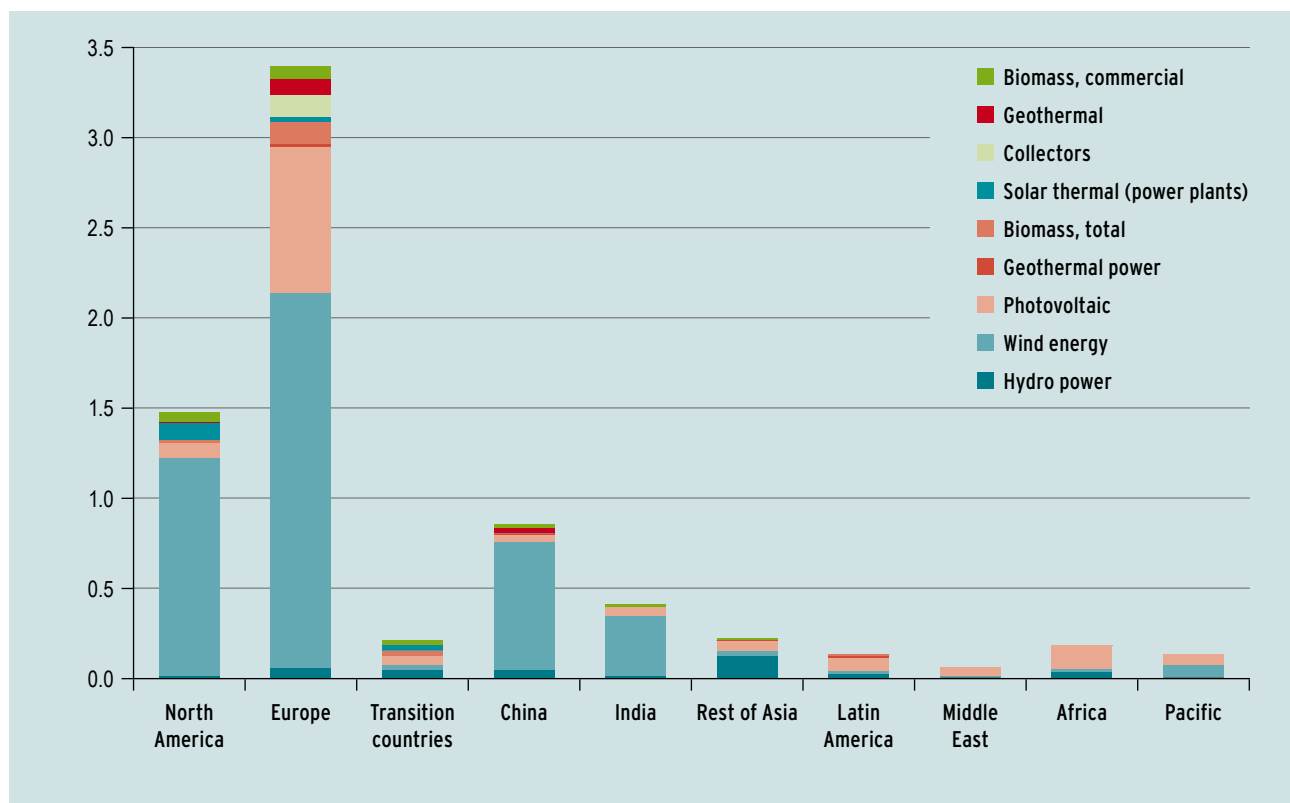
Export hit: Renewable energy

In 2007, German exports in the renewable energy sector totalled 6.53 billion EUR, and world trade as a whole came to 23.5 billion EUR. Nearly half of German exports in this sector were due to wind energy, with an export volume of over 3.1 billion EUR, followed by photovoltaics with nearly 2.5 billion EUR. In terms of company turnover, export rates in these

sectors averaged around 45 percent.¹⁶⁶ The main sales markets were in Europe, North America and China, though there were considerable differences between the types of technology. For example, German exports to North America and China were dominated by wind energy, whereas photovoltaic systems accounted for by far the largest share of exports to Africa (cf. Figure 93).

In an optimistic scenario, estimates of future exports by the sector are around 33 billion EUR for 2020 and nearly 48 billion EUR in 2030. A conservative scenario expects exports of nearly 20 billion EUR for 2020 and 33 billion for 2030.¹⁶⁷ Even on fairly pessimistic assumptions, exports in the renewable energy sector would show a threefold increase by 2020 and a fivefold increase by 2050.

Figure 93: German exports of capital goods in the renewables sector by regions 2007 (in billion EUR)

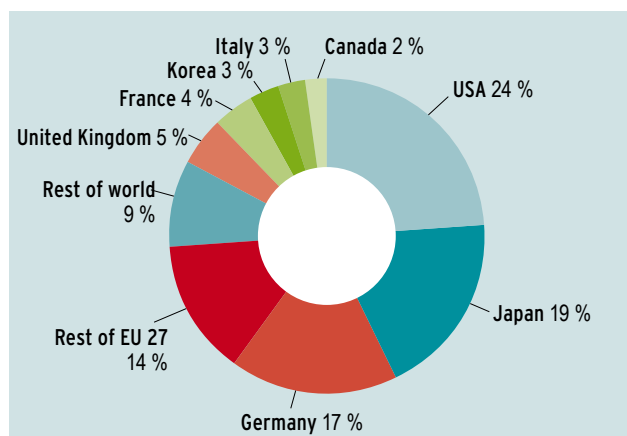


Source: Lehr et al (2011), p. 185

¹⁶⁶ Lehr et al (2011). Money amounts in real prices 2005.

¹⁶⁷ Lehr et al (2011). Money amounts in real prices 2005.

Figure 94: Worldwide shares of patents on products in the renewables sector by countries 2004-2007



Source: Schasse et al (2010), p. 93

Position of German companies with regard to patents

With regard to the number of patents – another indicator of international competitiveness – Germany is also very well placed in the renewables sector (cf. Figure 94). During the period 2004 to 2007 Germany took third place worldwide with 17 percent, after the USA with 24 percent and Japan with 19 percent.

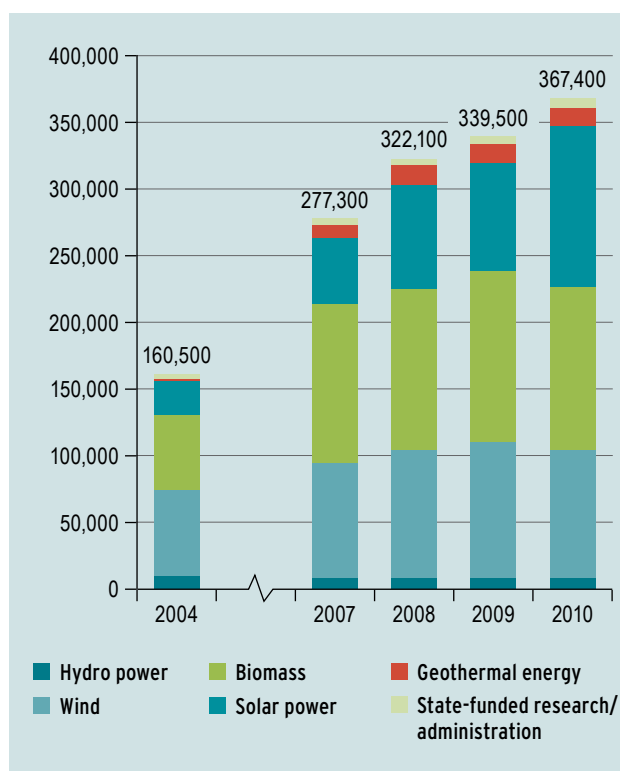
2.5 Employment effects of renewable energy

Environmental technology creates jobs. The biggest job generator in the field of green energy generation is renewable energy sources (cf. Part I, Chapter 2). In 2010 nearly 370,000 people were employed in the renewables sector (cf. Figure 95).¹⁶⁸ 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 2004.¹⁶⁹ 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 Outlook

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 is 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

Figure 95: Gross employment due to renewable energy in Germany 2004-2010



Source: DLR, DIW, ZSW, GWS (2011), p. 5

¹⁶⁸ DLR, DIW, ZSW, GWS (2011).

¹⁶⁹ Kratzat et al (2006).

the promotion of renewable energy sources. To date more than 61 countries and 26 regions or federal states have introduced feed-in payments based on the EEG model, and in the EU alone this means as many as 20 countries. Many developing and emerging countries such as China, South Africa, Kenya, Thailand, Indonesia, the Philippines and Argentina are also using this instrument to promote the expansion of renewable energy sources.¹⁷⁰ This shows how important it is to propagate the use of successful climate protection instruments in other countries.

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.¹⁷¹ Quota systems with tradable certificates of the kind introduced in some European countries do not result in comparable success in the expansion of renewable energy, 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.¹⁷²

German companies are well placed on the future market for green 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 force in the years ahead, driven

by growing profitability of renewable energy, national and international climate protection objectives and specific targets for the expansion of renewable energy sources that have been defined not only by Germany and the EU, but also many other countries.¹⁷³

The European emissions trading scheme will also put considerable pressure on companies to reduce CO₂ emissions from energy generation using fossil fuels. In the years ahead, the increasing shortage 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 emerging nations that are strong on technology. China, for example, has caught up rapidly in the field of solar cell production and is now by far the biggest producer of solar cells with a world market share of 48 percent in 2010.¹⁷⁴ Germany, by contrast, has experienced a marked drop in its market share, and in 2010 was pushed into third place in the world rankings behind Taiwan with a market share of 9.7 percent. 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 technological edge.

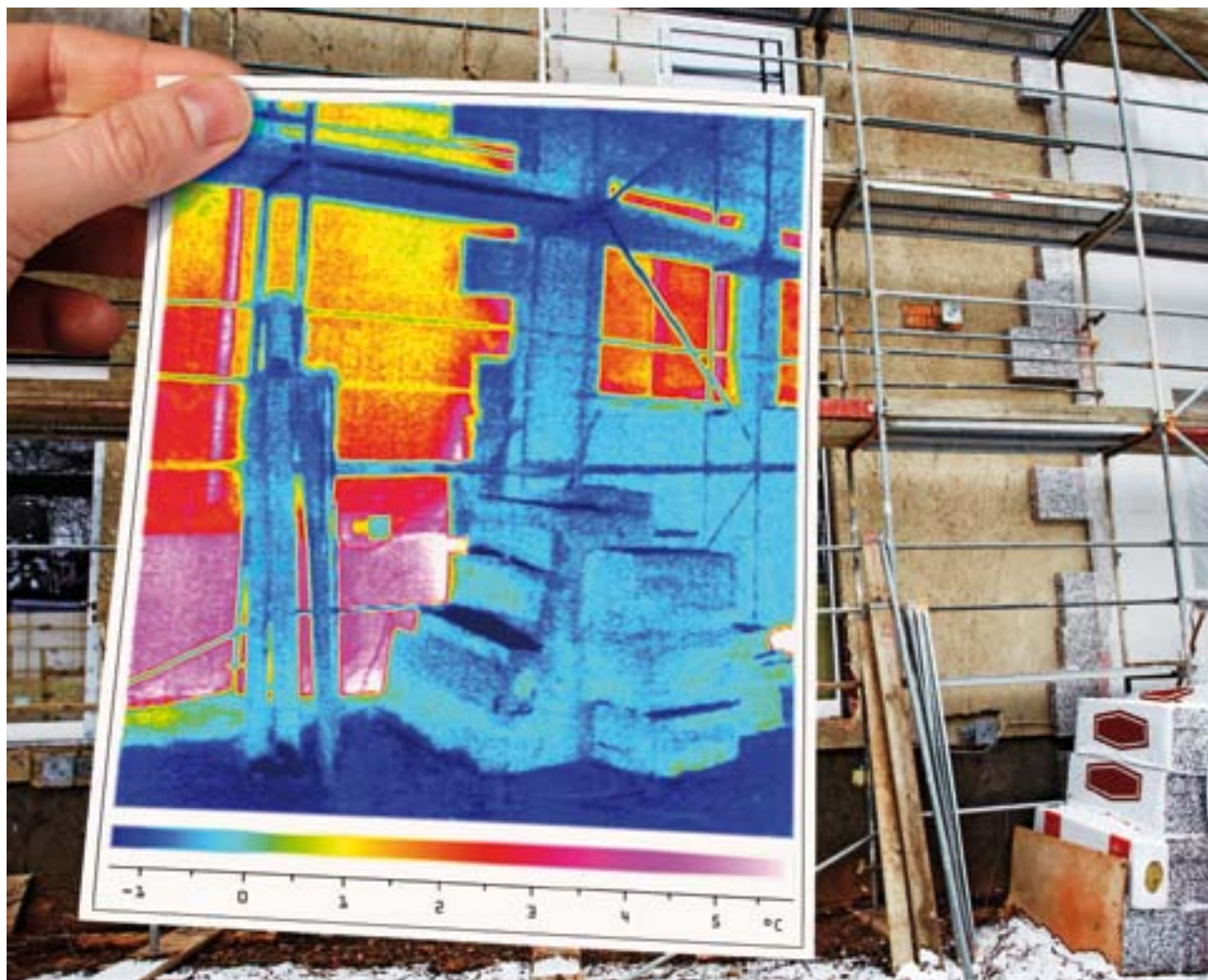
170 REN21 (2011).

171 COM (2008a).

172 WBGU (2011).

173 REN21 (2011).

174 Photon (2011b).



3 Energy efficiency

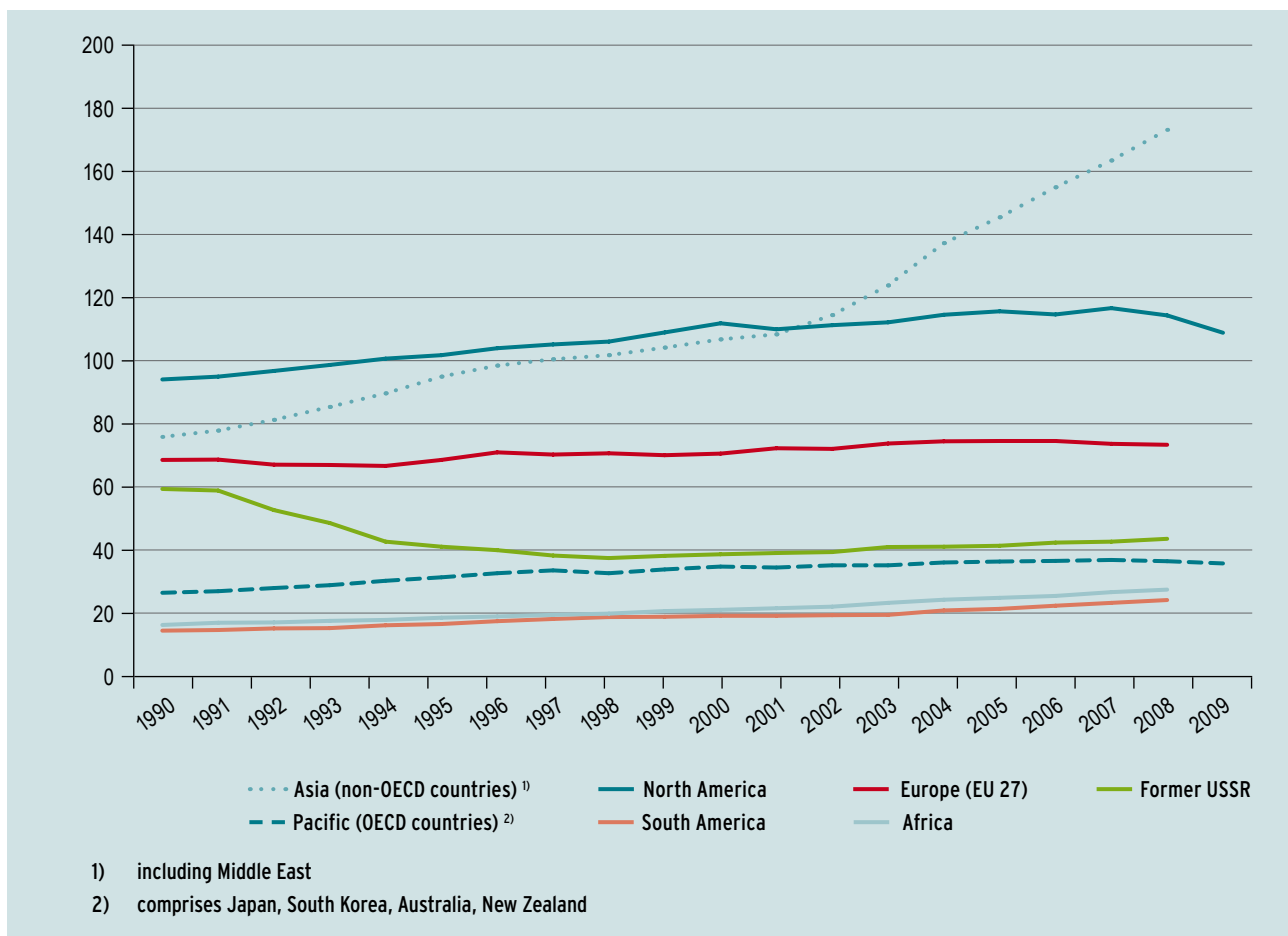
3.1 Challenges for improving energy efficiency

Improving energy efficiency is a major element in the fight against global warming. In view of the world's growing population, future annual emissions must not exceed two tonnes of CO₂ per capita if the target of limiting global warming to 2 degrees above pre-industrial times is to be achieved. At present the figure in Germany is five times higher. Diminishing resources and high levels of energy-induced environmental damage also make it necessary to cut back global energy consumption.

The worldwide trend in energy consumption provides a dramatic picture of the need for efficiency improvements: Between 1990 and 2008 worldwide primary energy consumption rose by around 40 percent.¹⁷⁵ Even in regions that already consume large amounts of energy, such as Europe or North America, consumption is still growing (cf. Figure 97). In the absence of additional measures to improve energy efficiency, global energy consumption will continue growing. In such a scenario the primary energy consumption of 2008 would increase by 1.4 percent per annum, from about 12,000 million tonnes of oil equivalent (MTOE) to 18,000 MTOE in 2035. This corresponds to a total growth of over 66 percent.¹⁷⁶

175 Federal Ministry of Economics and Technology (BMW 2010a).

176 IEA (2010).

Figure 96: Primary energy consumption trends in world regions (in exajoules)

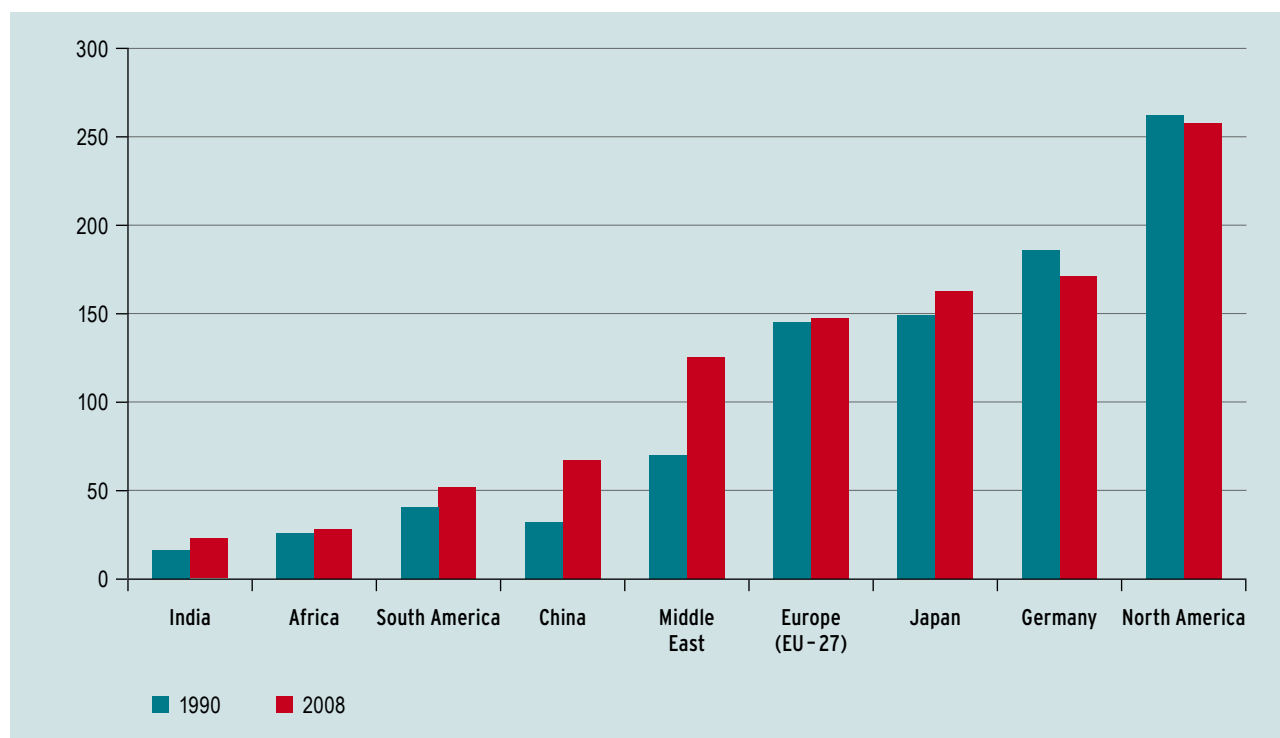
Source: Federal Ministry of Economics and Technology (BMWi 2010a)

In Germany energy productivity – a measure of the energy efficiency of a national economy – increased by nearly 40 percent from 1990 to 2010.¹⁷⁷ In spite of this increase, primary energy consumption fell by only 6 percent during this period.¹⁷⁸ This means that in the past economic growth has almost cancelled out the efficiency gains. On the whole, per capita consumption is still very high compared with most countries. Against this background, there is a need for additional efforts to continue improving energy efficiency.

The German government's Energy Concept envisages a long-term increase in energy productivity, averaging 2.1 percent per annum until 2050. Primary energy consumption is to fall by 20 percent by 2020 and 50 percent by 2050; the corresponding figures for electricity consumption are 10 and 25 percent. The technical ways and means exist for a marked increase in energy efficiency. Studies show that it would be possible to save 110 to 130 million tonnes of CO₂ in Germany if the economic potential for saving final

177 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 II, Chapter 1.3.

178 Federal Environment Agency (UBA 2011f).

Figure 97: Comparison of per capita primary energy consumption (in GJ)

Source: Federal Ministry of Economics and Technology (BMWi 2010b)

energy were fully exploited in all consumption sectors.¹⁷⁹ Of this, more than half is due to saving electricity.

Measures for improving energy efficiency make macro-economic sense, because they are a key to improving competitiveness – particularly in the face of high

EU Commission's Energy Efficiency Plan 2011

The EU target of a 20-percent reduction in energy consumption by 2020 cannot be achieved without additional measures. The EU Energy Efficiency Plan is intended to help here. Among other things, it envisages:

- reducing energy consumption in at least 3 percent of all public buildings every year, and making energy efficiency an integral element of all public-sector tender procedures,
- reducing energy consumption in buildings used for commercial purposes,
- increasing efficiency in electricity generation and space heating,
- obliging large enterprises to introduce energy audits and energy management systems,
- making further reductions in the energy consumption of household appliances, and
- using intelligent networks and smart meters to increase the transparency of electricity costs and give consumers greater economic incentives to save electricity. For example, the Member States must provide smart meters for at least 80 percent of their final customers by 2020, if a cost-benefit analysis reveals that this is economic at national level.¹⁸⁰

179 See for example Wuppertal Institut für Klima, Umwelt, Energie (2006); Prognos (2006); McKinsey (2007b).

180 COM (2011h).

energy prices that are likely to continue rising. They also reduce Germany's dependence on raw material imports and its vulnerability to substantial energy price increases. The economic importance of energy price increases is still considerable: for example, Germany's foreign energy bill rose from 58 billion EUR in 2005 to 112 billion EUR in 2008.¹⁸¹ The most important factor here was the explosion of resource and energy prices during this period.

Germany has a lead in many areas of energy efficiency technologies in particular. Extending this lead secures existing jobs and creates new ones. The European Commission believes that energy efficiency measures designed to save 20 percent of the EU's primary energy consumption could create up to two million jobs in Europe.¹⁸² At the same time this would result in direct energy cost savings of around 220 billion EUR per annum by 2020.¹⁸³ The EU Commission's Energy Efficiency Plan sets out measures for achieving the EU reduction target.

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 performance contracting are also gaining importance. In such cases a service provider optimises the customer's technical installations, bears the cost of this and guarantees a specified energy saving. This is paid for by the saving in energy costs. The service provider usually has a share in any further savings, thereby motivating him to implement additional measures during the multi-year contract. 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 (cf. Part III, Chapter 5).

The market of the future in the field of energy-efficient products essentially comprises the following product groups and technologies:

- **Energy-efficient building services technology** makes a considerable contribution to efficient use of energy. In Germany about 35 percent of final energy demand is due to space heating and water heating.¹⁸⁴ 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.¹⁸⁵ 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.
- **Energy-efficient electrical equipment and lighting** are of great importance, because the growing number of electrical appliances in German households means that more and more electricity is being consumed. To reduce electricity consumption it is therefore especially important to ensure that energy-saving electrical appliances and lighting become widely established on the market. Energy-saving lamps have lower life-cycle costs and use up to 80 percent less energy than conventional lamps. If more energy-saving lamps were used, it would be possible to save up to 11 billion kilowatt-hours of electricity in Germany alone, which is equivalent to the annual consumption of four million two-person households.¹⁸⁶ All in all, as much as 16 billion kilowatt-hours could be saved on lighting, cooling and freezing in private households.¹⁸⁷

181 BGR (2007); GVST (2010).

182 COM (2011h).

183 COM (2008b).

184 AG Energiebilanzen (2011).

185 Cf. Levine et al (2007).

186 BMU (2009b).

187 ZVEI (2008).

- **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.
- **Energy-efficient industrial cross-sectional technologies** are technologies that are used in many places independently of a specific industry. Examples include heat exchanger systems, compressed air 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 4 percent of Germany's total greenhouse gas emissions.¹⁸⁸ 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.¹⁸⁹ The potential savings in industry in the fields of lighting, drive systems and motors amount to 35 billion kilowatt-hours.¹⁹⁰
- **Information and communication technologies (ICT)** can help to save resources and reduce greenhouse gases in many fields. This is also known as “**Green through IT**”. Examples include intelligent control of power grids, cars or buildings, and avoiding traffic by means of teleworking

and phone or video conferences. Today everyone is talking about new IT concepts such as “smart grids”, “smart home”, “cloud computing” and “enterprise resources management”. They belong to the top trends in the IT sector, but at the same time they have considerable potential for improving energy efficiency for conserving resources.¹⁹¹ Estimates indicate that the use of IT technologies in the mobility, buildings, power grids and logistics sectors would make it possible to save around 194 million tonnes of CO₂ emissions a year in Germany by 2020.¹⁹² On a worldwide scale, the use of ICT products and services could save as much as 7.8 gigatonnes of CO₂ emissions – or about 15 percent of the forecasted global emissions.¹⁹³

At the same time, the use of computers and the Internet gives rise to considerable electricity consumption. In 2020 the IT sector will probably cause around 1.4 gigatonnes of CO₂ emissions worldwide. This corresponds to about 3 percent of global CO₂ emissions.¹⁹⁴ It is therefore necessary to develop and implement information technologies that are greener and more climate friendly (“Green IT”). Servers and computer centres, for example, offer great efficiency potential. 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 stood 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 EUR. 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 EUR by 2013.¹⁹⁵

188 UBA (2007c); UBA (2011g).

189 Walz et al (2008).

190 ZVEI (2008).

191 BMU (2011i).

192 BMU (2010f).

193 GeSi Activity Report (2009).

194 GeSi Activity Report (2009).

195 BMU (2009h).

Example: Klinikum Kulmbach - Modernising the hospital's computer centre by server virtualisation

Under the environmental innovation programme in the key funding area "IT goes green", the Federal Environment Ministry supported a server virtualisation project at the hospital "Klinikum Kulmbach". The previous 25 physical servers were combined and reduced to only four physical servers by means of virtualisation software. At the same time the necessary storage capacity was optimised by using new, more energy-efficient hard disks. This reduced the hospital's electricity consumption by 76,000 kilowatt-hours and its carbon dioxide emissions by 45.3 tonnes per annum. It also liberated the other servers for new tasks.

