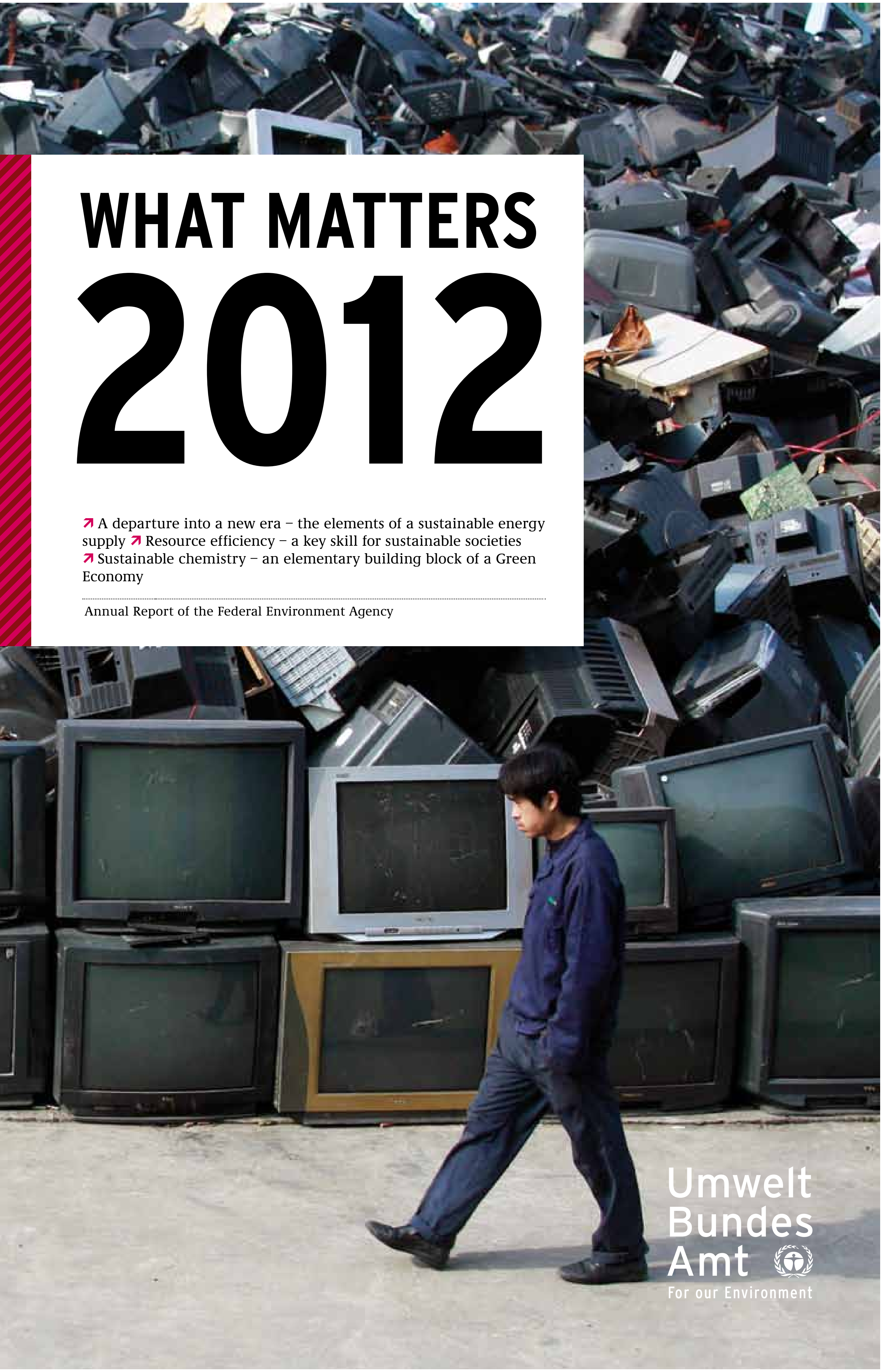
WHAT MATTERS 2012

↗ A departure into a new era – the elements of a sustainable energy supply ↗ Resource efficiency – a key skill for sustainable societies ↗ Sustainable chemistry – an elementary building block of a Green Economy

Annual Report of the Federal Environment Agency



Umwelt
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For our Environment

WHAT MATTERS 2012

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Annual Report of the Federal Environment Agency

Consistent with the UN Conference on Sustainable Development in Rio de Janeiro, 2012 is dedicated to the "Green Economy". A green economy requires products, production processes and services that help us organise economic development within ecological guidelines thus ensuring that climate, air, water, soil and biodiversity are not burdened beyond their limits. 20 years after the Earth Summit in Rio, this is not a U-turn, but a much-needed specification of the concept of sustainable development. Especially in the rich countries of the North, and increasingly in parts of the rapidly emerging economies, a debate is needed on life styles and on the issue of what constitutes wealth. It is clear that the previously dominant production methods associated with high greenhouse gas emissions and resource consumption have brought the world to the brink of ecological collapse which undermines the foundations of our prosperity. Therefore, we urgently need the transition to environmentally friendly, low-carbon and resource-efficient economies.

Environmental protection – often vilified as a cost driver and growth brakeman – has the potential to become a wealth driver of modern economies. The figures already prove this: in Germany, about two million people are employed in the environmental sector. In the field of renewable energy alone, there are a good 370,000 jobs in Germany

WE NEED A GREEN ECONOMY

JOCHEN FLASBARTH
President, Federal Environment Agency

today, whose number even further increased during the financial crisis. The climate protection target of forty percent reduction in greenhouse gases by 2020 set by the Federal Government can create another 630,000 jobs. The increase in material efficiency also has a huge potential for employment: up to 700,000 jobs can be created by 2030 by consistently implementing all material saving potentials in the manufacturing sector. Conventional environmental protection industries such as recycling and waste water treatment also continue to contribute to economic development and employment. Although their relative proportion will decline compared to the contributions of the climate and natural resource protection industry, they will remain very important.

The lead markets of the future are also becoming increasingly "green" globally. The world market volume on the green markets is estimated at 3.1 billion euros by 2020 and will thus more than double compared to 2007. Waste and water management will see a growing demand in many countries, and energy efficiency, renewable energy and resource productivity will continue to gain in importance both in industrialised countries and in emerging and developing countries. Germany has a leading position in many of these markets. The German share of world market for environmental goods is nearly 16 percent. The value of environmental goods production in Germany is around 60 billion euros. Given positive framework conditions – for example for research and development in climate and resource protection –, Germany can maintain and even expand its excellent position on the world market.

The transition to a green economy is not just a concept for industrialised countries such as Germany. The economic implications of a gradual transition to nature-friendly, energy- and resource-efficient and low-carbon industrial practices have been studied in a comprehensive study of the United Nations Environment Programme. The results suggest that an investment of two percent of global gross domestic product in environmentally friendly industrial practices by 2050 may lead to a 16-percent increase in global gross domestic product. The number of jobs in the energy sector in 2050 worldwide would be 20 percent higher than in the comparative scenario. At the same time, climate protection targets would be achieved and environmental and health costs markedly reduced. In the waste sector, jobs would be 10 percent higher compared to a development without green investment, and the quality of jobs in this sector would increase. Reduced global deforestation and a reduction of over-fishing would also be beneficial strategies in the long term, particularly for developing countries that are especially dependent on these sectors.

The orientation of economic development towards the objectives of a green economy is also being promoted in other countries. This enhances international competition in the green future markets. Leading market positions of certain countries are therefore not self-evident, they must be reasserted time and again. This creates a dynamic that is a basic driver for these young markets. China, for example, has now become the world's largest photovoltaic manufacturer with a global market share of almost 50 percent. Occasionally, it has been criticised in public debates that this development has also been supported by the German Renewable Energy Sources Act (EEG) and hence the German consumers financing its costs have promoted the production not only in Germany but also in other countries. This view overlooks the fact that the international competition has had a significant role in ensuring a much faster cost reduction in the photovoltaic industry than was considered possible a few years ago. While the system costs for a rooftop facility exceeded 4,000 euros per kilowattpeak (kWp) in 2008, they are now less than 2,000 euros per kWp. The highest electricity costs in photovoltaics, namely those of small rooftop systems, are today or will be by 2013 at the latest, lower than the average prices for household electricity.

As well as providing positive incentives for the market penetration of environmentally friendly technologies, the transition to a green economy also includes the need to reduce economic disincentives, particularly by environmentally counterproductive subsidies. Such environmentally harmful subsidies amounted to 48 billion euros in Germany in 2008. A part of these government grants may be abolished and some subsidies require an ecological re-orientation. The allowances in energy tax for energy-intensive companies for example, are justified only in so far as these companies are actually engaged in international competition and the tax allowances help prevent an environmentally undesirable exodus of companies. However, energy tax subsidies should be cancelled for companies that operate solely or predominantly in the domestic market. This would significantly increase the economic incentives for energy efficiency and energy savings.

For the future, it is necessary that more traditional markets be "greenified". The chemical industry is a good example. For Germany, it is an important industry, which has strong international competition, and this is why it is important to make it a driver for the green economy. Back in 2002, the World Summit on Sustainable Development in Johannesburg formulated the goal that the safe management of chemicals should be ensured globally throughout their lifecycle and their environmental impact minimised.

WHAT MATTERS 2012

Germany has decided the transformation of its energy system. The new energy era requires a fundamental transformation of energy supply. This poses great challenges to the country, but offers considerable opportunities for a fundamental economic modernisation.

Worldwide consumption of scarce natural resources and the competition for them is rapidly increasing. This trend exacerbates global environmental problems like climate change, soil degradation or the loss of biodiversity. We need to rethink and change our mode of production and consumption patterns – also out of a sense of responsibility towards future generations.

The chemical industry is an important economic factor in Germany and a driver of innovative products. Innovation however does not necessarily mean greater sustainability. The safe management of chemicals is not restricted to the industrialised countries; emerging and developing countries must also be involved.

"VISUALISING NATURE'S ECONOMIC VALUE"

Wholesome soil, food, drinking water, clean air or climate regulation: the services of nature are often considered as a matter of course, their economic value usually plays no role in conventional economic analyses. However, nature's services secure the livelihood of many people, especially in developing countries. The economist Pavan Sukhdev explains in an interview why sustainable development is not possible without a valorisation of ecosystem services.

Mr Sukhdev, the 2008 financial and economic crisis was a result of the fact that many people, chiefly in the USA, were given subprime mortgages by banks to buy houses which they could not afford. Chancellor Angela Merkel has said that the financial crisis and the environmental crisis are both a result of the same problems. What is your view?

Well, both problems happened because of flawed valuations and mis-allocation of capital. Financial Capital was mis-allocated massively leading up to 2008 due to too much liquidity pumped into the banking system, the usual pursuit of assets offering high yields despite the high credit rating, and then the greed of securitisation specialists devising structured assets with a high yield which also contained high-risk investments, e. g. bad property credits, and the mistake of investors believing these market valuations. The environmental crisis – both in climate and biodiversity – is a massive mis-allocation of Natural Capital. We carelessly convert Natural Capital (such as rainforests) into cash (thinking only of more land for cattle, more timber, more mines, etc. through cleared woodland) whereas we should first be calculating the value of lost forest ecosystem services such as the rainfall cycle, natural pollination, flood prevention, drought control, and so many other valuable services which we have simply not yet valued. So in that sense Chancellor Merkel is right: even though the two crises look very different, they can be traced back to common causes: wrong valuations, leading to mis-allocation of capital.

Which crisis poses a greater danger to society today and to future generations? The financial crisis or the environmental crisis?

Definitely the environmental crisis! I should say "crises" because there are many environmental crises: climate change, loss of biodiversity, overfishing and acidification of the oceans, increasing freshwater shortages in certain regions... the list goes on. I say this because unlike the financial crises from which you can escape by using public money to "bail out" collapsing banks, you cannot "bail out" an ecosystem that has crossed critical thresholds, nor "bail out" an overheated biosphere from the damage caused by climate change. Our environmental crises pose a survival challenge in the most fundamental ways, both to our generation and to generations to come.

In your study published in 2008, you assessed the economic value of services which nature provides, for example the value of clean water or the value of the capacity of forests to capture carbon dioxide. What were your key findings?

We pulled together various old estimates and some new ones to show that the global economic costs of biodiversity loss and ecosystem degradation were in the trillions of dollars. That was our TEEB Interim Report in 2008. But just calculating "global" costs is not going to solve the problem: there is no "global" government who owns the problem! We had to devise economically justifiable solutions that work at the "country" level or even "local" level. That is what we did in our four TEEB final reports, published at the UN CBD "COP-10" meeting at Nagoya, Japan. We showed different strategies and tools which visualised nature's economic value because this value is often ignored in political and economic decision-making processes.

What benefits would a "price-tag on nature" bring?

Firstly, it is wrong to think that TEEB is anything as simple as "putting a price-tag on nature" as if the whole biosphere is some commodity that you can pick up from a local supermarket: toothpaste, milk, eggs, Nature! Not at all! TEEB is about valuing Nature and that does not mean any simplistic, reductionist, neo-classical notion of privatising the multi-dimensional web of life into a single-dimensional marketable commodity! TEEB is about mainstreaming the non-market, estimated, value of ecosystem services into the realm of public policy, into local administration, into business strategy, into consumer behaviour. TEEB reports describe how this can be done by always recognising, sometimes demonstrating, and sometimes (more rarely) capturing the value of nature in the form of payments for ecosystem services. When we do so, we usually find that conservation comes out as a better choice than conversion and TEEB's final reports have over a hundred examples of this around the world.

What does the loss of nature's capital actually mean – above all for people in developing and emerging countries?

It was a key finding of TEEB that nature's services are economically very important for the rural poor. Our studies of some large developing countries (Brazil, India and Indonesia) found that ecosystem services consumed by poor households were a large component of the household income of poor rural households – various estimates are between 50 % and 90 %. So if you want a secure, viable and sustainable development strategy, you need to respect what nature already provides for free, and conserve nature locally. Biodiversity is not just a luxury for the rich, it is also a necessity and a safety-net for the poor. Maintaining and conserving ecological infrastructure adds to soil fertility, freshwater availability, pest control, crop pollination, etc. – many benefits which add to farming yields in the developing world. That is why TEEB says that ecological infrastructure is sustainable development's biggest asset.

The concept of a Green Economy will play a key role in the upcoming Rio plus 20 Conference: Can it be applied equally to industrialised countries, emerging economies and developing countries or are there differences?

"Green Economy" is a journey towards improved well-being, improved social equity and reduced poverty, lower ecological scarcities and environmental risks – and these four features are found at very different levels, from the developed to the developing world. In other words, the challenge of greening the economy is different in different stages of development. In the industrialised world, it is about reducing the per-capita ecological footprint, which is two to five times higher than a manageable level within the earth's capacity to generate resources renewably. This means large changes in consumption patterns, significant increases in energy and materials efficiency, and a gradual transition to clean energy.

In the developing world, it is much more about "green" development, by investing in green economic models in the first place. Better health and education are essential. At the same time, aiming for improved freshwater availability and sanitation, higher agricultural productivity in small farms, reduced deforestation, better managed fisheries, improved availability of electricity, etc., are all aspects of "greening" the economies of the developing world, and much progress is already being made in that direction.

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GREEN ECONOMY

A NEW MODEL FOR ECONOMIC DEVELOPMENT

Economic growth, as we know it, is not sustainable. Scarce resources and the fight against climate change will shape the international competition and tomorrow's markets. A green economy that efficiently uses energy and raw materials will provide benefits both for industrial countries as well as developing and emerging countries. Ecological modernisation of the economy will produce innovation and create new jobs.

Our current economy destroys the natural capital and thereby undermines the prosperity of future generations. Large-scale deforestation, over-fishing of the oceans and the loss of fertile agricultural lands are striking examples of this trend. The costs of climate change and loss of biodiversity may amount to about a quarter of global gross national product in 2050 [1]. A "business as usual" in which the developed countries maintain their resource-intensive economies and the developing and emerging countries adopt the production and consumption patterns of the industrialised countries is not a viable option. Therefore, it is necessary to move towards a green economy which operates within the bounds of ecological guardrails. To achieve this goal, global resource consumption must drop radically. Of central importance is also the long-term transition to a post fossil fuel economy and the preservation of biodiversity and the restoration of natural habitats.

BENEFITS OF A TRANSFORMATION TO A GREEN ECONOMY

In order to achieve a long-term transition to a green economy, at least two percent of the gross domestic product must flow globally into green investment in the opinion of the United Nations Environment Programme (UNEP). Using scenario analysis, UNEP estimated the economic and ecological effects such a strategy would have by 2050 [2]. In this green investment scenario, higher investments to increase energy efficiency and more investments in renewable energies, waste prevention, reforestation and improved water supply were assumed.

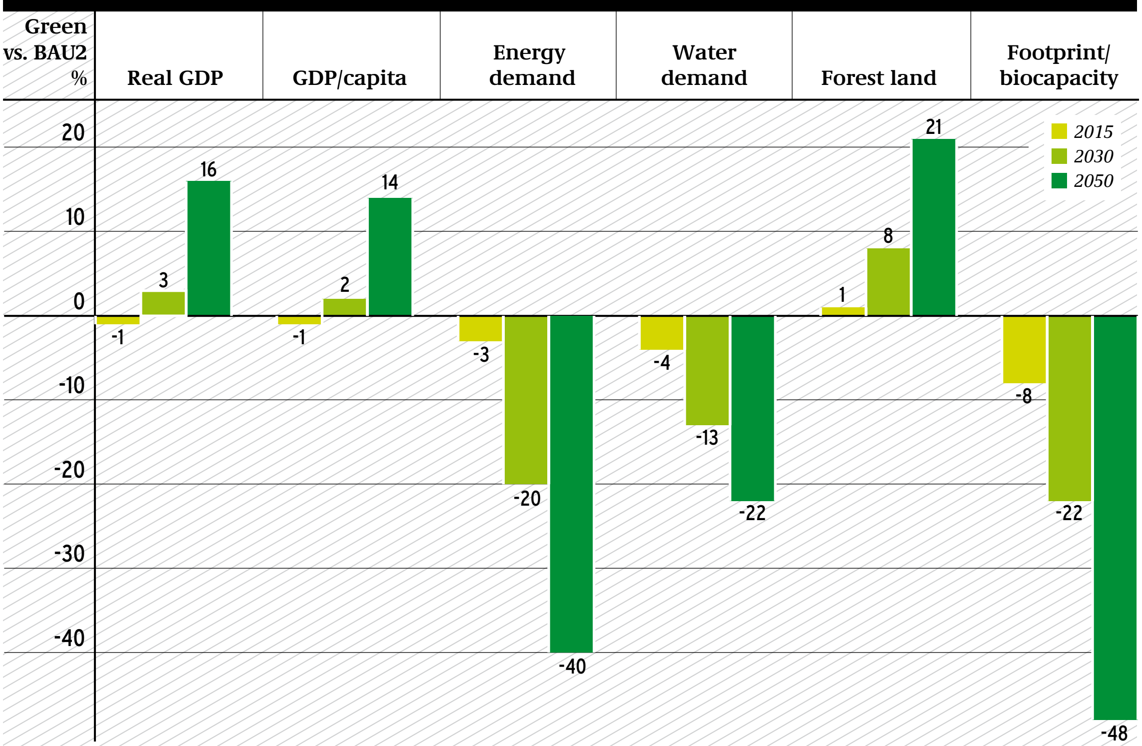
The model calculations show that the transformation towards a green economy is beneficial for the economy and the environment. In 2050, the global gross domestic product in the green investment scenario would be higher by 16 percent than in the business-as-usual scenario (see Figure). Water and energy consumption would be lower and the global temperature increase could be limited to two degrees Celsius. On the other hand, energy-related CO_2 emissions would increase in the business-as-usual scenario by almost two thirds by 2050.

The economic risks and damage due to accelerated climate change, water scarcity and the loss of ecosystem services were not included in the modelling of economic growth in the business-as-usual scenario. To that extent, the economic advantages of the green investment scenario are significantly higher than reported in the UNEP estimates.

The transition to a green economy also makes economic sense for developing and emerging countries [3]. Poorer countries are particularly dependent on natural resources. The destruction of ecosystems, climate change and rising commodity and food prices hit poor population layers particularly hard. Moreover, developing countries have the opportunity to avoid mistakes of the industrialised countries and establish in advance an economic structure based on the principles of a green economy, for example in developing green infrastructure and focusing on renewable energies.

In the long run no country can afford to ignore the environmental challenges of this century since

Effects of the green investment scenario (compared to business-as-usual scenario)



Source: UNEP [2]

scarce resources and the fight against climate change will shape tomorrow's international competition and markets. Those who do not succeed in a timely adjustment to these new challenges will be in danger of falling behind in international competition.

COMPETITIVE FACTOR RESOURCE EFFICIENCY

Increasing energy and material efficiency is expected to be a decisive factor in international competitiveness in the 21st century. The demand for goods and services will continue to grow because of the increase in world population and the economic catch-up process in developing and emerging countries. Our limited natural resources can only satisfy this demand in the long run when we succeed to produce "more" by "less" – that is decouple economic growth and the use of natural resources. Therefore, there is growing pressure to use and develop resource efficient technologies.

In certain sectors such as the automotive and engineering industries, the material cost is more than 50 percent of the gross production value. Thus there are extensive cost-saving potentials: for example, the German Materials Efficiency Agency estimates that about 20 percent of material costs could be saved on average in the manufacturing sector by more efficient production processes [4]. This would correspond annually to a value of about 100 billion euros for the whole economy.

THE FUTURE MARKETS ARE GREEN

The green future markets for clean energy, energy efficiency, resource and material efficiency, sustainable mobility, sustainable water management, waste and recycling management are expected to grow rapidly in the coming decades: the global market volume could more than double from 1,400 billion euros to 3,100 billion euros alone between 2007 and 2020 (see Figure).

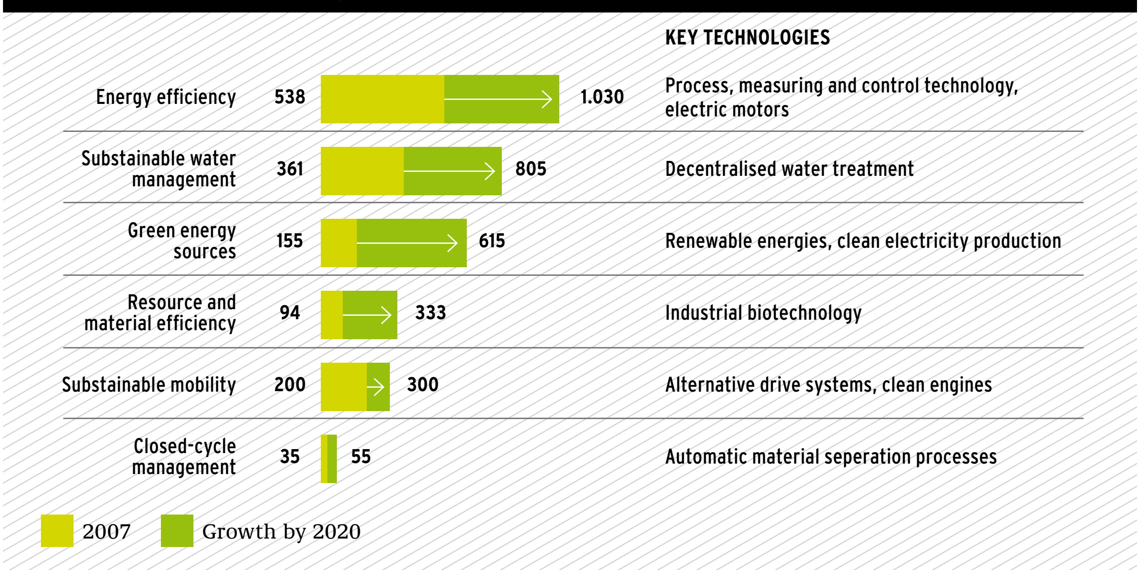
The German environmental industry will strongly benefit from this dynamic growth because it has a strong position in international competition on many markets. Currently, German companies have world market shares of between six and 30 percent in the green future markets [5]. Germany shows particular strengths in the environmentally friendly energy production and waste management and recycling industry. German companies account for over a quarter of the world market.