These measures improved the hospital's server utilisation, reduced its operating and hardware costs, and created a uniform system architecture. This will considerably simplify future optimisation and installation processes.¹⁹⁶

3.3 Market potentials

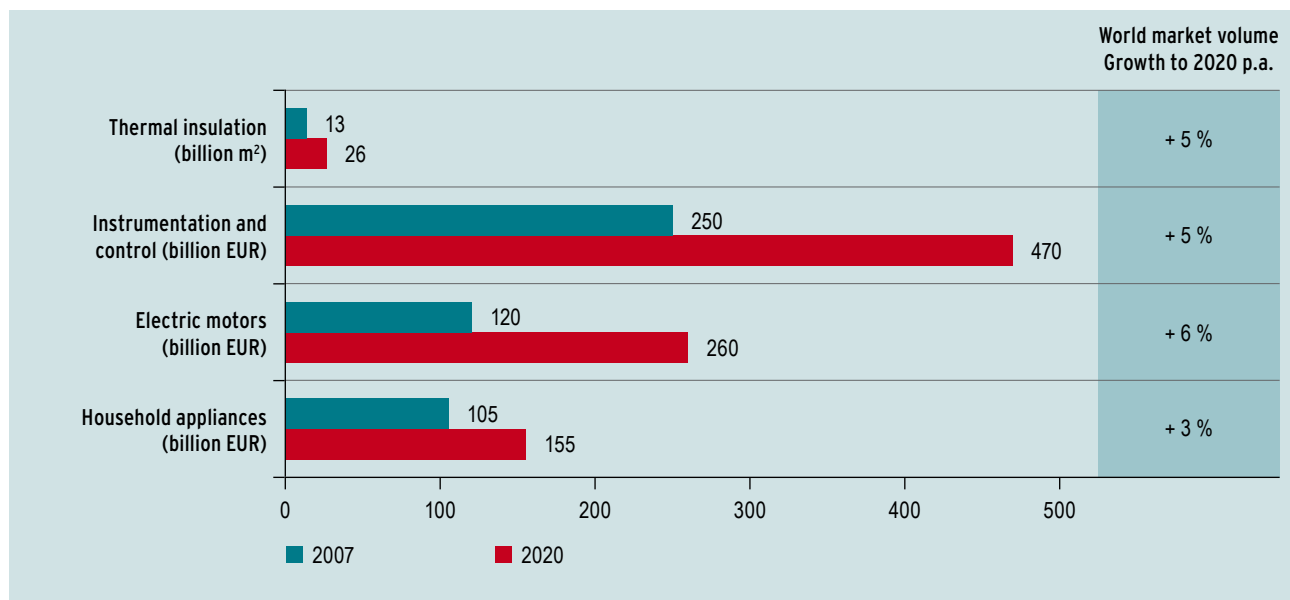
Fact file: Energy efficiency¹⁹⁷

Size of world market	2007	540 billion EUR
	2020	1,030 billion EUR
Germany's share of world market	2007	~ 12 %
Sales growth	2005 to 2007	20 %
	2008 to 2010	22 %
Growth in personnel numbers	2005 to 2007	11 %
	2008 to 2010	11 %

As early as 2007 the products and services that make a contribution to energy efficiency already had a world market share of 540 billion EUR. By 2020 this volume will probably double – which makes energy efficiency the lead market with the largest predicted market volume.

However, with annual growth rates of three to six percent in certain core areas (cf. Figure 98), the market is considerably less dynamic than other green markets of the future. This is connected with the

Figure 98: World market projections for energy efficiency

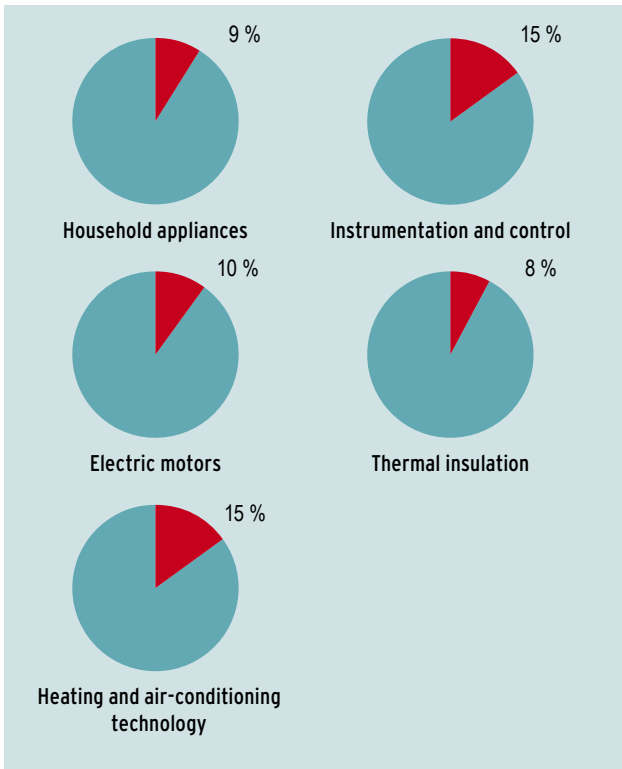


Source: BMU (2009b), p. 87

¹⁹⁶ BMU (no date).

¹⁹⁷ BMU (2009b).

Figure 99: World market shares of German companies in the field of energy efficiency 2007



Source: BMU (2009b), p. 88

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. With annual growth of over 50 percent the innovative field of solar cooling, which in 2007 accounted for only a few million EUR, will have a market volume of several billion EUR in 2020.¹⁹⁸

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 99). Particularly in the field of heating and air-conditioning technology they are among the biggest producers worldwide; their share of this world market is around 15 percent. In the instrumentation and control (IC) sector the figure is also 15 percent.

Figure 100: Development of world trade shares in the market for energy efficiency (in percent)



Source: Walz et al (2008), p. 63

198 BMU (2009b).

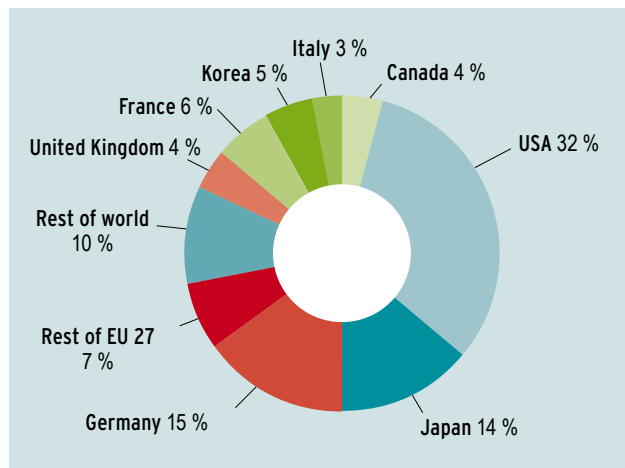
In the fields of electric motors, thermal insulation and “white goods”, German companies supply a tenth of the world market. The companies are highly profitable on average, and nearly a quarter report a return on sales in excess of ten percent.

In exports of energy efficiency products Germany, with 17 percent of world trade in 2004, was well ahead of Italy, the USA and Japan (cf. Figure 100). Sales opportunities exist especially in the industrialised markets of Europe and North America and in Eastern Europe and Russia.

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. The field is headed by the USA with 32 percent of patent applications. Germany, with 15 percent, had the second-largest share of patents for efficient energy use and conversion technologies, followed by Japan with 14 percent (cf. Figure 101).

Figure 101: Worldwide shares of patents in the market for efficient energy use and conversion by countries 2004–2007



Source: Schasse et al (2010), p. 93

3.4 Outlook

The market prospects for highly energy-efficient products and technologies will continue improving considerably because of the growing demand for energy, rising energy prices, and more stringent statutory requirements. The need to comply with the goal of limiting global warming to 2 degrees above pre-industrial times also makes it necessary to save energy and use it much more efficiently than at present. 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 compared with environmentally sound energy production, although a wide variety of opportunities exist in this field 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) and the principles paper adopted on 6 June 2011 for the accelerated transformation of energy systems will provide a further stimulus for greater energy efficiency.



4 Resource and material efficiency

4.1 Challenges for resource and material efficiency

The use of resources gives rise to environmental impacts throughout the entire value chain – from extraction of resources, through processing and use of products, to their disposal. Land use and energy consumption release greenhouse gases – the manufacture of cement and steel alone is responsible for around 15 percent of global CO₂ emissions. The metal content of ores from traditional deposits is declining, and some raw materials are now being obtained from remote regions. The environmental impacts and risks involved are often very considerable, for example in the production of oil from oil shales or extraction of ores in tropical forests. The necessary infrastructure places a further burden on the environment. There is also the problem of disposing of industrial and mining waste, especially when it contains heavy metals such as lead and cadmium or toxic chemicals such as arsenic or cyanide compounds.

Resource policy and the raw materials industries therefore have a special responsibility: the natural basis of life has to be conserved and protected out of responsibility for future generations. This means that the guiding principle of sustainable development has to be implemented as fully as possible in the extraction and use of mineral resources, the design, production and use of goods, and the recovery of recyclable materials in waste streams.

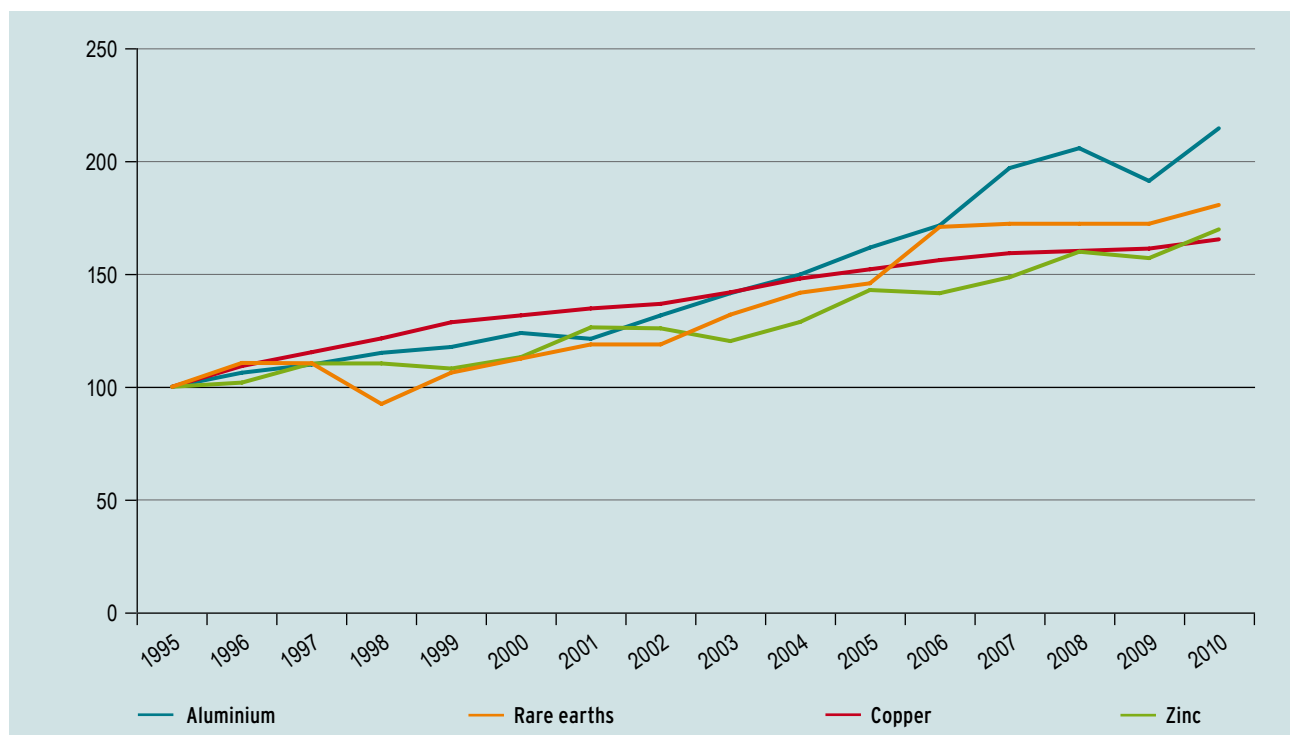
Making sustainable use of raw materials means first and foremost using them much more efficiently. Part of this strategy is to design products so that they last longer and are more capable of being recycled. Resource efficiency calls for thinking in terms of material flows from a life-cycle perspective that takes account of the entire global value chain right from initial resource extraction. Furthermore, non-renewable

resources must increasingly be replaced by sustainably produced renewable raw materials (cf. Part IV).

During the period 1980 to 2010, global use of raw materials increased by more than 50 percent to around 60 billion tonnes per annum. If no substantial progress is made with improving resource efficiency, the figure will probably be over 100 billion tonnes in 2030, and about 140 billion tonnes in 2050.¹⁹⁹ It is thus foreseeable that many resources will become scarcer and the demand-side pressure on resource prices will continue. Prices have been rising since the turn of the century, interrupted only by the dip in prices due to the economic and financial crisis. One major reason was the rapid increase in the raw materials requirements of emerging economies such as China, India or Brazil. For example, there was a roughly fivefold increase in the world market price of copper between 2000 and 2010. From 2005 to 2006 alone, the value of raw materials imported into Germany rose by 37 percent.²⁰⁰

Thus improving resource and material efficiency makes good sense not only from an ecological, but also from an economic point of view (cf. Part IV, Chapter 3). This is particularly true in the case of Germany, because as a highly industrialised country which is relatively poor in resources it is hard hit by major increases and fluctuations in raw materials prices. For example, the German metal industry is the biggest producer of steel and non-ferrous metals in the EU. The same is true of Germany's foundry industry. Its main customers are automobile and mechanical engineering and the construction and electrical engineering sectors. In 2008 material costs²⁰¹ as a share of gross production value in the manufacturing sector came to 47 percent, whereas the share due to personnel costs was just under 18 percent. The metal production industry and the food industry are particularly badly affected by high raw materials prices. Here the share due to material costs was around 60 percent in 2008 (cf. Part II, Chapter 2.1).²⁰² At the same time German industry is in an excellent position to profit from the future growth of the market for resource and material efficiency.

Figure 102: Development of production quantities of selected raw materials 1995-2010 (Index 1995=100)



Source: U. S. Geological Survey (2011)

199 Aachener Stiftung Kathy Beys (2011); UNEP (2011c).

200 Federal Statistical Office (2007).

201 Material costs include the cost of intermediate products, in other words not only resource costs.

202 Federal Statistical Office (2010d).

4.2 Products and technologies for sustainable use of resources

Products and technologies for sustainable use of resources are relevant in all branches of industry and all phases of production. The following section provides an overview of central approaches in this field and of the relevant technology lines and products.

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 magnetic billet heating on the basis of superconductor technology. This process makes it possible to halve energy consumption, while on the other hand the magnetic heating process improves product quality, eliminates the need for machining stages and reduces reject rates – in industrial operations, productivity improvements of 25 percent are achieved in the conversion of aluminium. The reduced plant maintenance requirements also help to improve profitability. According to the manufacturers, the purchase of a magnetic heater for extrusion presses pays for itself within two years.²⁰³ 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 national product – which in Germany’s case means about 35 billion EUR a year. Given systematic application of the existing tribological knowledge it would be possible to save an estimated five billion EUR 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. One example is the moulded wood process, in which wood is processed as a foam-like material that can be moulded to form pipes and at the same time permits an 80-percent saving in material compared with conventional production techniques. In view of the much reduced wastage, moulded wood pipes only need about 20 percent of the quantity of raw timber used in the conventional process. And there is another important difference: moulded wood is less exacting with regard to timber measurements and thereby supports near-natural forestry.²⁰⁴

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 as a trend towards making components and products such as memory chips and mobile phones even smaller helps to save raw materials. Advances in nanotechnology and molecular biology can support this development. New processor platforms containing multiple processor cores on a single chip result in massive improvements in computing power and energy efficiency.

Information and communications technologies (ICT) belong to the key technologies for using better networking to exploit great energy and resource efficiency potential in other sectors of the economy, e.g. mobility, living, logistics, communication and power grids. For example, an optimisation software that performs three-dimensional calculations for transport, loading and storage equipment can result in better utilisation of material and space in resource-intensive industries.²⁰⁵ The rapid expansion of information and communication technologies also results in rising energy consumption, however. The share of Germany’s electricity consumption accounted for by the ICT sector is already more than 10 percent. The

203 BMU (2009e).

204 BMU (2009f).

205 BMU (2009g).

expansion of the infrastructure is also giving rise to growing consumption of materials. What is more, ICT products have very short innovation cycles and are frequently replaced after a useful life of only a few years. Here there is a need to consider how the resource efficiency challenges on the product side can be reconciled with the opportunities that these applications offer.

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 metre 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 for careful investigation and if necessary minimisation of potential risks.

White biotechnology applications use enzymes or microorganisms to reduce the demand for process energy, by making chemical and organic processes possible at lower temperatures. They can also reduce the amount of material required, for example by using biotechnical processes to strengthen clothing fibres made of 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 the 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 2008 German industry used 3.6 million tonnes of regrowable raw materials and about 36 million tonnes of wood as material.²⁰⁶ Between 1997 and 2010 there was almost a fivefold increase in the area of farmland used for regrowable raw materials in Germany, from 400,000 hectares to 2.15 million hectares.²⁰⁷ This is largely due to the rapid increase in the area under energy crops. By contrast, the area under crops used as raw materials has remained relatively constant in recent years at around 300,000 hectares. Only about 15 percent of the regrowable raw materials produced in Germany is recovered as material, while the remainder is used for energy production.²⁰⁸ Regrowable raw materials can basically be used as materials in all branches of industry. In addition to classic uses in house construction, for example as environmentally friendly thermal insulation material, they are also suitable for use as packaging materials, lubricants, textiles or bioplastics. With about 2.7 million tonnes, the chemical industry makes the greatest use of non-wood biomass as a material.

4.3 Position of German companies

German companies occupy a very good position on the future market for resource and material efficiency, and in some areas this is capable of even further expansion. Experts tend to see German companies as pioneers in the lightweight construction technology sector, nanotechnology, in the use of regrowable raw

206 FNR (2009).

207 FNR (2010a).

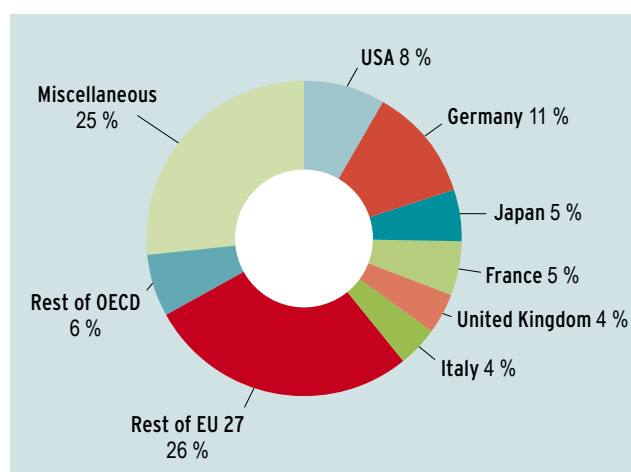
208 FNR (2010b).

Figure 103: Germany's competitive position on resource efficiency

Technology line	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 regrowable raw materials	Pioneer
Lightweight construction technologies	Pioneer
Long-lasting, repair-friendly product design	Mid-range
Miniaturisation	Mid-range
Nanotechnology applications	Pioneer

Source: Based on: Deutsches Institut für Wirtschaftsforschung et al (2007), p. 95.

materials and in the field of household waste recycling and low-waste production processes (cf. Figure 103). To date, however, they are only in mid field when it comes to miniaturisation and long-lasting, repair-friendly product design. The very good position in the field of household waste recycling 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 vehicles and waste wood which were in force in Germany were subsequently established at European level as well.

Figure 104: Shares of world trade in material efficiency

Source: Walz et al (2008), p. 86

According to estimates by the Fraunhofer Institute for Systems and Innovation Research, the volume of world trade in technologies and products for resource and material efficiency²⁰⁹ came to 112 billion EUR in 2004.²¹⁰ German companies, at eleven percent, had the largest share, followed by the USA with 8 percent and Japan and France with 5 percent each (cf. Figure 104).

The analysis of patent data shows that Germany's share of patents in all product groups was constant at around 14 percent between 2000 and 2004. The largest number of patent applications comes from the USA (29 percent), followed by Japan with 18 percent.²¹¹

4.4 Outlook

Material and resource efficiency is an issue of the future that will continue to gain in importance in the decades to come. In view of the increasing scarcity of certain raw materials and the environmental impacts associated with the production and use of raw materials, there is no alternative to improving resource efficiency. This strategy makes sense from an economic point of view as well, because material costs play a key role in international competition and the future market for resource and material efficiency offers excellent prospects. Germany and the EU therefore need to step up their efforts to improve

²⁰⁹ The analysis relates to the following product groups: regrowable raw materials, corrosion protection, fibre reinforcement and plastics additives.

²¹⁰ Walz et al (2008).

²¹¹ Walz et al (2008).

resource efficiency. And finally, developing and emerging economies need access to resource-saving production methods, because scarce resources and the impacts of non-sustainable resource extraction and use on the environment and on biological diversity are a global problem.

The topic of resource and material efficiency is playing an increasing role in the eyes of developers, manufacturers, distributors and consumers, partly because of the dramatic price increases and fluctuations that have taken place in recent years in the prices of certain resources. Nevertheless, the issue of resource efficiency – compared with climate protection, for example – tends to remain on the fringes of public awareness. The Federal Environment Ministry is therefore pursuing the goal of embedding the topic of resource efficiency more firmly in politics and society, and it is cooperating with various associations that can act as multipliers for the issue of resource efficiency. One important example is its cooperation with the German Engineers' Association (Verein Deutscher Ingenieure – VDI) in establishing the Centre for Resource Efficiency (VDI-ZRE), which is

intended to improve information and communication about ways of increasing resource efficiency in industry, especially in small and medium enterprises.

Moreover, specific measures designed to improve resource and material efficiency exist in many of the German government's policy areas, and guidance and assistance programmes play an important role here.

As part of its raw materials strategy of 20 October 2010, the German government commissioned the Federal Environment Ministry to draw up a national resource efficiency programme (ProgRes). The aim of ProgRes is to decouple economic growth from resource input, and to reduce resource extraction, resource use and the associated environmental impacts to the minimum possible level. By doing so, ProgRes – mindful of our responsibility for future generations – can make an important contribution to safeguarding the natural basis of life and hence maintaining prosperity, competitiveness and quality of life at a high level.

Assistance programmes in the material and resource efficiency sector

As part of its departmental research, the Federal Environment Ministry finances research projects and also, under the environmental innovation programme, investment projects in the field of resource efficiency and recycling.

The Federal Ministry of Economics and Technology (BMWi) provides assistance for qualified advice for individual SMEs on improving their material efficiency (potential analysis, in-depth consulting) under the "go-Inno" programme.

As part of its framework programme "Research for Sustainable Development" (Forschung für nachhaltige Entwicklungen – FONa), the Federal Ministry of Education and Research (BMBF) provides considerable assistance for research and development work on improving resource efficiency within the action field "Sustainable Management and Resources".

The Federal Ministry of Food, Agriculture and Consumer Protection (BMELV) assists research, development and demonstration projects in the field of regrowable raw materials.

Within its sphere of responsibility, the Federal Ministry for Economic Cooperation (BMZ) helps to ensure that German expertise in the field of resource efficiency also benefits the developing countries. Under the EITI initiative, the BMZ also takes part in activities aimed at establishing resource governance structures in states in the sub-Saharan region.



5 Sustainable mobility

5.1 Challenges for sustainable mobility

Transport gives rise to considerable pollution of the environment and hazards to human health. These include climate impacts due to combustion of fossil fuels, air pollution due to pollutants, landscape fragmentation and surface sealing due to road and rail infrastructure development, encroachments on aquatic ecology due to the development and maintenance of inland waterways, and noise exposure. Especially in cities, the environmental impacts of transport have substantial adverse effects on the quality of life of many people. In developing countries, for example, the transport sector is responsible for more than 80 percent of urban air pollution.²¹²

At the same time, traffic is increasing – especially on a global scale. This trend will be maintained in the years ahead (cf. Figure 105). There are many different reasons for this development: Economic globalisation is resulting in a growing international division of labour, giving rise to increases in the volume of world trade and in shipments of goods. Other significant driving forces behind the growth of transport are global population growth, the rapid economic growth of the emerging economies, and the growth of tourist travel.

The figures below illustrate the expected growth in traffic volume:

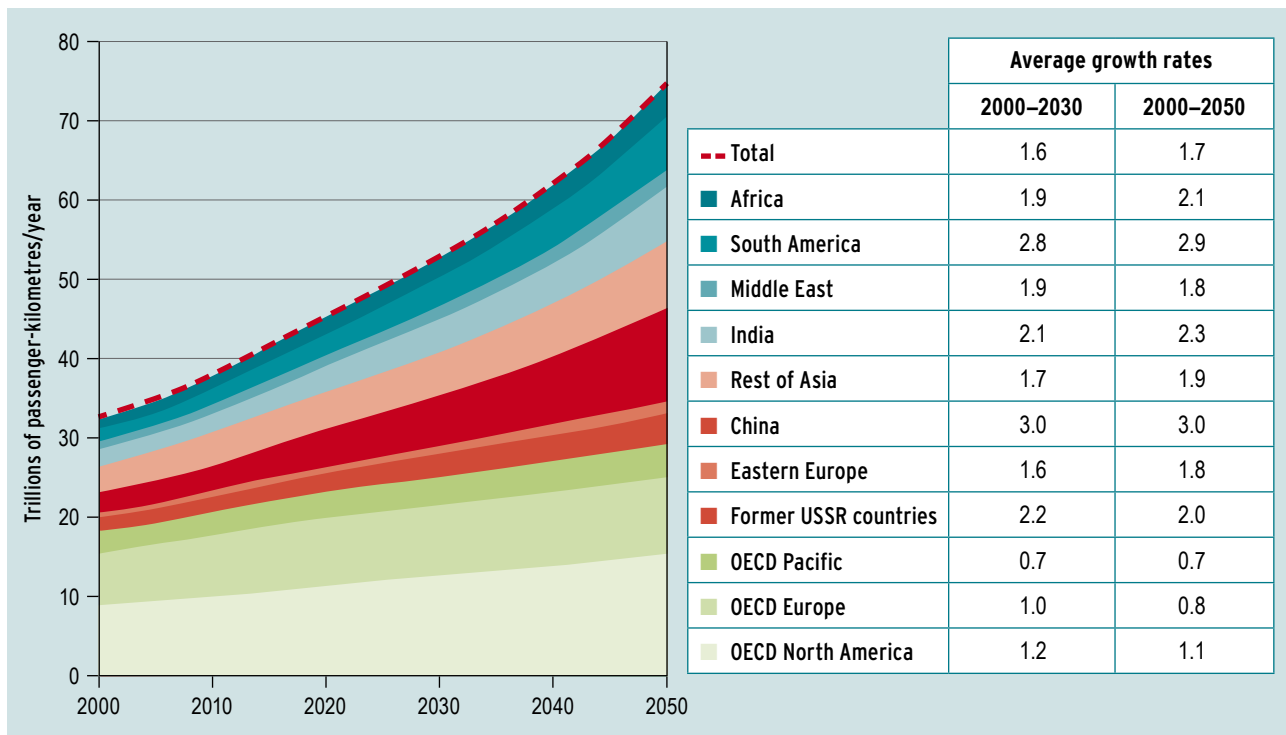
- The global number of cars is expected to treble to two to three billion vehicles by 2050.²¹³ In China, the number is expected to have already doubled by 2020, to 200 million cars.²¹⁴ Use of motorised passenger transport is likely to double between 2005 and 2050 to at least 9,000 km/person/year.²¹⁵

212 UNEP (2011a).

213 UNEP (2011a).

214 Cato (2011).

215 IEA (2009).

Figure 105: Predicted growth of passenger transport by regions up to 2050

Source: OECD (2008a), p. 50

- The estimates for road transport of goods in tonne-kilometres expect figures to at least double by 2050.²¹⁶
- In the air transport sector, passenger-kilometres will nearly treble by 2030.²¹⁷
- Marine freight traffic is expected to show up to 80-percent growth in tonne-kilometres by 2020.²¹⁸
- The volume of goods traffic in Europe will increase by 38 percent between 2005 and 2030. Over the same period, passenger transport will rise by 34 percent.²¹⁹

These worldwide trends would result in a doubling of energy consumption for transport.

Transport growth presents a challenge for climate protection in particular. Compliance with the internationally agreed 2-degree target as the upper limit for global warming requires greenhouse gas emissions to be at least halved by 2050. The transport sector will have to make an appropriate contribution to this. In the EU, 25 percent of energy-related CO₂ emissions in 2007 were due to the transport sector,²²⁰ and on a global scale the figure is around 23 percent.²²¹ In terms of energy consumption, the transport sector is the fastest-growing sector in the EU, and at the same time the sector which is most dependent on fossil fuels.²²² Although there have been substantial reductions in consumption – and hence emissions – by vehicles in the car sector, the steady growth in the volume of traffic has cancelled out the gains in efficiency. For example, CO₂ emissions in the transport sector in the EU increased by more than 26 percent between 1990 and 2007.²²³

216 IEA (2009).

217 ICAO (2010).

218 IMO (2009).

219 COM (2011i).

220 Eurostat (2010).

221 IEA (2009).

222 Cf. COM (2011h).

223 Eurostat (2010).

The aim of sustainable mobility is to promote economic development and satisfy human needs for mobility, while at the same time minimising the impacts of the resulting traffic on health and the environment.

Strategies for sustainable mobility

In view of the forecast growth rates, it will be a great challenge to satisfy growing mobility needs without causing undue adverse impacts on environment, health and quality of life. This makes it necessary to adopt several complementary strategies:

- **Avoiding transport:** Economic growth must be decoupled from transport growth, and transport must be avoided wherever possible;
- **Modal shift:** Environmentally sound and efficient means of transport must be used and networked, and the change to greener means of transport must be facilitated;
- **Emission reduction and transport optimisation:** Technical improvements must be made in the "greenness" and resource efficiency of the modes of transport, so that they can be operated with minimum impact on the environment.

A key factor in implementing these strategies is charging of external costs. The follow-on costs of transport for society in the form of environmental and health impacts or the cost of accidents must be charged to their respective sources – among other things to create fair competition between the transport systems.

A fundamental transformation in the direction of sustainable mobility not only reduces harmful effects and impacts on the population and the environment, but also offers considerable economic potential. Environmentally sound, energy-efficient top technologies in the transport sector – whether in road, air, rail or sea transport – help to safeguard and increase the competitiveness of the different sectors and, through improved energy efficiency, to reduce fuel costs for private and commercial users. Model calculations in the UNEP Green Economy Report also

show that employment in the transport sector would be 10 percent higher in a green investment scenario than in a business-as-usual scenario. There would be a marked increase in employment in the public transport sector in particular.²²⁴

Sustainable goods transport

Goods transport in Germany is responsible for a large proportion of environmental pollution by the transport sector: well over half the transport-related nitrogen oxide emissions (NO_x), and about half the transport-related coarse (PM_{10}) and fine ($\text{PM}_{2.5}$) particulates. Despite savings in specific fuel consumption and better utilisation of vehicle capacities, CO_2 emissions by land-bound goods transport have not decreased in recent years, but have stabilised at a high level because of the sharp rise in the volume of goods transport.

In 2005 the external costs of goods transport, which include environmental, health and accident costs, totalled 17 billion EUR, of which 92 percent was attributable to the road transport sector. A comparison of the specific CO_2 , NO_2 and PM emissions shows that in this respect rail transport is the greenest land-based mode of transport. It therefore makes sense to switch goods transport from road to rail.²²⁵ There is, however, a need to reduce noise emissions by rail goods transport.²²⁶ In 2010, rail transport accounted for a mere 16 percent of total goods traffic.²²⁷

The potential for the modal shift depends on the type of goods, but reliability, time costs and technical feasibility are also of special importance. Fundamental factors for switching transport from road to rail are therefore operational optimisation of logistics, improvements in rail infrastructure, and full charging of the health, accident and environmental costs caused by the transport of goods by road. If appropriate changes are made to the framework, on some routes in Germany it would be possible to switch between 25 and 40 percent of road transport to the railways by 2025.²²⁸

224 UNEP (2011a).

225 One possible means of transferring more goods traffic to the railways is combined transport. This means a combination of different modes of transport within a transport chain.

226 Federal Environment Agency (UBA 2009b).

227 VDB (2011).

228 Federal Environment Agency (UBA 2009b).

5.2 Products and technologies for sustainable mobility

Products and technologies for sustainable mobility are characterised by the fact that they reduce environmental and health impacts due to transport. Important technological sectors are set out below:

Efficient propulsion technologies and modern fuels improve efficiency and reduce fuel consumption. Higher fuel efficiency of petrol and diesel engines can be achieved, for example, by increasing the effectiveness of fuel combustion or increasing engine power per litre of engine capacity (downsizing). Efficient internal combustion engines can be used as drives on their own, or combined with electric motors in hybrid systems to realise further efficiency gains. These drive systems still have a lot of untapped potential and can help to reduce fuel consumption, especially in urban traffic. Battery-powered electric drives and hybrids that are charged externally (plug-in) can successively supplement existing drive concepts and permit low-emission local operation. The prerequisite for achieving a significant reduction in CO₂ emissions, however, is a secure supply of electricity from renewables.

Environmentally sound vehicle engineering and operation help 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. The use of low-friction oils also helps to save fuel.

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 still a need for further emission reductions in the road traffic sector; in this field further optimisation of engine and exhaust treatment components in particular can make a major contribution. Another important factor is the further development and widespread use of filters and catalytic converters on railways and ships, and – for all modes of transport –

improvements in noise abatement technologies. This also includes modern technologies for track construction and quieter road surfaces.

Environmentally sound infrastructure and traffic management systems 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 better 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. In the case of shipping it is important above all to improve the existing infrastructure. One example is the need to improve port infrastructures so that regional transport can increasingly be shifted to sea-going ships (“Short sea shipping”).

Biofuels are in use today mainly in the form of biodiesel and ethanol as admixtures to conventional motor fuels. To ensure that biofuels are environmentally sound, binding sustainability requirements for biofuels and bioliquids are laid down in EU directives. Germany has implemented the new EU directives by adopting two sustainability ordinances for the electricity and biofuel sectors. According to these ordinances, production of biofuels is only deemed sustainable if a certain amount of greenhouse gas emissions is saved along the entire manufacturing and supply chain compared with the use of fossil fuels. Plants for biofuel production may not be cultivated on land with high carbon stock or a high level of biodiversity. Biofuels that do not comply with these sustainability standards are not eligible for tax reductions and cannot be credited towards the stipulated biofuel quota.

If cultivated biomass (such as rapeseed, cereals, corn or sugar beets) is used for biofuel production, the overall greenhouse gas balance can be negative, in particular if the resulting indirect land use changes are factored in.²²⁹ This is why the German government advocates the inclusion of these indirect effects into European sustainability requirements.

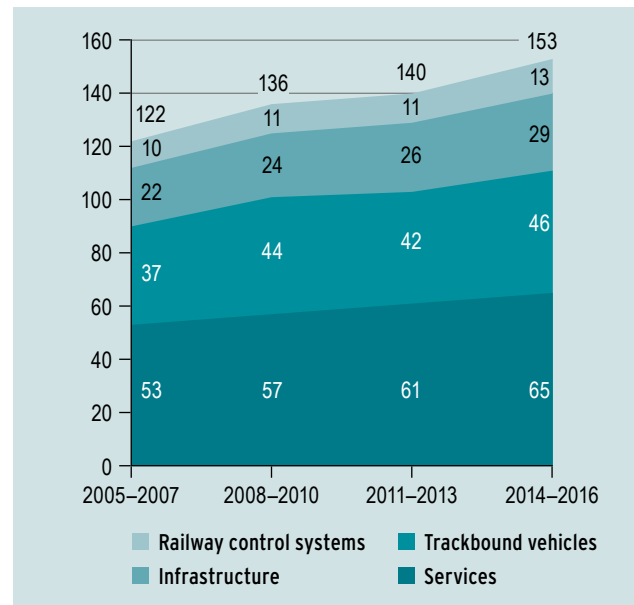
229 Federal Environment Agency (UBA 2010c).

The development of “second-generation” biofuels – which can also be produced from wood, straw or waste, for example – can improve the environmental and climate balance.

5.3 Market potentials

Fact file: Sustainable mobility ²³⁰		
Size of world market	2007	200 billion EUR
	2020	289 billion EUR
Germany's share of world market	2007	approx. 18 %
Sales growth	2005 to 2007	15 %
	2008 to 2010	17 %
Growth in personnel numbers	2005 to 2007	9 %
	2008 to 2010	13 %

Figure 107: Average world market volume of railway engineering products (in billion EUR)



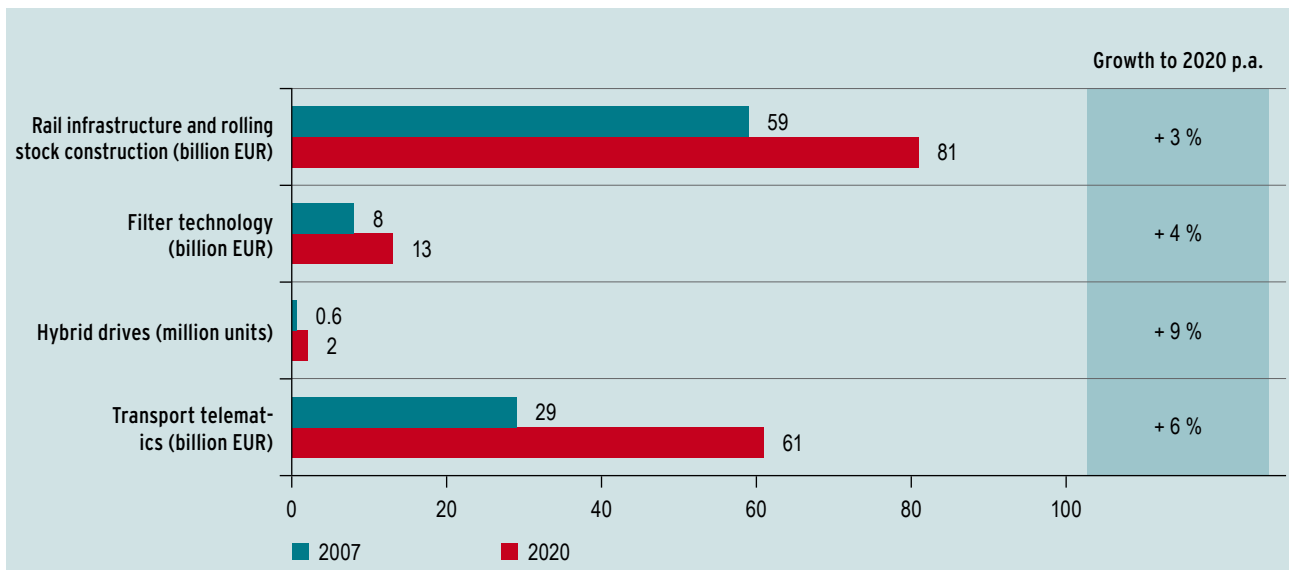
Source: Drummond (2009), after BCG (2008)

The development of the markets in the transport sector is driven by global mega trends. These include increasing environmental and climate requirements, rising motor fuel prices and dwindling resources, growing urban agglomerations around the world (“megacities”) and the globalisation of the world economy. Goods and services which make a contribution to sustainable mobility already represent a world

market of 200 billion EUR.²³¹ By 2020 this volume will increase to about 289 billion EUR.

All world markets in the core sectors of sustainable mobility show stable growth trends up to the year 2020. Growth is expected to be as much as 9 percent for hybrid drive systems, and 6 percent for transport telematics, which amounts to a doubling of the mar-

Figure 106: World market projection for sustainable mobility



Source: BMU (2009b), p. 183

230 BMU (2009b).

231 BMU (2009b).

ket volume from 2007 to 2020.²³² In the next three to four years the German automobile industry alone will invest 10 to 12 billion EUR in the development of alternative drive systems.²³³

In the rail transport sector, the volume of the world market will probably increase to 153 billion EUR by 2016 (cf. Figure 107).²³⁴ During the economic and financial crisis the world market for railway technology remained largely unaffected by the global recession.²³⁵ In the context of economic recovery programmes alone, 20 countries invested some 120 billion US dollars in the railway sector.²³⁶ This shows that many states today regard rail transport as an important factor for sustainable mobility.

Market of the future: Electric mobility

Electric vehicle drive systems are free from local emissions and considerably reduce greenhouse gas emissions if renewable electricity is used. Intelligent coupling with renewable electricity sources by means of time-sensitive charging also makes it possible to feed in additional power derived from wind and sun. Not only straight electric vehicles offer advantages, but also all externally chargeable (plug-in) hybrid vehicles, because they also permit purely electric operation that dispenses with liquid fossil fuels.

The use of electric drive systems is not confined to individual traffic: as fleet operations in urban areas, delivery traffic and mobile services offer highly suitable use situations for electric vehicles. The share of new registrations accounted for by wholly or partially electrified vehicles will rise to up to 50 percent in 2025, dominated by hybrid vehicles rather than purely electric ones.²³⁷

As part of the work of the National Electromobility Platform, the German government and industry have given a clear commitment to developing Germany into a lead market and lead supplier for electric vehicles. A comprehensive government programme will use a coordinated mix of measures to support electric vehicles as an environmental technology, in order to safeguard and expand the competitiveness of the German automobile industry. All the actors support the need for coupling with electricity from renewable sources.

5.4 Position of German companies

Shares of world market and world trade

In 2007, German companies had a total world market share of around 18 percent of the sustainable mobility technologies and products investigated.²³⁸ Germany and Japan lead the world in international trade in products for sustainable mobility (cf. Figure 108). Whereas Germany's share remained more or less constant at 14 percent from 1993 to 2004, other major industrialised countries in the EU, the USA and above all Japan lost considerable ground.

German companies are well represented in research into vehicle technology and design but are not able to translate this into corresponding market shares. The biggest competitors are Japan, France and Italy. Korea and China – because of their low labour costs – are also becoming increasingly competitive. 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. In the field of electric mobility, German companies have considerably stepped up their activities.

232 BMU (2009b).

233 VDA (2011).

234 Drummond (2009).

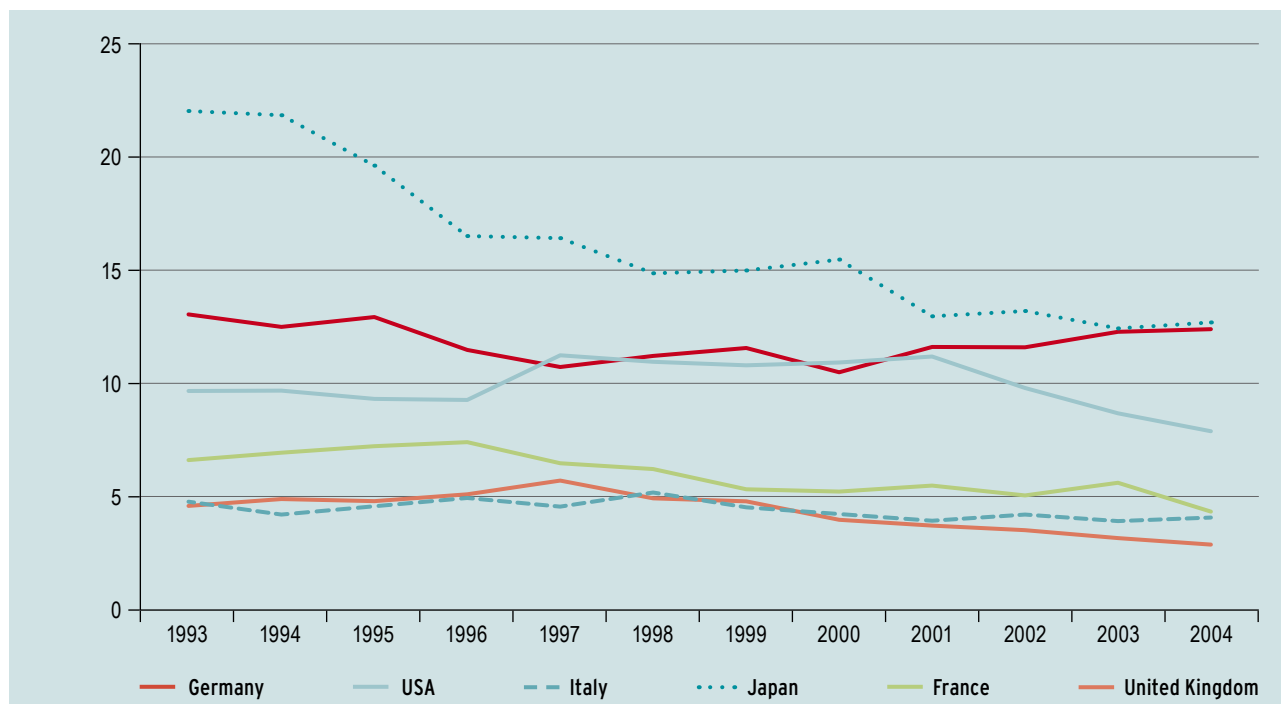
235 VDB (2011).

236 HSBC (2009).

237 Roland Berger Strategy Consultants, VDMA (2011).

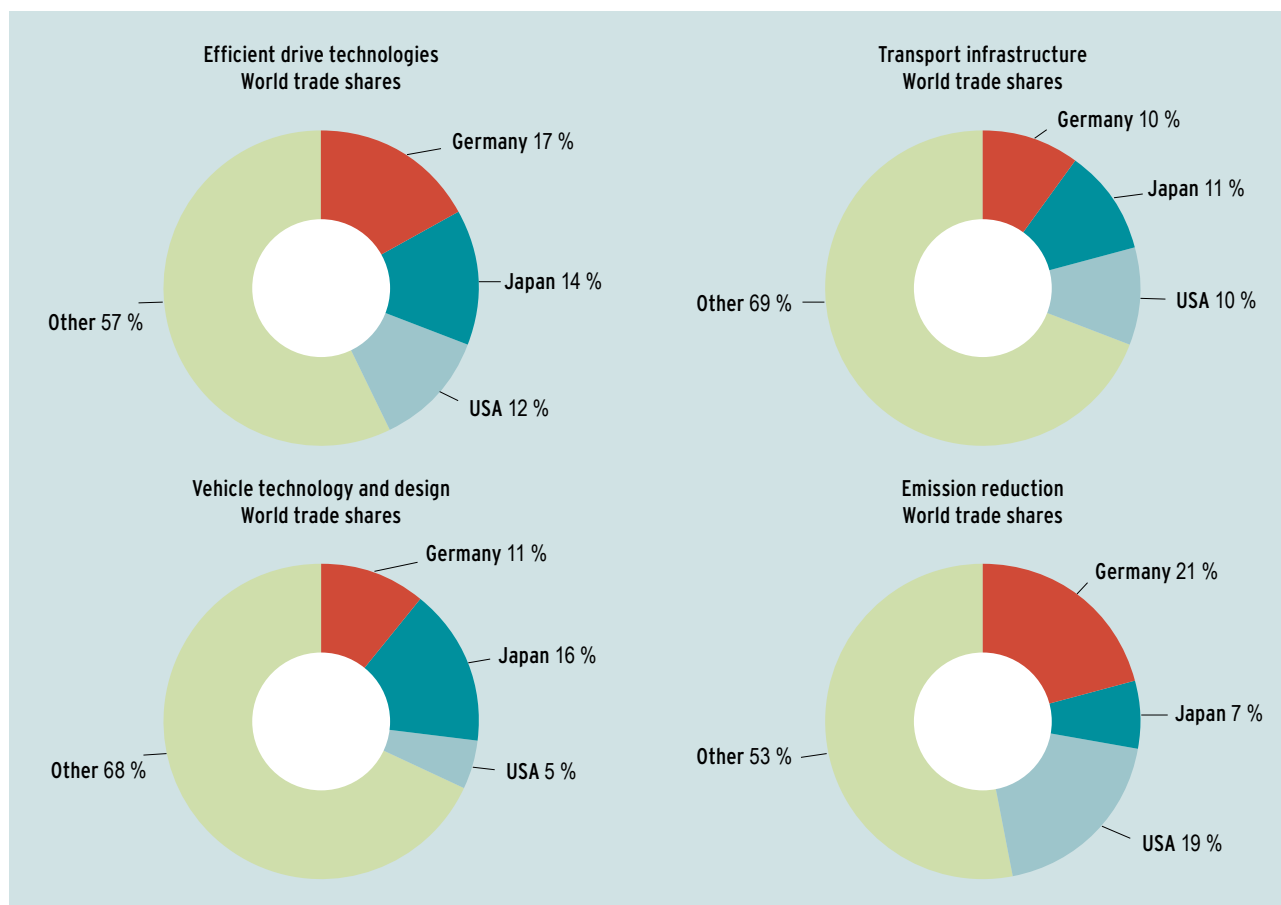
238 BMU (2009b).

Figure 108: Development of world trade shares on the market for sustainable mobility (in percent)



Source: Walz et al (2008), p. 112

Figure 109: World trade shares of the three largest suppliers of sustainable mobility products



Source: Walz et al (2008), own compilation

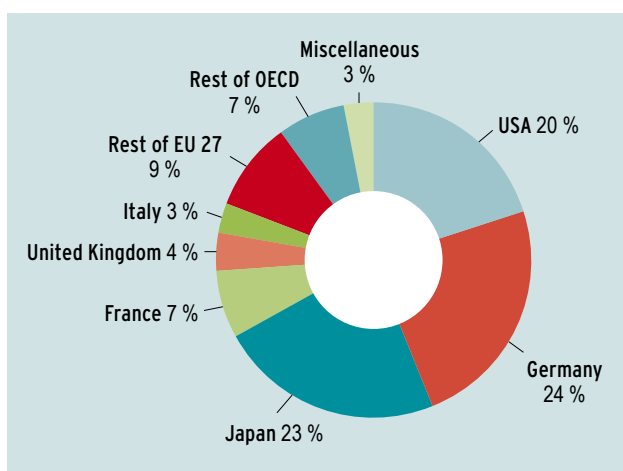
Patents held by German companies

The number of patent applications is an important indicator of innovations. On this criterion the field of sustainable mobility is developing much faster worldwide than the rest of the economy. Research is concentrated in a small number of countries – headed by Germany. From 2000 to 2004, German companies accounted for nearly a quarter of patent applications. The total share of the four biggest industrialised countries comes to 74 percent (cf. Figure 110) – 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.²³⁹ German companies enjoy above-average representation here, with a share of 31 percent for the years 2000-2004. German companies are particularly innovative when it comes to improving combustion engines.²⁴⁰

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, China and a number of neighbouring European countries are examples of competitors to be taken seriously.

Figure 110: Patent shares on the market for sustainable mobility, by countries



Source: Walz et al (2008), p. 98

5.5 Outlook

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 prices and more stringent environmental legislation and climate objectives – continue to gain in importance. In the field of efficient drive technologies, Japan and the major European countries are particularly specialised thanks to ambitious environmental standards and high fuel prices. In the years ahead, however, further development of conventional drive concepts and (partial) electrification of vehicles in particular will play a very important role in efforts to achieve the targets in the field of both climate protection and air quality. Here Germany has already stepped up its efforts considerably. In the field of electric mobility, the German government has set itself the target of putting one million electric vehicles on Germany's roads by 2020 and six million by 2030.

Through their environmental legislation, policy makers have made a considerable contribution to creating new markets for sustainable mobility products and propagating innovative environmental technologies. The measures are always developed within the constraints represented by environmental necessities and economic possibilities. This makes it possible to achieve the targeted objectives as cost-effectively as possible. For example, in 2007 the emission standards Euro 5 and Euro 6 were laid down for cars and light commercial vehicles; Euro 5 has been in force since 1 January 2011 and Euro 6 is due to come into force on 1 September 2014. In 2009 a substantial further advance was made in the heavy goods sector with the emission standard Euro VI, which will become a binding requirement for new vehicles at the end of 2013. Forward-looking regulatory approaches of this kind will also improve the competitive prospects for innovative companies, whose environmentally efficient products give them a lead over competitors, and will thus encourage the earliest possible introduction of such technologies. As the example of exhaust emission standards in China and other parts of the world 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.