The international competition in the green future markets is getting keener. Some countries have already developed industrial policies to strengthen their competitive position in the green future markets. South Korea, for example, will use two percent of the GDP for investment in climate protection and energy, sustainable transport and the development of green technologies [6] by 2013. Even some emerging countries are making great efforts in this area. Thus, China has developed into by far the largest producer of solar cells in a few years – with a global market share of 48 percent in 2010 [7].

ENVIRONMENTAL PROTECTION CREATES JOBS

The transition to a green economy offers great employment opportunities. Several studies have shown that challenging climate protection targets may create additional jobs, for example by the expansion of renewable energy sources or by the energy refurbishment of buildings. About 630,000 additional jobs are expected to be created by the need for energy efficiency measures to reach the German climate protection targets, i.e. the reduction of greenhouse gas emissions by 40 percent by 2020 [8]. Climate protection provides great employment opportunities at the European level as well: the European Commission expects up to 1.5 million additional jobs by 2020 if the EU implements 25 percent emission reduction instead of the ap-

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



Source: Federal Environment Ministry [5] proved 20 percent [9]. Moreover, if the reduction in greenhouse gas emissions achieves 30 percent, as many as six million new jobs may be created by 2020 according to a recent study [10].

Resource conservation may also offer great employment opportunities. Thus, up to 700,000 additional jobs may be created by 2030 if information and consultancy services which make it possible to implement best practices in all manufacturing companies with regard to material efficiency [11]. At the same time, the gross national product would increase by 14 percent compared to the reference scenario and resource consumption would drop by nine percent.

The transition to a green economy requires a profound ecological modernisation of the entire economy and society, covering all sectors and spheres of life. This will only succeed if the state sets the right framework and incentives. Part of this is that it systematically promotes environmental innovation, accelerates the development of green future markets and creates economic incentives that reward environmentally friendly and resource-efficient production and consumption patterns. Important are also challenging environmental targets which will provide economic players with a clear action framework. The following chapters show specific implementation options for a green economy using the examples of power supply, resource conservation and the chemical industry.

CORPORATE SOCIAL RESPONSIBILITY AND ENVIRONMENTAL MANAGEMENT

Most companies today face major economic and environmental challenges. It is not just about managing the effects of the financial and economic crisis, but also the threat of environmental crises such as global warming and increasing scarcity of natural resources. This will affect our lives and our economies seriously in this century. A strategy of "business as usual" will not meet the challenges and fails to provide a solution to the companies. Rather, it is important to recognise these challenges and to transform them in economic opportunities. Those who shape their businesses sustainably and provide innovative, environmentally friendly products and services can strengthen their competitiveness and become themselves drivers of social progress.

A systematic approach to environmental management may contribute to tackling the challenges described. EMAS is the most sophisticated instrument available. In practice, and based on the standard ISO 26 000, concepts for corporate social responsibility (CSR) have been developed that combine economic development, social responsibility and the protection of the environment. Many companies are already drawing up sustainability or CSR reports and are publishing their policies in these areas. Companies can cover the environmental part of CSR easily by their environmental management system and their EMAS environmental statement. A third-party certification helps them to gain particular authenticity.

A systematic energy management according to the new ISO 50 001 also has a close relationship with EMAS. A comparison of EMAS with EN 16001, the European precursor to ISO 50 001, shows that EMAS in principle covers all aspects of an energy management system.

RESPONSIBLE FOR THE TEXT:
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Transformation of the energy system

A DEPARTURE INTO A NEW

the elements of a sustainable
energy supply

Germany has decided the transformation of its energy system. Nuclear power should be phased out within a decade, energy efficiency improved and a shift to renewable energies will be accelerated. The new energy era requires a fundamental transformation of energy supply systems. This poses great challenges to the country, but offers considerable opportunities for a fundamental economic modernisation. And it is preparing Germany for the future, where prices for fossil and nuclear energy will continue to rise and eventually, no country can ignore the demands of climate change.

Our energy production and use is currently not sustainable. It is associated with significant environmental impacts and risks, some of which have long-term effects. About 80 percent of all greenhouse gas emissions come from the conversion and use of energy. Atomic energy poses high risks which are ultimately uncontrollable. For the transformation to sustainable energy use, three strategies must be implemented consistently [1]:

- First we need to decouple energy consumption from our living standards. The effects of planning and development processes to meet future energy needs must be considered in transport, urban and regional planning. Energy services (warm and bright living spaces, production of goods and the transportation of goods and people) must be able to manage with less final energy (electricity, fossil and motor fuels).
- We need to cover the inevitable final energy demand – despite careful planning – using the energy sources converted as efficiently as possible. This also applies to energy transport and use.
- The remaining primary energy demand must be increasingly, and over the long term, fully covered by renewable energy .

How necessary these three strategies are can be seen by using the example of electricity generation. Because of increasing living standards (computers, televisions, mobile phones), electricity consumption increased between 1995 and 2008 by 66 terawatt hours (TWh). The successful promotion of renewable energy sources in this period has led to an increase in renewable energy generation by about 69 TWh. Consequently this allowed renewable energy to cover only slightly more than the increase in power consumption. Based on the development initiated in the past two decades, these strategies must now be implemented in stages. Below, the Federal Environment Agency (UBA) shows the elements of sustainable development of energy supply which will be of particular importance in the coming years.

POWER EFFICIENCY IS THE LARGEST SOURCE OF ENERGY

Several studies are available on the economic savings potential of electricity and fuel consumption in all sectors [2]. Accordingly, greenhouse gas emissions can be reduced by up to 130 million tonnes (Mt) by 2020. More than half (about 70 Mt) can be accounted for by electricity savings of about 110 TWh. A large part of this potential (90 TWh) is actually economical because the avoided energy costs offset the cost of energy-saving facilities or measures within a time-frame of a few months to a maximum of five years.

ELECTRICITY in private households can in particular be used economically through energy-efficient household appliances. The average energy consumption of electrical appliances with energy consumption labelling decreased from 2005 to 2010 by nine percent [3]. High-efficiency motors and electronic variable speed drives can save power in industry. Large savings can be achieved by the joint optimisation of individual components such as electric motors, pumps, fans and compressed air generation throughout the entire system.

Buildings are responsible in terms of space heating, water heating, cooling, ventilation, auxiliary applications and all kinds of lighting for about 40 percent of final energy consumption [4]. Heat in-

OBJECTIVES OF THE GERMAN ENERGY AND CLIMATE POLICY

- Greenhouse gas emissions should be reduced by 40 % by 2020, by 55 % by 2030, by 70 % by 2040 and by 80 to 95 % by 2050 (compared to 1990).

- Primary energy consumption is projected to fall through more efficient conversion and utilisation of energy by 20 % by 2020 and by 50 % by 2050 compared to 2008. The refurbishment rate of buildings will be doubled from 1 to 2 %.

- By 2020 the proportion of renewables in gross final energy consumption should reach 18 %, and then continually increase to 30 % by 2030 and to 60 % by 2050. The proportion of electricity produced from renewable energy sources in total electricity consumption should amount to at least 80 % by 2050. In the transport sector, final energy consumption is projected to decline by around 10 % by 2020 and by about 40 % by 2050.

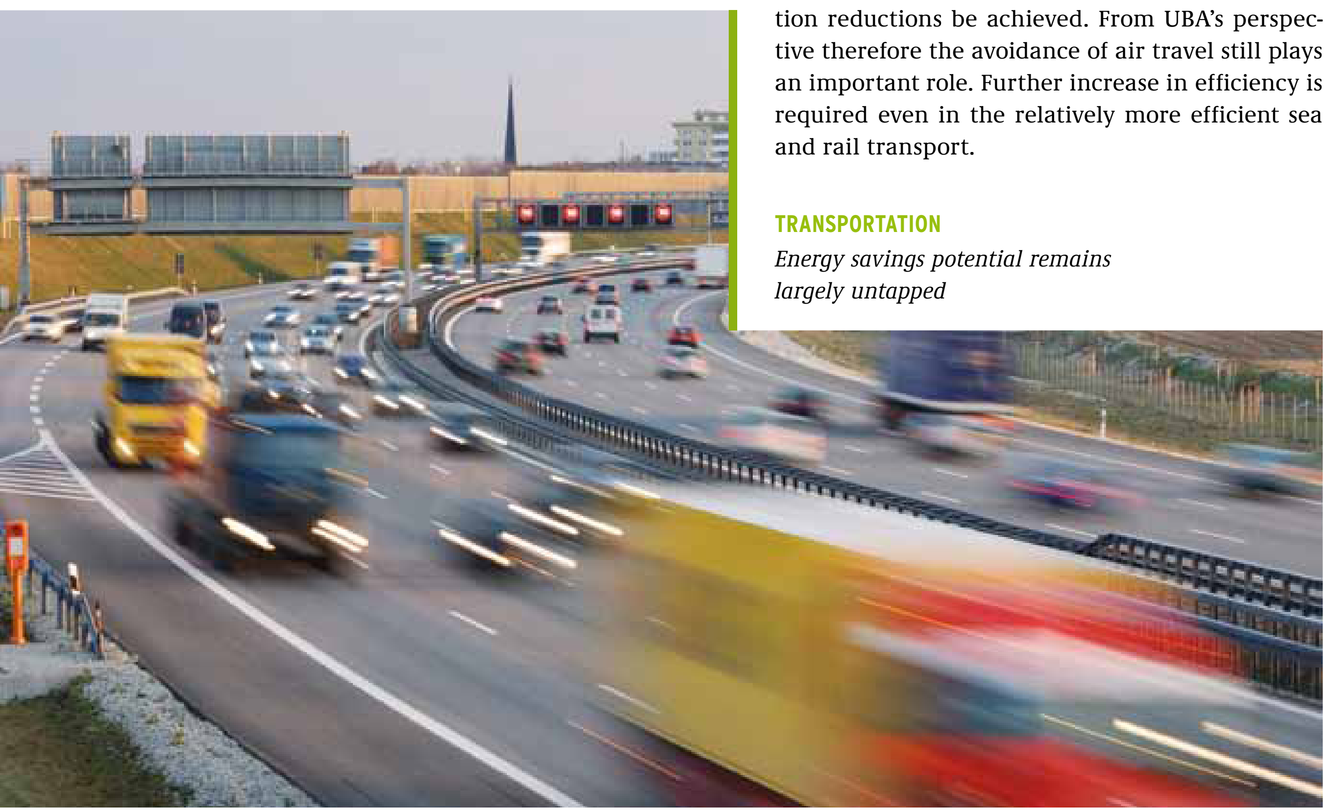
sulation, passive use of solar energy by windows, efficient heating and ventilation systems with heat recovery, all reduce energy consumption. The Energy Conservation Act 2002 introduced the low-energy house as a standard, currently the passive house is spreading. By about 2020, near zero-energy buildings will become the norm. In existing buildings, the refurbishment using passive house components is already technically feasible and often economical [5]. Their use leads to lower heating needs in the renovated building by up to 90 percent. Newer concepts such as zero- or plus-energy buildings are already technically feasible today. The latter generates more energy over the year than it consumes, collected by the building itself from renewable sources.

The low **HEAT** demand from buildings poses new challenges to the district heating system. In a passive house development for example, the distribution losses may be as high as the heat demand of the buildings. Nevertheless, a pipe-based heat supply may be ecologically and economically reasonable if passive houses are connected to the district heating return, short lines may reduce the distribution losses or heat can be generated locally (shared borehole heat exchangers for heat pumps, wood pellet boilers, combined heat and power) [6].

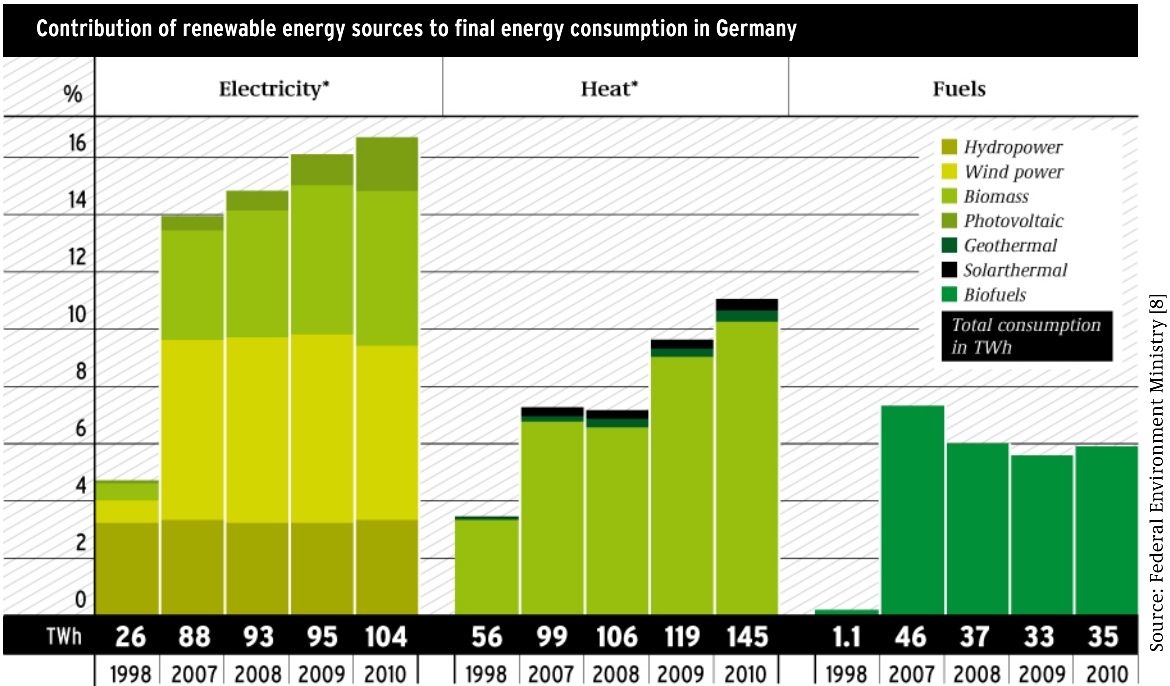
In industry and commerce, fuel efficient boilers providing process heat or heat exchangers for heat recovery can save fuel. Only the joint optimisation of energy-efficient individual installations within an operational energy utilisation concept can fully open existing energy saving potentials for electricity and fuels. The use of waste heat plays a big role. Energy management systems facilitate a systematic and continuous improvement of energy use.

In **TRANSPORT,** energy can be saved by avoidance and shifting to a more environmentally friendly means of transport. A higher technical efficiency in transport contributes significantly to the reduction of greenhouse gas emissions and to climate protection [7]. According to estimates by the Federal Environment Agency the energy saving potential of efficient hybrid cars will be about 60 percent by 2050. Plug-in hybrids reduce the consumption of liquid fuel compared to current vehicles at an electric mileage ratio of 50 to 75 percent by about 80 to 90 percent. UBA estimates suggest about 40 percent energy savings for trucks over the medium term. These estimates are based on the use of highly efficient motors and consistent lightweight construction. Externally chargeable vehicles with a partial electric drive (hybrid vehicles) may already be able to cover a large part of the mileage if the legal requirements on fuel consumption became available. If further innovations in storage density and battery manufacturing costs were made in the future, e-mobility will prevail in the long term. In principle, the driving power must come from renewable energy sources in order to ensure long-term acceptable CO_2 emission balances for the use of electricity as an energy power source in transport. Simultaneously, specific fuel consumption (especially in conventional engines) must be reduced significantly. The use of hydrogen from excess renewable energy in fuel cells may be a useful option, but for reasons of efficiency a stationary use and the direct use of electricity should generally be preferred.

In aviation, the technical potentials for fuel consumption reduction are not yet exhausted, but the reduction in specific emissions per year of 1 to 2 percent is not sufficient to compensate for the projected absolute increase in emissions. The use of renewable energy sources requires considerable effort and it is necessary to examine to what extent and in which periods of time can consumption reductions be achieved. From UBA's perspective therefore the avoidance of air travel still plays an important role. Further increase in efficiency is required even in the relatively more efficient sea and rail transport.



TRANSPORTATION
Energy savings potential remains largely untapped



* Biomass: solid and liquid biomass, biogas, landfill and sewage gas, biogenic parts of waste; deep geothermal not shown due to the small amount of electricity; values rounded; status: December 2011

RENEWABLE ENERGY – THE PILLAR OF FUTURE ENERGY SUPPLY

The main sources of renewable energy are the radiant energy of the sun, gravitational forces and radioactive decay processes within the earth. Besides the direct use of solar radiation, the origin of today's most important renewable energy sources are wind, geothermal, hydropower and bioenergy. According to the human time scale renewable energy sources are continuously available. The total supply exceeds world energy demand many times over. However, the use of renewable energy sources is also associated with effects on the environment and costs. Therefore, energy conservation and efficient delivery, conversion and utilisation of the energy are necessary requirements to meet the remaining energy needs from renewable energy sources.

Provision of electricity, heat and fuels from renewable energy sources has more than tripled, from about 83 TWh in 1998 to around 284 TWh in 2010 (see Figure). This means that renewables have increased their proportion in electricity production from 4.7 (1998) to 17.1 percent. In 2011 this proportion was further increased to around 20 percent. Heat supply from renewable energies in 2010 totalled approximately 145 TWh or 10.2 percent of the total final energy consumption for heating (space heating, hot water and industrial process heat). The largest contribution, about 93 percent, came from biogenic fuels. In the transport sector the energetic contribution was roughly 35 TWh in 2010, which corresponds to a proportion of about 5.8 percent in total fuel consumption by road transport. In 2010 the proportion of renewables in final energy consumption (electricity, heat and mobility) amounted to 11.3 percent. According to initial estimates a proportion of about 12 percent was achieved in 2011.

WIND: A great white hope for the transformation of the energy system is the use of wind energy on land and at sea. A maximum of 59 percent of the energy can be extracted from wind. Modern wind turbines already achieve an efficiency of up to 50 percent. The largest wind turbines have an installed capacity of up to 7.5 MW. The turbines start running at a wind speed of about three metres per second (m/s). The power increases with the cube of the wind speed. Doubling the wind speed therefore leads to an eightfold increase in power. The highest wind speeds occur off and on shore. Inland, they are much lower because of the uneven landscape and the friction of air at ground level. To compensate for this disadvantage, wind turbines on land are built much higher.

At the end of 2010 about 21,600 facilities with a capacity of 27,209 MW were installed in Germany. They produced about 37.7 TWh of electricity in 2010 [8]. 33 units with a capacity of 108 MW are at sea [9]. By the end of 2011 27 wind farms with a total of 1930 wind turbines were approved in the German Exclusive Economic Zone (EEZ).

GEOTHERMAL energy, in contrast to wind and solar energy, is constantly available and can contribute

WIND POWER
Especially at sea in the future

GEOTHERMAL
Heat from the earth's cellar

over 8,000 full load hours per year to the base load. Deep geothermal energy uses the temperature increase with depth of rocks and water to generate electricity and heat, while the near-surface geothermal energy uses temperature differences between ground and air temperature for heating and cooling buildings.

In deep geothermal energy, water circulates through existing or artificially created rock fractures and is heated by the rock temperature prevailing at the respective depth (petrothermal systems). Or it uses the hot water existing at depth directly (hydrogeothermal systems). Depending on the temperature, the water is used for electricity and heat generation or only for heat generation. Near-surface geothermal energy is limited by mining law to depths of up to 400 m. Temperatures encountered at these depths are used by heat pumps for heating or directly for cooling buildings.

Currently, there are 18 deep geothermal facilities with approximately 7.3 MW of electrical and about 188 MW of thermal capacity in operation [10] which generated about 0.028 TWh of electricity in 2010 [8]. In addition, there are 13 facilities under construction and 81 facilities in the pipeline. Since 2000, the provision of heat from geothermal energy has increased from 1.5 TWh to 5.6 TWh in 2010. However the largest proportion comes from near-surface geothermal energy including other environmental heat [10].

SOLAR ENERGY in Germany is used in the form of photovoltaic and solar thermal energy. Photovoltaic solar cells convert solar radiation directly into electrical energy; solar thermal collectors convert solar radiation into heat. In the field of photovoltaics in Germany, mainly mono- and polycrystalline silicon solar cells are used. But the market proportion of thin film cells based on silicon or other semiconductor materials such as cadmium telluride is also increasing. In 2009 and 2010 Germany was the world's largest market for solar cells. The Renewable Energy Sources Act (EEG), high social acceptance of the technology and the deterioration in funding conditions in other countries (e. g. Spain) helped provide approximately 3,800 megawatts peak (MWp; power under test conditions) in 2009 and around 7,400 MWp were installed in 2010. Thus, the installed capacity has increased to 17,320 MWp, the current yield being about 12 TWh.

In Germany, solar thermal energy is used by air collectors or swimming pool absorbers for heating bathing water. On the other hand flat plate collectors and vacuum tube collectors are employed for heating drinking water and supporting heating systems. In comparison to photovoltaic, solar thermal energy has developed in a less dynamic way: in 2009 approximately 1.6 million square metres (m^2) of collector area were installed [11] and in 2010 only 1.15 million m^2. The reason is that fewer funds were available in the market incentive program (see page 31) in 2010. The total installed collector area was about 14 million m^2 at the end of 2010 and generated 5.2 billion kilowatt hours (kWh) of heat or 0.4 percent of the German heat consumption [8].

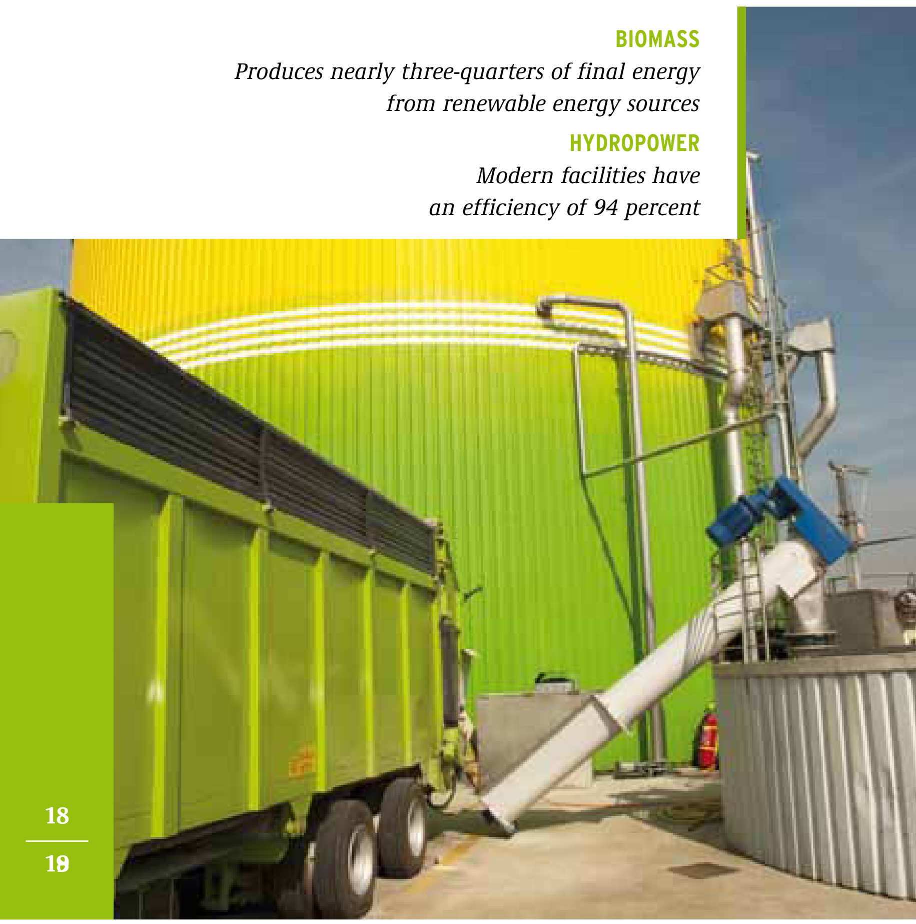
HYDROPOWER is used in modern hydroelectric power plants with efficiencies of up to 94 percent. Their lifespan is about 80 to 100 years; the machines must be replaced after 20 to 40 years. About 16 percent of global electricity production comes from hydropower plants. They generated 21.0 TWh of electricity in Germany in 2010. The installed capacity was 4,780 MW at the end of 2010 [8]. 85 percent of electricity was produced in about 400 plants with a capacity of more than 1 MW [12]. About 7,300 hydroelectric power plants have a capacity not exceeding 1 MW. The potential of hydropower in Germany is largely exhausted. Considerable further potential can only be tapped by modernising and expanding existing facilities.