²³⁹ The shares of individual product groups in the total volume of patents 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.

²⁴⁰ For a detailed analysis of patent specialisation in the individual product groups, see Walz et al (2008).



6 Waste and closed-cycle management

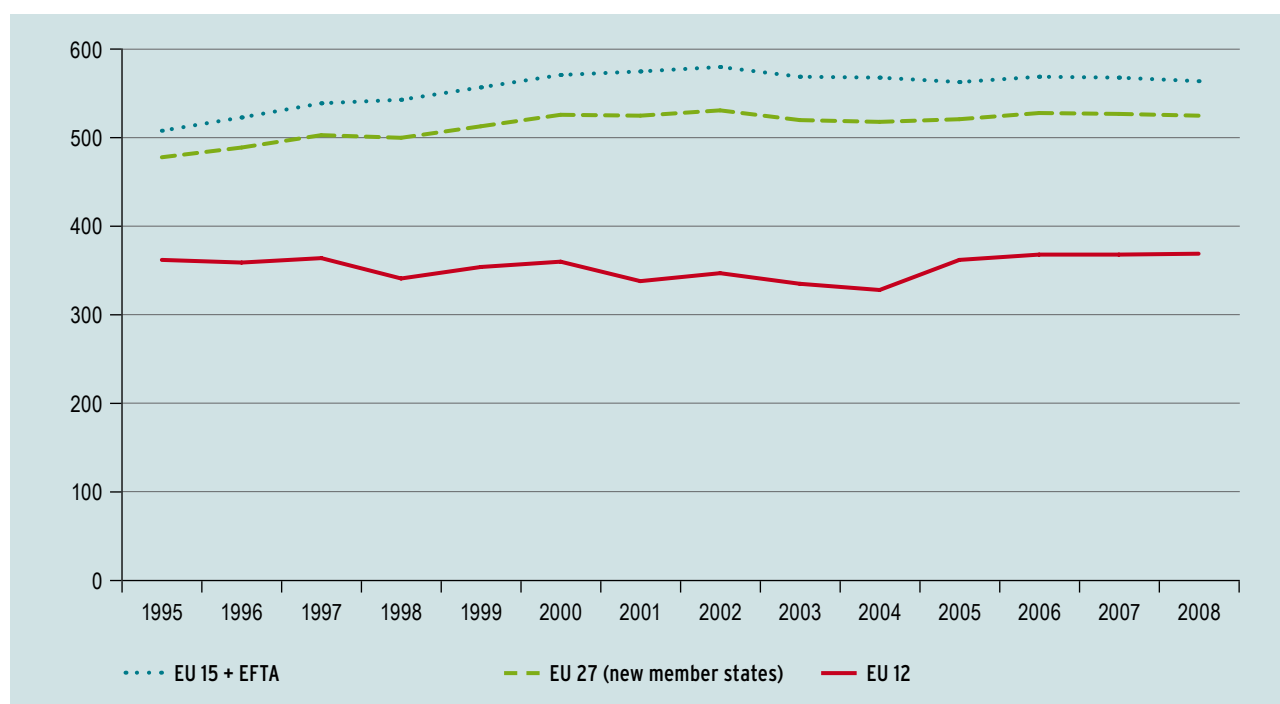
6.1 Challenges for waste and closed-cycle management

Environmentally sound waste management is one of the biggest challenges for environmental policy. In industrialised countries, waste and closed-cycle management tends to be further advanced and waste disposal is often better organised than in developing and emerging economies. On the other hand the volumes involved in the industrialised countries are considerably larger. In view of the rapid economic growth of many developing and emerging economies, the worldwide volume of waste will probably continue to display substantial growth. Accordingly there is a great need for action when it comes to establishing and expanding modern waste and closed-cycle management systems.

Waste quantities in the European Union are also increasing – not least because of the accession of states with growing economies (cf. Figure 111).

Every year around 320 million tonnes of waste are produced in Germany. The statistics show that there was a drop in waste quantities after the turn of the century (cf. Figure 112). 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 initially, but then remained virtually constant at around 48 million tonnes. By contrast, the quantity of commercial waste increased from 42.2 million tonnes in 2005 to over 51 million tonnes in 2009.²⁴¹ The general trend is for the total quantity of waste to decrease, while volumes of municipal waste remain steady.

241 Federal Statistical Office (2010e and 2010f).

Figure 111: Development of municipal waste in the EU (in kg per capita)

Source: EEA (2010)

To put an end to the growing mountains of waste, there is a need for an environmentally sound system of closed-cycle management based on the following hierarchy:²⁴²

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

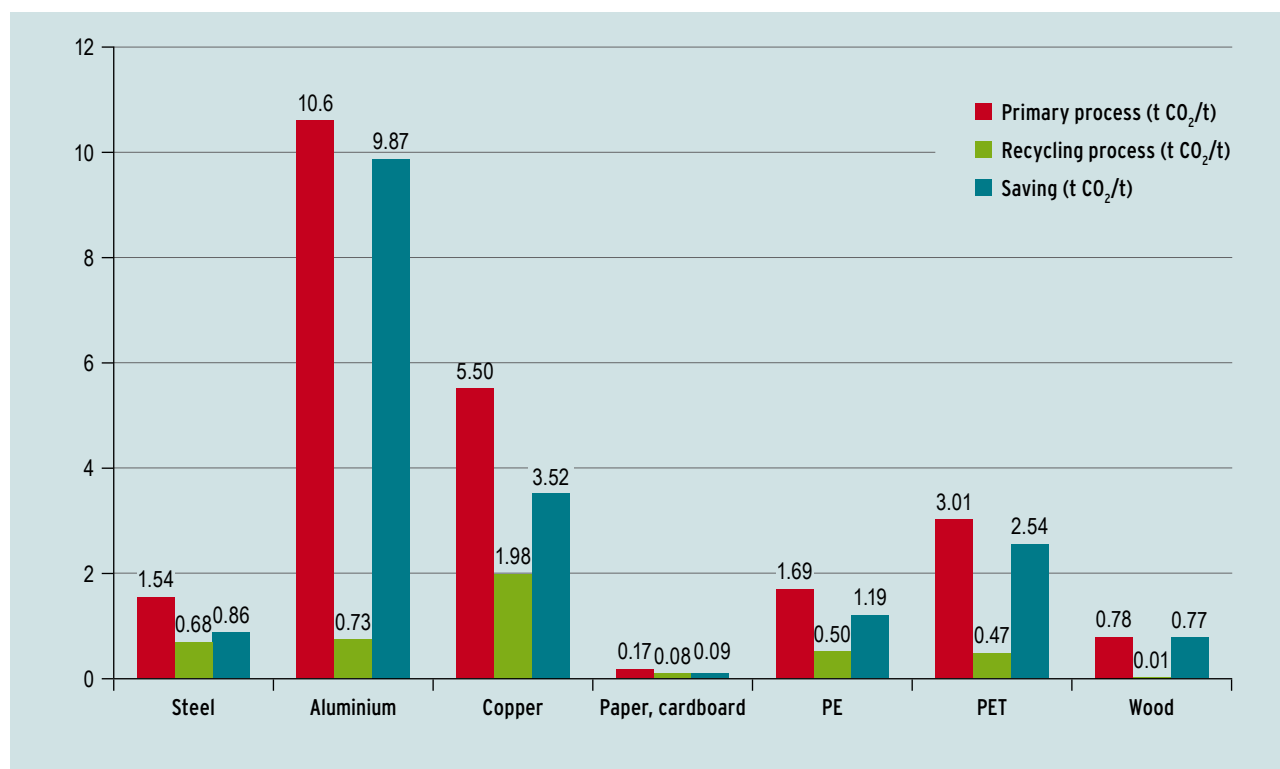
here (cf. Part IV), as are long-lasting, repair-friendly products. Consumers are called upon to play their part too. For example, they can dispense with superfluous packaging and buy resource-efficient products. This directly reduces the volume of waste and also sends a signal to manufacturers that they should change their product design and refrain from using complicated or excessive packaging.

Figure 112: Development of waste quantities in Germany

	Waste quantities (1,000 t)						
	2002	2004	2005	2006	2007	2008	2009
Total	381,262	339,368	331,876	340,899	351,111	344,602	322,293
of which:							
Municipal waste	52,772	48,434	46,555	46,426	47,887	48,367	48,466
Mining and quarrying waste (non-hazardous)	45,461	50,452	52,308	41,954	42,891	39,295	27,541
Construction and demolition waste (incl. road construction rubble)	240,812	187,478	184,919	197,735	201,842	200,517	195,021
Production and industrial waste	42,218	53,005	48,094	54,785	58,491	56,423	51,265

Source: Federal Statistical Office (2010e and 2010f)

²⁴² The act revising closed-cycle management and waste law, which is currently passing through the legislative process, will build on the five-level waste hierarchy of the EU Waste Framework Directive (prevention; preparing for reuse; recycling; other recovery, notably energy recovery; disposal).

Figure 113: Recycling reduces CO₂ emissions(tonne CO₂ per tonne input - base year 2007)

Source: Fraunhofer (2008)

2. Recycling waste: The principle of closed-cycle management 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 material cycles reduces consumption of raw materials and energy and thereby makes an important contribution to improving the quality of the environment and saving resources. A further contribution can be made by waste incineration, as this destroys toxic substances that would otherwise go for landfill.

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 90 percent of construction waste and 63 percent of municipal and production waste was recycled in 2009. Recycling offers great opportunities for companies, since it cuts spending on raw materials. Ac-

ording to an estimate by the IW (Institut der deutschen Wirtschaft), companies earned 6.5 billion EUR from processing recyclables in 2007. At the same time, raw material imports to the value of 5.3 billion EUR were saved in 2007.²⁴³ Rising raw material prices make it worthwhile for companies to develop completely new business fields, such as the recovery of critical metals or the use of old landfill sites as a source of raw materials. Recycling creates domestic added value and replaces considerable quantities of raw material imports. In this way it also helps to create additional jobs: some 250,000 people were employed in the German waste and closed-cycle management sector in 2007.²⁴⁴

Recycling not only avoids environmental impacts during raw material production, but also makes a contribution to climate protection. 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 for energy production mean that less waste ends up on landfill sites. Landfill sites containing organic material release methane emissions, with harmful effects on the climate. The municipal waste of the EU

243 idw (Institut der deutschen Wirtschaft Köln 2010).

244 BMU (2009b).

27 alone emitted between 83 and 110 million tonnes of CO₂ equivalent from landfill sites in 2007.²⁴⁵ For this reason, landfill is now only permitted 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. Apart from very small quantities that are not biodegradable, municipal waste no longer goes for landfill at all.

Incineration of waste for energy purposes makes a contribution to climate protection, because it prevents methane emissions that are extremely damaging to the climate, and because it replaces energy production in other power plants. By 2020 Germany is aiming to reduce greenhouse gas emissions by a total of 40 percent compared with 1990. The contribution that the waste industry can make here amounts to about 13 percent.²⁴⁶

6.2 Products and technologies for waste and closed-cycle management

Waste and closed-cycle management covers a broad spectrum of products and technologies that serve the purpose of waste avoidance, recovery and disposal. It is very labour intensive – this applies, for example, to the collection, sorting and treatment of waste – which makes it an interesting field for innovations for technical rationalisation.

Waste and closed-cycle 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 or fermenting organic waste,
- Technologies for recovering waste as heat, and
- Processes for environmentally safe disposal of waste as landfill.

Substance separation processes, for example, play an increasingly important role in sustainable waste management. Infrared-based 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 on landfill sites.

6.3 Market potentials

In 2007 the world market for facilities in waste and closed substance cycle management had an estimated volume of around 35 billion EUR. By 2020 it will have grown by more than half to 55 billion EUR.²⁴⁷ 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.

Fact file: Production of facilities for waste management and recycling²⁴⁸

Size of world market	2007	35 billion EUR
	2020	55 billion EUR
Germany's share of world market	2007	~ 24 %
Sales growth	2005 to 2007	18 %
	2008 to 2010	16 %
Growth in personnel numbers	2005 to 2007	15 %
	2008 to 2010	6 %

Waste and closed-cycle 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 population are increasing the demand for innovative waste technology. The raising of environmental standards – particularly in the eastern European member states of the EU – creates new opportunities for growth.

245 Federal Environment Agency (UBA 2011h).

246 Federal Environment Agency (UBA 2011h).

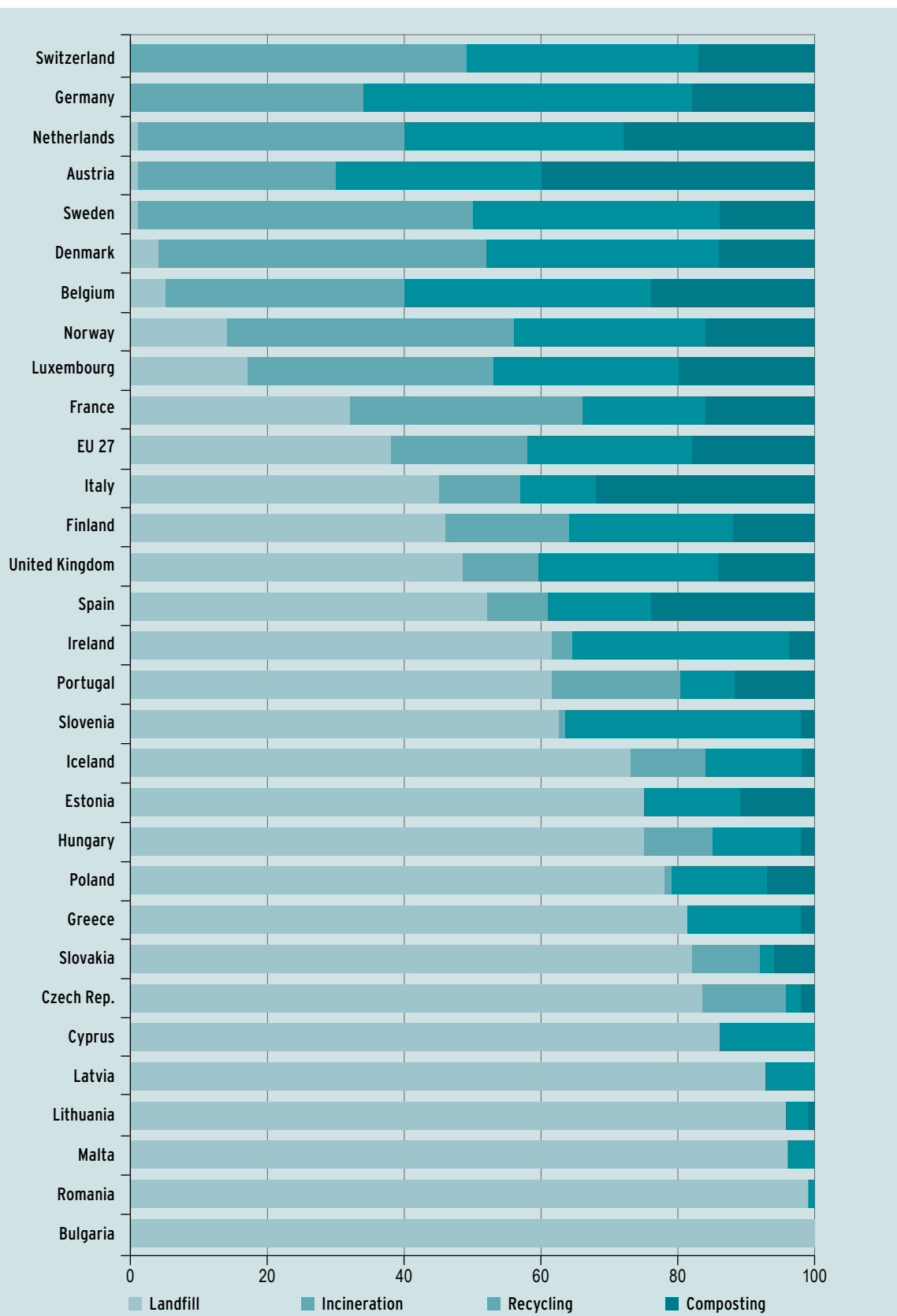
247 BMU (2009b).

248 BMU (2009b).

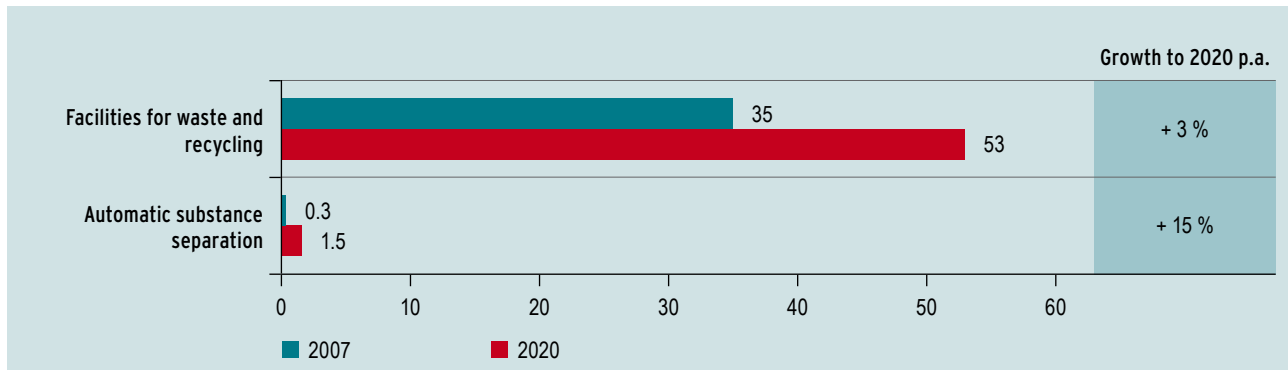
Figure 114 shows how the various countries in Europe treat their waste. This makes it clear that many countries could make further improvements in their recycling rate and closed-cycle management. The EU Framework Directive on Waste, revised in 2008, calls

for increased efforts to prevent and recycle waste. 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.

Figure 114: Treatment of municipal waste in Europe in 2009 (in percent)



Source: Eurostat (2011)

Figure 115: World market projection for core sectors of waste and closed-cycle management (in billion EUR)

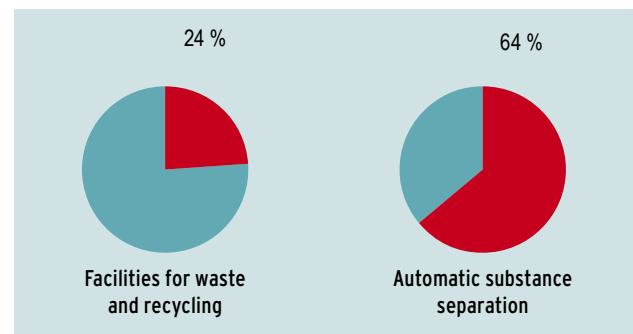
Source: BMU (2009b), p.140

The market for automatic substance separation plants offers especially good growth prospects (cf. Figure 115). At present there are some 2000 large recycling plants in Europe and the USA. In most of these the degree of automation is limited. Growing demands on the recycling properties of materials, and hence the efficiency of separation, and also technical advances in sorting technologies, have made automated substance separation more economic. To improve recycling it is essential to have modern technical facilities for waste separation. According to the findings of a business survey by Roland Berger Strategy Consultants, the world market volume for waste separation technologies can be expected to rise from 251 million EUR in 2007 to 1.5 billion EUR in 2020.²⁴⁹ 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.

6.4 Position of German companies

Shares of world market and world trade

German companies in the waste management sector have responded to the worldwide challenges by developing appropriate technical solutions and are profiting from the high environmental standards in Germany, e.g. by exporting innovative technologies. This is reflected by rising sales figures. Exports of goods in the waste management sector rose by around 20 percent between 2002 and 2008 (cf. Part I, Chapter 1). German companies currently have a world market share of around 24 percent in the field of plants for waste management and recycling. In

Figure 116: World market share of German companies 2007

Source: BMU (2009b), p. 141

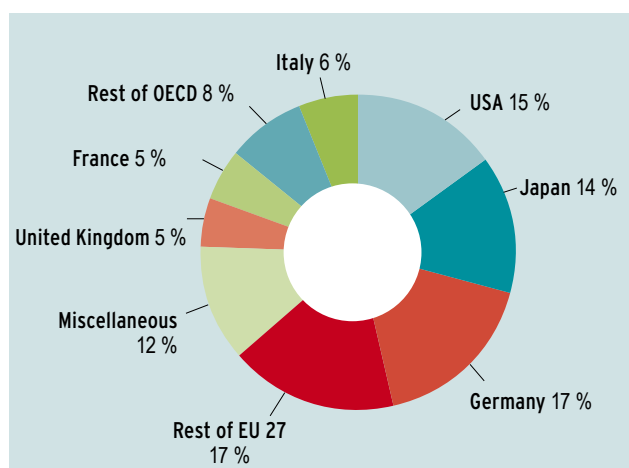
the automatic substance separation sector, German companies actually have almost two thirds of the world market (cf. Figure 116).

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 had the largest share of world trade in the years 2000-2004, ahead of the USA and Japan (cf. Figure 117).

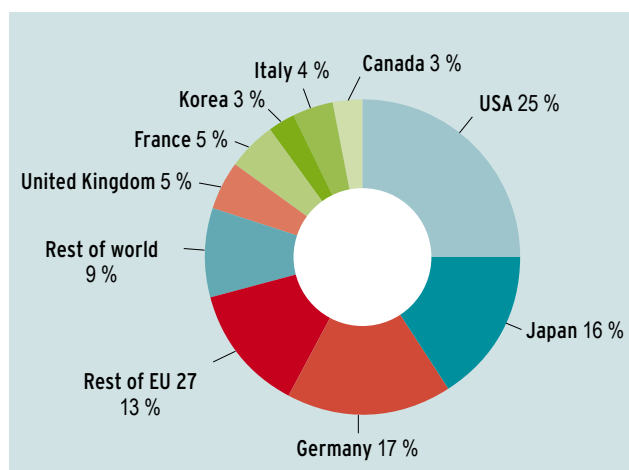
Patents held by German companies

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. Between 2004 and 2007 some 17 percent of patents in the recycling technology sector and about 10 percent in the waste management sector were due to Germany

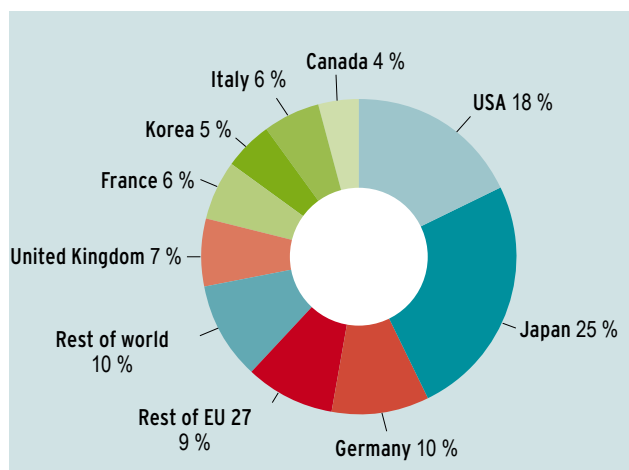
249 BMU (2009b).

Figure 117: World trade shares on the market for closed-cycle and waste management

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

Figure 118: Worldwide shares of patents in the recycling sector by countries 2004-2007

Source: Schasse et al (2010), p. 90

Figure 119: Worldwide shares of patents in the waste management sector by countries 2004-2007

Source: Schasse et al (2010), p. 90

(cf. Figure 118 and Figure 119).²⁵⁰ This puts Germany in first and third places respectively compared with other competitors.

6.5 Outlook

The market for waste and closed-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-cycle management, it made a paradigm shift that gave a new economic stimulus – e.g. for separation of waste or recovery as material; in 2005 the ban on landfill of untreated waste provided a strong incentive for more recycling. Important ideas also came from the European Union – from the End-of-Life Vehicles Directive through the Waste Electrical and Electronic Equipment (WEEE) Directive to the latest revision of the Framework Directive on Waste. It is also because of this progressive legislation that the German waste and closed-cycle industry occupies a leading international position today.

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 safe 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 and the demand for raw materials.

In view of these trends, it will be decisive to translate ecological needs into economic demand.

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 will set further growth surges in motion in the field of waste and recycling technologies. Furthermore, rising raw material prices will 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.

250 Schasse et al (2010).



7 Sustainable water management

7.1 Challenges for sustainable water management

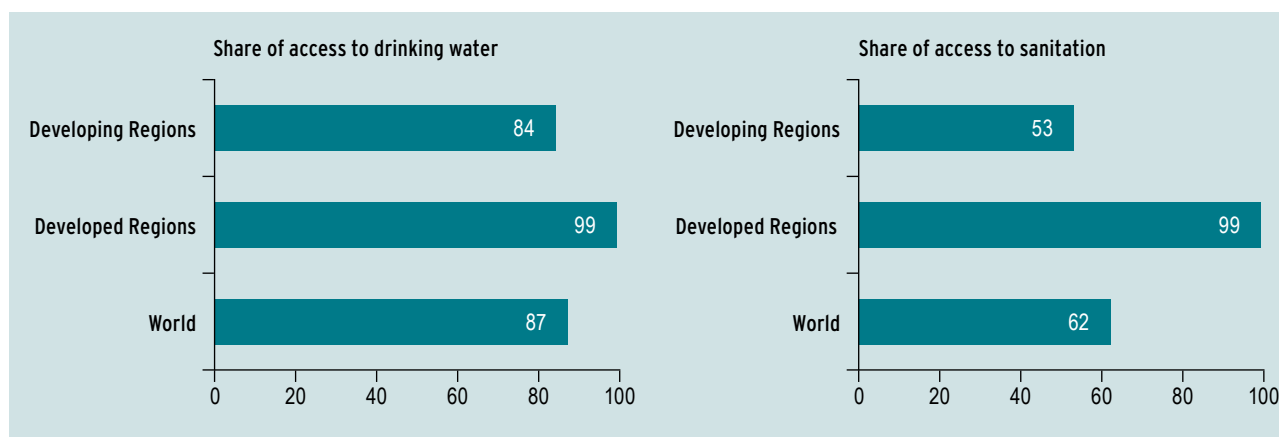
About 900 million people, especially in less developed countries, have to live without clean drinking water. Even more people – 2.5 billion or nearly 40 percent of the world’s population – have no basic sanitation (cf. Figure 120).²⁵¹ “No access to water and sanitation

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.²⁵² 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.²⁵³

251 WHO, UNICEF (2008).

252 UNDP (2006).

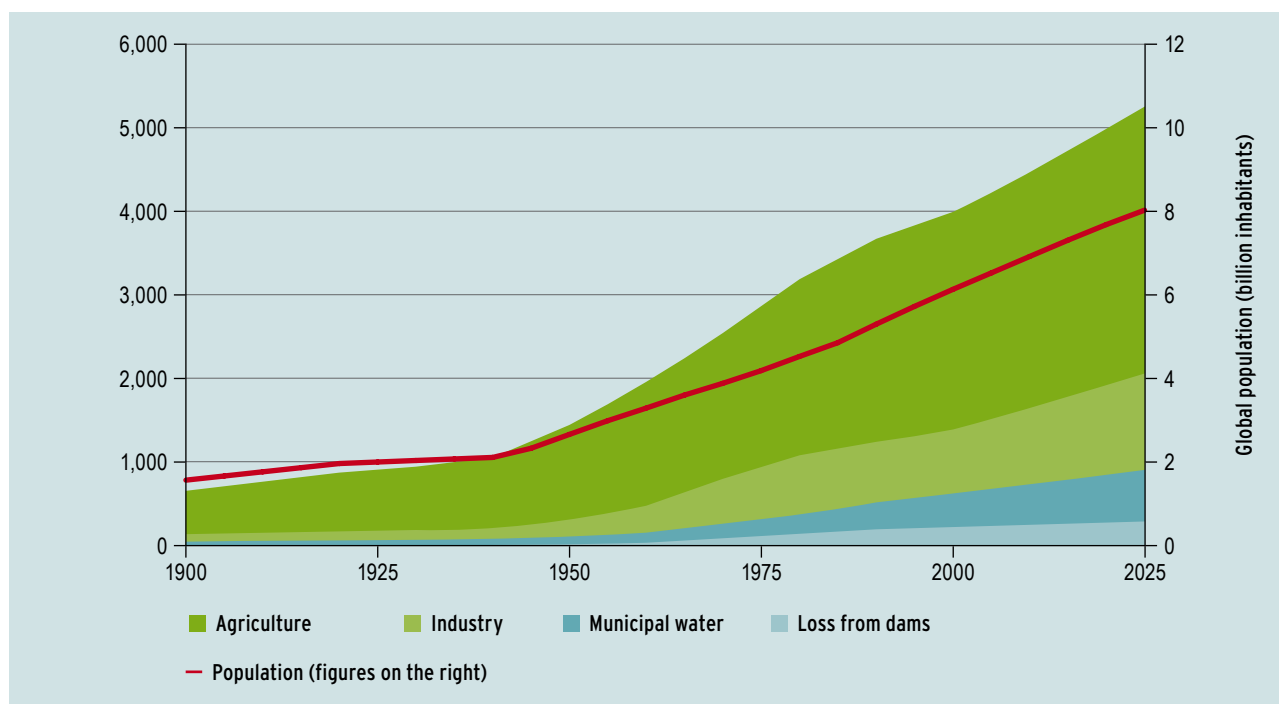
253 UNICEF (2008).

Figure 120: People with access to drinking water and sanitation 2006 (in percent)

Source: WHO, UNICEF (2008)

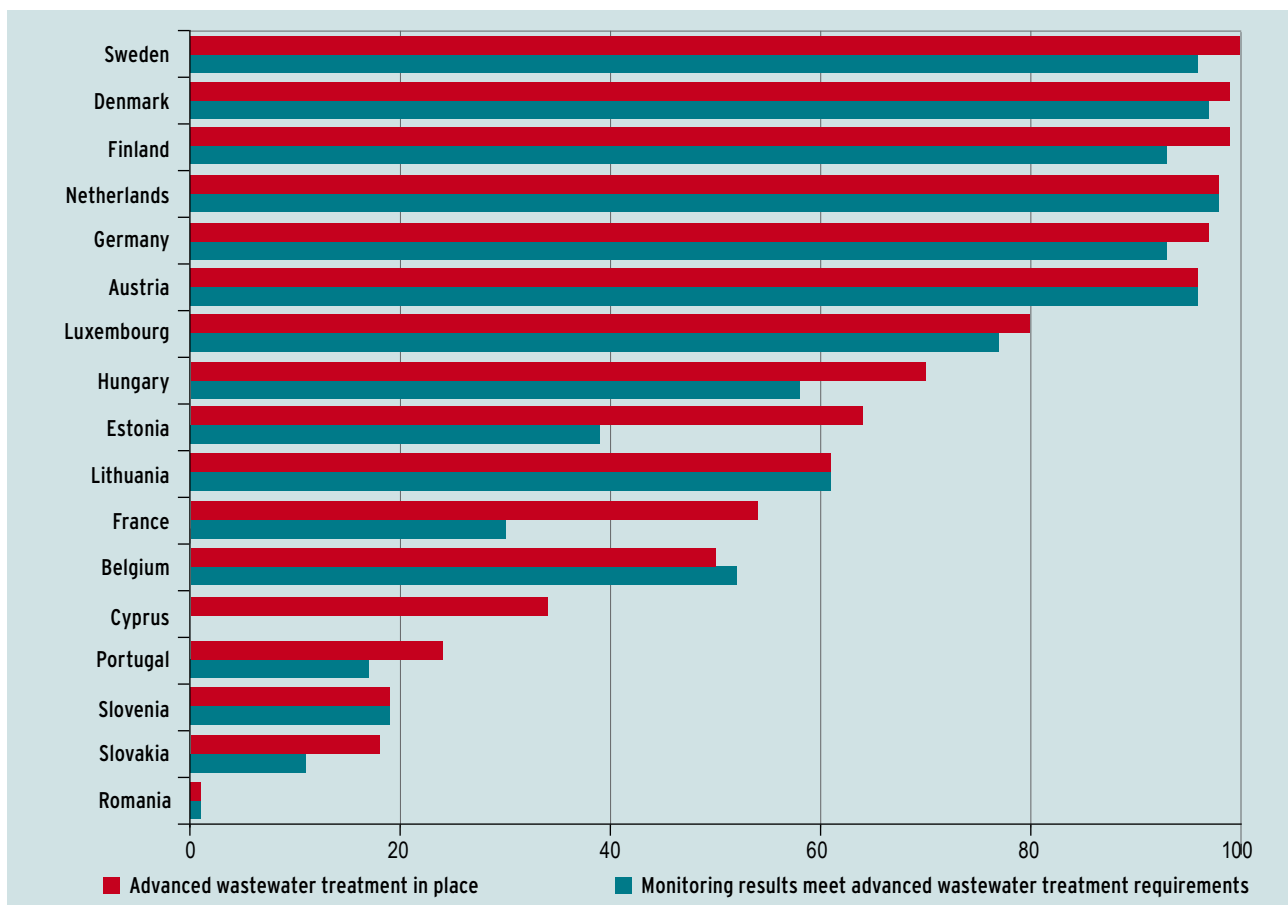
In the past century, worldwide water consumption has grown faster than the population. There is no sign of a change in this trend. Irrigation in the agricultural sector plays the greatest role, especially in the developing countries. Here over 80 percent of water abstracted currently goes for irrigation. The agricultural sector will continue to be the biggest consumer of water (cf. Figure 121).²⁵⁴

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 Development Goals of the United Nations is to halve the number of people without access to drinking water and sanitation by 2015, compared with 1990. This target will probably be achieved as far as drinking

Figure 121: Global water abstraction (in cubic kilometres)

Source: Sustainable Asset Management (2010), p. 10

254 UNDP (2006).

Figure 122: Progress with advanced wastewater treatment on a European comparison (in percent)

Source: Arbeitsgemeinschaft Trinkwassertalsperren e. V. (ATT) et al (2011), p. 59

water is concerned, but that will still leave about 670 million (or 9 percent) of the world's population without a supply of drinking water. If the current trend in access to sanitation is maintained, the figure will fall short of the mark by 1 billion persons. About 2.5 billion people will continue to have no sanitation.²⁵⁵

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.²⁵⁶ Even in eastern Europe, the Caucasus, central Asia and south-eastern Europe there is still a lack of clean drinking water and sewage works. Many EU Member States have yet to tackle the task of implementing the

EC Wastewater Directive, which requires the treatment of municipal waste water in accordance with ambitious purification stages (cf. Figure 122).

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:

255 WHO, UNICEF (2008).

256 OECD (2003).

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, which make it possible to supply drinking water free from bacteria and viruses, are playing an increasingly important role in the treatment of untreated water.

Wastewater disposal: State-of-the-art technology involves collecting the wastewater at the point of origin and feeding it to a central sewage works where it is treated. The purified wastewater is usually discharged into a body of water or, less frequently, re-used for agricultural purposes. The resources consumed in wastewater purification can be reduced by means of modified process design, energy saving and recycling of raw materials. This makes wastewater treatment both more economic and greener. Environmental inputs of micro-pollutants such as medicines, hormones, cosmetics and nanomaterials present wastewater disposal systems with great challenges. Such inputs can be reduced by new and additional treatment technologies.

Decentralised water management: Decentralised water management focuses on the water cycle as a whole. The aim is to close material 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. In predominantly agricultural countries, up to 80 percent of the water is used by agriculture. 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. Both industry and private households can save water with the aid of efficient equipment and process optimisation. For example modern washing machines, dishwashers and fittings are using less and less water.

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

Fact file: Sustainable water management ²⁵⁷

Size of world market	2007	361 billion EUR
	2020	805 billion EUR
Germany's share of world market	2007	~ 10 %
Sales growth	2005 to 2007	15 %
	2008 to 2010	14 %
Growth in personnel numbers	2005 to 2007	4 %
	2008 to 2010	8 %

Varying estimates exist of the total volume of investment in water supply and wastewater disposal that is needed worldwide, but they are all in the range of around 400 to 500 billion EUR per year. The spectrum of predicted growth rates is also broad, but on the whole a marked increase is expected in the years

257 BMU (2009b).

Figure 123: World market projection for sustainable water management (billion EUR)

Source: BMU (2009b), p. 160

ahead. The differences are due to statistical uncertainties, different assumptions about developments in water and wastewater prices, different classifications of the stages in the value chain etc.²⁵⁸

According to estimates by Roland Berger Strategy Consultants, the world market for sustainable water management was around 361 billion EUR in 2007. By the year 2020 it is expected to grow by an average of 6 percent per year to 805 billion EUR.²⁵⁹ The World Water Council believes there is a need for capital investment of 180 billion US dollars per year in water infrastructure in the developing countries. This is more than twice the present level of spending.²⁶⁰ According to UNO, some 11.3 billion US dollars would have to be invested every year to achieve the Millennium Development Goal in the field of water supply.²⁶¹ SIWI (Stockholm International Water Institute) estimates 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.²⁶² In the EU, funds of between 170 and 230 billion EUR will be needed in the years ahead to comply with the wastewater directives in force today.²⁶³

In 2007, water supply – in other words the provision and distribution of water – accounted for by far the largest share of the world market for sustainable water management, with an annual volume of around 172 billion EUR. For the period up to 2020 all market segments show annual growth rates of between 5 and 10 percent. Growth is expected to be fastest in the field of efficiency improvements in water management, followed by wastewater treatment and products for water supply. The biggest absolute increase in market volume of some 200 billion EUR is found in the field of wastewater treatment (cf. Figure 123).

The world market for decentralised water management had a volume of around 18 billion EUR in 2007. 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 eastern 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.

258 Deutsche Bank Research (2010).

259 BMU (2009b).

260 World Water Council (2003).

261 WHO, UNICEF (2005).

262 SIWI (2005).

263 BMU (2009b).

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 sharp drop in costs, the use of membrane technologies is becoming increasingly common.²⁶⁴

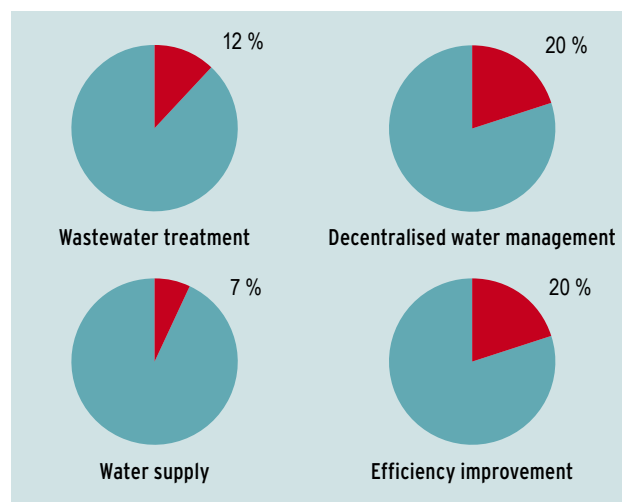
In 2007 the global market for membranes and membrane modules was still around 800 million EUR.²⁶⁵ Estimates for the year 2010 expect demand for membrane filters to reach around three billion US dollars in the USA alone. By 2020 the worldwide market volume is likely to grow to 70 billion dollars.²⁶⁶ Because 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

In 2007 Germany had a 10-percent share of the world market for sustainable water management – corresponding to annual sales of 35 billion EUR. This overall figure includes some very good market positions in individual technologies. With 20 percent of the world market, German companies occupy a particularly strong position in the efficiency improvement and decentralised water management sectors (cf. Figure 124). For this reason German companies, as market leaders in the field of decentralised water management, will profit from the increased demand for use of rainwater, for example. With annual growth rates of 5 percent, the market volume in this sector

Figure 124: World market shares of German companies 2007

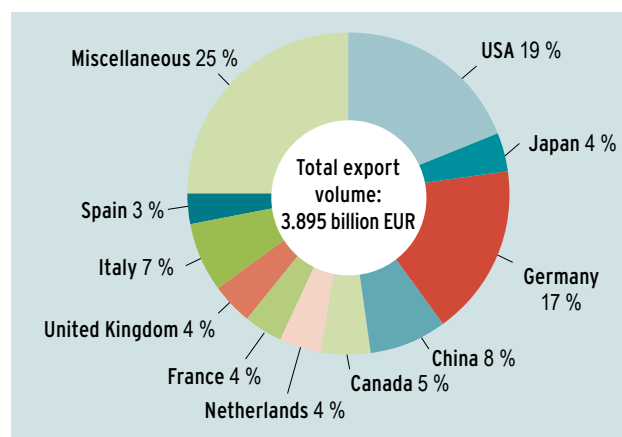


Source: BMU (2009b), p. 159

can be expected to rise to around 35 billion EUR by 2020.²⁶⁷

In the world trade in water and wastewater technology products, Germany has a leading position behind the USA with a share of 17 percent. They are followed at a distance by China, Italy and Canada (cf. Figure 125).

Figure 125: The main exporting countries on the world market for water and wastewater technology 2010



Source: VDMA (2011)

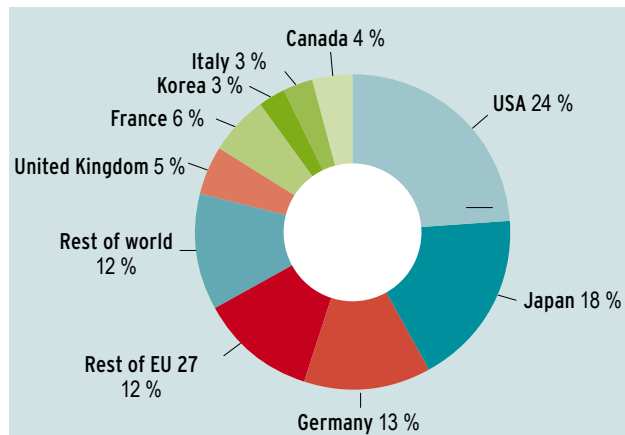
264 Luther et al (2007).

265 BMU (2009b).

266 Luther et al (2007).

267 BMU (2009b).

Figure 126: Worldwide shares of patents in the wastewater sector by countries 2004–2007



Source: Schasse et al (2010), p. 92

Patents held by German companies

In the market of the future for wastewater technologies Germany, with 13 percent of all patent applications, lies third behind the USA and Japan (cf. Figure 126). Whereas the number of patents in the wastewater sector increased worldwide between 2004 and 2007, it showed a slight drop in Germany.²⁶⁸ As a result, Japan overtook Germany with its patent applications.

7.5 Outlook

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 new, innovative technologies that were capable of meeting these requirements.

One obstacle to international cooperation to date has been the small-scale structure of the German water management sector. The mainly small and medium-sized companies in the German water management sector had hardly any international orientation. In the past, the German water management sector was frequently unable to offer appropriate package solutions at international level that met 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, the provision of technical components and the development of operating and management concepts must be combined in a way that meets demand.

In 2008 the German water management sector repositioned itself by establishing the German Water Partnership (GWP). The umbrella brand GWP is a decisive step forward in eliminating deficits and in further expanding Germany's position of the international markets. It 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.

268 Schasse et al (2010).

PART IV: FOCUS TOPIC: RESOURCE EFFICIENCY



1 Resource conservation as a global challenge

Key points at a glance

Natural resources are the Earth's natural capital and the basis for all economic activity. Without them we can neither meet our daily needs nor achieve prosperity.

However, the use of natural resources has taken a course which is not viable in the long run – whether in ecological or economic terms. Estimates by the International Resource Panel expect that worldwide resource consumption will rise from the present 60 billion tonnes per year to 140 billion tonnes per year by 2050. A large proportion of natural resources are only available on a limited scale, however, and are not renewable. Even today, the economy is feeling the considerable burden of sharp rises and fluctuations in raw material prices. What is more, the extraction, processing, use and disposal of resources along the entire value chain gives rise to environmental impacts: energy consumption and release of greenhouse gases, pollution of air, water and soil, adverse effects on ecosystems and biodiversity.

Increasing resource efficiency is therefore a factor of central importance in order to safeguard prosperity in the long term, conserve the natural basis of our life for future generations and improve Germany's competitive position on an international comparison. In the National Sustainability Strategy 2002, the German government set the target of doubling resource productivity, i.e. the ratio of gross domestic product to the materials and resources input in Germany, by 2020 compared with 1994. The aim is to achieve greater economic output while at the same time reducing resource input – it is essential to “decouple” economic growth from resource input.

Possible means of increasing resource efficiency can be found all along the value chain: from sustainable resource extraction, via long-lasting and resource-conserving product design and material-efficient production processes and incentives for resource-efficient consumption, right through to closing material cycles by reusing and recycling resources. Resource efficiency fosters innovation and competitiveness. But experience, e.g. from efficiency consulting for businesses, shows that even economically worthwhile efficiency measures are not implemented on their own merits, or at least not fast enough. The state is therefore called upon to create the right favourable framework conditions. Against this background, the German government has decided to develop a National Resource Efficiency Programme.

1.1 The worldwide increase in resource utilisation makes it necessary to act

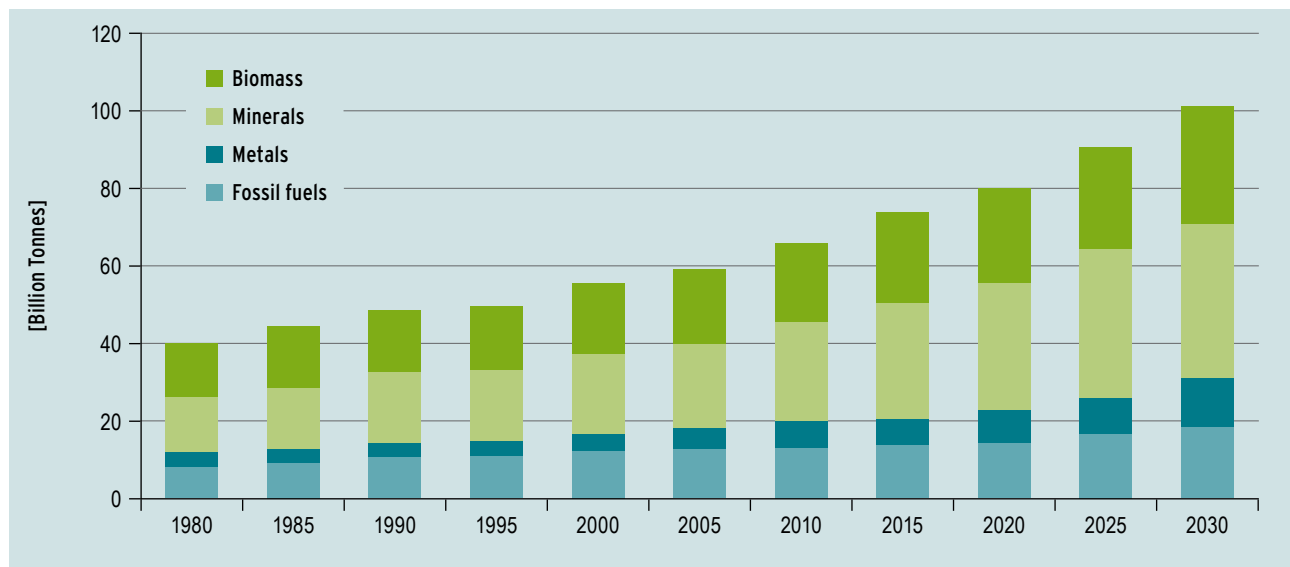
Natural resources are the Earth's natural capital and the basis for all economic activity. Without natural resources such as renewable and non-renewable raw materials, soil/land, water, air, food and energy, we cannot meet our daily needs for life or create prosperity. However, our use of resources has taken a course which cannot be continued in the long term without affecting the prospects of future generations for economic prosperity and social cohesion.

At present, worldwide consumption of abiotic resources amounts to nearly 60 billion tonnes a year. Estimates expect worldwide resource requirements to rise to more than 140 billion tonnes a year by 2050 unless we succeed in decoupling economic growth from resource consumption.²⁶⁹ In a "business-as-usual" scenario, resource consumption will probably exceed the 100 billion tonnes mark as early as 2030 (cf. Figure 127).

Reasons for this strong increase in demand are global population growth, rapid economic growth in emerging and developing economies, technological developments, and a resource-intensive management approach in the industrialised societies. For example, per capita consumption of natural resources averages about 43 kg per day in Europe, as much as 90 kg in the USA, only 14 kg in Asia and only about 10 kg in Africa.²⁷⁰

A "business-as-usual" scenario in which the industrialised countries continued with their resource-intensive economic activities and the developing and emerging economies adopted the same model for prosperity would in the long term result in an economic and ecological disaster. Even today there are signs that many raw materials are getting scarcer, and hence more expensive. Moreover, the use of resources is reaching its ecological limits, or has in many cases already exceeded them. Water resources, soil, forests and seas are already over-utilised or destroyed in many parts of the world; biological diversity is dwindling dramatically and important biochemical substance cycles such as the carbon and nitrogen cycles have been radically altered by man.²⁷¹ Water shortages – for which climate change is at least partly responsible – are already a problem in many regions of the Earth and are increasingly affecting Europe as well.²⁷²

Figure 127: Global resource extraction 1980–2030 (projections 2010–2030 based on a "business-as-usual" scenario)



Source: Aachener Stiftung Kathy Beys (2011), p.2

269 UNEP (2011c); Aachener Stiftung Kathy Beys (2011).

270 Global 2000, SERI (2009); SERI (2010).

271 Cf. WBGU (2011).

272 Cf. IPCC (2007b).

It is therefore high time to change course and develop new forms of economic activity which create more prosperity while using less resources. This is a central task of this century, and only if – global – solutions are found can future generations enjoy a high level of prosperity as well.

Germany, as one of the world's leading industrialised countries, has a special responsibility in the process and can – as in the field of climate protection – gain economic benefits from improving resource efficiency. It is not difficult to foresee that resource efficiency will become a central factor of competition in the future and that the markets for efficiency technologies will continue to grow (cf. Part III, Chapter 3). It is therefore necessary to pave the way for a resource-conserving approach to management and consumption as early as possible. There is thus a need to set in motion a comprehensive ecological modernisation process which covers all sectors of the economy and society and which uses technical and social innovation to increase resource efficiency.

1.2 Impacts of resource utilisation on nature and the environment

As a rule, resource extraction and use give rise to adverse environmental impacts throughout the entire life cycle of a product.

This starts with the extraction and production of the raw materials. The harnessing of mineral resources, their extraction and preparation, involves high consumption of nature. The production and further processing of raw materials is associated with land requirements, material and energy consumption, and emissions into soil, water and air. Mining changes the landscape, ecosystems and the water balance. In Germany alone, resource extraction involves moving more than 2.2 billion tonnes a year of material that never actually enters the cycle of economic activity (especially overburden).²⁷³ Mining-induced damage to buildings and so-called “everlasting burdens”, like those caused by pumping stations in the Ruhr coalfield, saddle future generations with a burden of millions of euros a year. The use of chemicals, e.g. for extracting gold and mercury, combined with

the release of heavy metals hitherto bound in the rock, gives rise to considerable pollution of the environment in many countries.

Admittedly it is possible to recultivate sites after extraction has ceased and convert them to an ecologically improved status. Good examples of this exist in Germany, and also of nature conservation oriented monitoring during the period of active use.²⁷⁴ In many other countries, however, recultivation measures are not prescribed or not implemented.

The growing demand for raw materials is also resulting in the exploration and use of inferior-quality and less accessible deposits. This makes it necessary to use more and more energy to extract the resources. For example, an estimated 7 percent of global energy consumption is used merely for extracting, preparing and processing metals.²⁷⁵ Since ore contents are dwindling, energy requirements can be expected to continue increasing. In view of the increased energy requirements, it seems likely that in the medium term there will also be a rise in demand for fossil fuels and an increase in greenhouse gas emissions.

To extract resources today it is necessary to move an average of about three times as much material as a hundred years ago.²⁷⁶ At the same time, resource extraction is increasingly moving into ecologically sensitive areas, e.g. Arctic regions or the depths of the oceans. This involves additional risks for the environment.

The subsequent processing, transport, use and recycling of the resources, materials and products also involve further environmental impacts, e.g. in the form of emissions into the soil, water and air. The environmental impacts arising from recycling are less than those from the original extraction of the resources. At the end of the value chain one is left with waste which, if it not properly disposed of, can also result in serious environmental impacts, e.g. methane emissions or groundwater pollution.

The resources that are growing scarcer worldwide also include fertile arable land. The growing global population, increasing demand for agricultural produce as a result of the growing proportion of food accounted for by animal products, and the increas-

273 Non-utilised extraction: Federal Statistical Office (2010b).

274 Cf. NABU et al (2004).

275 Duchin et al (2010).

276 UNEP (2011c).

ing production of biomass for energy and industry are stepping up the pressure on land as a resource and creating growing competition between uses. Soil degradation as a result of over-utilisation, lack of water and the impacts of climate change are making the shortage worse. The challenge consists in meeting the fast-growing demand for agricultural produce on a sustainable basis. This also includes protecting biological diversity.²⁷⁷ If natural resources are over-utilised instead, the problem will be exacerbated by further soil degradation or the exhaustion of groundwater resources.