BIOMASS can be used to obtain fuel, heat and electricity. In principle, any biomass can be energetically used, thus the range of available techniques for conversion and use is correspondingly large. Almost three-quarters of final energy provided from renewable energy sources in Germany come from biomass which is used mainly for heat production. Electricity from biogenic raw materials (such as wood, agricultural residues and energy crops) amounted to 33 percent from wood burning power plants and 43 percent from biogas in 2010 [8]. Since the EEG amendment in 2004 the use of biogas saw a strong increase to approximately 5,900 facilities in late 2010 [13]. In addition, the biogenic part of waste and – of lesser importance – vegetable oils, sewage gas and landfill gas also contribute to biogenic electricity generation [8].

In Germany, traditional log burning dominates heat supply from biomass. New firing concepts with higher thermal utilisation levels are only gradually gaining a share. So far only about 140,000 modern wood pellet heating systems are being used in private homes. However, industry increasingly uses its biogenic production waste or waste heat from power generation to provide process and low-temperature heat. Fuels from renewable energy sources have almost exclusively come from biomass. According to the Biofuels Quota Act of 2007, biodiesel is added to fossil diesel and bioethanol to petrol (E5, since 2011 E10,). According to the official statistics the use of biomass energy has avoided 65.7 million tonnes of CO_2 equivalents. However, this assessment fails to include greenhouse gas emissions due to the increased cultivation of crops which emerge, for example on so far "carbon neutral" uncultivated land.

BIOMASS
Produces nearly three-quarters of final energy from renewable energy sources

HYDROPOWER
Modern facilities have an efficiency of 94 percent



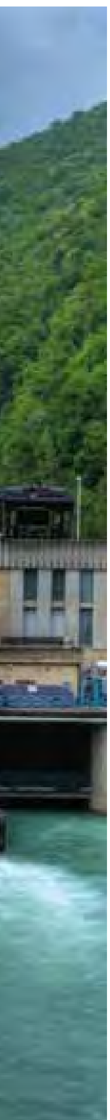
TRANSFORMATION OF THE ENERGY SYSTEM CREATES ECONOMIC OPPORTUNITIES

Especially at high and, as expected, further increasing energy prices, it makes economic sense to improve energy efficiency in order to enhance competitiveness. Germany's energy import bill for crude oil, gas, coal and electricity rose from about 58 billion euros in 2005 to 112 billion euros in 2008 [14]. Energy consumers have so far failed to satisfactorily seize the opportunity to use energy more efficiently.

Back in 2007, products and services to increase energy efficiency had a world market volume of 540 billion euros which is expected to double by 2020. The annual growth rates of three to six percent in some key areas are significantly lower than in other green markets. However, they are very significant for mature industries which dominate the future market of energy efficiency. Revenue growth in some innovative market segments is very high: solar cooling whose market volume was only a few million euros in 2007 will have an annual growth rate of over 50 percent and a market volume worth several billion euros in 2020 [15]. In addition, an increase in energy efficiency often leads to more employment. Rather more labour-intensive sectors tend to benefit from this such as the trade of building energy refurbishment. Also, measures to increase energy efficiency replace a part of imported fuels such as oil or gas by domestic added value. Analyses indicate that climate protection through improved energy efficiency in transport, businesses and in building refurbishment lead to positive net employment effects. Thus, a consistent CO_2 reduction strategy in transportation may create 215,000 additional jobs by 2020 [16].

The cost of renewable energy is countered by a significant macroeconomic benefit in many areas. The use of renewable energies, for example, avoids greenhouse emissions and air pollutants. This reduces the follow-up cost to society by environmental and health pressures. Only a part of the beneficial effects can be quantified economically (see Table). Thus factors such as an increased security of supply or spill-over effects of current research activities are not yet taken into account. In addition, less fossil fuel needs to be imported because of the extension of renewable energies. In 2010 this was around six billion euros in savings [19]. This had positive effects on the overall economic result as imports have been largely replaced by domestic added value. Thus additional jobs have been created and security of supply has been increased.

The positive effects of the international competitiveness of German companies are an important factor. German companies are very well represented in the world market for renewable energies. This was strongly supported by the promotion of renewable energies in the electricity sector. The economic impact of climate protection has steadily increased worldwide in recent years: the turnover in international trade in climate protection goods increased annually by 19 percent from 2002 to 2008 [20] and in renewable energy sources by almost 33 percent. These figures illustrate the increasing economic and international importance of this industry. The growing use of renewable energies is also obvious from the employment figures in the industry which have more than doubled in the years from 2004 to 2010 from 160,500 to 367,400. Manufacturers and their suppliers as well as planning, construction and operation of the facilities have also benefited from this development. Even the crisis year of 2009 provided evidence for a strong upward trend by a moderate increase in the number of employees (see Figure).



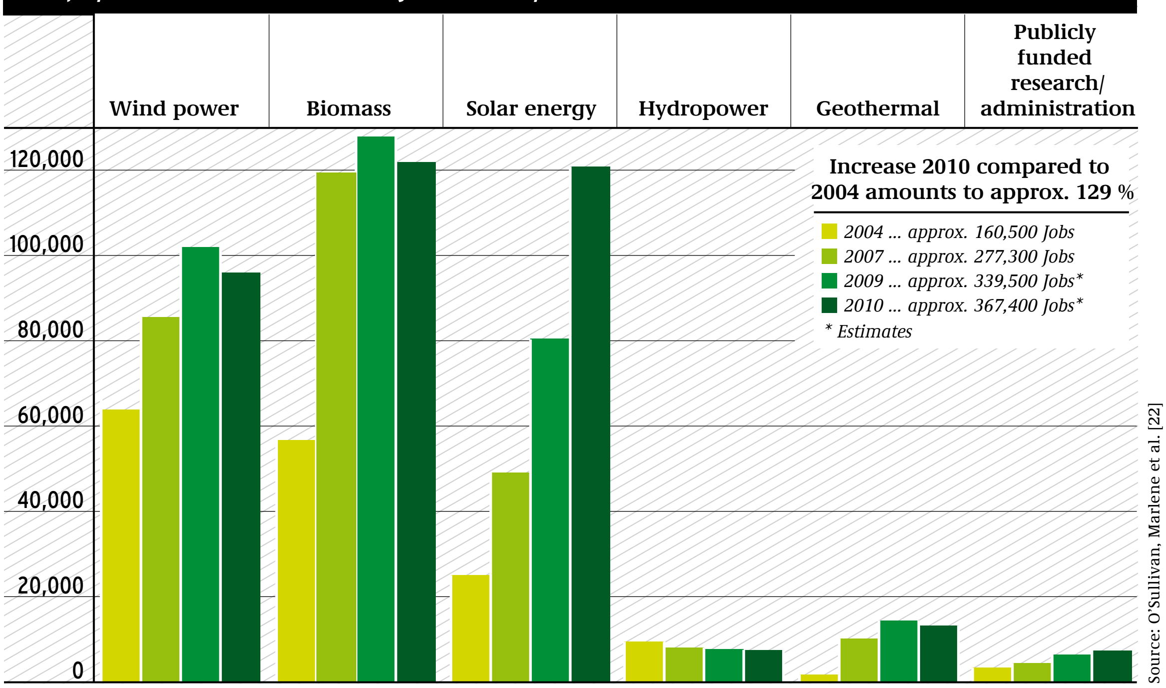
Costs and benefits of the expansion of renewable energies in the electricity sector (in billion euros)

	2007	2008	2009	2010
Analytical differential system cost of electricity	4.30	4.7	5.6 [17]	8.1
Costs for compensation and control energy	0.6	0.6 (2007)	0.4	0.4
Grid expansion (estimate for 2007)	0.02	0.02	0.02	0.06
Transaction costs (estimate for 2007)	0.03	0.03	0.03	0.03
Sum: costs of RE electricity	4.95	5.35	5.75	8.6
Sum: benefits of RE electricity: avoided damage to the environment due to RE electricity	5.6	5.9	5.7	5.8

Source: Institute for Futures Studies and Technology Assessment (IZES) [18]; for 2010: Federal Environment Ministry [8]

Amongst the individual sectors of renewable energies in Germany, significant differences were seen in economic development and thus also in the impact on employment in 2010. Although the compensation for photovoltaic facilities has been further reduced, the solar industry reached the highest growth rates. Bio-energy has (as yet) the highest proportion, but the interim freeze to the Market Incentive Program (MAP) significantly weakened the heat market. Wind energy was not able to continue the positive trend in recent years because of the limited suitability of designated areas. Scientific studies consider that a further increase in renewable energy to 500,000 to 600,000 jobs is feasible for Germany by 2030, especially depending on the evolution of German RE foreign trade as well as renewable energy prices and EEG differential costs [21].

Employment effects of renewable energies in Germany



ENERGY POLICIES NEED ECOLOGICAL GUIDELINES

The main criteria for the sustainable development of energy supply are its health, environmental and nature compatibility as well as its low risk. Our current energy use violates these criteria: combustion of conventional energy resources leads to emissions of greenhouse gases and air pollutants such as nitrogen oxides and dust, the use of nuclear energy is associated with risks from accidents and waste disposal. When switching to renewable energies, however, significantly less greenhouse gas and other harmful emissions are generated, fossil resources are conserved and security of supply enhanced.

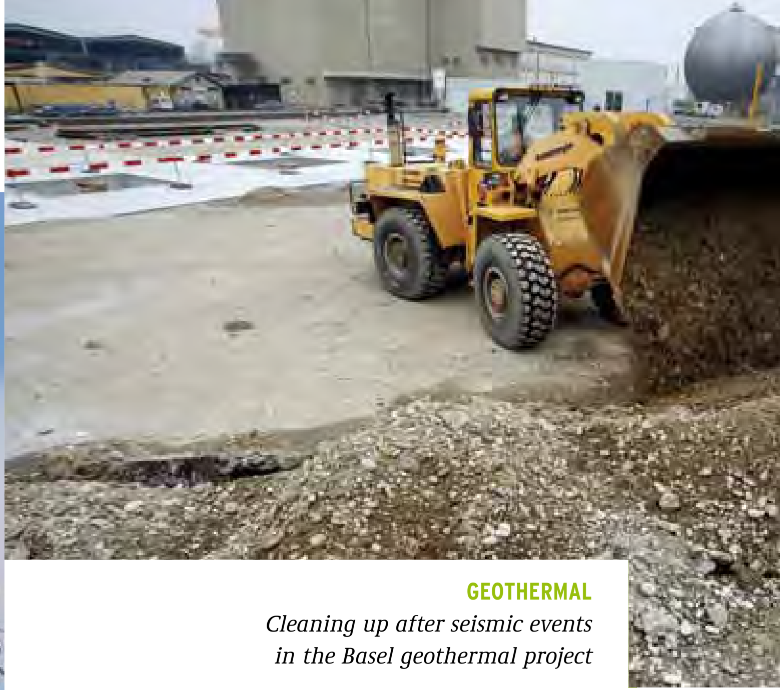
Nevertheless, the use of renewable energies and the measures for efficient use of energy have environmental effects which must be measured using the criteria for sustainable development. Compliance with applicable quality standards for the pollution generated is the minimum requirement. Preventing impacts on the environment and nature has a high priority, interventions in ecosystems must be reversible. In the case of new technologies, possible new environmental impacts must be thoroughly investigated and, if necessary, new standards developed. In this context it is necessary to create acceptance in society, especially among the people involved, and to optimise overall economic efficiency including the external costs.

WIND: The approval authority will assess the effects of land based wind turbines on people (noise emission, oppressive impact, optical effects such as casting shadows and lighting) as well as on nature and the landscape (for example, impairment of habitat and breeding of birds and bats). The impacts on the natural habitat of individual species such as bats or birds of prey are being researched extensively in order to avoid a violation of animal protection law. There are always complaints from local residents, especially about noise or light pollution. Therefore UBA recommends that the designation of sites for the construction of wind turbines should be primarily performed based on objectively assessable criteria. Potential effects on the natural environment must be examined carefully. In order to reduce negative environmental impacts, technically available measures should be examined. Thus, proximity detectors for aircraft (transponders) should turn on the equipment light sources (lighting) only when needed. Furthermore, in the case of evidence for increased bat activity, individual switch-off algorithms should be specified depending on day and season, weather and wind speed. To increase the overall acceptance, it is also important to involve the affected citizens early and actively in the planning and design of their environment.

The development of wind energy at sea must be in accordance with the requirements of the Marine Strategy Framework Directive (MSFD), which wants to achieve a “good environmental status” of the seas by 2020. The permits for offshore wind turbines will be issued under the Offshore Installations Ordinance (SeeAnlVO). The provisions of the Federal Nature Conservation Act (BNatschG), the Flora-Fauna-Habitat Directive (FFH RL) and the Birds Protection Directive (VS RL) also apply. Thereafter, significant disturbances of many species (for example, sea birds and porpoises) are prohibited during their breeding, rearing, moulting, wintering and migration periods. To gain experience with the environmental impacts of wind farms at sea, a maximum of 80 turbines per wind farm will be allowed. A broad study programme of the ecological impacts during construction and operation of the facilities will provide the basis for decisions on further extension.

WIND POWER
Minimum distance needed

WIND POWER
More consideration for nesting sites



GEOTHERMAL
Cleaning up after seismic events in the Basel geothermal project

The following ecological impacts are relevant:

- Collision with and the barrier effect of facilities and loss of roosting and feeding areas for birds.
- Hearing loss, behavioural changes and extensive displacement of marine mammals such as porpoises, and also fish and invertebrates, by noise during piling foundations.
- Changes of soil biological communities in the vicinity of facility foundations.

To protect migratory birds, UBA recommends needs-based lighting for offshore wind turbines. In addition, a temporary shutdown of the lighting and the wind turbines should be taken into consideration during nights with simultaneous heavy migration and poor weather and visibility conditions. Noise pollution should be reduced for the protection of marine mammals. The technical noise mitigation measures need to be further developed and tested to comply with the recommended medium noise levels in the construction of offshore wind farms. Promising alternative methods for introducing foundations (for example, replacing ramming with boreholes), or noise abatement during pile driving (air bubble curtain, hydro-silencer or dewaterable cofferdams) should be defined as state of the art as soon as possible.

GEOTHERMAL ENERGY: The energetic use of geothermal energy requires an interference with the natural balance of the earth's upper crust. Environmental impacts can be localised and are technically manageable. In deep geothermal energy, seismic events may be triggered by high-pressure water injection, as happened in a geothermal project in Basel, Switzerland. To avoid such events or predict their magnitude, the natural stress state of the earth's crust in the project areas must be further explored.

Poor planning and execution of drilling are the key sources of risk. It is especially important to avoid hydraulic short-circuits between different groundwater levels. Again, appropriate protective measures are well known and the risks are manageable. Environmental effects caused by temperature changes in the groundwater are difficult to assess because there are still large gaps in our knowledge. It can at least be assumed that warming has an influence on the biological activity in the groundwater. Therefore, UBA has commissioned a study whose results are expected by early 2013.

SOLAR ENERGY: Only relatively low environmental impacts are associated with the use of solar energy for our heating and power requirements, but environmental criteria may be relevant for the location of the facility. Built-in or sealed surfaces such as roofs are not critical. Open space facilities have been built mainly on land from industrial or military use. Ample military training areas, however, show a wide ecologically typical variety. Large-scale solar plants act almost like a building so that in each individual case, protection and use must be weighed against each other. No facilities should be built in protected areas.

HYDROPOWER: All the rivers in Germany have been changed among others by the use of hydropower. Only nine percent are currently achieving the desired EU objective in water protection: the "good ecological status". The reasons are mainly structural changes in the rivers due to the use of hydropower. To ensure a steady power production, river damming is needed which has serious effects: the rivers are not permeable for animals and solids. In addition, fish will often swim into turbines and rakes when migrating downstream. Without accompanying measures being taken such as the construction of fish migration opportunities, suc-

cessive facilities may have adverse effects on the fish population. Habitats are changed in dammed water and in the remaining river bed parallel to the hydro plant's feeder canal if the minimum water outflow is insufficient.

In consideration of the objectives of water conservation and climate protection, UBA recommends the following guidelines for electricity generation by hydropower:

- Development and application of strategic concepts which can provide information on whether and in which river areas an expansion, further conservation or restoration of hydropower, is feasible with little conflict and in an effective way to achieve the respective environmental objectives.
- When specifying the measures at a single hydropower site, the cumulative effects of multiple sites with an effect on aquatic ecosystems must be taken into account.
- Implementing all appropriate measures to mitigate the above environmental impacts. These include fish ladders, fish protection facilities, fish migration opportunities, morphological improvements and an ecologically effective minimum water outflow.

BIOMASS

Better from residues, not from the field

BIOMASS: The provision of biomass and its energetic use may be accompanied with negative environmental effects. Due to the increased demand for biomass, existing acreage is more intensively used and new areas in previously underused land are utilised (e. g. land use changes such as ploughing up of grassland). This can lead to eutrophication and acidification of soil and, as a consequence, to those of the waters, but also to correspondingly higher emissions of greenhouse gases (especially nitrous oxide). Loss of biodiversity and soil fertility and of the natural filtering and carbon storage functions of soils and forests would see further environmental consequences. In addition, inadequate environmental standards of facilities using bioenergy can lead to emissions of air pollutants such as dust or formaldehyde. The production of biomass exclusively for energy production can also compete against food and feed production.

Because of these risks, UBA is calling for a priority use of organic residues in advanced plant technology. In the use of crop biomass, wherever possible, higher priority must be attributed to food and materials use (furniture, lumber, bioplastics) than to its use for energy. Sustainability requirements for the provision of liquid biomass to generate electricity and liquid and gaseous biofuels are already broadly implemented in Germany by appropriate regulations. UBA is contributing to international bodies in shaping sustainability indicators and standards for the requirements of global production. UBA aims at extending these criteria to solid and gaseous bioenergy sources and to all areas of biomass production (food, materials use) over the long term. This is the only long-term way to avoid the negative environmental and natural impacts, for example due to the relocation of food crops on forest land deforested for this purpose (indirect land use change).

EFFICIENT ENERGY USE: Reduced energy consumption by increasing energy efficiency reduces environmental effects accordingly such as CO_2 emissions and the environmental effects of agriculture. A house heated by wood, for example, emits significantly less air pollutants after an energy refurbishment. Insulation does lead to higher production costs, but its environmental impacts are significantly lower than the savings in the utilisation phase [23]. For an optimum increase in energy efficiency, appropriate boundaries of the optimised system must be selected. Sometimes, the entire life cycle (production, utilisation, disposal) of a product or system must be considered to achieve far-reaching relief for the environment. This is illustrated by the following examples:

- While the passive use of solar energy with large windows contributes to heat energy saving in winter, energy consumption for air conditioning increases in summer when the rooms overheat. Solar gains must therefore be optimised over the whole year.
- To avoid indoor mould and health hazards caused by building energy refurbishment, all thermal bridges must be eliminated and adequate ventilation ensured when sealed windows are installed. In addition, the exterior walls should be provided with thermal insulation at the same time. Properly constructed buildings have, even on cold days, a comfortable room temperature because the surface temperature of the walls and windows is high due to the insulating cover.
- For most electrical appliances, energy consumption in the utilisation phase has the greatest environmental impact. Efforts to improve energy efficiency of products may lead to increased resource and energy consumption during manufacturing. Thus economical electric motors require more copper than those of higher power consumption. Products should be made increasingly reusable, durable and must have low energy and resource consumption in all stages of their life cycle [24].

TRANSPORTATION: The transportation sector in Germany must comply with the requirements of sustainable development. For this purpose it is necessary to reduce greenhouse gases and air pollutants, improve noise protection and use less space [7]. In order to achieve the 40 percent target of the Federal Government's climate change policy by 2020, according to UBA's estimates, the transportation sector's greenhouse gas emissions must be reduced by at least 40 million tonnes by 2020 compared to 2005. Nitrogen oxide (NOx) emissions also need to fall further. Despite steadily tightening the exhaust gas emission limits, the current EU limit value for nitrogen dioxide is being exceeded in many inner cities. Noise is the suppressed environmental traffic problem, from which hardly any citizen in Germany will be spared. The long-term goal is the protection level recommended by the World Health Organization to avoid serious disturbance: average sound level of 55 dB(A) during daytime and 45 dB(A) by night.

A GREENHOUSE-GAS-NEUTRAL GERMANY – A FEASIBLE IDEAL?

As part of the sustainability discussion, UBA has developed paths which could help Germany make its climate impacts "neutral." UBA studies the potential reductions in greenhouse gases for the relevant causes of climate change (energy, transport, industry, waste management and agriculture). The energy sector plays a key role and is responsible for more than 80 percent of all greenhouse gas emissions and has the highest potential for savings. A sustainable energy supply is the foundation of a greenhouse-gas-neutral Germany. Other areas such as agriculture and industry also have to reduce emissions, but they are more likely to encounter technical and economic limitations. The power sector accounts for 40 percent of greenhouse gas emissions. It is becoming the key for a new energy supply because it contributes to develop energy-based applications for heating purposes such as heat pumps. UBA is examining three scenarios of the transition to 100 percent electricity from renewable energy sources [25].

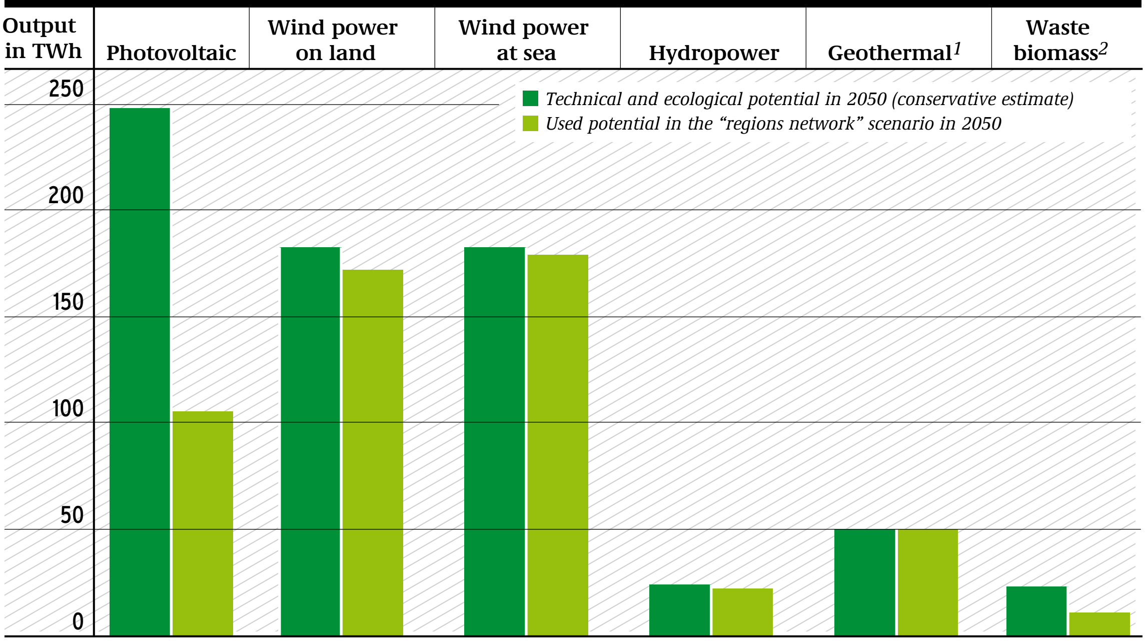
The "regions network" scenario describes the cooperation between regions in Germany which make optimum use of their respective potentials for enhancing energy efficiency and renewable energy sources and exchanging them. The "local self-sufficiency" scenario examines the power supply of small-scale, decentralised structures from their own sources. The scenario "major international technology" assumes the power supply of Germany and Europe will be satisfied by large, centralised power generation complexes such as wind farms in the North Sea or solar thermal power plants in North Africa. All scenarios describe ideal forms of renewable energy that will be brought together in an integration scenario in an appropriate manner. While the results of the "regions network" scenario are already available, the investigation of "local self-sufficiency" and "major international technology" scenarios will be completed in the course of 2012.

The investigation of the "regions network" scenario proves that a power supply based exclusively on renewable energy sources can be established using currently available techniques by 2050. Neither the existence of Germany as an industrialised country nor the security of the usual supply is jeopardised in this scenario. Also, consumption patterns are not questioned. The prerequisites are the most extensive use of the potential for renewable energy within the framework of ecological guidelines, exploiting the potential for efficiency and the use of load management. In addition, electricity grids and storage facilities must be expanded. Barriers that hinder this development should be systematically reduced.

BARRIERS TO SUSTAINABLE DEVELOPMENT IN THE ELECTRICITY SECTOR

The potential for renewable energy in Germany is substantial (see figure), but its exploitation is currently encountering systematic limits. Foremost among these is the provision of suitable land in terms of land use planning which mainly affects the use of wind energy and geothermal energy. Likewise, regulation of underground space – if the legislator specifies priority for certain functions – may help to secure suitable locations for geothermal heat and power generation and limit other uses such as carbon storage.

Potentials of renewable energy in Germany in 2050



1) Net electricity generation (i.e. own consumption has been taken into account)
2) Only biogas, 57% annual efficiency in power generation in gas-steam power plants

Source: UBA 2010 [25]

PHOTOVOLTAIC
Ideally placed ...

The requirements for environmental protection will also limit the potential for sustainable use of renewable energies. These limits should not be immovable; the environmental effects can often be limited or avoided by developing the technology or using alternatives. When using biomass, the effects compared to conventional agriculture can be reduced or avoided through sustainable farming methods or by using residual materials. Decades ago, the construction of pumped storage power plants caused massive problems in the Alpine environment. Adaptation measures (minimum residual flows, vegetated natural dams, underground power plants) managed to mitigate these effects.

INVOLVING CITIZENS

Citizens should be involved at an early stage in the development of renewables

Also, lack of acceptance in the use of renewable energy may hinder the progress of many projects. Planners and equipment installers can improve the acceptance by using mitigation techniques such as flexible lighting of wind turbines or laying underground cables instead of overhead lines in grid expansion, but above all the affected residents should be actively involved at an early stage. Overall, the public's agreement to climate protection and the shift towards renewable energies in Germany is high.

Finally, high costs and lack of suitable technology may be a considerable hindrance. Earlier, due to high material and energy consumption for the production of solar cells, the cost of the kilowatt hour of solar energy was significantly higher than that of electricity from wind energy and hydropower. Research and development, investment and promotion have helped optimise the production processes and significantly reduce the cost, which is expected to continue in the future. The expansion of deep geothermal utilisation in the first place requires more research and testing to develop the petrothermal potential. An obstacle to the development of deep geothermal energy utilisation is the limited capacity of the drilling technology.

SYSTEM INTEGRATION OF RENEWABLES IN THE ELECTRICITY SECTOR

The evolution to a power generation and efficient use based fully on renewable energy presents us with new challenges. Low running costs of renewable energies such as wind or solar energy change the conditions of the electricity market. Since these industries are able to offer low prices in the electricity market, they replace power plants with higher operating costs which results in a tendency towards lower prices on the electricity exchange. Currently, the effects on pricing are not yet clearly in view. They depend on a number of developments such as the European grid expansion, new storage facilities and load management. The regulation of the electricity market must meet these new market conditions. Policy guidelines for the electricity market therefore should be regularly checked for their suitability to the changing market conditions and, if necessary, adapted.

By switching to renewable energy, power generation is increasingly dependent on weather and season. The consumption is subject to daily and seasonal fluctuations, too. The energy system must therefore be made more flexible through the following measures in order to compensate for discrepancies between production and consumption. By introducing load management for electricity consumers, peak demand can be reduced and large supplies of energy from renewable sources fed into the grid can be better utilised. It is controlled by contractual agreements or time-variable supply-dependent electricity tariffs. A prerequisite here is an appropriate measurement, information and communication infrastructure (smart metering).

Further expansion of storage facilities such as pumped storage power plants for the short-term storage supports the time lag from the use of wind generated electrical energy in particular. For long-term and portable storage in the future, hydrogen can be produced electrolytically and possibly converted into methane. The existing well-developed natural gas infrastructure allows both the taking of limited quantities of hydrogen as well as the efficient storage and distribution of methane. However, the conversion of hydrogen into methane is still in the development or demonstration phase and far from commercial viability.

Electricity generation from controllable systems such as biomass or biogas plants must be increasingly oriented towards electricity demand. This, however, may tend to reduce the use of heat and thus energy efficiency of biomass in combined heat and power plants (CHP). Market optimised power production and sustainable use of biomass must be harmonised in the future when energy

PUMPED STORAGE POWER PLANT
Construction of an underground hydroelectric power plant

supply should be fully shifted to renewable energies. For the time being there are large and cost-efficient flexibility potentials in fossil power plants which may ease the short- and medium-term integration of renewable energies and should be preferably used.

SMART ENERGY GRIDS

For the best possible combination of the options listed, several power generation and storage facilities linked by grid and information technology (virtual power plant) and consumers must be controlled by so-called smart grids using information technology. In addition, decentralised systems may take over control of the network (frequency and voltage stability, balance energy) to reduce the need for conventional power plant capacity for grid support. Finally, the European grid must be expanded, especially at border crossings in order to use the Europe-wide and trans-continental potential of renewable energies and storage for large-scale power equalisation.

The German grid infrastructure is not suitable for transporting large amounts of electricity over long distances such as from wind farms in the north and east to the consumption centres in Southern Germany. Also, power flow directions change due to decentralised electricity production from renewable sources, for which the existing distribution system from large central power plants to remote users is not suitable. Additional grid capacity must be achieved in terms of sustainability, primarily by the network operators' optimising and strengthening the existing power lines, for example by increasing the size of existing conductor cross-sections, by conductor temperature monitoring or by the use of high temperature cables. The construction of new lines is associated with large effects on the natural environment and landscape as well as on the human environment, at considerable cost and long implementation periods for balancing conflicting interests.

BARRIERS TO AN EFFICIENT USE OF ENERGY

For the successful implementation of the transformation of the energy system we need societal acceptance and support. Each individual can help to save energy, be it with efficient home appliances or heating, but also in industry and commerce. However, the large potential for rational energy use faces a wide range of barriers of a fundamental, economic and socio-psychological nature [26], which can be summarised in the following categories:

Lack of information and motivation: In most households as well as industrial and commercial businesses, energy costs are a relatively small proportion of total expenditure [27]. Users and providers of products and services usually only look at the cost, while the critical life-cycle costs are considered only qualitatively.

Financial constraints: Households with a low income cannot afford to buy more economical devices that are often more expensive. Bookkeeping in the public sector distinguishes between acquisition and operating costs, thereby preventing the consideration of total costs. Companies, however, are investing more in their core business rather than in energy-saving measures.

Risk aversion: The development of efficient products and services means a technical and economic risk to the provider. Not only consumers but also providers of services prefer proven but inefficient solutions. Sometimes the lack of information is perceived as "risk". Therefore, the price of energy-saving products may be high because of small production numbers.

Lack of control: In the case of existing regulatory requirements the lack of controls can also be a barrier. Thus, at present only a few home builders actually implement the provisions of the Energy Saving Ordinance because the relevant state authorities often exert inadequate control.

BRINGING TRAFFIC ONTO A SUSTAINABLE COURSE

The implementation of the transformation of the energy system in transport is based on three strategies: influencing the need for traffic and shortening the distances (traffic avoidance), shifting transport to more environmentally friendly modes of transport and third, reducing the specific emissions of vehicles by higher efficiency and the use of alternative fuels and engines. UBA has summarised measures for all three areas in its report "CO_2-Emissionsminderung im Verkehr in Deutschland" (CO_2 emission reduction from transport in Germany) [28].

Freight transport is the problem child of the transformation of the energy system in the transport sector which is forecasted to continue to grow strongly. UBA has developed a „Strategie für einen nachhaltigen Güterverkehr" (Strategy for sustainable freight transport) [29]. The Federal Government must extend the rail network to bring more freight onto the ecologically beneficial railways. The rail freight transport can be doubled by an investment programme of a comparatively reasonable eleven billion euros by 2030 [30]. In addition, the proportion of renewable energies in traction power must be further increased.

The prerequisite for avoiding the movement of people is a change in settlement and transport planning which could reverse the current trend towards longer and longer distances. The key concept „Stadt und Region der kurzen Wege" (City and region of short distances) provides recommendations for action [31]. The remaining traffic should be relocated to more environmentally friendly (and efficiently built) attractive public transport as well as cycling and walking networks. About half of all car journeys are within a distance that can be covered comfortably by bike or on foot [32]. Car sharing can also make a contribution and break the dominance of the private car in passenger transport along the lines of "using a car instead of possessing one."

INNOVATIVE SOLUTIONS ARE ENCOURAGED

As part of the Environmental Innovation Programme of the Federal Environment Ministry, UBA supervises investment pilot projects. They serve many other companies, municipalities and organisations providing an example of the practical application of the latest technologies. The Federal Government has a substantial interest in supporting these solutions to meet the necessary technical and economical but environmentally positive changes. For example, following are two examples of projects in the field of renewable energies:

Photo: agnion Technologies GmbH, Hettenshausen

THE HEATPIPE REFORMER

The heatpipe reformer of agnion Technologies GmbH gasifies solid biomass according to a new process in which the combustion chamber is separated from the gasification chamber. The heat required for gasification is transported through heat pipes from the combustion chamber in the gasification chamber. This produces a fuel gas which, in a gas engine with an overall efficiency of 80 percent, generates heat with an efficiency of 50 percent and electricity with a very high efficiency of 30 percent. With its thermal power of about 1 MW and a consumption of 3,000 tonnes of biomass per year, this plant is well suited for urban district heating systems.

Photo: LaTherm GmbH, Dortmund

LATENT HEAT STORAGE

When using biogas in CHP plants, the heat produced frequently cannot be used (for example in waste treatment or agriculture). The newly developed latent heat storage of the Dortmund LaTherm company is installed in a standard container and can accommodate 2,500 kWh of heat, which corresponds to a calorific value of 250 cubic metres (m^3) of natural gas. The container is delivered to a customer where the heat is released at very little loss of about one-tenth of a percent per day. For a transport distance of 7.5 kilometres, diesel consumption is 3.3 percent of the energy content of the storage at most. The storage is loaded with waste heat from the Dortmund North waste incinerator which is used to heat a swimming pool. This avoids the combustion of 33,000 m^3 of natural gas and the emission of 77 tonnes of carbon dioxide per year.

100 % RENEWABLE ENERGY REGIONS

In addition to these innovative individual projects, there are a growing number of municipalities and regions which intend to switch their energy solely to renewable energy. Small communities can easily implement those decisions due to local self-administration: their decision paths are short and there is close contact with citizens. In addition to climate protection or limited fossil resources, the expectation of higher regional added value also serves as a motivation. The money saved from the "imported energy" can be invested locally. The "100 % Renewable Energy Regions" comprise about 27 percent of Germany's land area, on which about 22 percent of the population are living. UBA is working on these activities among others as part of an annual nationwide municipal congress on renewable energies.

INSTRUMENTS FOR THE IMPLEMENTATION OF THE TRANSFORMATION OF THE ENERGY SYSTEM

To reduce barriers and create incentives and basic conditions, the instruments shown below are of particular importance. To facilitate rapid and sustainable development of the energy system, the Federal Government decided various legislative changes in the context of Energy Policy 2011. Other changes are needed in the energy law and other legal areas which contribute directly and indirectly to the transformation of the energy system.

ECODESIGN DIRECTIVE AND ENERGY EFFICIENCY ACT

UBA recommends that the Ecodesign Directive and the Energy Labelling Directive should be further developed as instruments for implementing the "EU Top Runner Approach" to promote the spread of energy-efficient products even further. This includes challenging and dynamically enhanced efficiency standards for electric-powered and energy consumption-related products that are oriented towards the best available technology as a target value. Energy labelling must be clear and user-friendly and regularly adapted to technical progress. Manufacturers of such devices need the opportunity to highlight the advantage of their products. Effective enforcement must ensure that the requirements are implemented in practice [33].

For Germany, UBA recommends an ambitious and comprehensive "Energy Efficiency Act." This introduces a certified mandatory energy management system for big industrial companies step by step to remove the lack of information and specify efficiency potentials. For smaller businesses, regular energy audits may be suitable as an introduction to energy management. The new Energy Service Act is a first step in this direction.

THE AMENDED RENEWABLE ENERGY ACT

Renewable energy in the electricity sector in Germany is mainly promoted by the Renewable Energy Sources Act (EEG). The objective of the amended EEG 2012 is the continuous expansion of renewable energy to at least 80 percent of the total electricity supply by 2050 at the latest. Due to the investment protection for plant operators established by the EEG, the targets so far have always been exceeded. Many countries around the world have therefore taken up the funding principle.

Key items to be maintained over the long term are the priority scheme for the supply of electricity from renewable energy sources, the port obligation of the facilities and the obligation to take delivery of the electricity. The compensation for electricity fed in is based on the electricity production costs and will be paid for 20 years. Continuous adjustment of the feed-in tariffs to the cost development is as important as the market and system integration. In addition, the proper linkage of EEG with other climate protection instruments such as emissions trading is necessary. Emissions trading takes into account EEG's development targets from the emission limit specifying stage.

So far EEG has specified no incentives for the subsidised plant operators to provide a flexible response to electricity demand. Exit options limited in time and to parts of electricity from the fixed fees such as direct marketing with the market premium may support a demand-driven electricity supply. In the market premium system, the plant operator receives a comparable total remuneration as in the fixed fees system. These arise as the sum of revenues in the electricity market and the market premium. However, proper operation of the system allows (slightly) higher profits. Due to the price signals in the electricity market an incentive emerges to simultaneously adjust electricity production to the demand and thus contribute to the integration of renewable energies. Corresponding potentials are primarily available in adjustable systems such as biogas facilities.

ECO-POWER AND PROOF OF ORIGIN

In recent years the market proportion of eco power products has risen sharply. However, there is no standard definition for the term "eco power" and it is not legally protected. Since the market for eco power is expected to grow steadily in the coming years, transparent criteria in both the national and European context are particularly important.

Proofs of origin confirm the source of electricity from renewable energy sources if this is not sponsored via the EEG. They offer consumers a high reliability. They enhance transparency in the electricity market, increase the attractiveness of renewable energy sources and thus indirectly support their extension. The proofs of origin are managed by the proofs of origin registry which is currently being established by UBA pursuant to § 55 EEG. With the commissioning of the registry, an energy utility may only specify that the electricity is from renewable energy sources on the electricity bill in the context of the electricity labelling according to § 42 Energy Management Act, if it has proof of origin for the quantity delivered. Thus, electricity labelling is more reliable and multiple sale (through multiple designation of the quality of "renewable") is excluded to a large extent. Proofs of origin certify that a relevant amount of electricity has been produced in a facility that uses renewable energy sources and can thus provide essential foundations for quality assessment, which can use eco power labels for themselves.

AMBITIOUS STANDARDS FOR ENERGY-EFFICIENT BUILDINGS

The Federal Government aims at achieving almost carbon-neutral buildings by 2050. For this purpose it is necessary to double the energy refurbishment rate, reduce the primary energy demand by about

80 percent by 2050 and make renewable energy a significant energy source. For this, a challenging schedule for the entire housing stock must be identified which combines the regulatory elements with a long-term funding strategy.

The requirements of the Energy Conservation Act (EnEV) must gradually be further increased. The Federal Government is considering a tightening by 30 percent from 2013. UBA recommends that this tightening is indeed implemented. Thus an even higher standard for new buildings may be achieved in the following stage from 2016 which roughly corresponds to the passive house standard. These important interim steps should help implement the EU target for a nearly zero-energy standard for new buildings by the end of 2020. Refurbishments should be made using passive house components no later than 2018. Zero- or plus-energy buildings are also necessary over the long term for a climate-neutral building pool. The German Federal States must carry out the planned tightening of EnEV effectively to ensure that the requirements are implemented in practice.

UBA recommends that the KfW (Reconstruction Credit Institute) programme "Energy Efficient Refurbishment" be equipped with at least two billion euros per year up to 2020 and longer. Given the varying provision of state funds in recent years it may be useful in the future to promote building refurbishment independently of the budget. In addition, complementary economic incentives by tax allowances are considered effective. From the UBA's point of view individual measures are eligible only if they lead to a full energy refurbishment of the building over the medium term. Problems such as mould can only be avoided in this way.

BUILDING ENERGY REFURBISHMENT AND RENT REGULATION

In the future, the energy characteristics of a building should be seen as a value and rent increasing criterion and included in the usual local reference rent – with funding from the Federal Government also in the local ecological rent index [34]. This would ensure that landlords can better refinance their additional investment in the energy quality of a building and that tenants will not be unreasonably burdened. From UBA's perspective this would provide a major but currently lacking incentive. Another possibility would be a temporary exclusion of rent reduction during the constructional measure. Alternatively, a temporary surcharge on the net rental income in the amount of the savings in heating and energy costs may be considered. Tenancy regulation must create an equitable balance of interests between tenants and landlords in such a way that, for example, rent increases will be offset within a reasonable time by decreasing operating costs.

RENEWABLE ENERGIES HEAT ACT AND MARKET INCENTIVE PROGRAMME

The Renewable Energies Heat Act (EEWärmeG) is supposed to increase the proportion of renewables in final energy consumption for heating and cooling in Germany by 2020 to 14 percent. This percentage should be achieved by the expansion of renewable energy for heat supply in buildings. In new buildings a portion of the building supply with heat and cooling must come from renewable energy sources such as geothermal, solar thermal or biomass (mandatory use). However, alternative measures for the efficient use of energy are allowed.

For existing buildings – except for public buildings which are thoroughly renovated (role model) – no mandatory use of renewable energies but only financial support from the Market Incentive Program (MAP) is being provided for. The restriction of mandatory use to new buildings reduces the scope of the law considerably. UBA therefore advocates mandatory use even in the complete refurbishment of other existing buildings. Regardless of this however, renewable energy sources in combination with energy efficiency measures in buildings must be strongly encouraged.

In addition to the measures under the EEWärmeG, MAP promotes the development of renewable energy for heat supply in general by grants paid by the Federal Office of Economics and Export Control (BAFA). Moreover, large commercial installations of renewable energy are sponsored from the "Premium" KfW Renewable Energies Programme. A total of over 350 million euros were available in 2011. The target of the Federal Government to increase the proportion of renewable energies in heat supply from 10 percent today to 14 percent by 2020 requires the continuous development of MAP.

THE COMBINED HEAT AND POWER ACT

The Federal Government wants to double the proportion of combined heat and power (CHP) of German electricity generation to 25 percent by 2020. This should provide an important contribution to reducing energy consumption and greenhouse gas emissions. This goal should be achieved mainly by the Combined Heat and Power Act (KWKG). It promotes the construction and modernisation of high-efficiency CHP plants of any size: a surcharge is paid for the electricity generated staggered by the size and age of the plant.

In the course of the energy system transformation decisions the Federal Government has also amended the KWKG in two important respects in 2011. First, the time limit was postponed by four years to the end of 2020 by that time a facility must be put into use for obtaining funding. Secondly, the additional limitation of funding to four or six years for systems with more than 50 kW of installed capacity was abolished. Now only the limitation to 30,000 full load hours applies, which primarily benefits facilities with low annual operating hours. The KWKG amendment introduced in December 2011 targets further improvements in the funding. So the remuneration for facilities falling under emissions trading shall be increased, and the requirements for eligibility to plant modernisation will be significantly reduced. Other planned changes include: introduction of funding for heat and cold storage, cooling networks as well as CHP retrofitting of condensing facilities and heating plants respectively, improved funding conditions for small-diameter heating and cooling networks and simplified procedures for heat networks and small-scale CHP facilities.

INVOLVING TRAFFIC MORE STRONGLY IN ENVIRONMENTAL COSTS

The true cost of transport is of crucial importance [7]. To involve car traffic more directly in the environmental costs it has caused, UBA believes the increase of the European energy tax on fuels to be reasonable. If this cannot be harmonised at the European level, a mileage-dependent toll for cars should be introduced [35]. In freight transport, a lorry toll should be increased by the environmental costs and extended to all roads. In freight traffic by road and rail, noise emission in particular should be charged to the user. In air transport, the introduction of a kerosene tax and VAT for international flights would lead to equality with other modes of transport. In the shipping industry, an emissions trading system should be established.

Binding CO_2 targets for new registrations of motorised vehicles are an essential tool to increase energy efficiency in road transport. At an EU level, binding targets have been set: 130 g CO_2/km for cars and 175 g CO_2/km for light utility vehicles. These values apply to cars from 2012 and to light utility vehicles starting in 2014, a gradual phasing will make it possible to achieve the values. In addition, targets have been set for 2020, about 95 g CO_2/km for cars and 147 g CO_2/km for light utility vehicles. The values are valid for the average new car fleet in the EU. They are broken down into appropriate target values for the individual manufacturer fleets. Furthermore, UBA also recommends similar measures for trucks which lead to a significant reduction in specific CO_2 emissions.

ENERGY TAXES AND ENVIRONMENTALLY HARMFUL SUBSIDIES

The resulting environmental impacts from energy consumption lead to high social follow-up costs. Therefore, the polluter should bear the external costs via energy taxation. This creates an economic incentive to reduce energy consumption, thus the associated external costs are also reduced. In addition, the state should adjust tax rates periodically to reflect inflation because otherwise they decrease in real terms over the years. Depending on the use of different energy sources, there are also large differences in the tax burden on CO_2 emissions.

For an efficient climate policy a stronger alignment of tax rates to CO_2 emissions is necessary. It would also be sensible to strengthen the linkage between energy taxation and financing of development programs for climate protection. For example, a combination of increased taxation of harmful energies and an effective conversion program for inefficient heating systems may create incentives to convert to fuel-efficient and climate friendly heating systems.

However, Germany is still far from a flawless sustainable fiscal policy which would promote environmental protection and take into account relevant environmental issues systematically in all state revenue and spending decisions. A central problem here is the subsidy policy. According to the calculations of the Federal Environment Agency, grants totalling some 48 billion euros can be classified as harmful to the environment in Germany in 2008 [36] of which 17.7 billion can be attributed to the energy supply and use. Subsidies that sponsor unsustainable energy supply and use should be abolished. This includes energy tax relief for companies in the manufacturing sector, tax cap in the eco-tax for the manufacturing sector and energy tax relief for certain energy-intensive processes and methods, unless they are essential to compensate for international competition distortion.

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CONTRIBUTING SECTIONS:

I 1.3 "Environmental Law"
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I 2.2 "Energy Strategies and Scenarios"
I 2.3 "Renewable Energies"
I 2.4 "Energy Efficiency"
I 2.5 "Energy Supply and Energy Data"
I 3.1 "Environment and Transport"

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Resource-efficient economies

RESOURCE EFFICIENCY

a key skill for sustainable societies

Worldwide consumption of scarce natural resources and the competition for them is rapidly increasing. This trend exacerbates global environmental problems like climate change, soil degradation or the loss of biodiversity. An efficient, prudent and rational utilisation of natural resources is one of the greatest economic, social and environmental challenges of our time.

Natural resources are the material, energetic and physical basis of life. Our prosperity is based not only on minerals, fossil fuels or biomass. As natural resources, biodiversity, the environmental media of water, soil and air, flow resources (wind, geothermal, solar, tidal energy) and surface area are also important factors for our economies. They serve to satisfy our needs, as energy sources, habitat, sinks (see box on page 37) for our emissions, recreational space, pools of active pharmaceutical ingredients and much more. Annually, we extract, process, and reap 60 billion tonnes of raw materials worldwide from our environment [1]. Ultimately, all forms of resource utilisation across the entire value chain – extraction and processing of raw materials or use of the resulting products – impact other natural resources. Pollutants in soil, water and air and surface sealing exert pressures on the environment. They negatively affect the sustainability of ecosystem services, natural biocoenoses and human health. Natural resources are limited and are often not available in high quality. The global population and economic growth increases the pressure on natural resources and may cause competition for use.