1.3 Social aspects of the increasing use of resources

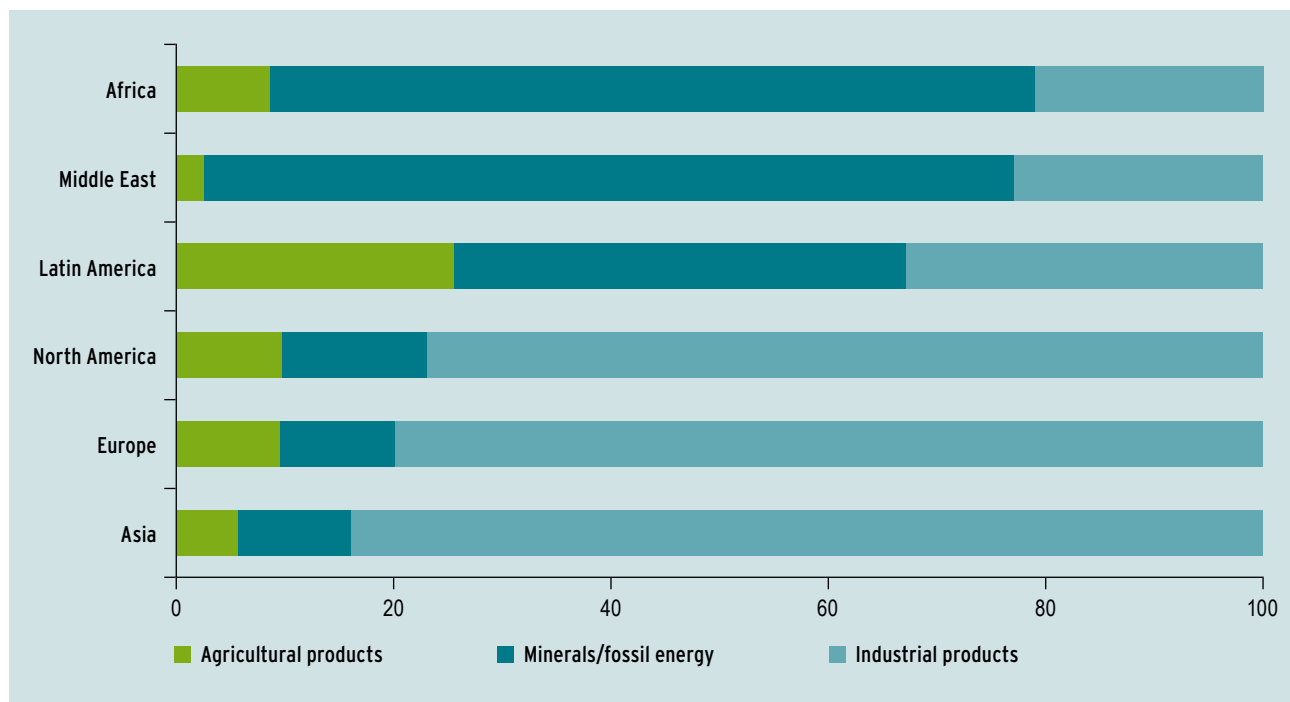
The value added in resource-rich developing countries frequently remains small, although the developing countries have to bear a considerable part of the adverse ecological and social impacts of the extraction of these resources. The resources extracted in Africa, Asia and Latin America are often exported, and it is only in the industrialised countries (and increasingly in the emerging economies) that they

undergo further processing in lucrative value chains (cf. Figure 128).

Certainly the extraction and processing of resources can contribute to economic development and the creation of jobs. However, studies indicate that resource riches may also inhibit the social and economic growth of a country. Empirical evidence suggests that there has tended to be a negative correlation between resource riches and economic growth in the last few decades.²⁷⁸ What is more, the employment situation in the resource extraction sector in developing countries is often characterised by low wages, poor working conditions and lack of health and safety protection. Soil erosion, deforestation, poisoning of rivers by pollutants or large-scale pollution of whole areas, as seen in the Niger Delta or the Amazon Basin, are depriving many people of the basis for life, especially in rural areas. These problems are often joined by serious environmental health impacts.

At the same time the developing countries are suffering particularly from rising energy and food prices. Simply as a result of the increases in food prices, the

Figure 128: What world regions export 2006 (Export shares in percent)



Source: Global 2000 and SERI (2009), p. 16

277 Cf. WBGU (2008); WBGU (2011).

278 Cf. Auty (2001).

developing countries' food import bills rose by up to 20 percent in 2010 compared with the year before.²⁷⁹ The World Bank estimates that because of the rise in food prices some 44 million people have fallen below the absolute poverty limit of 0.86 EUR per day since mid 2009. If prices increased by a further 10 percent, another 10 million people would be in absolute poverty.²⁸⁰ However, it is not in the developing countries alone that rising energy and food prices are a social problem – the rises are also hitting people with low incomes particularly hard in the industrialised countries as well.

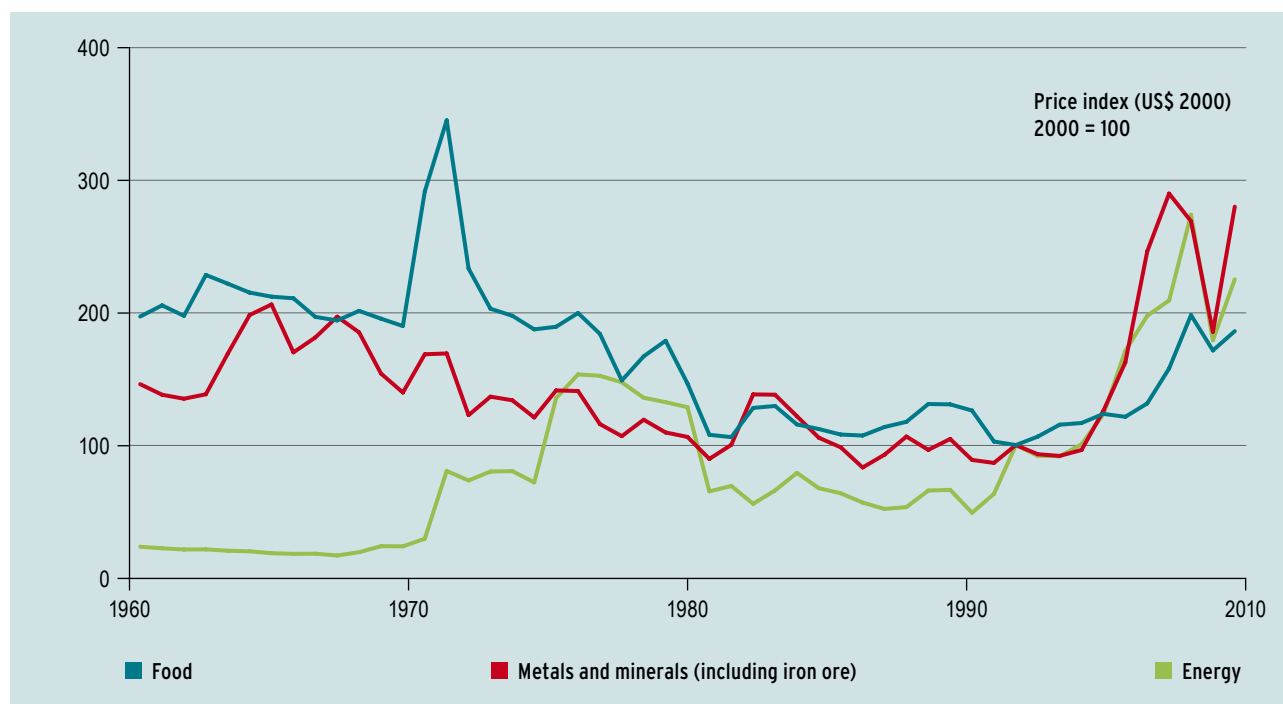
Resource production is also an important cause of social and military conflicts. Natural resources play a role in 40 percent of all internal conflicts. According to the United Nations Environment Programme, there were 18 military conflicts relating to natural resources in the period 1990 to 2008 alone.²⁸¹

1.4 Economic impacts of imminent resource scarcity

Sharply fluctuating and, in recent years, sharply rising raw materials prices (cf. Figure 129) are putting the economy under pressure. This problem could grow worse in the decades ahead because of the increasing scarcity of natural resources.

With the rise in resource prices, there has been a sharp increase in trading on the resource derivatives markets.²⁸² Raw materials markets with rather low market volumes in particular are susceptible to speculation on resources. The oil price shock of the 1970s with its adverse effects on growth, employment and inflation was a clear example of the vulnerability of the economy to sharp rises in resource prices. The fact that the major increase in oil prices after the

Figure 129: Development of resource prices 1960–2010



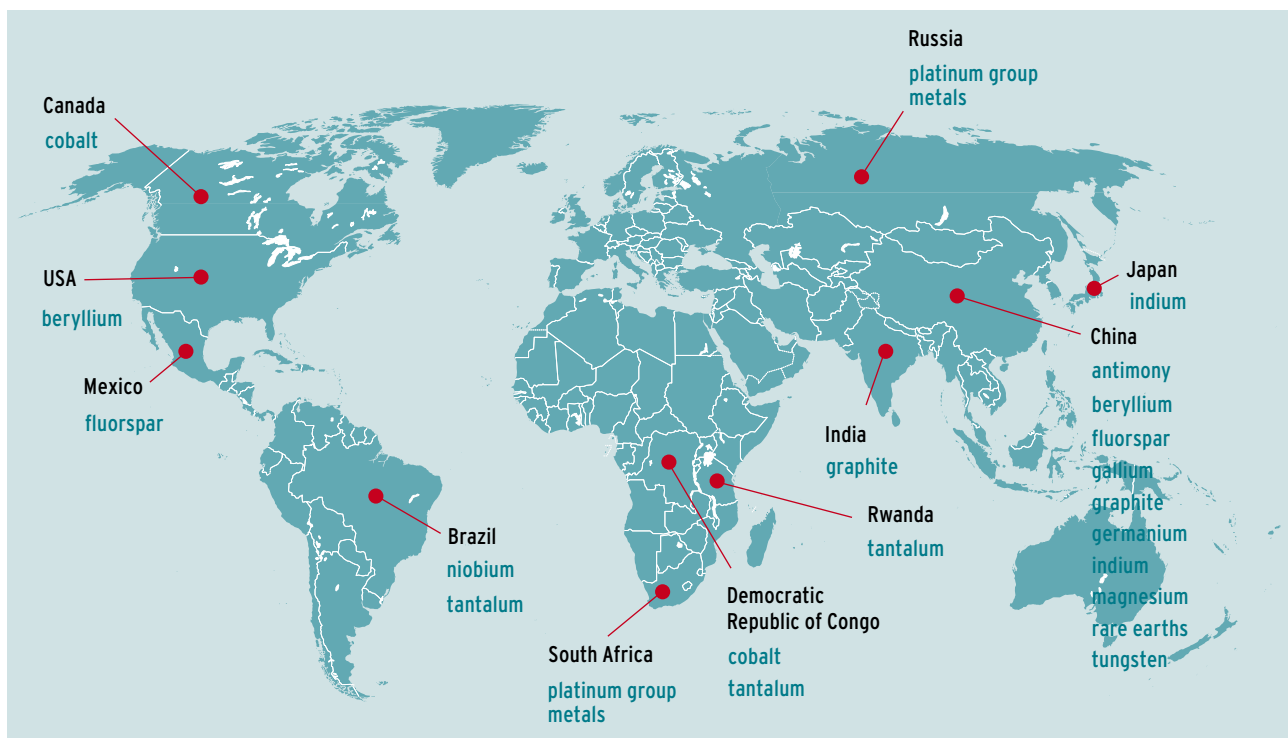
Source: UNEP (2011c), p. 13

279 FAO (2010).

280 Worldbank (2011).

281 UNEP (2009).

282 Cf. Schulmeister (2009).

Figure 130: Concentration of production of critical resources

Source: EU COM (2011d)

turn of the century had a far less damaging effect on economic development was due in no small measure to the increases in energy efficiency that had taken place in most industrialised countries since the 1970s – by as much as 37 percent between 1980 and 2002 alone.²⁸³

After a temporary decline during the 1990s, resource prices showed a further marked increase after the turn of the century. A major driving force here was the increase in demand in the emerging economies. Since the demand for resources by the industrialised countries has not yet slackened off, and since the emerging and developing economies will probably continue to catch up their economic backlog in the years ahead, the demand-generated pressure on prices will probably be maintained.

The European Commission believes that the risk of supply shortages and associated price increases is particularly great for a total of 14 economically important resources.²⁸⁴ These “critical resources” include rare earths and platinum group metals, for example. In the case of several critical resources, production is concentrated in a small number of countries (cf. Figure 130). There is thus a danger of supply shortages arising if exports from less stable countries dry up, or if individual states or companies exploit their market power to enforce large price rises. Examples include the switch to short-term supply contracts by the major mining companies and the Chinese restrictions on exports of rare earths.

A number of future technologies require sharply rising quantities of special metals (cf. Figure 131). Some of these technologies play an important role in the necessary ecological modernisation of the economy.

283 OECD (2008b).

284 EU COM (2011d).

Figure 131: Worldwide annual resource requirements for selected future technologies in 2006 and 2030

Raw material	2006	2030	Future technology
Gallium	0.28	6.09	Thin-film photovoltaic, IC, WLED
Neodymium	0.55	3.82	Permanent magnets, laser technology
Indium	0.40	3.29	Displays, thin-film photovoltaic
Germanium	0.31	2.44	Glass-fibre cables, IR optical technologies

The figures shown are the ratio of the resource requirement to the current world production quantity (=1).

Source: IZT, Fraunhofer (2009), p. 15

Another reason why there are limits to increased extraction of these resources is that the metals in question are often only by-products in the production of mass metals of greater economic importance (e.g. indium as a by-product of zinc, tungsten as a by-product of tin). This means their production cannot simply be stepped up to meet increasing demand. In such cases there is a great risk of structural shortages and price fluctuations. Another factor is that to date recycling of many of these metals at the end of their product cycle has amounted to less than 1 percent, because they are often used in extremely small quantities (e.g. gold in mobile phones). As a result it is a complex technical and logistical process to recover them and return them to the substance cycle. At present, therefore, they are mostly lost by dissipation.²⁸⁵

The economic consequences of increasingly scarce resources are particularly relevant for Germany, a

highly industrialised country which is relatively poor in resources. Germany is nearly a 100-percent net importer of metal ores, phosphate, graphite and magnesite, and also imports a substantial proportion of energy resources, numerous industrial minerals and refined metal products.²⁸⁶ This is also reflected in its expenditure on imports of raw materials, which more than doubled between 2003 and 2008 and only displayed a temporary drop as a result of the economic and financial crisis in 2009 (cf. Figure 132).

The extent to which Germany will be affected by future supply shortages and price increases in the resource sector depends among other factors on the pace of advances in resource efficiency. In other words, the imminent resource depletion also offers economic opportunities for Germany: countries that prepare for it in good time and take steps to improve resource efficiency will have advantages in international competition in the future.

Figure 132: Value of German resource imports (in billion EUR)

Resource class	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Energy	35.0	36.1	34.6	38.5	41.7	56.5	70.6	66.4	90.0	60.3
Metals	16.1	15.4	13.9	13.2	17.7	20.9	32.0	36.8	36.4	22.7
Non-metals	1.9	1.8	1.6	1.5	1.6	1.7	1.8	1.9	2.0	1.6
Total ¹⁾	53.0	53.3	50.1	53.1	61.0	79.1	104.4	105.1	128.3	84.5

1) Deviations of the total are due to rounding.

Source: BGR, Bundesrepublik Deutschland – Rohstoffsituation, various years

285 Cf. UNEP (2011d).

286 BGR (2010).



2 Improving resource efficiency as a political task for the future

It was in 1972 that worldwide public awareness was first focused on resource conservation by the Club of Rome's report "The Limits to Growth"²⁸⁷. The conservation and sparing use of resources were key issues of the Agenda 21 adopted at the Earth Summit in Rio de Janeiro in 1992.²⁸⁸ The follow-up conference in Johannesburg in 2002 underpinned the conservation of natural resources with recommendations about measures and their implementation.²⁸⁹ In 2012 the international community of states will discuss ways and means of making the transition to a green economy at the UN Conference for Sustainable Development in Rio de Janeiro; the issue of resource efficiency will play a central role here. The activities of the United Nations are supplemented by the International Resource Panel²⁹⁰ set up in 2007 under the auspices of the UN Environment Programme (UNEP), in which experts from industrialised, emerging and developing countries prepare analyses and recommendations on sustainable management of natural

resources and on decoupling growth from resource consumption. Resource efficiency has become considerably more important at European level as well. In December 2005 the European Commission adopted a "Thematic strategy on the sustainable use of natural resources"²⁹¹, which among other things calls upon the member states to draw up national programmes for resource conservation. The EU Sustainability Strategy dating from 2006 addresses the conservation of natural resources as a central challenge.²⁹² The "Europe 2020" strategy adopted by the European Council in 2010 focuses in one of its lead initiatives on "Resource-efficient Europe".²⁹³ The lead initiative sets out to decouple economic growth from resource consumption and to support the transition to a low-emission and resource-efficient economy that is sustainably competitive. In autumn 2011 the Commission presented a "Resource Efficiency Road Map" giving concrete shape to the lead initiative.

287 Meadows et al (1972).

288 Cf. UN (1992).

289 Cf. UN (2002).

290 See www.unep.org/resourcepanel.

291 EU COM (2005).

292 Cf. EU COM (2006).

293 Cf. EU COM (2011e)

In the National Sustainability Strategy of 2002, the German government set specific targets for a management approach that conserves natural resources.²⁹⁴ They include the aim of doubling resource productivity by 2020 compared with 1994 – measured as the ratio of gross domestic product to the input of abiotic raw materials. With this quantified target, Germany is an international pioneer of resource efficiency policy.

Germany has made progress towards this target, but so far the pace is not sufficient to achieve the target of doubling by 2020. By 2009 an increase of nearly 47 percent in resource productivity had been achieved. However, a linear path to the target would have required 57 percent. Moreover, a considerable portion of the progress achieved is due to structural changes in the German economy and to relocation of production abroad. Additional efforts will therefore be necessary to achieve the target in the sustainability strategy.

In view of this, the German government, in its raw materials strategy of 20 October 2010, decided to develop a National Resource Efficiency Programme and instructed the Federal Environment Ministry to

prepare a draft. The German government is aiming to take the decision on the programme before the UN conference “Rio plus 20”.²⁹⁵

The German Bundestag has also taken up the issue, and on 23 November 2010 it set up the study commission “Growth, prosperity, quality of life – routes to sustainable management and social progress in the social market economy”.²⁹⁶ Working group 3 of the study commission is to investigate whether and how the growth of GDP can be permanently decoupled from the growth in the consumption of resources, environmental and biological capital and climate-relevant emissions, and to identify future fields of technological progress which can be expected to help reduce resource requirements.

The diversity of the political answers at the various levels demonstrates the multi-faceted nature of sustainable use of resources. A sustainable German resource efficiency policy will help to discharge our global responsibility for the ecological and social impacts of resource utilisation in Germany, strengthen the future viability and competitiveness of the German economy, and thereby promote stable employment and social cohesion.

294 Cf. Federal Government (Bundesregierung 2002).

295 Federal Ministry of Economics and Technology (BMWi 2010c).

296 See www.bundestag.de/bundestag/ausschuesse17/gremien/enquete/wachstum/index.jsp.



3 Economic benefits of a proactive resource policy

3.1 Overview

A resource policy that increases resource efficiency and seeks to close material cycles as far as possible is a good thing both for the individual companies and for the entire economy. This is particularly true

in the case of Germany, because as a resource-poor country it is heavily dependent on imports of resources.

Economic benefits of improving resource efficiency

- **Greater security of supply:** Reducing primary resource requirements tends to reduce dependence on resource imports. This has a positive effect on security of supply for German companies. This aspect is particularly relevant in the case of “critical resources” which are not only of great economic importance but also involve considerable procurement risks (cf. Chapter 1.3).
- **More economic stability:** Resource-efficient products and production processes and increased recycling reduce the economy’s vulnerability to sharp price rises and fluctuations on the international raw materials markets.
- **Competitive advantages:** At the enterprise level, efficient use of resources can result in substantial cost savings and competitive advantages (cf. Chapter 3.2). In view of the growing scarcity of resources, this aspect will become increasingly important, especially in international competition.
- **Improved employment situation:** If individual companies succeed in exploiting their economically worthwhile potential for improving resource efficiency, this could create new jobs on a considerable scale. An increase in recycling also tends to promote employment (cf. Chapter 3.3).

To strengthen Germany's economic position on the world markets and safeguard our prosperity, it is therefore necessary to take action to improve resource efficiency. This also strengthens the competitive position of German businesses on the green markets of the future, which offer great economic opportunities in the decades ahead. For example, estimates indicate that the world market for energy-efficient products and technologies will grow from 540 billion EUR in 2007 to 1,030 billion EUR in 2020. Over the same period, the world market for waste and closed-cycle management will probably expand from 35 billion to 55 billion EUR.²⁹⁷

3.2 Growing more competitive through resource-efficient management

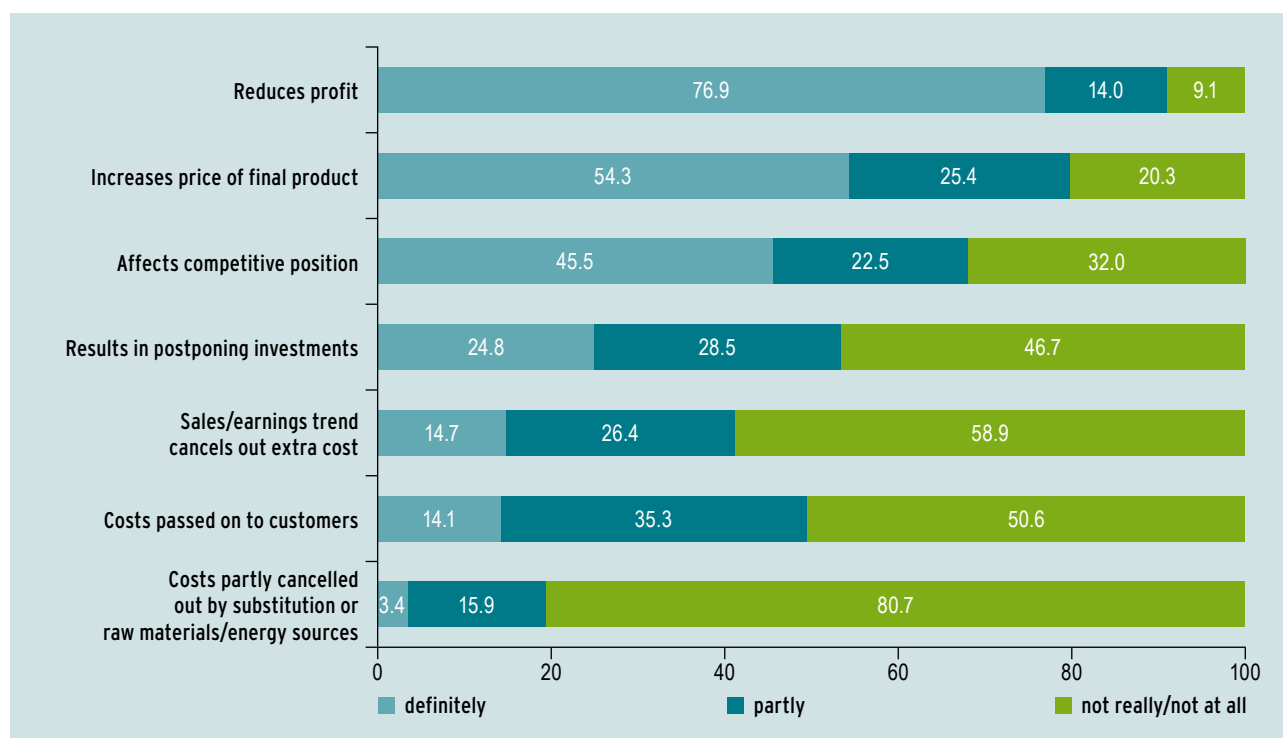
Material costs are the largest block of costs for companies in the manufacturing sector.²⁹⁸ They account for 47 percent of gross production value,

whereas personnel costs amount to only 18 percent.²⁹⁹ Material costs are thus a central factor for a company's competitive strength. This is a cost factor that companies can address to cut operating costs and at the same time reduce their resource requirements.

The great importance of resource and material costs is also revealed by a survey of German industrial companies conducted in 2010. In it, 85 percent of the respondents said that resource and energy prices were important factors influencing their future business situation. In the opinion of these companies, they had a greater influence on their future business situation than labour costs (75 percent) or the shortage of skilled labour (50 percent).³⁰⁰

The impacts of high energy and resource prices as seen by industry are illustrated in Figure 133. More than two thirds of small and medium enterprises stated that high energy and resource prices adversely affected their competitive position. This underlines the need to reduce resource consumption.

Figure 133: Impacts of high energy and resource prices as seen by industry (in percent)



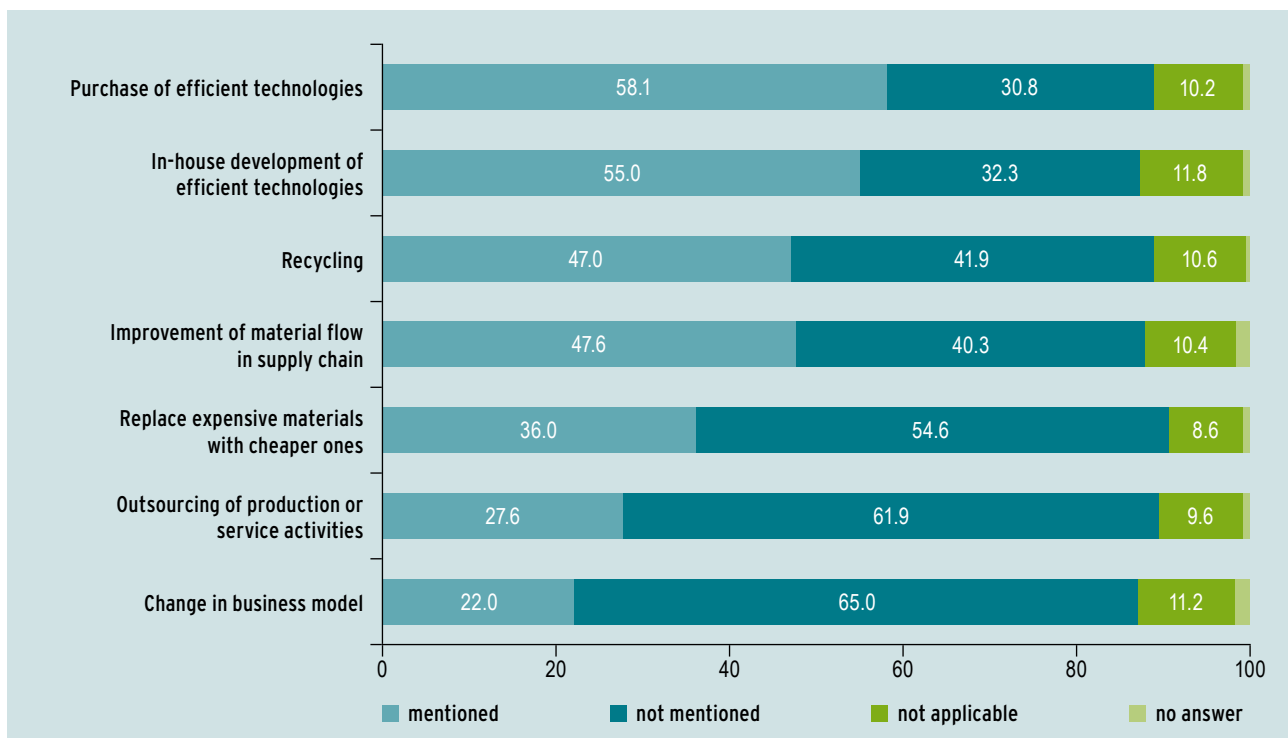
Source: BDI (2011), p. 23

297 BMU (2009b).

298 This figure also includes intermediate products, i.e. not only resource costs. Cf. in this connection Part II, Chapter 2.