Resource conservation examines materials management extended over product lifecycles and looks for ways to reduce resource utilisation and associated environmental impacts.

Already today, and not only in terms of resource utilisation, non-sustainable forms of growth and development in industrialised countries have put the world on a collision course with fundamental planetary boundaries, especially at the expense of the developing countries. If the production and consumption patterns of the industrialised world were to be adopted by nine billion (bn) people in the future, planetary boundaries would be far exceeded, with catastrophic consequences. The problems are escalating, and because the global consumption of resources continues to rise almost unabated, there is a growing need to solve them. This involves the following:

- Reducing environmental problems caused by the excessive consumption of resources and which overly burden water, soil and air sinks.
- Avoiding social problems associated with resource processing and utilisation.
- Avoiding or limiting resource depletion, because access and distribution of resources can also trigger or cause resource conflicts.
- Reducing dependency on imports and their associated economic and political consequences.
- Minimising negative economic and social effects that result from global price increases and fluctuations in commodity prices.
- Reducing waste and increasing recycling.
- More equitable distribution both between the regions of the world and between generations.

Increasingly, the question is discussed to what extent wealth can be secured through less, structurally altered, or without growth, and thus with less negative environmental impact [2]. Some limitations of material growth have already been exceeded today - particularly in regard to the capacity of environmental media to absorb contaminants, but also for some raw materials such as conventional oil [3], [4]. In economic terms, natural capital is scarce. In relation to global economic growth and the rising demand of the world population, it will undoubtedly become even more scarce.

RAW MATERIALS RESERVE
We extract 60 billion tonnes every year

THE WORLD RE-SURVEYED: THE LIFE CYCLE IS WHAT MATTERS

Resource conservation follows the model of an economy embedded in natural material cycles with minimal resource consumption, the development of which does not take place at the expense of other regions. The Federal Environment Agency (UBA) has the central goal of reducing total raw material consumption and the associated environmental impact, thus safeguarding prosperity and opportunities for development.

According to the concept of ecological footprint, worldwide we are already utilising the performance capacity of 1.3 earths. On the one hand, we use the earth to satisfy our demand for biomass materials such as food, natural fibres and wood, and, on the other hand, to assimilate our greenhouse gas emissions. The tracks we leave behind are beyond the limits of a sustainable development path [5].

SINKS:

The endpoint of material flows. In the context of natural resources, sinks describe nature's function of absorbing, for example, pollutants.

REBOUND EFFECT:

An effect, which describes savings achieved by efficiency gains do not lead to an equally lower use of resources, since these savings again increase usage. We can differentiate between direct (increased usage within the same application) and indirect (increased usage in other applications) rebound effects.

DECOUPLING:

Neutralisation or reduction of a quantitative relationship between causally connected developments. It is often used in the context of comparing the lesser rate of increase in natural resource usage vis-à-vis economic growth. This describes relative decoupling. Absolute decoupling would mean that the use of resources in increasing economic growth does not increase, or even decreases.

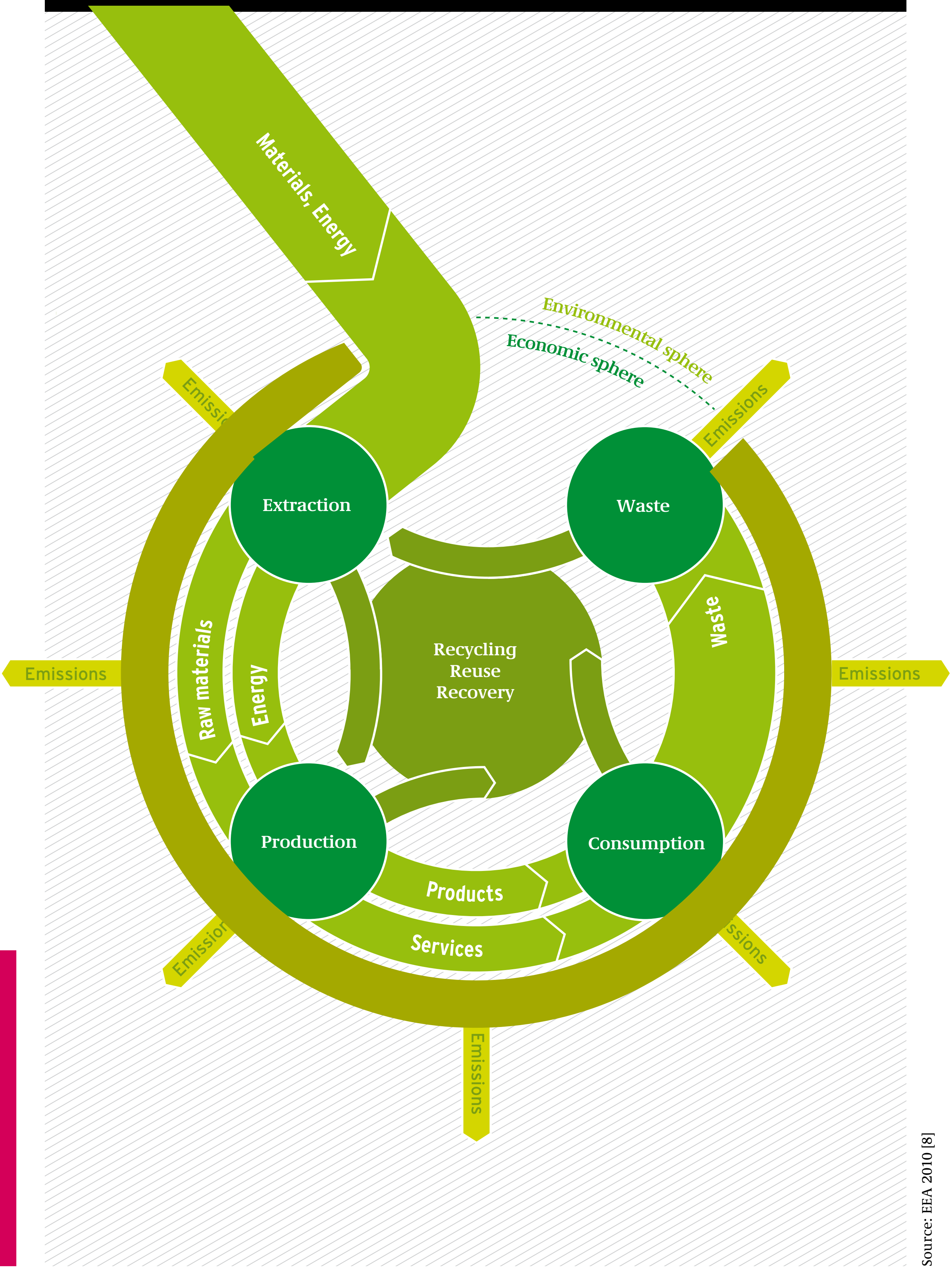
Source: Federal Environment Agency: Glossary of Resource Protection

The "Thematic Strategy on the sustainable use of natural resources" of the EU Commission demands that economic growth is decoupled from resource extraction from the environment [6]. In addition, raw material consumption is to be decoupled from the associated negative environmental impacts, in order to actually reduce the pressure on protected natural assets to tolerable levels (see box). Herein it is important that there be an absolute reduction of resource consumption and associated negative environmental impacts, independent of economic growth. Otherwise the danger is that resource productivity – the ratio of yield and required resources – is increased, while environmental pressure, because of increased raw materials extraction and the associated environmental effects, increases in absolute terms. In addition, it is important to avoid so-called "rebound effects" (see box). These occur, for instance, when technical efficiency gains of products are offset or overcompensated by a rise in consumption in the same or in other segments – such as in consumer electronics, where more efficient and less expensive devices are in use, but, increasingly, a larger number of them appear in homes. Similarly, it might happen that savings in fuel cost from an efficient car are used to make additional trips.

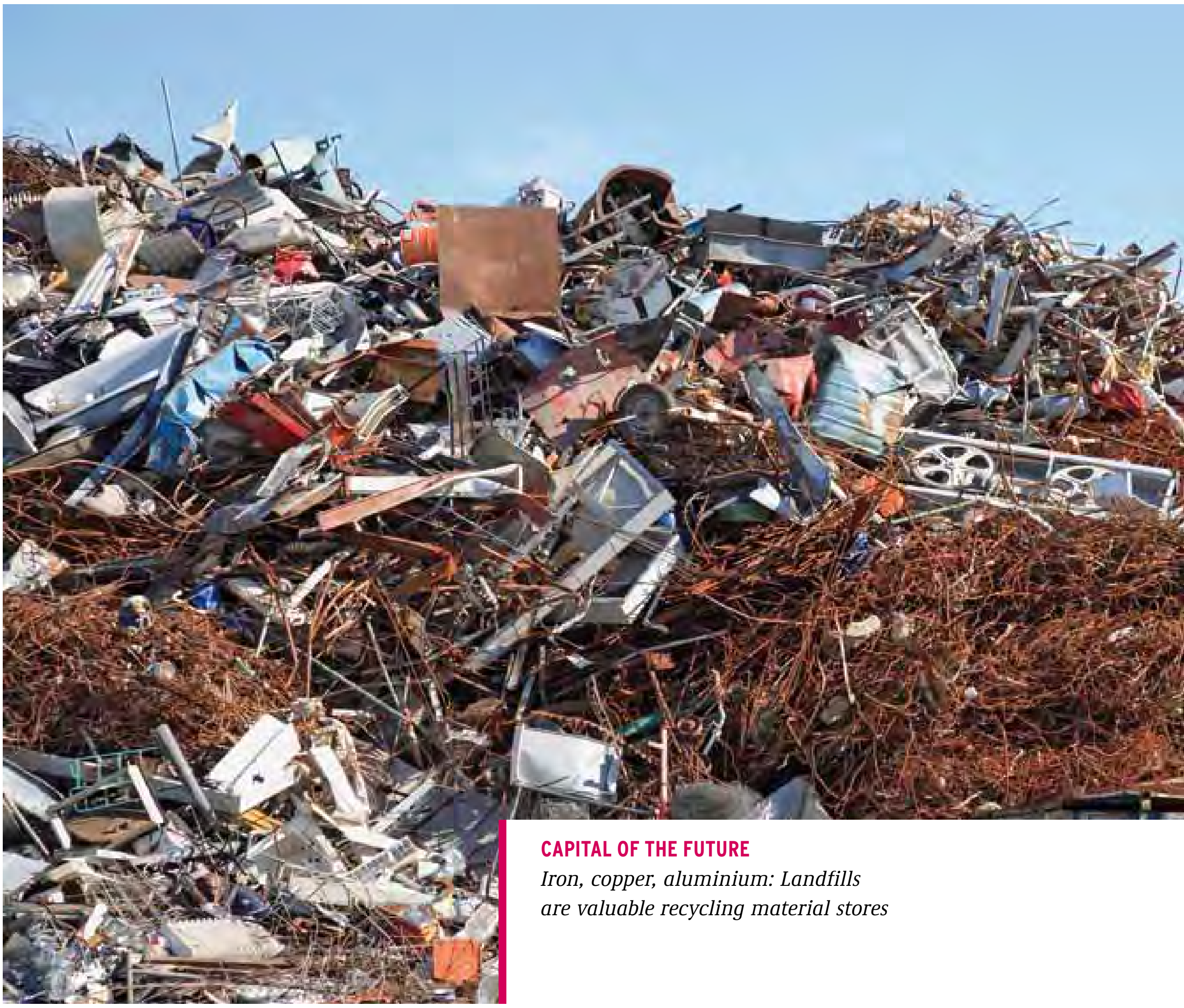
Increasing resource efficiency is therefore a necessary but not a sufficient goal of a resource-efficient economy. In the eyes of UBA, such an economy must look for a favourable combination of efficiency (ratio of yield to required resources), consistency (embedding economic activity in natural cycles) and sufficiency (moderation in consumption). Even if we transform the economy in terms favourable to environmental protection, resources are needed. Green technologies of the future will for instance need more and more speciality metals such as gallium, tantalum, and neodymium. However, there are limits for this, as they are often only coupled or by-products in the production of other raw materials. Particularly problematic is the fact that many of these "strategic" metals are not sufficiently recycled at the end of the product life cycle [7].

Resource conservation can only be designed holistically from a "life-cycle perspective". It extends from raw material extraction, processing, production, distribution and consumption to the disposal phase. Along this value chain, and for different products and different raw materials, various types of raw materials- and energy flows, as well as different land consumption and pollutant emissions emerge. If, for example, material consumption is reduced in a production process by using an alternative material, this does not automatically mean that overall environmental effects beyond the production process are reduced. Classically, product life cycles are examined linearly. But resource conservation is based more on biogeochemical cycles, as they typically take place in nature. These cycles are intertwined, so that they can be understood as a cyclical process. The extraction of raw materials at the beginning of the cycle is directly related to the natural environment. The disposal phase, however, is the end of the original function, but not the end of a product itself or its material (see figure). Although it is also linked to the environment by waste and emissions, it also represents a connecting element to production and consumption. The type of reuse and recycling of products within cycles – this also includes the usage rates of recycled materials in production – significantly affect overall raw material flows and environmental impacts.

Life cycles from materials flow aspect – Resource saving is based on materials cycles



Source: EEA 2010 [8]



CAPITAL OF THE FUTURE
Iron, copper, aluminium: Landfills are valuable recycling material stores

URBAN MINING: SALVAGING DORMANT RAW MATERIAL TREASURES

The materials stock in Germany is growing by around 0.6 billion tonnes annually [9]. About 100 Cheops pyramids could be constructed from this. This means that the inflow from imports and domestically produced raw materials exceeds the outflow via exports and emissions by a multiple. Despite its lack of raw materials, Germany (like many other industrialised countries) has thus accumulated an enormous fortune in the form of a so-called "anthropogenic stock." It is not only found in buildings, infrastructure, transportation and other durable goods, but also in landfills. These anthropogenic stocks are valuable recycling material reservoirs. Their total content of recyclable materials such as iron / steel, copper, aluminium, zinc and many precious metals is in the order of annual worldwide extraction, and in some cases significantly exceeds the available national geological reserves. The anthropogenic stock is capital for the future that we must manage systematically. The use of these man-made raw materials stores ("Urban Mining") is an essential strategy for a resource conserving, sustainable Germany.

Countries poor in raw materials like Germany are dependent on the import of many goods. From 2000 to 2008, imports rose by 16 percent. This increased the share of highly processed manufactured goods by 40 percent [9]. These goods are sometimes associated with complex production processes, the resource consumption of which entail environmental protection related and social consequences, for which we bear a special responsibility. From UBA's perspective, resource conservation can only succeed if this global responsibility is fulfilled by the countries whose production and consumption patterns are driving forces for raw material production and processing. The systematic shift of negative environmental effects abroad (burden shifting) must be prevented.

At the international level, resource conservation as a responsibility for preventive policy has hitherto been weak. To achieve this, producer and consumer countries should institute a broad policy dialogue on measures for resource conservation. To address resource conflicts, raw materials foreign policy should be extended to include risk-reducing measures (such as greater transparency of the material and financial flows in supplier countries, certification of supply and retail chains) for producer and transit countries.

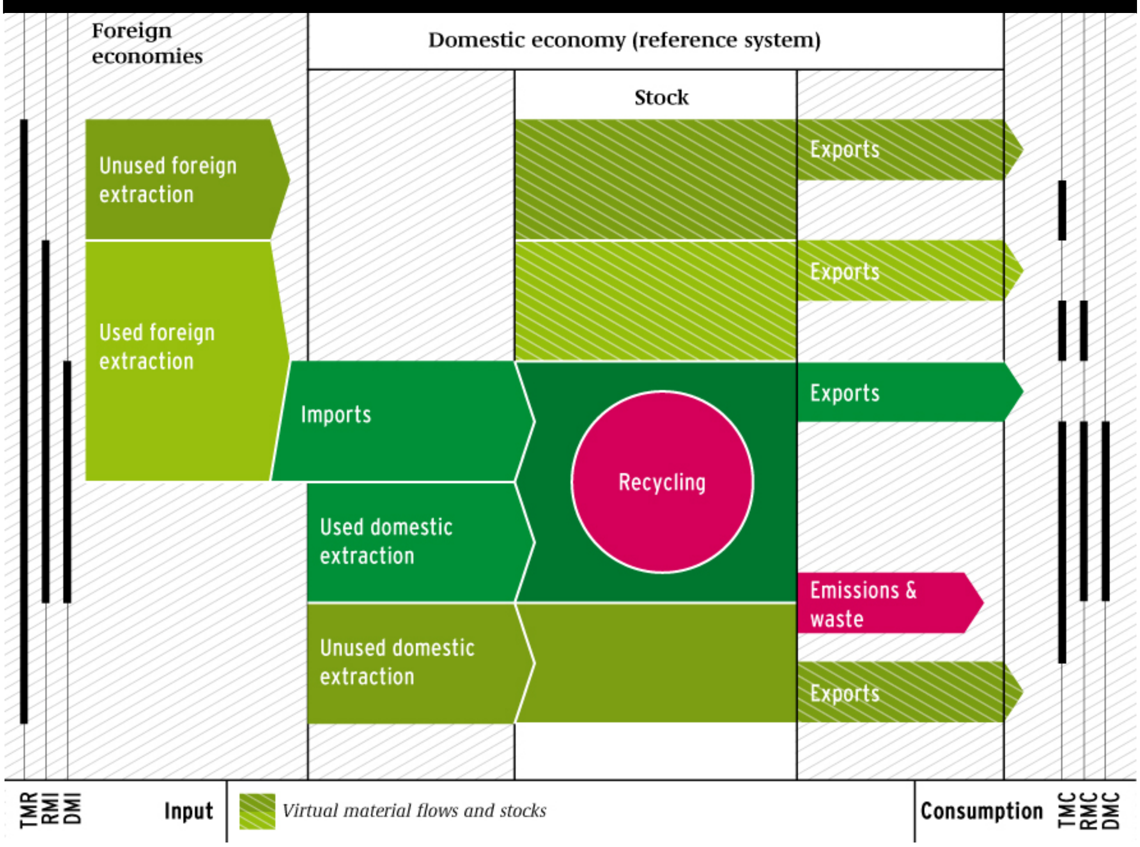
INDICATORS: MAKING RESOURCE CONSUMPTION MEASURABLE

Indicators play a central role in active resource policy. They collect, describe and evaluate complex issues, such as environmental effects from the use of raw materials. The indicators used must make the key factors of influence identifiable, the international integration of economies visible, and be able to show substitution and displacement effects. Along value chains, they must also be compatible on the enterprise and overall economic level – meaning that they must be addable. In order to enable international bodies and institutions to work with comparable and compatible indicators, harmonised data structures in official statistics at the European and international level are necessary. This means that, in principle, all natural resources within a system of indicators need to be included .These include abiotic (such as metals and industrial minerals) and biotic (animal and vegetable) raw materials, energy resources, water as a raw material, land and soil, biodiversity and environmental media and ecosystems as sinks.

However, the current scientific debate shows aspects of the established indicators which are currently not, or only insufficiently described. In particular, there are knowledge gaps regarding the relationships between emissions and land use changes and their effects on the condition of environmental media, ecosystems and biodiversity. Major methodological progress was made in transnational accounting of material flows (see Figure). Therefore, at present, the emphasis is on materials-related indicators, while indicators for the other areas mentioned must still be (further) developed.

In addition to energy productivity, raw material productivity, which relates exclusively to abiotic materials, serves as an indicator for measuring resource conservation in Germany‘s sustainable development strategy. The goal of the Federal Government is to double its raw material productivity by 2020 compared to 1994. Raw material productivity relates gross domestic product (GDP) to direct abiotic material input (direct material input, DMI). It is thus analogous to the labour and capital productivity, and serves as a measure for the efficiency of raw materials as a production factor. The DMI in the denominator of the indicator is measured in units of weight and contains both the domestic extraction of materials as well as imports of raw materials, semi-finished and finished products with their own weight. This indicator allows for showing trends regarding the efficiency of raw materials use in our economy over a long time series. Since 1994, raw material productivity in Germany has increased by 47 percent [10].

Material flow indicator chart



Source: Federal Environment Agency 2012: Glossary of Resource Protection

INCLUDING THE RAW MATERIAL EQUIVALENTS OF IMPORTS

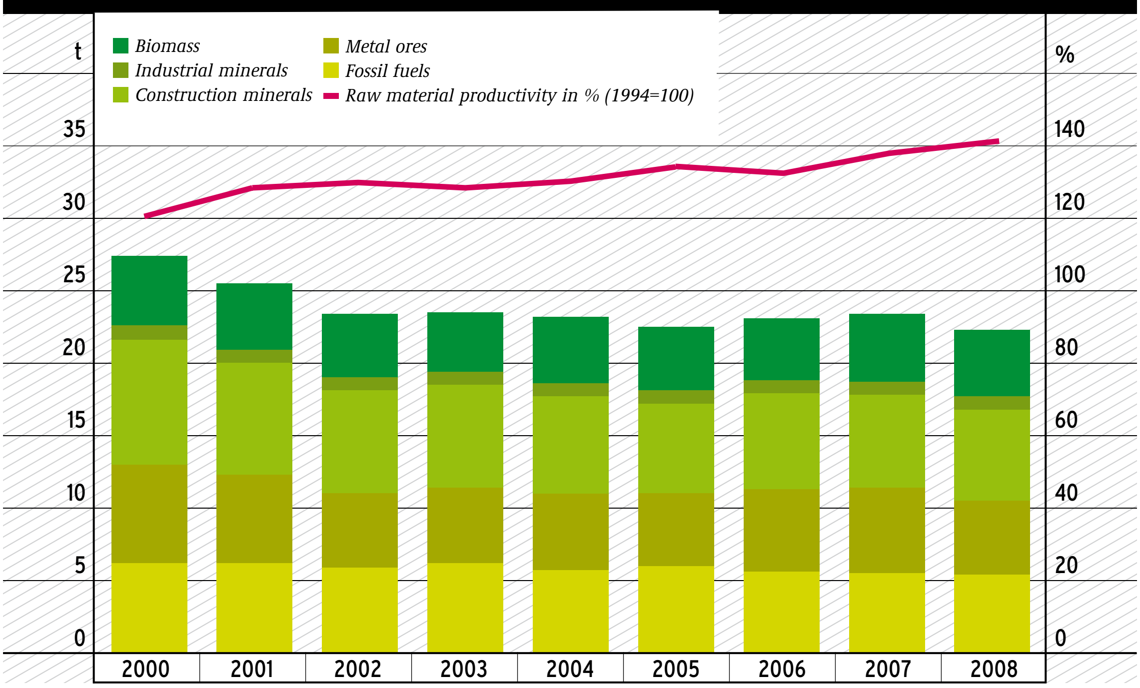
Examining raw materials productivity alone can lead to critical misinterpretations, because the imports in the indicator represent only a portion of the raw materials used. An apparent reduction in raw material consumption and thus an increase in raw material productivity may result because raw material intensive processes are move abroad, so that domestic production and import of raw materials are reduced. Instead, more intensively processed semi-finished and finished goods are imported. Such structural transfer effects, which arise from increasing international division of labour, can be represented by converting imports to raw material equivalents (RME). In this process all goods are represented with their indirect, economically used raw material flows needed for their production, but which are not themselves part of the goods. For example, the import of one kilogram of zinc products is associated with 14 kg of actual raw material input. One kilogram of silver even requires 5.8 tonnes [11].

The above cumulative raw material demand figures include all primary utilisation of minerals and energy sources for refining. If the cumulative raw material demand is used as a basis for imports, then the weight of the imports increases by a factor of four. In 2005 this meant a profuse doubling of the DMI from 1.3 billion tonnes to 2.8 billion tonnes in the RMI (raw material input). Within the past ten years the RMI has grown by three percent, in contrast to the DMI decline. Therefore the development of raw material productivity in real terms is lower than denoted by the indicator of the sustainability strategy.

The use of productivity measures alone does not allow for direct conclusions about the absolute performance of the raw material consumption. But it is important for assessing the sustainability of resource policy. Because of its link to GDP, the raw material productivity indicator primarily represents raw material consumption from an economic perspective. For raw material based national comparisons, consumption indicators adjusted for exports are commonly used. Domestic material consumption (DMC) is a rough guide for this purpose. On average, when a European consumes 17 tonnes of raw materials annually, this is three to four times that of a resident in a less developed country.

However, in order to represent absolute consumption of raw materials across national boundaries without overlap, and in consideration of international patterns of production, domestic raw material consumption (RMC) can be used as an indicator. This consumption indicator simultaneously takes imports and exports in raw material equivalents into account. All materials necessary for the production of the imports and exports are accounted for. By this method, raw material extraction in the production countries is accounted for in the importing countries – as it is just in terms of the polluter pays principle. The RMC for Germany is currently around 22 tonnes per year per head (see illustration). Initial comparisons of selected countries on this basis are currently under development.

Domestic raw material consumption per capita and raw material productivity



Source: Federal Statistical Office 2011 [12]
(the calculation also included secondary raw materials)

OVERBURDEN
The extraction of raw materials and primary energy produces large amounts of waste

REPRESENTING MATERIALS EXTRACTION COMPREHENSIVELY AND TAKING CASCADING USE INTO ACCOUNT

In the process of extracting raw materials and their transformation in economic processes, large quantities of overburden, tailings and excavated soils arise which are not directly used in production processes. The amount of "unused extractions" is primarily determined by surface mining activities, the type of deposit and the efficiency of mining. At the same time, this also causes significant environmental impacts. They affect geological formations and natural habitats, change areas in the long term, sometimes irreversibly, and affect the water balance. As long as the environmental effects of used and unused extractions are not recorded separately, observing them both can help assess the overall potential environmental impact from raw material extraction. For this purpose the total material requirement (TMR) is the indicator. After exports are subtracted, the result is the total material consumption (TMC).

Efficient, high quality cascading management of raw materials in goods by reusing, recycling, and, at the end of the product life cycle, energetic recovery makes a significant contribution to resource conservation. Cascade use increases the productivity of raw materials and is therefore an essential starting point for the sustainable management of natural resources. The use of secondary raw materials and fuels replaces virgin raw materials and the associated resource utilisation domestically and abroad. In 2007 in Germany, copper recycling alone saved 118 Million tonnes of global raw material flows - the mass of 90 million medium-sized cars. 94 percent of these raw material flows and their environmental impact would have taken place abroad [13].

To describe the level of closed material and product cycles in the German economy, recycling indicators along the value chain are needed. In addition to waste management collection and recycling rates, figures for actual use rates of recycled materials in production processes are needed. In order to show the overall economic consequences, another step is necessary. Putting the volume of secondary raw materials in adequate proportion to the total demand for raw materials, allows for capturing the progress of a sustainable circular economy.

BASING PRODUCTION ON RESOURCE EFFICIENCY

The shift towards a resource conserving economy can be achieved through economic modernisation and technological innovation. In that context, the development of more energy efficient production processes and energy-saving devices is merely a first step. The next important step towards resource efficiency for companies is the need to increase materials efficiency throughout the product life cycle by developing products which are less material intensive. But in order for this strategy to actually lead to a sustainable use of our natural resources, engineers, designers, purchasing managers and managers must rethink their ways: Only a global life cycle perspective can yield correct choices for a modern, sustainable, resource efficient economy. A resource-conscious corporate culture starts in vocational training, continues in employee training and can be supported by external consultants. The integration of these aspects in environmental and quality management systems helps to anchor the process of change within business. Most important, however, are motivated employees. You need to be convinced that resource efficiency is the right strategy for sustained successful businesses.

ECODESIGN: RESOURCE EFFICIENCY AS A MARK OF PRODUCT QUALITY

Ecodesign is a systematic and comprehensive approach for reducing the environmental impact of products and technical systems throughout their life cycle. It complements the traditional requirements for product development (such as functionality, safety, ergonomics, aesthetics, or the price-performance ratio) in terms of requirements in the areas of environmental compatibility and resource conservation. Decisions made in the early planning and design phases of a product considerably determine not only cost, but also its environmental impact and resource consumption associated with its production, use and disposal. Even at that stage, the people involved in the development process influence every stage of its value chain and material life cycle, and can promote targeted eco-innovations.

In the meantime, a number of quantitative and qualitative evaluation criteria and supporting tools have been made available for a more environmentally friendly and resource conserving design of products, such as: checklists, manuals and – LCA-based – software solutions from simple screening tools to simplified or comprehensive life cycle assessments. Specific instructions on how to involve resource and environmental aspects in planning and development of products now also offer standards and guidelines from international, European and German standards organisations. The following product design approaches contribute particularly well to protecting natural resources:

- High quality, use of recycled materials in, for example, paper, glass and metals material flows, but also the use of recycled plastics in packaging and, increasingly, in high-quality and complex electronic products such as computers.
- Design of more material efficient products, taking into account the impact of the supply chain: for example, substitution or reduction of the use of precious metals, the extraction of which causes severe environmental impacts; less packaging quantities.

- Reducing resource consumption in the utilisation phase by more energy-efficient televisions, computers, etc.; washing machines with low water consumption, or printers which feature double-sided printing.
- Use of renewable raw materials, taking into account their availability, their rates of regeneration, possible competition for land use and environmental impact associated with their cultivation in comparison to the use of non-renewable raw materials (such as insulating materials made from renewable raw materials).

- Making products more rugged and durable and optimising their use (durability, ease of repair, customisation, feature enhancement and multi-functionality) for example, upgradeability of computers, replaceability of the monitor on notebooks, standardisation of power supplies and batteries.
- Making reprocessing possible (e. g. toner cartridges), secondary use of devices after reprocessing by the manufacturer (such as multi-function devices) or by third parties (such as the ReUse Computer Association).
- Designing for recycling: for example, suitability for dismantling, limiting the diversity of materials and separability, providing product information for recyclers (recycling passport).
- Products with the "Blue Angel" environmental label in the "resource protection" cluster for example, meet these requirements (see page 51).

In the Ecodesign Directive, the European Commission for the first time laid down the eco-design requirements in a framework directive. The measures adopted so far relate primarily to the energy efficiency of products. In principle, it is possible to extend this to aspects of resource efficiency. The issue of energy was taken up first because for the previously examined products, the energy efficiency in the utilisation phase plays the most significant role regarding the environmental effects they cause. However for adequately addressing resource aspects, there are still weaknesses in the methodology used. The Federal Environment Ministry and Federal Environment Agency therefore promote further development of the methodological fundamentals and, in particular, suitable indicators.

USING INNOVATIVE PRODUCTION TECHNIQUES TO FULLY REALISE EFFICIENCY POTENTIAL

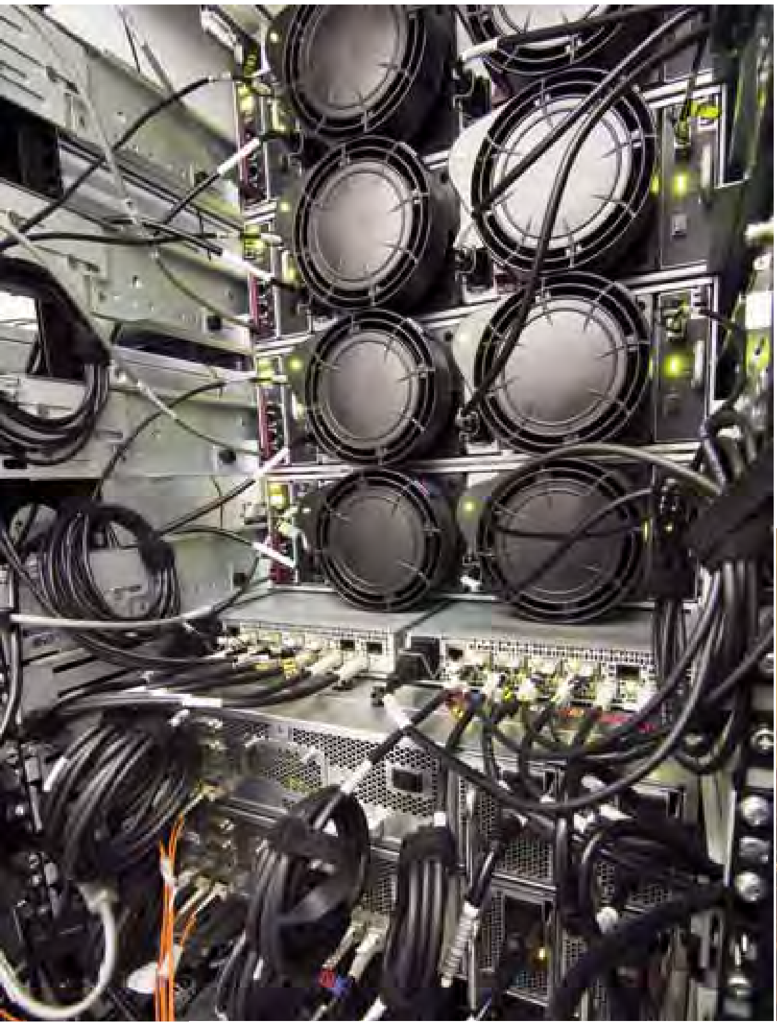
In recent years, many companies have made great efforts to increase the resource efficiency of their production processes by using both energy and materials more efficiently. Rising energy and raw material prices have driven this trend significantly. To realise the potential for further increases in energy and material efficiency, existing processes must be further optimised and new techniques and processes introduced and implemented. Currently, economic and technical risks still hinder and slow this down: they are obstacles for realising efficiency potentials.

In order to further increase energy and material efficiency, the companies concerned - also industry wide - must develop solutions and take advantage of synergistic effects more efficiently. For example, one industry can use waste materials from another industry as raw materials, such as ground granulated blast-furnace slag from iron production in the manufacture of cement. Even joint heating and cooling networks need not be limited to industrial parks, but can also include neighbouring residential areas and businesses. The federal government aims to cover at least 80 percent of gross electricity consumption from renewable energy sources by no later than 2050. This also includes industry – especially energy intensive industries. For this purpose, completely new technical solutions are required in future. The renewable energy sources must be directly usable for the production process which would have the following advantages: reduction of transmission and conversion losses, the decentralised production of electricity, proximity to the actual consumers and the resulting net benefits.

For the purpose of harmonising environmental standards in industrial production at a European level, and in the context of the European Industrial Emissions Directive, the best available techniques (BAT) established for individual industries are specified in the so-called BREFs. They are for example used as a basis for the assessment in the permitting process of industrial installations (see page 70). For these, the Federal Environment Agency authors the German contributions and attends to the entire process. This work focuses not only on emissions into air and water, but also on increasing the material and energy efficiency. Some BREFs already describe measures to improve energy efficiency and specify them as best available techniques. In this context one must also point out the efficient use and management of resources as a specific and EU-wide binding requirement (BAT conclusion). At the national level, efforts are under way to more closely integrate this aspect into permitting processes. Also currently under way are efforts to supplement the basic waste prevention and energy efficiency obligations for operators according to the Federal Emissions Protection Law, by a requirement for the efficient use of raw materials.

Together with the Federal Environment Ministry and the Kreditanstalt für Wiederaufbau (Reconstruction Credit Institute), UBA supports the implementation of energy- and material-efficient technologies into large-scale applications of the Environmental Innovation Programme. For example, it has been shown that the use of flame-free gas porous burners in ladle heating plants in the foundry industry can halve energy requirements compared to conventional burners and increase product quality. In addition, it is important to replace material-intensive manufacturing processes with more resource efficient alternatives. For example, in the manufacture of titanium components, investment castings performed with the lost wax process can significantly lower both material and the energy requirements compared to cutting and milling processes.

At trade fairs, congresses and committees of industry associations, UBA regularly provides advice on these new techniques, methods, and opportunities for supporting investment projects. It also contributes to the European information exchange on best available techniques under the Industri-



BONANZA
In German data centres alone, by 2008, 1.8 tonnes of gold were used

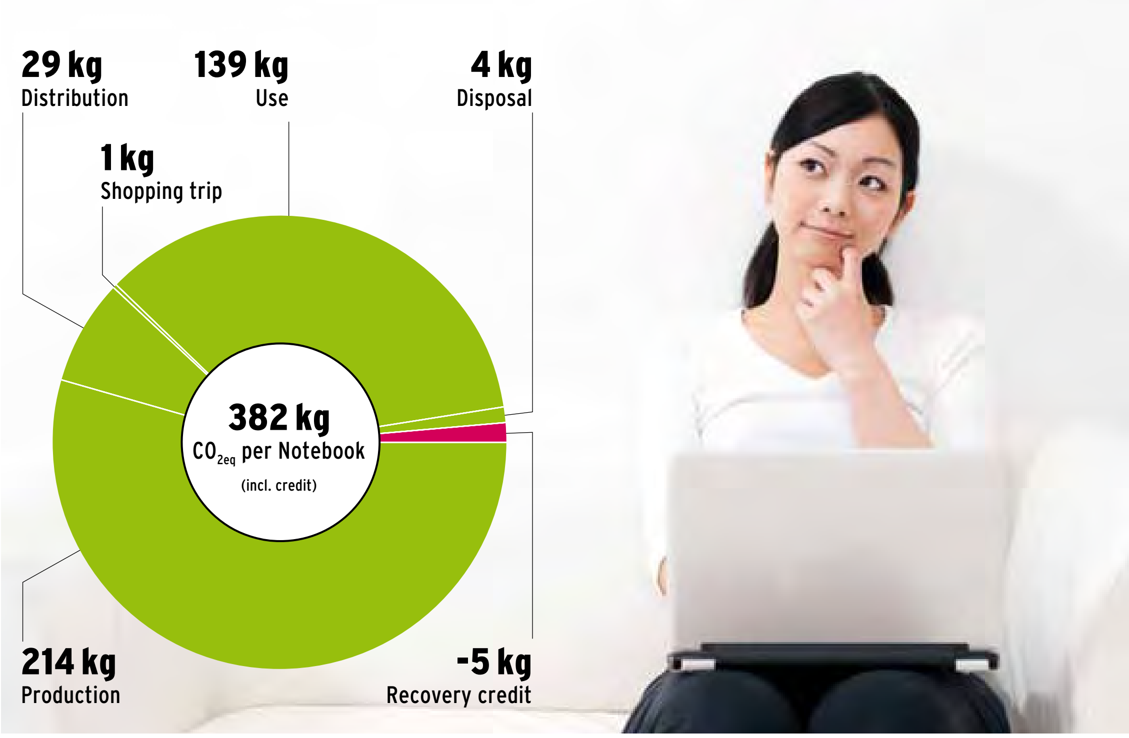
al Emissions Directive, and thus promotes the EU and worldwide propagation of resource conserving production processes. To improve material and energy efficiency, the businesses concerned must actively participate. They can, for example, contribute to achieving this goal by participating in the Environmental Innovation Programme, which helps alleviate business risk with financial support.

SUSTAINABLE INFORMATION AND COMMUNICATIONS TECHNOLOGY

Information and communication technology (ICT) equipment, as well as consumer electronics such as laptops and netbooks, televisions, multimedia or tablet PCs, mobile phones and video game consoles are becoming increasingly common in homes, briefcases and school bags as well as in offices and businesses. In addition, there are also data centres and infrastructure to connect them with each other or to the Internet. Although some devices are becoming more energy efficient, the total energy consumption associated with their use is increasing. On average, the power consumption of ICT in 2007 was over 55 terawatt hours (TWh), or 10.5 percent of total electricity consumption in Germany [14]. Computers and related devices impact the environment not only by their use. Their production also consumes resources such as water, energy, precious metals and rare earth metals. In German data centres alone, by 2008, 1.8 tonnes of gold were embedded in the electronics – at a value of around 43 million euros [15].

In the future, the consumption of energy, metals and other raw materials in the manufacture of ICT will need to be recognised much more strongly. Many raw materials are scarce and expensive and their production pollutes the environment. This is not just about climate protection. Discarded computers, mobile phones and other devices are collected separately and, especially metal and plastic containing components, are fed into high quality recycling. By optimising collection and separation systems, the recovery of precious and special metals should also be increased.

Greenhouse gas emissions over the lifecycle of a notebook



Source: Own illustration using data from IZM and the Eco-Institute 2011 [16]

The production of ICT products not only consumes resources, it also impacts the climate. The production of a notebook computer produces emissions of around 214 kilograms of carbon dioxide equivalents ($CO_{2(eq)}$) – more than half the greenhouse gas emissions of its entire life cycle [16]. Even if a new device is more energy efficient than an older one, the expenditure of its production is so large that savings during its use do not offset them, assuming realistic time periods. Above and beyond quality recycling, the lifetime of the devices is an important aspect. Anyone who uses a device longer consumes no resources for a new device, thereby avoiding further energy consumption and emissions from the manufacturing process. This reduces the proportional environmental impact of production.

The manufacturers also need to participate. Whether a device is durable and can be easily repaired is to a significant degree determined by its product design. Some producers of ICT products take used devices back to disassemble and repair them so that they can be reused in whole or in part. What is no longer usable goes to high quality recycling. For notebook computers and other ICT devices with the "Blue Angel" label (see box page 51), the manufacturer has to provide spare parts for at least five years. This measure also extends the life span. In this area, further standardisation of components, interfaces and accessories can help. A first step was made in 2011 with the uniform charging plug for smartphones. Other components such as chargers, batteries and screens for laptops and other mobile devices need to follow.

But ICT also offers opportunities. Smart use of ICT systems contributes to reduced energy consumption and sparing the use of raw materials. The Federal Environment Ministry and UBA support first-mover deployment of innovative, resource-saving and energy-efficient ICT with the "Green IT" focus programme of the Environmental Innovation Programme. Information about this is available from the Green IT Advisory Office at the Federal Association for Information Technology, Telecommunications and New Media, which is supported by the BMU and UBA.

EFFICIENCY IN THE CONSTRUCTION SECTOR

The construction sector in Germany is one of the most resource-intensive economic sectors. In existing civil engineering projects alone, around 60 billion tonnes of building materials are stored in Germany. Each year more than 500 million tonnes of construction minerals are added. In addition, about 35 million tonnes of cement produced in Germany and 5.5 million tonnes of reinforcing and structural steel are used, the production of which consumes considerable resources. In construction, demolition or deconstruction at the end of the building and infrastructure life cycle, 200 million tonnes of construction and demolition waste are produced annually – they contain many potentially recyclable materials. Additionally, the energy consumption directly associated with construction and housing constitutes about 30 percent of the total German consumption, with the associated impact on the global climate. Last, but not least, land use is still increasing considerably, regardless of the associated environmental protection-related problems.

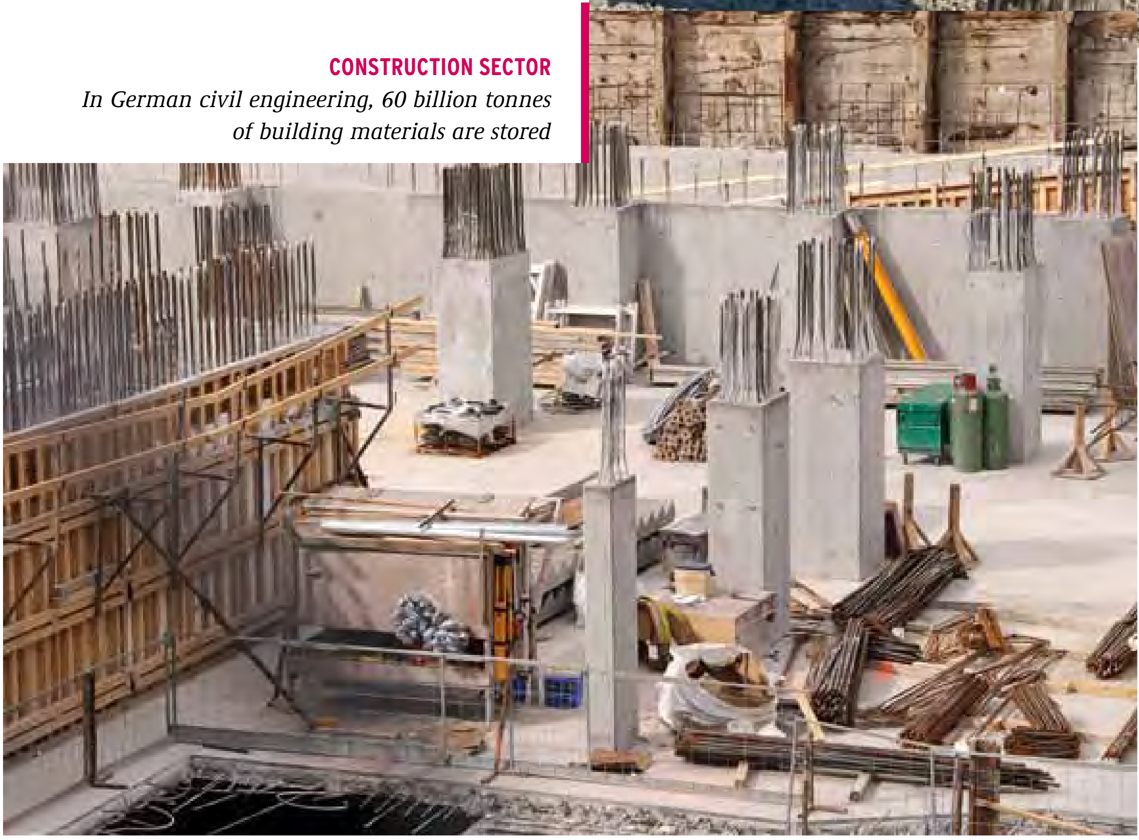
A large untapped potential to reduce the consumption of resources exists in the construction of buildings. The energy consumption of buildings during their use phase has to be drastically reduced in order to meet climate protection goals. Sustainability also includes reducing the content of hazardous substances and their emissions over the entire life-cycle of the building – from the production of building materials, throughout their use and disposal. To assess this impact properly, reliable instruments are needed. While the "Blue Angel" certainly assists consumers in the selection of products for interior construction and renovation, the environmental product declarations for building products (EPD) deliver particularly appropriate information to assess the sustainability of a building. Several manufacturers of building products have voluntarily developed the environmental product declarations as a communication tool. They create transparency about resource consumption, environmental and health risks.

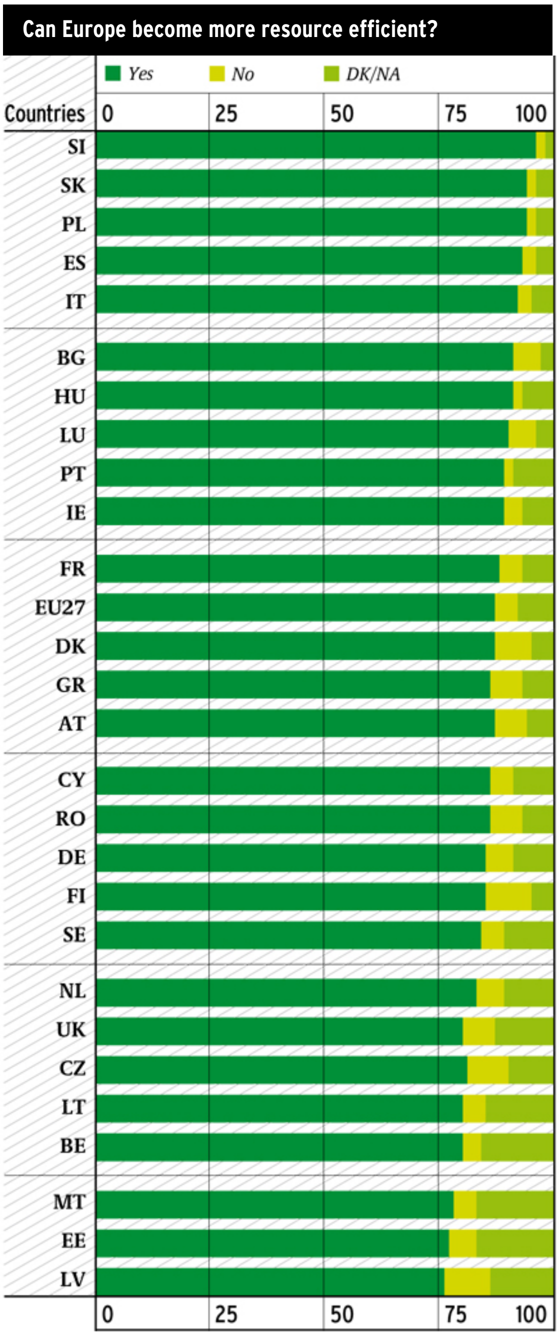
A new EU regulation in effect from July 2013 opens up a new path towards designing the European market for the free movement of building products in a resource conserving fashion. It includes resource conservation as a basic requirement for all buildings. From now on, Member States may require in their regulations that all building products used conform to important criteria for resources conservation. The EU regulation provides requirements such as: "The construction works must be designed, built and demolished in such a way that the use of natural resources is sustainable" and in particular ensure the following:

- Reuse or recyclability of the construction works, their materials and parts after demolition;
- durability of the construction works;
- use of environmentally compatible raw and secondary materials in the construction works.