299 Federal Statistical Office (2010d).

300 BDI (2010).

Figure 134: Company measures to reduce material costs (in percent)

Source: The Gallup Organization (2011b)

A recent survey shows that many companies have already taken appropriate action: more than 50 percent of businesses with over 100 employees and nearly 30 percent of smaller companies said they were taking measures to improve energy and material efficiency with a view to reducing their material and energy costs.³⁰¹

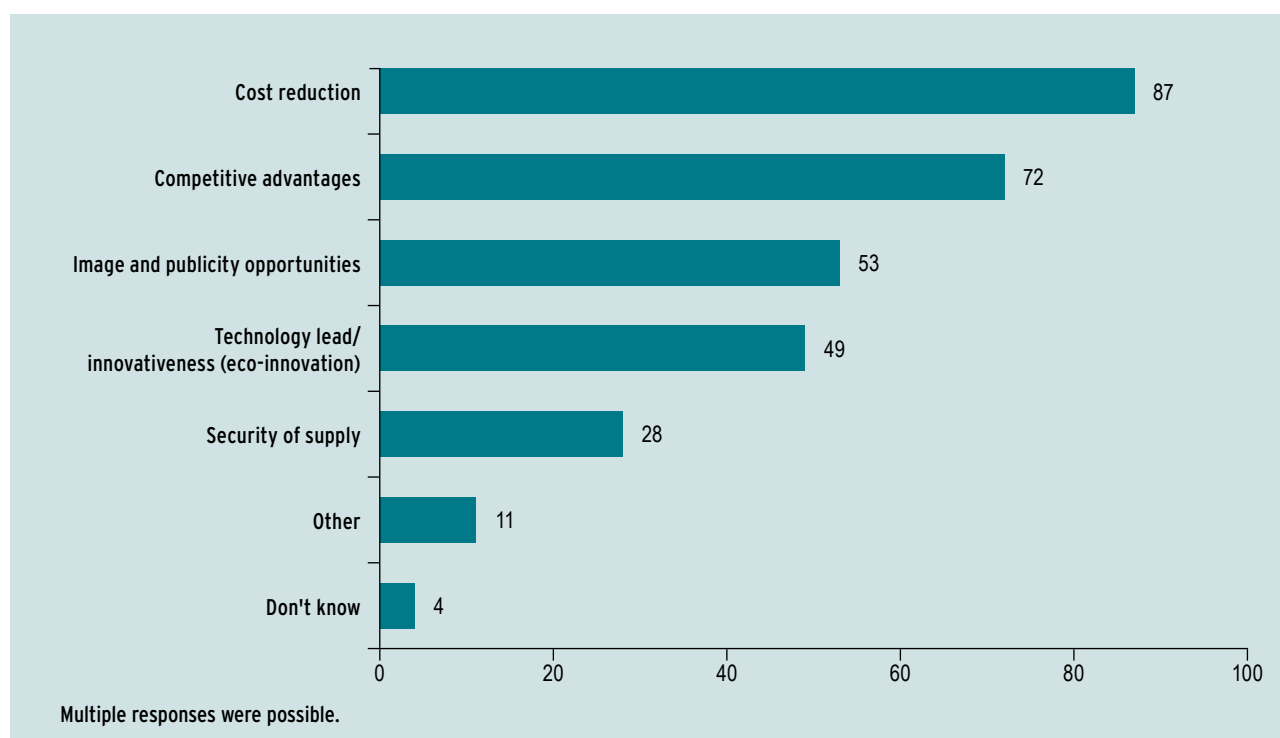
A business survey in the EU investigated what measures companies were taking to reduce their material costs. The points most frequently mentioned by German companies were the use of more efficient technologies, followed by increased recycling and improvements in material flows within the supply chain (cf. Figure 134). A similar picture was found in other EU countries. It is striking to note that more than half the German companies developed their own technologies for greater resource efficiency. This makes it clear that improving resource efficiency is an important driving force behind innovations and at the same time a growth market for environmental technology.

As Figure 135 shows, there are a number of good reasons for companies to invest in resource efficiency. Aspects mentioned in addition to cost savings and competitiveness include image improvements or greater security of supply. Roughly one company in two regards improving resource efficiency as an opportunity to gain a technological lead through ecological innovation.

In spite of German companies' great awareness of the potential of resource efficiency, they are far from exploiting it to the full. For example, in the course of the VerMat programme, through which the Federal Ministry of Economics funds company-specific consulting by the German Material Efficiency Agency demea to improve material efficiency, substantial savings potential was identified in almost all companies. An evaluation of 569 potential analyses showed that the average annual material savings potential was around 210,000 EUR per company.³⁰² In terms of company turnover, the savings opportunities averaged about 2.1 percent (cf. Figure 136). The greatest

301 BDI (2011).

302 demea (2010).

Figure 135: Objectives supported by resource efficiency (in percent)

Source: Erhard, Pastewski (2010), p. 16

savings potentials – in terms of annual turnover – were found in small companies; in some cases they were more than 5 percent of turnover.

In most cases the existing savings potential can be achieved without great effort, and involves only small investments which pay off very quickly. Over half the measures suggested by the external consultants could be implemented with an investment of less than 10,000 EUR and a payback period of less than six months. Experience shows that businesses

often only accept payback periods of more than 3 years if the measure is of great relevance to the business.³⁰³ For this reason many profitable savings opportunities involving sizeable or longer-term expenditure are frequently not implemented.

Estimates indicate that companies in the manufacturing sector could cut their material costs by a total of up to 20 percent by means that are relatively easy to implement, though in some cases there would be a need for support from assistance programmes.³⁰⁴

Figure 136: Savings potential identified in VerMat programme

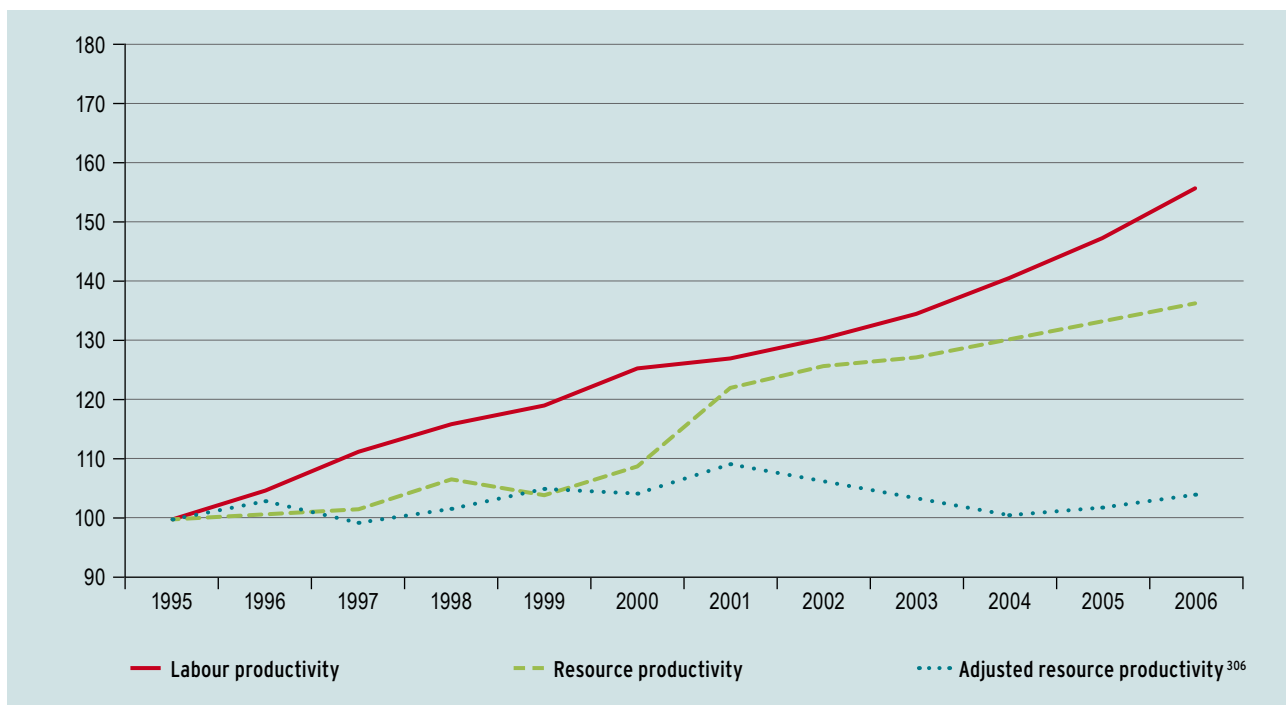
	Mean	Median
Annual savings potential (absolute) in EUR	210,000 Euro	110,000 Euro
Savings potential per employee in EUR	3,000 Euro	1,600 Euro
Savings potential as % of annual turnover	2.10 %	1.30 %

Basis: 569 reports

Source: Schmidt, Schneider (2010), p. 185

303 Schmidt, Schneider (2010).

304 Arthur D. Little et al (2005).

Figure 137: Development of resource and labour productivity in the manufacturing sector (Index: 1995 = 100)

Source: Faulstich et al (2009), p. 41

On the basis of existing studies, the German Material Efficiency Agency also assumes that a 20-percent increase in material efficiency would be possible by 2015.³⁰⁵ Since materials to the value of 500 billion EUR are processed in Germany every year, this corresponds to a saving of 100 billion EUR per year.

The long-term trend in resource productivity in the manufacturing sector demonstrates that there is a need for action to improve resource efficiency: Despite the considerable relevance of material costs to the competitive strength of businesses, resource productivity has risen more slowly than labour productivity since 1995. In fact, adjusted resource productivity³⁰⁶ has remained more or less at the same level since 1995 (cf. Figure 137). The reasons for this are complex. Chapter 4.1 looks in more detail at central obstacles to improving resource efficiency and possible approaches to eliminating them.

3.3 Overall economic benefits of improving resource efficiency

Improvements in resource efficiency offer considerable advantages for the economy as a whole. They reduce dependence on supplies of resources from the world market. Fluctuations in resource prices have less impact on the economy and on company profits. There is less risk of inflation induced by resource price increases.

Analyses using the macroeconomic model *Panta Rhei* confirm the favourable economic effects of improved material efficiency. They indicate that around 700,000 additional jobs will be created by 2030 if businesses in the manufacturing sector implement the opportunities identified by consulting and information to cut their material costs by an average of

³⁰⁵ demea (2010).

³⁰⁶ The adjusted resource productivity figure is for the manufacturing sector less the effects of the industries "Production of glass, ceramics, processing of non-metallic minerals".

Figure 138: Effects of a 20-percent reduction in material costs in Germany by 2030 resulting from information and consulting instruments

Difference from basic scenario	Gross domestic product	National debt	Gainfully employed	Final energy consumption	Resource consumption (TMR)
relative	+ 14.20 %	- 10.20 %	+ 1.90 %	+ 0.42 %	- 9.20 %
absolute	+ 374.7 billion EUR	- 226 billion EUR	+ 696,100 people	+ 33,147 TJ	- 506.4 million t

Source: Distelkamp et al (2010), p. 5

20 percent (cf. Figure 138). At the same time there is a reduction of more than 9 percent in raw materials consumption, measured here using the indicator Total Material Requirement (TMR)³⁰⁷. Public finances benefit as well – in 2030 the national debt is about 226 billion EUR lower than in the business-as-usual scenario.³⁰⁸

The Panta Rhei model was also used to analyse the economic impacts of increased recycling; in each case it was assumed that there was a threefold increase in the share of secondary raw material in the

final products. One scenario assumed that recycling caused additional costs. Against the background of rising resource prices, a second scenario assumed that the use of recycled material involved the same costs as the use of primary materials.

The employment effects are moderately positive for both scenarios. Even more positive are the effects on resource consumption, measured with the indicator TMR. This shows a decrease of around 197 million tonnes or 490 million tonnes, depending on the scenario in view (cf. Figure 139).

Figure 139: Effects of recycling non-ferrous metals in Germany 2030

Difference from basic scenario	Gross domestic product	National debt	Gainfully employed	Final energy consumption	Resource consumption (TMR)
relative Scenario 1	+ 0.01 %	- 0.05 %	+ 0.02 %	+ 0.01 %	- 3.30 %
Scenario 2	+ 0.04 %	- 0.10 %	+ 0.03 %	+ 0.01 %	- 8.90 %
absolute Scenario 1	+ 0.33 bn Euro	- 1.0 bn Euro	+ 7,000	+ 534 TJ	- 196.8 million t
Scenario 2	+ 1.0 bn Euro	- 2.5 bn Euro	+ 10,600	+ 916 TJ	- 489.8 million t
Scenario 1: Use of secondary raw materials involves additional costs					
Scenario 2: Use of secondary raw materials involves no additional costs					

Source: Distelkamp et al (2010), p. 6

307 The TMR comprises all material flows due to used and non-used extraction in Germany, plus all material flows occurring outside Germany due to used and non-used extraction that are caused by imports.

308 Distelkamp et al (2010).



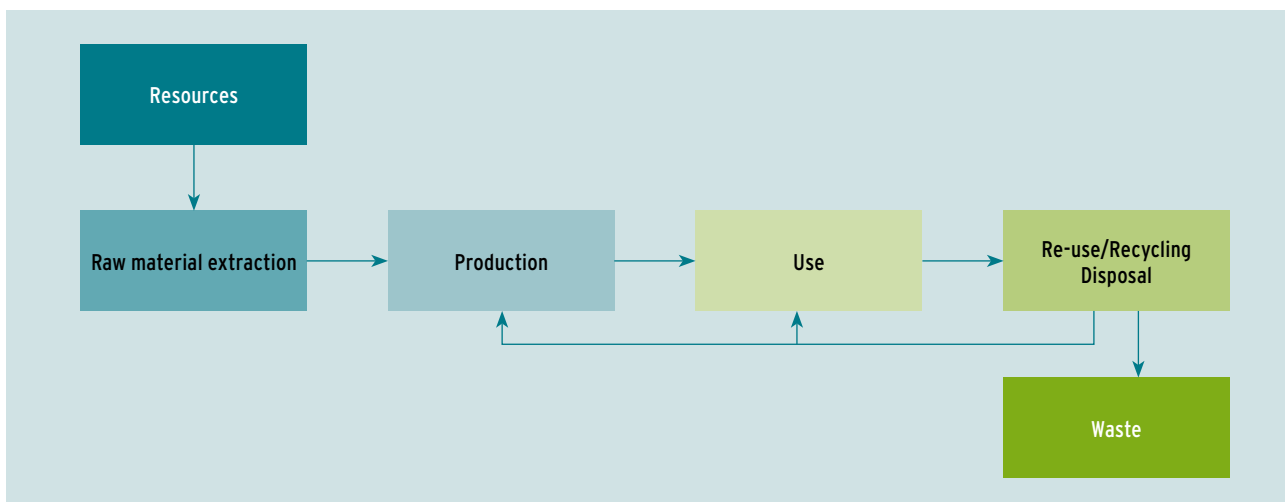
4 Ways to improve resource efficiency along the value chain

4.1 Starting points and obstacles

Numerous starting points for improving resource efficiency can be found all along the value chain (cf. Figure 140).

For example, the removal of domestic mineral resources such as sand, gravel or quarry stone can be reduced by stepping up recovery from mineral waste and making more efficient use of resources in the construction sector.

Figure 140: Resources in the product life cycle



Source: Own diagram

Economic, technical or organisation steering instruments could support recovery from mineral waste, as could the inclusion of recycled material in tender procedures for construction measures. Companies could make a contribution by using resource-saving, low-waste production processes and by developing products that are as resource-light, long-lasting, repair-friendly, re-usable and recyclable as possible. On an inter-company basis, resource and material flows could be optimised by means of an environment-oriented supply chain management system.

Through their purchase and use decisions, consumers could make a contribution to conserving resources, for example by buying energy-efficient and resource-efficient household appliances or low-consumption cars. This would at the same time give the manufacturers more incentive to develop resource-efficient products. The concept of “loaner-ship, not ownership” also permits more sparing use of resources: examples include car sharing, bicycle rental systems, ride-share agencies, ski rental systems, public libraries, E-media systems (music, films, books), rental of power tools from DIY stores, agricultural machinery rings or chemicals leasing.

In certain areas of the waste management sector there is still considerable potential for developing more strongly in the direction of closed-cycle management. Technology metals used in small quantities are frequently lost by dissipation. In every mobile phone that does not undergo a high-grade recycling process, metals such as gold, silver, palladium, copper, tantalum or cobalt are lost. Admittedly these metals are only used in small concentrations. But with worldwide production of mobile phones totalling 1.3 billion per year, even these minute quantities add up to over 30 tonnes of gold and over 300 tonnes of silver a year.³⁰⁹

Substances are also lost as a result of exports of used goods such as second-hand cars or electrical and electronic equipment to countries with a poor recycling infrastructure. In many cases these are illegal exports, i.e. the exported product is not – as declared – a functioning used economic good, but waste. This is banned under the Waste Shipments Act (Abfallverbringungsgesetz). There are no statistical records of such illegal exports, which means they are difficult to quantify.

In some cases, exports of end-of-life vehicles and electronic equipment prolong the useful life of the product and promote the re-use of parts. But ultimately they pass on the problem of waste disposal to other countries. The equipment frequently ends up in countries with a poor recycling infrastructure. As a result, valuable secondary raw materials are lost, because the recovery rates in low-tech recycling technologies are only a few percent and concentrate solely on a few particularly valuable metals.

In view of the multitude of possible starting points, it is reasonable to ask why so many potential opportunities have remained unexploited, although companies, consumers and the public sector could often benefit directly from improvements in resource efficiency. The answers are many and various:

- Material flows in the production process are sometimes very complex, and there is not always a transparent allocation of costs to individual process stages and products. This means that starting points for efficiency improvements are not always easy to find. Small and medium enterprises (SMEs) in particular often do not have the necessary time and awareness of the problems. Company-specific consulting and environmental management systems come into their own here, permitting systematic identification of savings potential.
- Some savings opportunities can only be exploited on an inter-company basis, through coordination with customers and suppliers. In such cases, company networks can make a valuable contribution to resource conservation.

309 Hagelücken (2010). Based on the estimation that the average mobile phone contains 24 mg of gold and 250 mg of silver.

- The use of new technologies, materials and products involves financial risks which SMEs in particular are often unable to take or which are difficult to obtain security for in the credit business. Targeted state assistance for innovations can help to reduce these risks.
- In many cases companies only make investments with very short payback periods. As a result, they tend to ignore potential for medium-term cost savings through improvements in resource efficiency. Also, companies often overestimate the costs and payback periods of resource efficiency measures. Company-specific efficiency consulting services can help here. A comprehensive consulting approach covers the examination of technical aspects and operational workflows with the aim of reducing consumption of raw materials, energy and water. The findings usually identify efficiency potentials which yield direct economic benefits for the companies concerned and which in the long term lead to an improvement in their competitive position.
- It is still the case that in most businesses, not enough use is made of employee knowledge about opportunities for improving resource efficiency. It is therefore important to get employees actively involved, mobilise their motivation to act in a resource-conserving fashion, and also ensure their constructive participation in business efficiency consultations.
- Unlike the energy efficiency issue, conservation of natural resources is still far from being an everyday part of public awareness. Providing easily understood target group specific information on resource-efficient activity is therefore an important task, as is integrating resource efficiency in school and vocational initial and further training.
- Consumers frequently lack the necessary information about the entire life cycle costs of a product. As a result they often buy appliances which at first sight are inexpensive, but which prove to be inefficient and short-lived, involving high follow-on costs for energy and disposal, and are soon replaced by a new appliance, because repairs and maintenance are more expensive than a new product. Information, education and the labelling of resource-specific product properties are therefore important starting points for resource-light consumption.
- Closing material cycles is made more difficult by products that cannot be recycled, or only at considerable cost. Product developers and manufacturers often give insufficient thought to what will happen to their products when they reach the end of their life. There is therefore a need to augment the statutory requirements with regard to product responsibility.
- Particularly in the case of valuable material flows, there is still a need to optimise collection infrastructures. For example, waste containing technology metals could in particular be collected by more targeted means and sent for high-grade recycling. Clear labelling and standardisation of materials can also help to increase recycling rates.
- Sharp fluctuations in prices of secondary raw materials are an obstacle to investment in a closed-cycle management system. Framework conditions that help to stabilise the markets, e.g. through specified recycling rates, are therefore an important factor here.
- Economic framework conditions play a role: the labour factor bears a heavy burden of taxes and social charges, whereas charges based on resource utilisation play a much less important role. Thus the system of taxation and charges creates much stronger economic incentives to cut jobs than to reduce resource consumption.

This cursory overview of the various obstacles to improving resource productivity in the various phases of a product's life cycle shows that a large number of measures, and the involvement of all social actors, are necessary to exploit the potential opportunities for increasing resource efficiency.

4.2 Increasing resource efficiency in production

Developing and supporting resource-efficient production processes is an important step towards resource-conserving management. As shown in Chapter 3.2, the efficiency potential in production is considerable. One tried-and-tested instrument for systematically identifying such potential opportunities is environmental management systems, especially the European Eco-Management and Audit Scheme (EMAS) (cf. Part II, Chapter 3.4). A glance through the environmental statements produced by EMAS participants³¹⁰ reveals a wealth of practical examples of resource savings and the cost reductions they made

possible in these companies. Survey findings relating to EMAS companies also confirm the benefits of this instrument for resource conservation.

Experience in the last decade shows that consulting at individual company level permits significant savings in resources and resource costs in companies.

Nevertheless, not enough use is made of consulting services. The most important instrument for improving the acceptance of consulting services is information. Efficiency checks (e.g. PIUS-Check (Effizienzagentur NRW), material efficiency self-check (Deutsche Materialeffizienzagentur), EffCheck (Efficiency Network Rhineland-Palatinate) and the resource checks of the VDI Resource Efficiency Centre)

EMAS in practice - Results of a survey³¹¹

In an online survey of EMAS-certified companies and organisations, nearly all stated that energy and resource efficiency were important or very important to them. The following measures in particular were mentioned in the field of resource efficiency:

- Reducing waste and improving recycling and waste separation,
- Changing to recycled paper,
- Water-saving measures and multiple use of water, e.g. closed water cycle,
- Limiting the variety of materials,
- Improving recycling rates, among other things through reprocessing of solvents.

In some cases these measures led to substantial savings (cf. following table):

Improvement in resource efficiency and resource conservation due to EMAS (savings in EUR per annum)

Company size	Water	Energy	Waste volume	Material
Small (1-50 jobs)	100-5,000	50-12,000	30-30,000	800-50,000
Medium (51-250 jobs)	600-25,000	500-315,000	1,500-4,000,000	100-50,000
Large (> 250 jobs)	4,000-3,000,000	9,000-800,000	2,000-3,500,000	5,000-500,000

310 An overview of EMAS environmental statements can be found at www.emas.de/teilnahme/umwelterklaerungen/sammlung/.

311 Adelphi (2009).

give companies a chance to identify initial efficiency potential. Other tools, like systematisation of efficiency technologies with the aid of process chains using detailed knowledge of technologies and savings potentials, serve to provide knowledge specially tailored to the specific branch of industry. Examples of the basis used here are the reference documents on best available technologies, drawn up with the collaboration of the Federal Environment Agency. Moreover, descriptions of examples of successful consulting in other companies can encourage people to think about their own efficiency potential. As support for efficiency consulting, various technical guidelines on resource efficiency are either available or currently at the drafting stage (e.g. DIN standards or VDI rules).

In recent years, larger companies and innovative SMEs in particular have made substantial investments in improving their resource efficiency. There are numerous consulting and assistance programmes to support the implementation of such investments.

Exchange of experience between politics, businesses, associations, trade unions, research and society can also make a contribution. To this end the Federal Environment Ministry has initiated the Resource Efficiency Network as a nationwide platform.³¹²

Programmes and institutions for improving resource efficiency at national and Länder level (selection)

The **German Material Efficiency Agency** (Deutsche Materialeffizienzagentur - demea) was established on the initiative of the Federal Ministry of Economics and Technology. It is intended to raise public awareness of the importance of material efficiency and provide information about it. With its assistance programme VerMat it is also helping companies to exploit material efficiency potential.

www.demea.de

The **VDI Resource Efficiency Centre** (VDI-ZRE) is a project cooperation between the Federal Environment Ministry and the German Engineers' Association (Verein Deutscher Ingenieure - VDI) that is financed by the ministry's Climate Initiative. The VDI ZRE provides small and medium enterprises in particular with a comprehensive information platform for increasing resource efficiency in the business and in the production process. Services such as resource checks, innovation radar, best-practice examples and process chain analyses, databases for resource efficiency consultants and an extensive funding atlas offer a practically oriented introduction to implementing resource efficiency measures in the business.

www.vdi-zre.de

Since its establishment in 1998, the **NRW Efficiency Agency** (Effizienz-Agentur NRW - EFA) has been an important point of contact for manufacturing companies in North Rhine-Westphalia with regard to cleaner production (PIUS) and resource-efficient management. To date it has initiated and accompanied more than 1,000 projects for improving efficiency in small and medium enterprises. These have exploited savings potential of over 10 million EUR per annum.³¹³

www.efanrw.de

The **Rhineland-Palatinate Efficiency Network** (Effizienznetz Rheinland-Pfalz) is a central, non-commercial information and advisory platform on environmental, energy and resource-efficiency topics. It groups the individual initiatives in Rhineland-Palatinate into a comprehensive range of information and advisory services and supports projects aimed at cleaner production (PIUS) and reducing resource consumption in small and medium enterprises.

www.effnet.rlp.de

312 For further information, see www.netzwerk-ressourceneffizienz.de.

313 Maas (2010).

4.3 Consuming resources sparingly

Consumer demand for products and services has enormous environmental impacts (cf. Part II, Chapter 4). This consumption is of considerable importance for resource requirements. Through their decisions on purchase and use, consumers have a significant influence on the quantity and quality of material flows. Housing, mobility and food are particularly resource-intensive need sectors.³¹⁴

Changes in consumers' buying and use habits have repercussions on the products and services offered, and call for entrepreneurs to take new steps, as the example of car sharing shows. Car sharing, originally set in motion by small groups of enthusiasts, has now reached the major car makers, who are offering their own concepts. Potential also exists for new services in the field of extending the life of consumer durables by means of repair, re-marketing, upgrading or re-design, though experience shows that to date this has only been successful in niche markets (e.g. information and communications technology, furniture).³¹⁵ The further use and re-use of products also offers substantial potential for resource conservation. Recent developments indicate a growing readiness of certain sections of the population to take up offerings in the field of "second-hand culture".³¹⁶ Ebay & Co are important pacemakers here for the development of online trading in second-hand goods, but there is also a trend towards offerings in the non-commercial sector, e.g. private barter and rental exchanges.