The Member States may require, for example, recyclable components or labelling of dangerous substances in order to separate them out during demolition. After that, the European Commission will make sure that information pertaining to this performance requirement is posted to the CE marking of building products in the domestic markets. Public sector procurement rules can play an important pioneering role with that.

CONSTRUCTION SECTOR
In German civil engineering, 60 billion tonnes of building materials are stored





Source: European Commission 2011 [17]

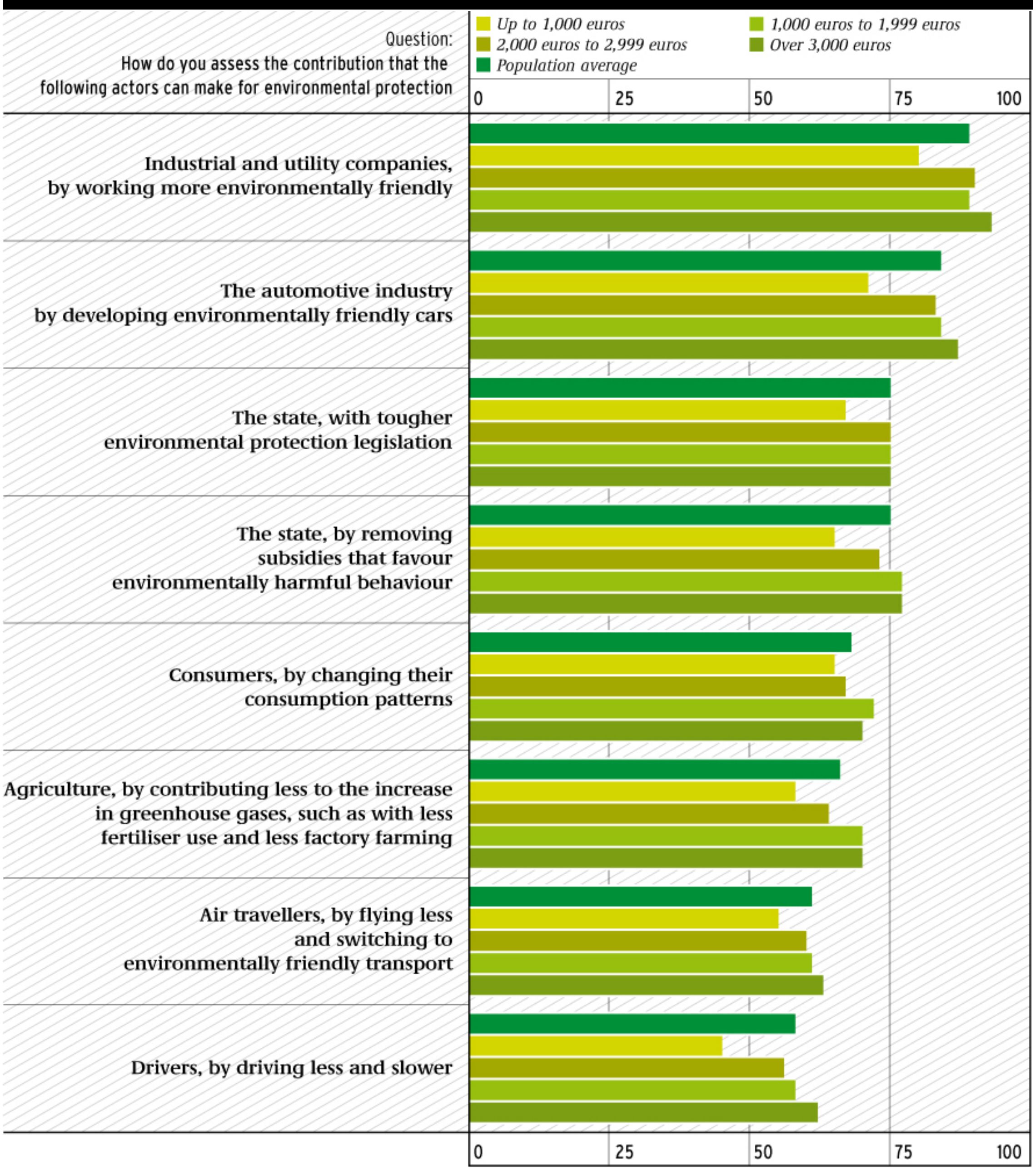
IT WILL NOT WORK WITHOUT THE CONSUMER

Successful resource policy is not possible without the active involvement of the public. With their countless everyday acts, the people decide whether the conservation of resources becomes the blueprint of our economic activities and actions. Basically, consumers recognise the need for more efficient resource use in Germany and Europe: In a survey commissioned by the European Commission from March 2011, nearly nine out of ten respondents said that Europe could use natural resources more efficiently [17]. At 85 percent, the German population almost reaches the EU average of 87 percent (see Figure at left).

Recent UBA surveys also show that – in contrast to climate protection (reduction of greenhouse emissions, renewable energy, energy efficiency) – environmental policy pertaining to natural resources (such as recycling, soil protection) is regarded as slightly less important [18]. The environmental awareness study also shows that the public sees great potential for environmental protection measures for all stakeholders including industry, government and consumers. It is worth noting, however, how different the influence of industry, government and consumers is assessed. The public believes that the greatest potential for the implementation of resource-conserving measures lies with industry (power generation, automotive industry). This is followed by the State (more stringent legislation, removal of subsidies), while their own contributions (consumer behaviour) are assessed as significantly lower. 68 percent of citizens surveyed believe that their own consumption behaviour holds a lot of potential for environmental protection (see Figure on the right).

The above mentioned survey of the European Commission makes a similar assessment. According to it, on a European average, four out of ten EU citizens believe that their households do not produce too much waste. Apparently this part of the population considers its own need for action in terms of resource conservation as a low or lower priority. At the same time, consumers believe that efficiency increases from technological innovations such as material-saving or better recyclable or reusable products are of more significance. In addition to this high affinity for technical efficiency, the readiness for cultural renewal that can realise the potential for resource conservation through social innovation is increasing in Germany and Europe. For instance, one in four motorists considers car sharing (see box on page 51) an attractive option. Also, half of the respondents welcome the opportunity to rent articles of daily use in their immediate residential vicinity [18]. 68 percent of EU citizens are willing to buy second-hand products (such as textiles, household appliances, furniture), 86 percent can imagine buying products made from recycled material – and at 91 percent, this figure is even higher for the German population. At the same time, crucial barriers emerge in the context of non-purchases of second hand products or recycled products. These include uncertainty about quality, health risks or safety aspects of the product [17]. Despite these developments, and driven by increasing wealth and consumption over the past 35 years, private households in Germany own more consumer goods than ever [19]. The necessary decoupling of resource consumption and increasing wealth has not yet taken place. The environmental "Blue Angel" label is a guide for consumers, which basically also takes into account the resource consumption of a product.

Potential for environmental protection measures



Source: BMU/UBA 2010 [18]

CHANGING ATTITUDES – USING SOCIETY'S VALUE CHANGE

The question of how to promote sustainable and resource-efficient consumption patterns and lifestyles is moving to the centre of ecological consumer policy. Changing existing consumer trends is a big, if not the biggest challenge for successful resource policy. To advance the necessary structural decisions for a less resource intensive life and economy in Germany and Europe (in terms of the EU 2020 strategy), it is necessary to further develop the environmental policy instruments and to integrate economic, social and environmental policy.

Environmental policy thereby becomes active social policy which promotes the necessary social and cultural shift toward greater sustainability. It can create opportunities for social integration [20] and strengthen and revitalise regional and local economies. New business models, services, and social networks for the collective use and continued use of products can be created that way and gain significance by way of a public-supported discussion of less resource intensive consumption patterns and lifestyles.

The basic strategies to increase material efficiency and resource conservation in private consumption [21] describe courses of action that encompass the sphere of influence of consumers towards less resource intensive consumption over the entire product life cycle. The strategies of "use without ownership", "extended use" and "reuse" promote individual and collaborative consumer behaviour with the goal of creating the structural and cultural conditions for establishing a new model of prosperity. Supplemented by further recycling measures, these strategies are also an important component in the Europe-wide development of national waste prevention programmes.

People encounter the requirements of resource conservation in their various roles and contexts, each with different options for action: as political and business leaders, as employees in companies and organisations, as citizens and consumers. In order to use their entire decision making scope, they need guidance and practical knowledge about environmental and resource protection as well as the motivation to apply that knowledge. Successful resource policy must therefore be clear, provide target audience specific information about how to conserve resources, and create opportunities for active participation for citizens. Public awareness for environmental issues already exists, and the opportunity lies in extending it to important aspects of resource conservation. In this context it is essential to focus on the priorities of the individual and his or her options for action.

Basic strategies for increasing resource efficiency

Phase	Basic strategies for increasing resource efficiency
Question needs	Reflect on personal needs Seek, procure and evaluate information Consumption discourse in social forums
Buyer awareness	Resource-saving products Small and/or lightweight products Multi-functional and/or modularly useable products Durable products (timeless design, robust, repairable) Re-used, extended use and recycled products Minimise packaging
Consume economically	Save resources during the utilisation phase, avoid waste
Use without ownership	Rent (such as leasing of copiers), sharing (such as carsharing) or pooling (such as launderettes) Private lending, sharing and swapping (such as tools, carpooling) Virtualisation (electronic data instead of products such as music CDs, books)
Use for longer	Reuse products DIY product maintenance (caring and cleaning) and repair Use maintenance and repair services
Return	Return/pass on recyclable and still usable products

Source: Kristof/Süßbauer 2009 [21]

Besides general information about resource conservation and better guidance in regards to efficient products, it is important to integrate the idea of protecting resources in parenting and educational processes. The groundwork and cornerstones for an educational strategy for resource efficiency have already been developed on behalf of UBA [22]. For example, in order to facilitate consumers' orientation, the "Blue Angel" has been further developed as a national resource efficiency label (see box). Consumer education in the context of new social media (consumer advice 2.0) and e-commerce (electronic commerce) is also being improved. As a component of a modern, contemporary consumer education, UBA is currently preparing a web-based information pool for sustainable lifestyles to better guide consumers in this field. In addition, it will enter into strategic alliances with players in e-commerce to achieve that environmentally relevant product information becomes better integrated in Internet shops, comparison shopping sites and web-based advertising [23]. In future UBA will continue to actively work on these approaches, so that national resource efficiency policies can open up the associated potential and additional well-being effects [24].

THE "BLUE ANGEL" – CLEAR GUIDANCE FOR CONSUMERS

Since 1978, the national eco-label "Blue Angel" has been given out for products that differentiate themselves from comparable products in their compliance with environmental criteria. In addition to basic criteria like health, water and climate protection, there is an additional category with the inscription "protects our resources." It primarily includes products that are made from recycled materials: in addition to classic products such as recycled paper, it also includes re-manufactured toner cartridges or cloth towel dispensers. They help reduce overall use of raw materials. In order to further develop the "Blue Angel" as an orientation mark for resource efficiency, its portfolio should be expanded to include products made from resource-conserving materials and recycled materials, products with extended lifespans (durability, reuse, repairability), resource-efficient services and products from renewable resources.

CARSHARING – USE INSTEAD OF OWNERSHIP

Cars stand still more than they are in motion. Cars are parked for about 23 hours a day on average – in addition to the many materials that go into their production, they also take up an undue amount of parking space. The success of carsharing services shows that shared car use can save significant amounts of resources. According to estimates by the CarSharing Association, a shared car replaces about four regular cars. In addition, carsharing leads to a more conscious use of the vehicle, since it is used less frequently, and public transport is used more often.

Thanks to modern communication technologies, the principle is simple: After a one-time registration car-share users can book a car at any time for a certain time period and pick it up with their customer card at specified pick-up locations. Carsharing was launched at the end of the 1980s – with key safes at the pick-up locations – in Switzerland and Germany by small associations and cooperatives. Today they are available in over 300 cities in Germany, with around 190,000 users sharing 5,000 cars. By now, traditional mobility services and car manufacturers participate in this market. While the Deutsche Bahn (German Railways) "Flinkster" service, like the services of many municipal transport companies, cooperates with existing carsharing organisations, the big car manufacturers are testing their own models. After Daimler started "Car2go" in 2008 in Ulm, BMW ("DriveNow") in Munich and Volkswagen ("Quicar") in Hanover have been implementing their own projects. Carsharing is especially interesting for business car fleets because they can not only save resources but also costs. With the support of the Federal Environment Ministry and the Federal Environment Agency, the Carsharing Association has released the "Carsharing for business customers" brochure.

RESOURCE POLICY - AN INTERDISCIPLINARY ACTION AREA

Resource (efficiency) policy is a challenging and inter-disciplinary action area which is now off to a start with ProgRess – the German Resource Efficiency Programme – on a national level and at the EU-level as part of the schedule for a resource-efficient Europe. An innovative sustainable resource policy does not have to be completely “reinvented” – despite great complexity, it can learn from other policy areas and use the experience of other countries. Because of its significant and achievable cost savings effects alone, resource efficiency policy that connects the strategies for abiotic and biotic materials, water, energy and space, is the upcoming major issue of environmental and economic policy.

In the context of the challenges described, resource efficiency policy must advance the redesign towards a resource-saving, sustainable economic system with corresponding structures of production and products. Reliability – based on political consensus – and scientifically sound mitigation goals serve to guide long-term investment decisions for structures of production and infrastructure with long investment cycles (such as mobility and energy systems).

Resource policy is an interdisciplinary task that must be seen in an international context and must involve global aspects. As a resource-poor country, Germany is both a major importer of resources and a major exporter of solutions for the resource efficiency of products and services. On a physical level, the global aspects become apparent because of the impact of imported raw materials (such as the transfer of the environmental impact onto the supplier countries) or international waste exports. Helping to shape the flagship initiative on resource efficiency as part of the EU-2020-strategy launched by the European Commission in January 2011, and the schedule of autumn 2011 based thereon, is just as important as the technology and know-how transfer with emerging economies and developing countries as equal partners.

In order to choose the suitable instruments from a wide range of alternatives, policy must focus its goals into core strategies. However, resources policy is a highly complex field with many players and approaches, so there cannot be just a single policy instrument. Instead, it is important to choose a carefully crafted “policy mix” with just the right instruments. That way, many barriers can be detected, various audiences can be addressed, and different players can be integrated as supporters. Prioritised core strategies also provide interdisciplinary orientation and help with the public communication of this new policy field. The core strategies and the instruments chosen for their implementation are selected according to the following criteria:

- The core strategies need to reach the key target groups and address those of their action areas that are key to resource efficiency.
- The “policy mix” chosen needs to finance itself overall to avoid additional burdens on public budgets.

Source: Further developed based on Kristof/Hennicke 2010 [26]

- The instruments allocated to the core strategies for the initial phase should build on what already exists, so that implementation can succeed as quickly and easily as possible. For this purpose, existing structures should be expanded (if they already include resource efficiency), or opened up for the topic.
- The number of selected instruments must be kept at a manageable level. In addition, the instruments chosen need to focus on key areas.
- The instruments should be chosen so that they can flexibly adapted to new developments and changing conditions, or may be adjusted to combine well with other instruments which may become necessary later. Once the resource issue is more broadly established, and initial successes emerge, the "policy mix" and the policy instruments must be further developed.

These recommendations are based on extensive policy analyses of the MaRess research project [26], as well as the detailed legal analysis of instruments for the conservation of resources [27]. The figure provides an initial overview of the six core strategies proposed, and shows which objectives they pursue. Three of the core strategies are directed at different points of change processes. The others address products, services and financial markets with their respective stakeholders.

The core strategy "Mobilising institutions – key to a successful diffusion" makes it clear that we need strong institutions that promote and spread resource efficiency. To achieve this, the use of three coordinated instruments is required. The basic requirement is to expand and to better network the existing national stimulus and consulting programmes around the issue of resource efficiency (eg. KfW programme, Go Inno). It also requires that the stakeholders who drive these programmes network intensively; a good starting point for this is the competence resource pool which was initiated by demea, Effizienz-Agentur NRW (Efficiency Agency NRW), and the Wuppertal Institute and where in cooperation with, among others, ZRE, RKW, DIHK synergy effects are explored. Going forward, it to combining the activities in a single resource efficiency agency should also be considered which, at a federal level, would be a focal point for all dissemination activities directed at and for businesses, as well as for programme bundling, evaluation and further development. Stimulus and consulting programmes alone are not enough to more tightly integrate resource efficiency into the day-to-day of especially smaller and medium-sized enterprises. Institutions that act as "caretakers" are important because of their initiation and support functions and their practical implementation support on site. By expanding and qualifying the existing pool of consultants with the help of active stakeholders (such as ZRE, demea, Effizienz-Agentur NRW, PIUS network) and by supporting regional structures and networks, the necessary technical know-how and adequate implementation assistance can be provided to businesses.

This is a programme of measures with which existing economic resource efficiency technologies and solutions can be distributed and put to use more quickly, thus reducing costs. The core strategy "Giving innovation a direction – sustainable future markets for resource efficiency solutions" helps policy makers ensure that innovations make important contributions to improving resource efficiency. Support for innovation in Germany must focus more on increasing resource efficiency. In a first step, in existing programmes such as the Environmental Innovation Programme of the Federal Environment Ministry, or in the FONA programme of the Federal Ministry of Education and Research, new support priorities around this issue can be established and promoted. Since venture capital is an essential prerequisite for the successful propagation in the market, policy makers should – for example, in cooperation with KfW – facilitate better access to capital for businesses.

In the long term, the "Changing attitudes of mind" core strategy has the greatest potential for advancing the claim for higher resource efficiency. By improving qualifications in businesses, by placing more emphasis on the subject of resource efficiency in universities and vocational training, and by better networking among relevant universities, research institutions and operators, resource efficiency gains can be achieved with less effort and greater success. The "Resource Efficiency Network" launched by the Federal Environment Ministry in 2007 also plays an important role. A campaign targeting "(future) political and social decision-makers" should be started in parallel with the existing ZRE campaign targeting businesses. A concept for this has already been developed [28]. In parallel to these two campaigns, the resource efficiency network can bring together leading representatives from politics, business, science, society and the media for "concerted action" with the objective of bringing the issue of resource efficiency to a broad public debate.

The "Resource-efficient Products and Services" core strategy supports manufacturers and service providers in bringing resource-saving products and services to market. These are to meet dynamised standards and labelling requirements. In addition, UBA recommends supporting resource efficiency-oriented product design. In this way, particularly resource-efficient products are promoted and the most consumption intensive "dirty end" will be gradually withdrawn from the market.

THE PUBLIC SECTOR: LEADING BY EXAMPLE

The core strategy of "The state as a consumer of products and services and provider of infrastructure" focuses on public sector demand and its considerable market size. If the state purchases more resource-efficient products and services, it can send objective driven messages for market development and thereby reduce development and marketing risks. For this reason, the core strategy has the following key approaches: life cycle cost analysis, as already required according to the "General administrative regulation for the procurement of energy efficient products and services" [29], is to be established as a general and binding purchasing criterion for selecting the most economical offer. In addition, pooling of public sector demand for innovative products increases the incentive for companies to develop more resource-efficient solutions.

Publicly provided or controlled infrastructure is often resource intensive. Therefore it is important for any expansion, restructuring, and maintenance activities to be optimised in a context of resource efficiency. In road construction, which is highly resource-intensive, roads must be planned based on demand. It is, for example, important to take into account demographic changes and demands arising from domestic migration and changed freight traffic volume. Although the use of recycled materials is desirable, roads may not be used as sinks for mineral recycled materials which could be utilised at a higher level of quality (as in buildings). For wireline infrastructure, such as electricity grids and water networks, a proactive land management approach is recommended.

The core strategy of "Incentives for resource efficiency solutions via the financial sector" addresses the goal of establishing resource efficiency as an essential factor for competitiveness in the financial sector. This would not only to improve resource efficiency in businesses and promote the introduction of more resource-light products in the market, but also help stabilise the financial sector, since the emphasis is on long-term objectives. At first, the MaRess project [26] recommends the establishment of a "Resource efficiency and sustainability in the financial sector" Commission of Inquiry to establish the topic in this area and to seek solutions to current problems (such as adverse effects of speculative bubbles in the resources sector at national and global levels). In addition, resource-related key performance indicators, (R-KPI) and a data base for them needs to be developed which, with the help of which the financial sector, can integrate the resource issue into their decision-making routines (such as risk management and lending rules). Resource-related key performance indicators should also be used for financial supervisory and corporate reporting.

RESOURCE-INTENSIVE INFRASTRUCTURE
Traffic routes must be planned in line with demand

Core strategies and their target audiences

Core strategy	Target audience
"Mobilising institutions – key to a successful diffusion"	↗ Businesses ↗ Consultants and intermediaries
"Giving innovation a direction – sustainable future markets for resource efficiency solutions"	↗ Manufacturers and users of resource efficiency technology and suppliers of resource-efficient products/product-service systems ↗ Co-operations of businesses and research institutions ↗ Innovative providers of resource efficiency-oriented techniques, products and services
"Resource-efficient products and services"	↗ Manufacturers of products and service providers at the end of the life cycle (such as extended use and re-use, recycling or disposal)
"Incentives for resource efficiency solutions via the financial sector"	↗ Science and politics ↗ Finance
"The state as a consumer of products and services and provider of infrastructure"	↗ Public sector procurement personnel ↗ The public sector as a provider of infrastructure
"Changing attitudes"	↗ Businesses and intermediaries ↗ (Future) decision makers ↗ Multipliers from politics, business, science, society, media ↗ Training providers and consultants ↗ Scientific community ↗ Teacher training

Source: Kristof/Hennicke 2010 [26]

FINALLY

A major environmental and economic goal of the Federal Government's sustainability strategy, published in 2002 under the title "Perspectives for Germany", is to double the productivity of raw materials from the 1994 base year to 2020. In this context, resource productivity means the ratio of gross domestic product (GDP) to its abiotic material input. In the results of the "Environmental-Economic Accounting Report 2010" the Federal Statistical Office notes that the raw material productivity increased by 46.8 percent between 1994 and 2009. But while GDP increased due to higher economic growth (up 18.4 percent), the use of materials decreased by only 19.4 percent since 1994. Taking into account indirect exploitation of raw materials abroad which are used for production, material input actually increased by three percent in real terms – resource productivity therefore increased by even less. These numbers are not the best precursors for reaching the ambitious goal in time. We therefore have to work much harder to achieve resource-saving production and consumption patterns. This includes material-efficient products, materials and more energy efficient production processes and the closure of commodity cycles with recycling and cascading use. To this end UBA helps companies, consumers and policy makers with research and development, networking and providing information to stakeholders by developing economic, institutional and legal instruments and, not least by setting ambitious goals and developing sound indicators.

The transformation of the energy system brings about new challenges. In particular, the use of commodity metals such as copper or critical, strategic metals such as rare earths, indium, cobalt, and tellurium (wind power and photovoltaics) is problematic in terms of environmental policy. In its capacity of research and policy consultant, UBA also works on solutions in these areas. Last but not least, Germany needs a culture of resource efficiency. For this purpose, resource efficient economic management must be awakened from its slumber. In the area of climate protection we are already wide awake. However, a responsible use of all natural resources, our natural capital, is essential.