To enable consumers and the distributive trade to take advantage of their freedom of action, they need guidance and knowledge about environmental protection and resource conservation and the motivation to make use of such knowledge. One major opportunity for improving resource efficiency therefore lies in the use of labels to identify particularly resource-friendly products or services. Labelling also gives consumers guidance, heightens public awareness of the importance of resource conservation and at the same time opens up market opportunities for new products and services for manufacturers and distributors.

The Blue Angel has been awarded since 1978 to products that differ from otherwise comparable products by complying with ecological criteria (cf. Part II, Chapter 4). The Blue Angel eco label is awarded on the basis of various sets of criteria. In addition to health, water or climate protection there is a further category: "Conserves resources". This category consists especially of products made from secondary raw materials. As well as classics like recycled paper, the products selected include reprocessed toner cartridges or fabric towel dispensers, because they reduce the input of raw materials.

A full list of products and services that have been awarded the Blue Angel can be found on the website www.blauer-engel.de.

In addition to consumer information on the environmental properties of products, the Eco-Design Directive provides an opportunity to lay down binding efficiency standards for products (cf. Part II, Chapter 4). It thus represents a central lever for promoting penetration of the markets by efficient products. The Eco-Design Directive has thus resulted in a sharp drop in stand-by losses of electrical equipment – with benefits for the environment and for the consumer's pocket. In future the Eco-Design Directive is to be used not only for the energy efficiency of products, but also increasingly for their resource efficiency.

Furthermore, standardisation of products can help to reduce waste and thereby conserve resources (cf. Chapter 4.4). One example is the standard charger unit for mobile phones that was introduced in the EU for smart phones in 2011. According to the European Commission, more than 51,000 tonnes of electrical/electronic scrap arise in the EU every year as a result of charger units that have become useless.³¹⁷ Another example is recycling standards that lay down specifications for recycling-friendly design of components or vehicles.³¹⁸

314 Cf. Federal Environment Agency (2007b).

315 Cf. IÖW, Wuppertal Institut (2010).

316 Cf. IZT et al (2010).

317 EU COM (2011f).

318 Federal Environment Agency (UBA 2009c).

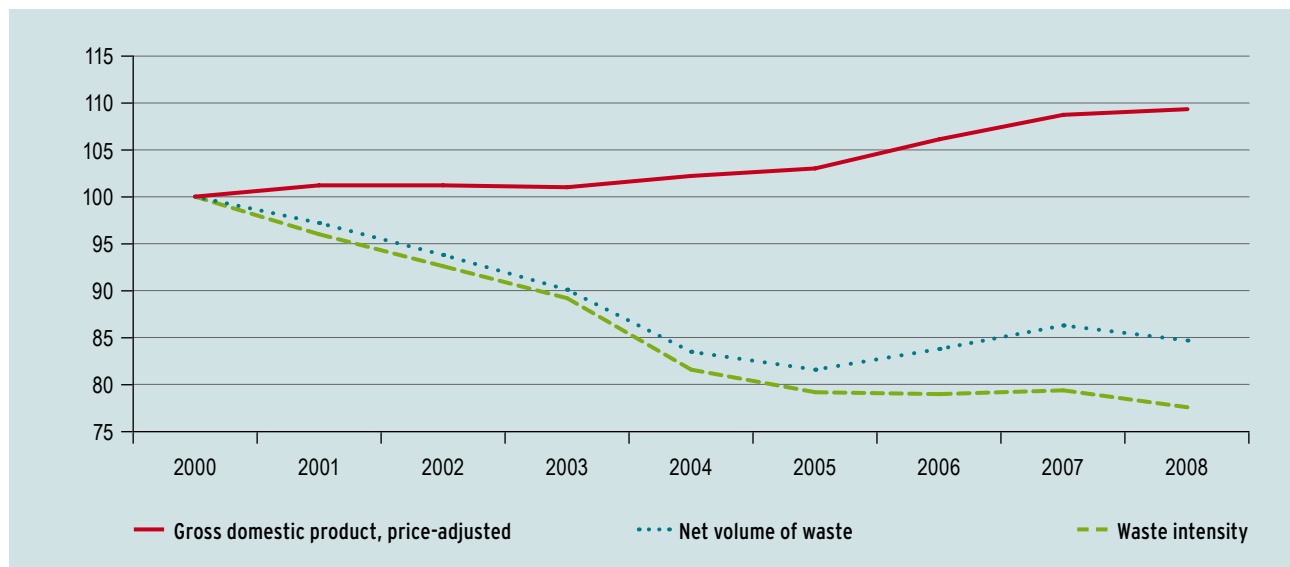
The state is also a consumer. It should set a good example in improving resource efficiency and use its buying power to encourage the development and market launch of resource-efficient products. With an annual volume of 260 billion EUR, public-sector procurement offers great potential for supporting resource-efficient products (cf. Part II, Chapter 4).

To promote resource-efficient products, it should be a rigorous and binding requirement to take account of life-cycle costs when identifying the “most economic offer”. This is because resource-efficient products are sometimes more expensive in terms of initial investment, but often have considerably lower costs during the use phase which either pay for the higher initial costs or more than cancel them out. As a rule, their disposal costs are lower as well. In future, procurement procedures in the public sector should not only take account of energy efficiency³¹⁹, but should also give greater consideration to the material efficiency of products and services and, as far as possible, the external environmental costs. This would make sense from an overall economic point of view, because it would enable the state to reduce the follow-on costs for society in the form of environmental and health impacts.

4.4 From waste management to closed-cycle management

Through comprehensive recycling and other forms of utilisation, closed-cycle management makes a major contribution to resource conservation and reduces the need for extraction of fresh raw materials. Environmental impacts associated with the creation of waste must be avoided and minimised, and material cycles must be closed as far as possible in order to use the resources present in the waste. This is also laid down in the new five-tier waste hierarchy set out in the Framework Directive on Waste, which is being transposed into national law in the new Closed-Cycle Management Act (Kreislaufwirtschaftsgesetz – KrWG). This specifies waste avoidance as the top-level goal, followed by the basic succession of preparation for re-use, recycling, other uses of waste (e.g. for energy), and finally waste disposal. Taking into account the entire life cycle, priority goes to the best option from the point of view of environmental protection. The waste created by the use of resources must be decoupled from economic growth. The following Figure 141 shows the decoupling of waste volume from economic output to date.

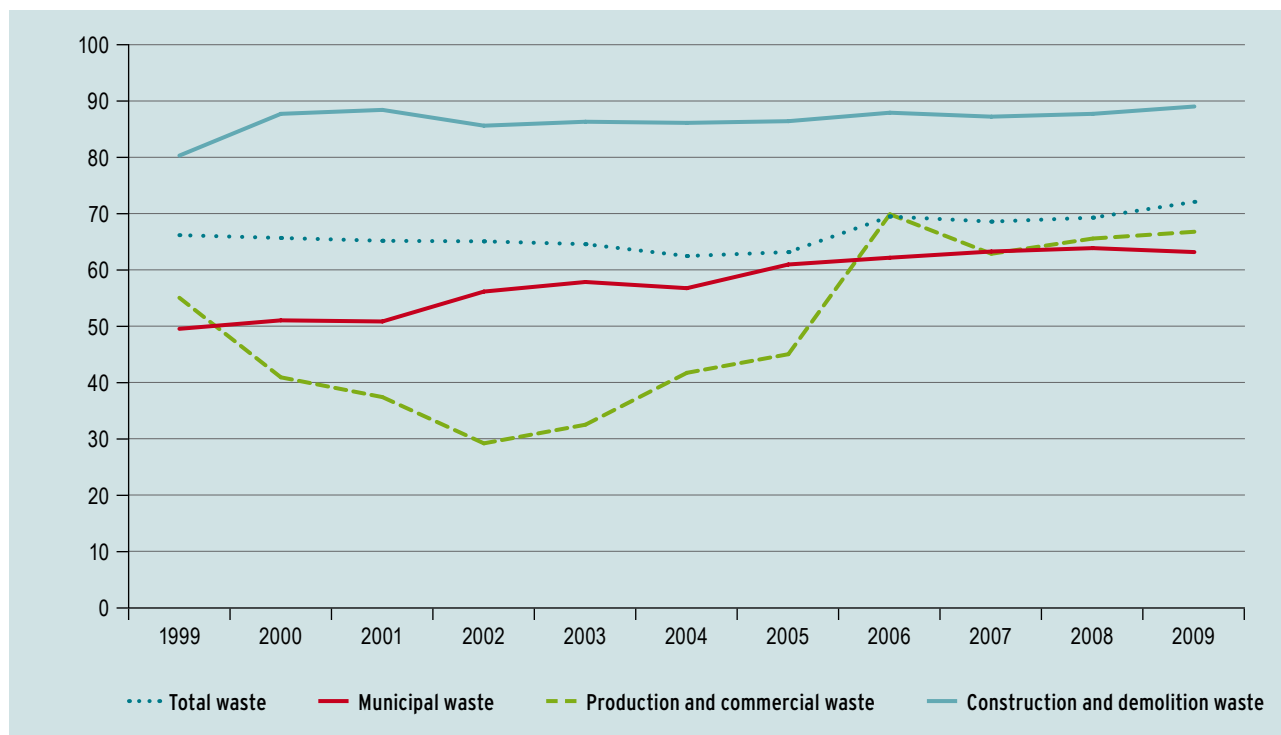
Figure 141: Decoupling of waste volume from economic output (Index 2000 = 100)



Source: Federal Environment Agency (2011d)

319 In this context cf. also the EU Commission’s proposal for a Directive of the European Parliament and of the Council on energy efficiency and repealing Directives 2004/8/EC and 2006/32/EC of 22.6.2011, COM (2011) 370 final.

Figure 142: Recycling rates for the main waste flows (in percent)

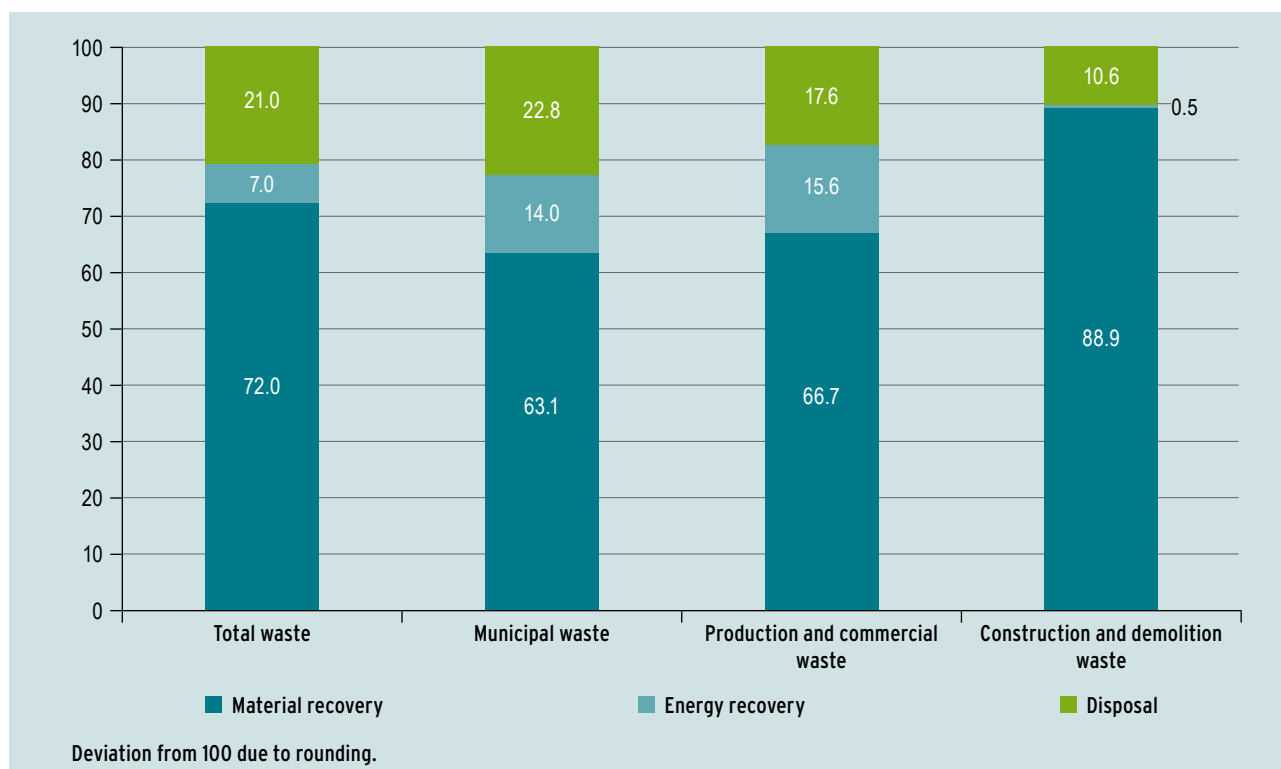


Source: Federal Statistical Office, waste balance, various years, own calculations

In Germany there is a well developed closed-cycle management system with a municipal waste recovery rate which stood at 77 percent in 2009. Materials recovery in particular makes a major contribution to

increasing resource productivity. For example, the recycling rate for municipal waste was around 63 percent in 2009. Figure 142 shows the material recovery rates for waste as a whole, and for municipi-

Figure 143: Overview of main waste flows in 2009 (in percent)



Source: Federal Statistical Office, waste balance, various years, own calculations

pal waste, production and commercial waste, and construction and demolition waste.

On an international comparison, recovery rates in Germany are very good (cf. Part III, Chapter 6, Figure 4). Figure 143 provides an overview of the main waste flows disposed of and recovered in 2009.

Rules on product responsibility such as the Packaging Ordinance (Verpackungsverordnung), the Batteries Act (Batteriegesetz), the End-of-life Vehicles Ordinance (Altfahrzeugverordnung) or the Electrical and Electronic Equipment Act (Elektro- und Elektronikgerätegesetz) contain specific recovery requirements and also, to some extent, product design requirements for easier re-use and recovery. These requirements have proved effective. In this way a modern, full-coverage collection, sorting and recovery structure for packaging waste has developed in Germany since the early 1990s, and makes an important contribution to the production of secondary raw materials. Approximately 70 percent of packaging waste is recovered as material.³²⁰ Thanks to free acceptance of end-of-life batteries at well over 150,000 collecting points, the collection rate in 2009 reached around 44 percent of the batteries placed on the market. The required recovery rates for end-of-life vehicles (85 percent of end-of-life vehicle weight, at least 80 percent of which is to be recovered as material) were exceeded in 2009 with nearly 87 per-

cent and 83 percent respectively. Another example is the latest product responsibility system: since the introduction of the Electrical and Electronic Equipment Act the volume of old equipment collected in Germany has been between about 600,000 and 800,000 tonnes. In 2007 and 2008 the average recovery rate was about 94 percent, and the proportion recovered as material was around 81 percent.

Nevertheless, in view of the increasing scarcity of raw materials and energy sources, further steps to close material cycles are both necessary and possible. For example, cascading systems make it possible to extend the useful life of certain raw materials (e.g. wood). Ultimately the materials existing as waste at the end of the life cycle should be recovered with the greatest possible ecological benefit and recycled where possible. Examples of important areas of activity include the recovery of precious and critical metals and of rare earths.³²¹

The German government intends to continue developing the existing waste management rules on product responsibility from a resource conservation point of view. In particular, the Packaging Ordinance is to be developed into a general recyclables ordinance. The idea is that non-packaging waste of metal and plastic (e.g. pots and pans, buckets, children's toys), which currently still count as residual waste, should be collected along with packaging waste and sent for

Export Initiative Recycling and Efficiency Technology (RETech)

The Federal Environment Ministry is lead managing the establishment of the RETech initiative, with the aim of assisting German companies and institutions to exploit the potential of recycling and waste management technologies to the full. Together with a network of actors in industry, administration and academia, RETech seeks to raise waste management standards abroad, improve the state of development of waste management in emerging and developing countries in particular, and optimise support and networking for the German mainstays of technology exports and know-how transfer. RETech is also intended to ensure greater transparency, better coordination and more efficient design of the exporters' established activities at federal and regional level.

The services offered by the RETech Initiative are aimed in particular at:

- Recycling, waste management and consultancy service providers in the waste management sector,
- Constructors of machinery and installations for waste and recycling technology (incl. supplier industries),
- Municipal and private-sector decision makers and investors abroad,
- German and foreign universities and research establishments.

www.retech-germany.net

320 Federal Environment Agency (UBA 2010d). Figures 2008.

321 Cf. UNEP (2011d).

high-grade recovery. This would make it possible to collect up to 7 kg more per capita per year than in a collection that is confined to packaging waste. Further optimisation of closed-cycle management is targeted with the introduction of nationwide separate collection of bio waste from 2012 onwards.

4.5 Promoting product and process innovations

Innovative products and technologies offer new ways and means of reducing resource requirements. The points of departure are many and various, and frequently offer great economic opportunities (cf. Part III, Chapter 3–5). For example, processes or products can be improved by means of new technologies or materials, such as high-strength and temperature-resistant steels. The use of such steels in power plants permits higher temperatures and higher pressures, thereby improving efficiency. New products in the information and communication technology (ICT) sector can also make a contribution to resource saving, being used to replace or improve resource-intensive processes (e.g. video conferences instead of travel, or better capacity utilisation in logistics). Environment-friendly product development (eco-

design) takes account of environmental requirements throughout all phases of a product's life cycle and makes it possible to design products that are significantly less resource intensive, more recycling friendly or longer-lasting. Statutory requirements such as the Eco-Design Directive help resource-saving products to become established on the market faster. Greater use should also be made of public procurement as a demand-oriented instrument for market diffusion.

A number of programmes offer companies financial support with the implementation of innovations. On the one hand there are programmes specifically tailored to environmental protection and resource conservation, such as the Federal Environment Ministry's Environmental Innovation Programme, which can provide assistance for first-time large-scale application of a resource-saving technology or of process combinations. On the other hand there are also more broadly based innovation promotion programmes, such as the Central Innovation Programme for SMEs (Zentrales Innovationsprogramm Mittelstand) or the EXIST programme designed specially for start-up ventures from universities. The last two programmes also permit assistance for research and development.

Examples of resource-efficient process innovations from the BMU Environmental Innovation Programme:

- **Efficient production of large titanium components:** Substantial resource savings can be achieved in the manufacturing process for the production of large titanium components, e.g. for the aircraft industry. Material savings of 80 percent and energy savings of 75 percent are possible per kilogram of finished titanium component.
- **Coating colour recovery in paper production:** The new process makes it economic to reprocess residual coating colour and recover 3,500 tonnes of coating pigment a year. This reduces electricity consumption by 90 percent and water consumption by 130,000 cubic metres a year, and avoids 265 tonnes of harmful CO₂ emissions. All in all, the process reduces the total amount of residual material in paper production by 60 percent.
- **Innovative lightweight construction system:** The new lightweight construction system is a sandwich material on the basis of regrowable raw materials. It is 70 percent lighter than solid wood materials and significantly stronger. The advantages of this material are particularly useful in mobile applications such as the interior finishing of caravans and ships. For example, a caravan equipped using this system is up to 280 kg lighter than a conventional model. This results in much reduced fuel consumption (reduction of about 1.4 litres per 100 km) and reduces CO₂ emissions.

4.6 Outlook for a resource-efficient economy

Economically and ecologically, there is no alternative to making less wasteful and more efficient use of natural resources. Many companies have recognised the economic opportunities of resource efficiency and are already acting accordingly: They are taking account of resource conservation in product design, using secondary raw materials from closed-cycle management, and optimising production workflows. Banks are also increasingly addressing the issue of resource efficiency. In project funding, dependence on resource supplies and resource prices, and hence companies' resource efficiency, will play a growing role. The German government and many federal Länder are already providing support in the form of assistance programmes, information and consultancy facilities and efficiency networks.

Nevertheless, there is still plenty to do. The challenges and opportunities of resource efficiency are only having a gradual impact on public awareness, and compared with their "sister" issue of energy efficiency have received relatively little attention from the media to date. This is despite the fact that the global and national challenges of resource efficiency are comparable to those of the transformation of the energy system and the shift to a climate-friendly economy. Given a global population of 9 billion people in 2050 and rapid economic development of the emerging economies, demand for resources will continue to soar. For Germany's competitive position and the conservation of the natural basis for life, it is therefore essential that Germany continue to make progress along the road to a resource-efficient economy and society. In 2050,

sparing and at the same time efficient management of natural resources will be a key competence of societies with a viable future.

Germany is in an excellent position to become one of the most resource-efficient economies in the world. But this calls for efforts by a large number of actors in industry and society – and support from a state that creates favourable framework conditions for innovation and transformation to resource-efficient management approaches.

Against this background, the German government has decided to develop a National Resource Efficiency Programme. The Federal Environment Ministry has presented a draft that offers a strategic framework for goals and action priorities of sustainable resource utilisation. The programme provides an overview of existing activities, identifies needs for action, and describes measures for achieving the National Sustainability Strategy's goal of doubling resource productivity by 2020. It identifies approaches for increasing resource efficiency for every step in the value chain of products and services – from resource extraction through production and consumption to recovery and disposal.

Successful implementation of the programme will require close cooperation between politics, industry, research and a wide range of social groups – in other words participation by the entire population in our joint progress towards a resource-efficient society. After all, sparing and efficient use of natural resources is an essential precondition for preserving our ecological basis for life, maintaining Germany's economic performance and sustainably safeguarding employment and social equity.

OUTLOOK: GERMANY ON THE PATH TOWARDS A GREEN ECONOMY

Environmental and efficiency technologies have become an increasingly important factor for economic growth in Germany. The environmental economy plays a major role in innovation, growth and employment in Germany. It provides jobs for around two million people and accounts for more than five percent of production – and these figures are trending upward. German companies are global leaders in many environmental and efficiency technologies. With a 15.4 percent share of global trade in 2009, Germany was again the world champion in exports of environmental goods.

Various studies conducted by scientific research institutes and consulting firms highlight the significance, potential and dynamic development of the green markets of the future. International competitors like the US, China, Brazil and India are intensifying efforts for an economic and ecological modernisation of their economies – with increasing success. Germany is thus facing the challenge of maintaining its leading position on the global markets for environmental technologies despite growing international competition.

Progressive environmental policy plays a pivotal role in this context. Nearly one third of all innovative companies say their environmental innovation activities have also been prompted by environmental legislation and regulations.

Ecological modernisation of our economy – towards a resource-efficient, environmentally sound and nature-friendly economy

20 years after the first Rio conference the United Nations (UN) will again hold a Conference on Sustainable Development (Rio 2012) in Rio de Janeiro in June 2012 to renew the international community's political commitment to sustainable development. The green economy will be one of the main topics of the conference together with the reform of the UN in the environmental/sustainability sector. There can no longer be any doubt that global problems such as climate change, biodiversity loss and resource scarcity can only be solved if we restructure our economies. All actors must intensify their efforts to find sustainable solutions to these problems.

The goals of modern environmental policy encompass protection of nature and the environment and ecological modernisation of the economy. The concept of the green economy defines the course for the necessary transformation and provides orientation for the development of economies and societies in a globalised world.

The green economy focuses on economic aspects and combines them with ecological ones. It does not constitute a new paradigm, but a strategic approach of respecting ecological limits, anticipating economic scarcities, using economic opportunities and minimising ecological risks. This strategic approach is characteristic of an innovation-based economy that

- continuously reduces harmful emissions and pollutant inputs into all environmental media,
- is based on closed-cycle management and reuses waste as far as possible,
- decouples economic growth and prosperity from the consumption of natural resources and the resulting environmental impacts,
- reduces resource consumption in absolute terms, especially by making more efficient use of energy, raw materials and other natural resources and by substituting renewable for non-renewable sources,
- protects the climate and strives for a long-term energy supply which is based entirely on renewable energy sources,
- generally seeks to act in harmony with nature and the environment, preserves biodiversity and restores natural habitats.

Regulatory framework for self-organising processes in a social market economy

The path towards the green economy can best be pursued using the regulatory model of the social market economy, supplemented and enhanced through a regulatory framework which rewards environmentally sound management and creates incentives for increasing resource efficiency.

There is a new quality to environmental damage today. Moreover, it is often not factored into market mechanisms, assigned a monetary value and attributed to the polluter. Many consider environmental goods to be freely available. The externalised costs, which constitute a fundamental infringement of the principle of responsibility, result from market failure, but also from regulatory failure. The state must therefore set the right framework for economic self-organising processes. If environmental goods are not given an adequate price, or no price at all, markets cannot function efficiently.

The renewal of the social market economy must keep within the ecological guardrails defined by the capacity of nature. This means that renewable natural goods (such as forests and fish stocks) should only be used to an extent that allows them to regenerate. Non-renewable natural goods may only be used to the extent that their functions can be replaced by other means. Moreover, the pollutants released must not exceed the adaptive capacity of natural systems (e.g. the climate, forests or oceans). The ecological capacity of the Earth is the absolute limit that we have to respect in our economic practices and way of life.

Energy efficiency and resource efficiency – key competencies ensuring the competitiveness of German industry

Key challenges for our economy include climate change and the finite character of natural resources. With its Energy Concept adopted in June 2011 the German government set the course for a fundamental transformation of energy supply. The main pillars of the Concept are the shift towards renewable energies and an increase in energy efficiency. Moreover, Germany will completely phase out electricity generation in nuclear power plants by the end of 2022 at the latest.

The thorough restructuring of energy supply in Germany is a task for decades to come, and it holds enormous economic opportunities. The Energy Concept encourages forward-looking investments in renewable energies and increased energy efficiency. It also promotes innovation and technological progress. Germany already has a competitive edge in efficiency technologies. Securing and enhancing this position in view of increasing international competition secures existing jobs and creates new ones. A high level of energy efficiency is the key to economic competitiveness, especially at times of surging energy prices.

Global competition over ever scarcer raw materials is also growing. Efficient and sound use of finite resources is one of the biggest economic, social and ecological challenges of our times, and a question of assuming our responsibility towards future generations. Resource efficiency is thus developing into another key competence of societies that want to be viable for the future, and a decisive competitive advantage. Resource efficiency reduces dependence on raw material imports and highly fluctuating prices, increases planning security for German industry, promotes innovation and protects the environment.

In addition, there is a growing need for resource-conserving technologies both in Germany and worldwide. This opens up new export opportunities. In future, the label “made in Germany” should be associated even more with resource efficiency. Germany is in an excellent position to become the most resource-efficient economy in the world. We have innovative businesses, a technological lead in many efficiency technologies and in closed-cycle management, stringent environmental standards and informed and active citizens. To create the best possible political framework for a further increase in resource efficiency, the German government is currently developing a national resource efficiency programme.

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