Looking at the entire building and infrastructure inventory as an "organic metabolism" which undergoes a continuous ebb and flow of material flows and which therefore constitutes an enormous, still growing anthropogenic and in the long term usable stock, is one of the new ecological perspectives. This also includes resource-efficient consumption patterns, by which housing and mobility needs of people which can be met in a more environmentally sound fashion, by using new consumption concepts which do not confuse "use" with "ownership". The biggest and most important new perspective is the re-evaluation of people's livelihoods. How many resources can an individual still claim in a sustainable and moderate fashion, considering resource limits, the diminishing capacity of our planet, climate change and unchecked population growth?

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III 1.1 "General Aspects of Product-related Environmental Protection, Sustainable Consumption, Innovation Programme"
III 1.3 "Eco-design, Environmental Labelling, Environmentally Friendly Procurement"
III 1.4 "Substance-related Product Issues"
III 2.2 "Resource Conservation, Material Cycles, Minerals and Metal Industry"

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Chemistry of the future

SUSTAINABLE CHEMISTRY

an elementary building block of a Green Economy

The chemical industry is an important economic factor in Germany and a driver of innovative products. Innovation however does not necessarily mean greater sustainability. An environmentally sustainable production, application and processing of chemicals should use less energy, raw and auxiliary materials, reduce emissions and discharges into water, soil and air, avoid waste, replace hazardous chemicals and operate safe facilities – and all this world-wide. The safe handling of chemicals is not restricted to the highly innovative industrial countries; emerging and developing countries must also be involved.

Whether they are drugs, cosmetics, detergents and cleaning agents, adhesives, paints or plastic products – chemical substances and products have become indispensable in our daily lives. And the demand for chemical substances and products is steadily increasing. Global chemical sales in the past five years have grown by more than seven percent [1] where the growth centres of chemical demand keep shifting: Germany has now been overtaken by China with 20.1 percent, ranking fourth place in terms of world market shares in the global market with 6.3 percent of chemical production [2] . U.S. is leading with 20.7 percent and Japan is in third place with 6.8 percent. The Organisation for Economic Cooperation and Development (OECD) in 2001 predicted that 31 percent of the total chemical production will be relocated from the OECD countries into emerging and developing countries by 2020 [3].

The chemical sector must adopt more sustainable paths. The main objective is to minimise the consumption of resources including a reduction in environmental use. A paradigm shift should be achieved in the economy so that economic success is not based on mass in the future, but quality – especially in the ecological dimension. This does not only apply to producers of chemicals, but all industries including the end users who use chemicals such as fertilisers, pharmaceuticals, plastics and pesticides.

The chemical industry must be more sustainable if it is supposed to be future proof because the earth's natural limits will be exceeded through increasing use. In 2008, the OECD warned of the state of the environment: "The costs of inaction are high, while challenging measures for environmental protection are affordable and can go hand in hand with economic growth" [4]. Already 63 percent of the people in Brazil, Russia, India and China – the key emerging economies – are supplied with high-quality water at a mediocre to poor standard. This proportion will rise to 80 percent by 2030 if water management fails to improve and the pollution by harmful substances and chemicals is not stopped.

In Europe, the high level of regulations developed over the years has led to a reduction in the exposure of human health and the environment to chemicals. Thus the chemicals regulation REACH and the Directive on the Integrated Pollution Prevention and Control (IPPC) provides an important framework to establish the safety of chemicals. The number and consequences of chemical accidents have decreased considerably. However, an all-clear signal cannot be given because the production and use of chemicals in a globalised world are no longer national or regional issues since their effects on the environment can be felt world-wide.

When introducing a shift towards an ecologically sustainable economy, the Federal Environment Agency (UBA) wants to understand and establish a new quality of economic responsibility in a globally sustainable world for the future. At the same time it supports the Johannesburg target: at the World Summit on Sustainable Development in Johannesburg in 2002, the international community declared in favour of safe handling of chemicals throughout their life cycle and minimising their significant negative impacts by 2020. The Year of

GROWTH INDUSTRY
The chemical industry is an important economic factor – not only in Germany

Chemistry 2011 proclaimed by the United Nations was the starting point to increasingly use the potential of chemistry for sustainable development and to more strongly align the industry towards the needs of sustainability.

TO WHAT OBJECTIVES SHOULD SUSTAINABLE CHEMISTRY BE ALIGNED?

UBA seeks to implement all principles of sustainable chemistry where chemicals are produced and used. For this purpose in 1999 it developed the four management rules of the Enquete Commission of the German Bundestag (Parliament) "Protection of man and the environment – objectives and framework conditions of sustainable future development" which can ensure "life and economic activity within the capacity of the ecosystem" [5, 6]:

- The use of a resource must not permanently exceed its rate of regeneration or the rate of substitution of all of its functions.
- The release of substances over the long term must not exceed the absorption or assimilation capacity of the environmental compartments.
- Hazards and unacceptable risks to humans and the environment by anthropogenic influences must be avoided.
- The time scale of anthropogenic impacts on the environment must be balanced with the time the environment needs to complete a stabilising reaction.

The precautionary principle is closely connected to the sustainability principle, as specified by the Council of Environmental Experts (SRU) in their environmental report published in 1994 [7] and confirmed by the European Commission in its communication in 2001 [8]. These include not only the protection of ecosystems, but also the preservation of the quality of life and resource and fair economic activities. Also, developments in society must be socially just and they should be shaped by all social stakeholders.

According to this principle, non-renewable natural resources such as minerals and fossil fuels should only be used to the extent where their functions cannot be replaced by alternative, renewable materials or energy sources. The use of renewable resources must be based on their rate of regeneration. Substances should be released or energy consumed over the long term only to such an extent that the ecosystems can adapt or absorb them. Hazards and risks to human health – including effects and interactions which cannot be sufficiently assessed – should be avoided.

Chemicals may have diverse effects. The ozone layer can be destroyed by CFCs (chlorofluorocarbons), the climate may be influenced by harmful fluorinated gases or the fertility of marine organisms can be impaired by hormonally active chemicals. Precaution and sustainability are guiding principles for the protection of worker's and consumer's health. UBA has specified the "green economy" model launched by the United Nations with its concept of sustainable chemistry which affects production, processing, application and evaluation of chemicals as well as products. Back in 2004, UBA and OECD developed the general principles for sustainable chemistry (see box on page 64).

CLEAN DRINKING WATER
For many people in India – still a luxury

PRINCIPLES OF SUSTAINABLE CHEMISTRY

Qualitative development

- Use of harmless and degradable materials based on their intrinsic properties and today's knowledge, or – where this is not possible – of materials with a low risk to humans and the environment.
- Resource efficiency in production and consumption of durable products.
- Safe handling of hazardous substances where they are unavoidable (for example, where the hazardous property is closely related to the function).

Quantitative development

- Reducing the consumption of natural resources.
- Using renewable resources under sustainable aspects.
- Avoiding emissions or chemical discharges into the environment or – if this should not be possible – reducing them according to the best available technique. These measures can also help save costs.

Comprehensive life cycle analysis

- Analysis of raw material extraction, manufacturing, processing, transportation, use and disposal of chemicals and used products in order to reduce resource and energy consumption and to avoid dangerous substances.

Action instead of reaction

- Developing and marketing chemicals so as not to impair the environment or human health nor overuse the environment as a source or sink during their life cycle. Problematic substances must not be replaced by less dangerous or untested substances. Damage costs for businesses, causing economic risks and cleanup costs for the state must be reduced.

Economic innovation

- Sustainable chemicals, products and production methods create confidence among industrial users, private consumers and government customers and provide a competitive advantage.

The concept of sustainable chemistry cannot be achieved if it is only implemented in the advanced industrial countries. It must be applied world-wide – adapted to the relevant region – and include boundary conditions for emerging and developing countries. High standards for the protection of the environment and human health form the core of an economically successful implementation. But the implementation is only effective if industry, civil society and government work together. A sustainable management of chemicals is successful in a green economy when all aspects of sustainability – ecological, economic and social – are seen as opportunities for the future. Only then can the UBA model provide a solid pillar for sustainable chemistry in the UN target for the Green Economy.

WHAT CONTRIBUTES TO SUSTAINABLE CHEMISTRY?

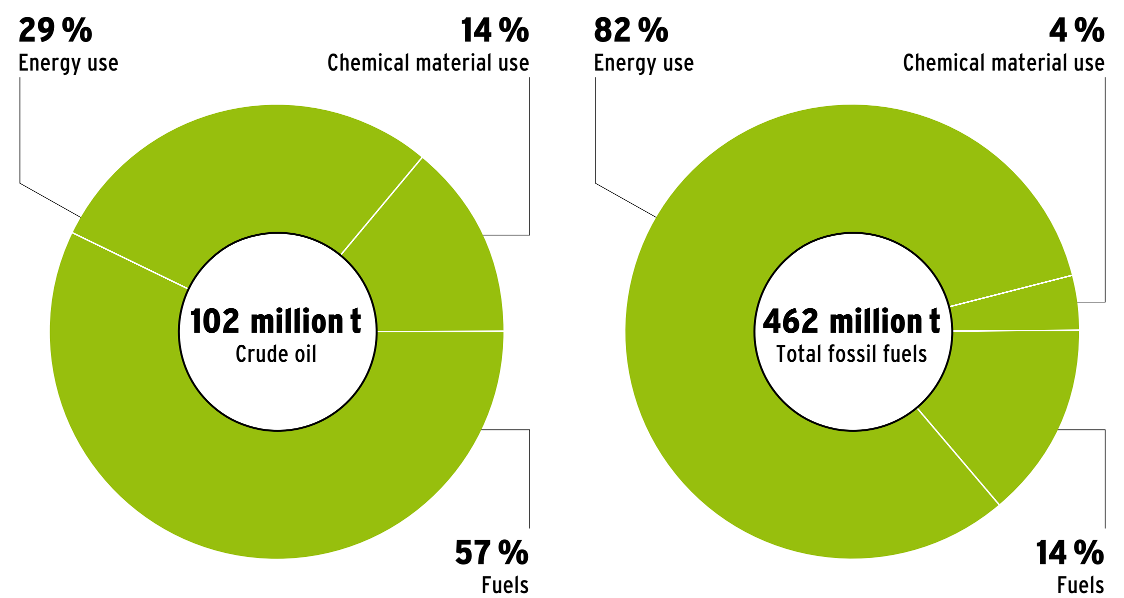
Sustainable chemistry includes the various activities of production, processing, application and evaluation of chemicals and their products. All areas are encouraged to enhance their resource efficiency, reduce energy consumption and establish a recycling economy as far as possible. For this purpose, the following sections will point out and explain the respective starting point, the actual need for action, the starting points for policy and interest groups involved and the particular perspective of the future using examples.

The chemical industry in Germany has increased its production between 1990 and 2009 by 42 percent, while energy use was reduced by 33 percent and emissions of greenhouse gases by 47 percent [9]. Having an annual consumption of 18.4 million (metric) tonnes (t) of fossil fuels still means further efforts are needed to reduce resource consumption (see Figure 1). The chemical industry is also dependent on innovative techniques and syntheses. Nano- and microsystems technology, industrial biotechnology, the use of renewable materials and the application of ionic liquids have great potential for energy and material efficiency. This will be illustrated by a few examples.

EXAMPLE: MICRO SYSTEM TECHNOLOGY

Micro process engineering performs certain chemical processes in minuscule devices – reactors, mixers and heat exchangers – having structures a few microns to a few millimeters thick. Micro-reactors are often no bigger than a video cassette. These "miniature chemical factories" allow precise reaction control and can avoid the use of environmentally hazardous substances.

Share of chemicals in the use of fossil fuels in Germany in 2009



Of the crude oil that Germany consumes each year, the chemical industry uses 14 percent as a raw material. Somewhat more than half of the total oil is used for fuel production, the rest for energy (especially heating oil). In 2009 the German chemical industry used 18.4 million tonnes of fossil fuels (petroleum products, natural gas and coal) for material use. An appropriate processing into basic chemical building blocks opens an almost unlimited variety of synthesis opportunities.

Source: VCI (2011): Factbook 01. The Energy (r)evolution, Facts and figures III

Compared to conventional methods which are generally based on batch process control in large-scale stirred tank reactors, micro-reactor technology offers numerous advantages for the production of fine and specialty chemicals. These include high selectivity and increased product yields because short contact times of the reacting substances under very controlled reaction conditions exclude side reactions. This can reduce raw material consumption, waste production and energy use. The optimised surface-to-volume ratio leads to increased process stability and the continuous process control to high and consistent product quality. Compared to larger systems, small reactors can be adapted quickly and in a material efficient way. This aspect of resource conservation also means an economic advantage because one can react more quickly to market changes or emerging specific demands.

EXAMPLE: IONIC LIQUIDS

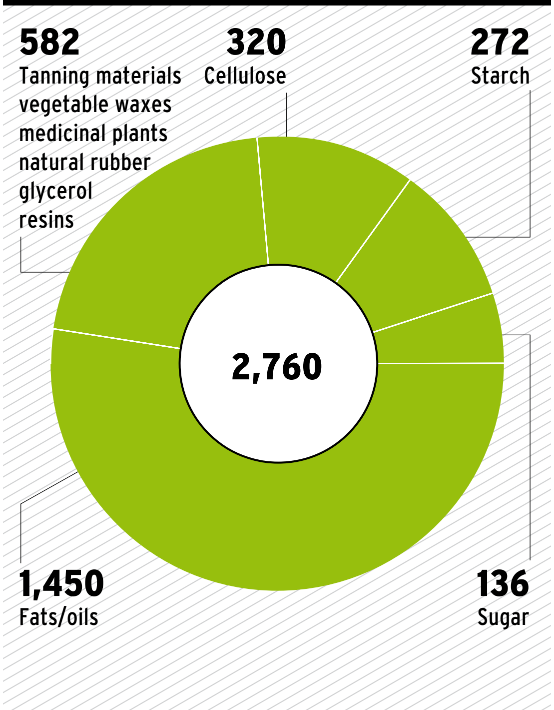
Ionic liquids are salts that are liquid at temperatures below 100 °C and exhibit no measurable vapour pressure and only a minimum risk of explosion or fire. This opens up many technical applications as solvents in chemical processes, in separation procedures and as electrolytes in electrochemical processes. Due to the possible variations of anions and cations, the class of ionic liquids includes a large number of compounds. A few hundreds of these salts are commercially available. The (eco)toxicological risks are not known or understood for all substances but many ionic liquids have no hazardous properties. However, they cannot replace conventional solvents in general, so that an individual assessment is always needed. UBA requires manufacture to use or dispose of the products so they do not pose threats to humans, animals and the environment. The few documented examples of applications on an industrial scale have shown that processes may be significantly more environmentally friendly and cost-effective, and thus the potential for improvement is available.

EXAMPLE: SYNTHESIS OF CHEMICALS FROM RENEWABLE RESOURCES

The chemical industry in Germany processes 2.7 million tonnes of renewable raw materials which is the largest proportion (80 percent) of the total biomass used by the industry as raw material. Thus, 13 percent of manufactured chemicals such as plastics, fibres, detergents, cosmetics, paints, adhesives and building materials, hydraulic oils, lubricants and pharmaceuticals are produced from renewable raw materials (see Figure). This proportion will grow to approximately 30 percent by 2025 [10].

Increase in industrial use of biomass in the chemical industry in Germany was rather low in recent decades. Polymers (polylactide, PHA), bio-polyethylene (from ethanol) and epichlorohydrin (from glycerol) are produced on an industrial scale primarily in the U.S., Brazil and Asia. However, the use of renewable resources is not necessarily sustainable because it depends on the way they are obtained and the available alternatives. It also only provides benefits, as mineral-oil based production, if the reaction products are extensively used in a composite system and do not constitute waste.

Use of renewable resources in the chemical industry (Germany, 2008); figures in 1,000 tonnes



Source: Fachagentur Nachwachsende Rohstoffe (Agency for Renewable Resources, FNR)

STRATEGIES AND TOOLS FOR INDUSTRIAL USE OF BIOMASS

The Federal Environment Agency has commissioned a study to develop strategies and tools for the use of biomass as a material. They are supposed to promote the climate and resource protection targets of the Federal Government. The study should specify appropriate value-added chains to increase resource and area efficiency by using biomass as a material, establish fundamentals and decision support tools for a sustainability assessment of the use of biomass as a material and develop a comprehensive methodology for sustainability assessment of biomass-based products or bio-based raw materials. The research report will be published at the end of 2012.

ASSESSMENT OF CHEMICALS – KNOWLEDGE FOLLOWS RESPONSIBILITY

When using chemicals, the challenge for the future is that people and the environment should not be endangered in the long term. For this, one needs information on material properties, exposure – i.e. dose or concentration of a substance people and the environment are exposed to – and the effects. The joint central Federal/State material data pool (GSBL) provides material information about the properties of chemical substances, their legal regulations and emergency preparedness and response on the Internet. In the future, inherently safe chemicals must be increasingly used because they do not cause short- or long-term problems in the environment or to human health. In particular, small and medium enterprises find it easy to handle chemicals if they have no a priori hazardous properties and therefore no extensive risk mitigation measures are required. This also applies to products and commodities from which they are released during or after use. In addition to environmental and health hazards, the physical dangers such as “explosive”, “highly flammable” or “oxidising” are relevant to their handling. However, if risks are inevitable, one can only take accident prevention measures using detailed knowledge of the hazardous properties such as those provided by GSBL.

Chemicals are sustainable with regard to the environment only if they are degraded quickly, soon after being released [11] and have no long-term harmful effects. Currently, for example, certain chemicals can be detected in the Arctic where they have never been used or released. For the future, we must create conditions to protect ecosystems and human health from hazards such as irreversible world-wide effects.

Very different substances, some with very different properties are of particular concern: for example, carcinogenic, mutagenic and reprotoxic substances, so-called CMR substances which are carcinogenic and mutagenic to humans or animals or have teratogenic properties. They include those substances that are no longer retrievable from the environment and develop long-term effects. They include long-life (persistent), enricheable (bioaccumulative) and toxic chemicals (PBT/vPvB substances). The figure below lists the criteria which sustainable chemicals must meet to protect people and the environment.

Constitutive laws govern the use of chemicals to make them as safe as possible. The use of chemicals with normal characteristics of concern, primarily pesticides and other insecticides (biocides), should be at least acceptable or as harmless as possible. Pesticides and biocides are therefore subject to approval. This means that these substances and products are prohibited unless they are expressly permitted under an individual approval decision. The objective of substance law is, for example, for substances with specific harmful properties, in particular CMR, PBT and vPvB and those having effects damaging the endocrine system, not be used at all or only when exposure to humans and the environment can be excluded. This objective applies especially to biocides and pesticides. Success is a new EU regulation that governs the approval and use of pesticides. Thus pesticides have not been approved since 2009 if they met the exclusion criteria (cut-off criteria); these are the above-mentioned properties, including those damaging to the hormone system. The same will apply to biocide products from 2013 due to the amended EC law. The approval procedure prescribed for pesticides and biocides enables the authorities to refuse approval for other particularly serious effects of the relevant agent to be assessed. For industrial chemicals with these properties, there is a list of substances of greatest concern in the EU chemicals legislation (REACH, see page 66). Such substances may only be used when a special approval is granted. In order for these regulations to prevail and for legislation and authorities to enforce them, manufacturers and importers must provide data for assessment.

Requirements on sustainable chemicals

Non-sustainable

- CMR properties
- Respiratory sensitizers
- Extreme acute (eco)toxicity
- PBT/vPvB properties
- High persistence and mobility
- Origin of the raw material: low social and environmental standards
- High greenhouse gas emissions
- High resource consumption

Sustainable

- No irreversible and chronic effects
- Low acute (eco)toxicity
- Low persistence
- No bioaccumulation
- Low spatial range
- Origin of the raw material: high social and environmental standards
- Low greenhouse gas emissions
- Low resource consumption

Source: © Federal Environment Agency

REACH CLOSES GAPS IN OUR KNOWLEDGE

The handling of chemicals is regulated by the chemicals regulation REACH within the European Union. The rules require manufacturers and importers to assess the hazards posed by the substances and risks arising from them to ensure adequate protection of health and the environment. They must submit data on toxicity and use, including the assessment of the extent to which people can be exposed to these substances, to the European Chemicals Agency ECHA in Helsinki according to a binding timetable. High-volume substances and substances with certain hazardous properties had to be registered by the end of 2010. Substances in the range of 100 to 1,000 tonnes per year (t/a) will follow by 1 June 2013 and those in the range 1 to 100 t/a by 1 June 2018.

Certain basic data and, for materials from 10 t/a, a chemical safety report must be submitted as part of registration. This document describes the derivation of possible hazardous properties and the conditions for their safe use. In addition, REACH regulates the communication within the supply chain – from producer through treatment to industrial users. The approval requirement for substances of very great concern and the right of citizens to information from the trade, encourage the substitution of less hazardous substitutes and alternative methods. REACH also agrees to limit the use and production of such substances.

Pharmaceuticals are a particularly sensitive category. They are usually only partially degraded (metabolised) in human beings and animals and are often stable in the environment. For human pharmaceuticals, PBT properties have not been relevant as far as approvals are concerned; they can be approved even where existing environmental risks are present because the benefit for patients is valued much higher than the potential risks to the aquatic environment and the rest of the environment. Animal pharmaceuticals, however, are approved based on a risk-benefit analysis and environmental characteristics, including PBT properties. This may also mean that a certain animal pharmaceutical is not approved or the approval is connected with specific application conditions.

The regulation of CMR, PBT and vPvB chemicals is only a partial step towards sustainability. This is because new challenges for substance assessment have emerged in recent years concerning the known characteristic effects in human- and eco-toxicity. Thus UBA has learnt that the effect of chemicals in the environment and in people has a mutual affect and was often cumulative. Environment and humans are exposed to various mixtures of chemicals in everyday life and initial attempts to assess such effects are currently being developed. Legal substance assessment must consider hormonal effects of chemicals much more robustly in the future since born and unborn children, being the most sensitive population, deserve special attention.

PHARMACEUTICALS
Many pharmaceuticals are not completely degraded in the body and are stable in the environment

PESTICIDES

They are subject to a rigorous approval procedure for the protection of consumers and the environment

MORE ENVIRONMENTALLY COMPATIBLE USE OF CHEMICALS

The criterion of intrinsic safety reaches its limits when certain hazardous properties are important. Fuels must be flammable and stabilisers must be stable (persistent). In addition, no pesticide will be approved that is not effective, which means that where it is applied, it kills fungi, snails, insects, mice or competing plants. In addition to this direct killing effect, pesticide use also has indirect consequences: where there are no insects, there will be no birds that live on insects; where mice have been killed, owls will starve. Therefore, strategies for sustainable use of pesticides must not be based only on the approval of active substances and products. Pesticides are an example of highly potent toxins which are openly applied in the environment. To protect consumers and the environment, they are subject to a rigorous approval procedure in Europe. But this only assures the acceptability of individual substances and not the general acceptability of pesticide use in terms of their impact on water, soil and ecosystems. The actual practice of chemical plant protection is therefore not sustainable but causes a progressive loss of biodiversity in Europe's agricultural landscapes. Therefore the overall input must be reduced to achieve a sustainable use of pesticides. In addition, their application must be compensated for by ecological compensation areas such as fallow land or flower strips and increased organic farming. UBA therefore supports the implementation of the European framework directive on the sustainable use of pesticides and is developing rules for the sustainable use of biocides.

Sustainable management of chemicals must consider other aspects as well. The greenhouse gas potential of some chemicals may be significantly higher than that of carbon dioxide, and other substances may destroy the stratospheric ozone layer. On the basis of physico-chemical properties such as volatility, the way chemicals reach humans and the environment can be assessed. To test the sustainability of chemicals, specific resource requirements (energy, raw and auxiliary materials), the production yield, emissions to air, water and soil, and the amount of waste generated must be considered. Because most chemicals can be produced along different synthesis pathways, their energy and resource needs may be different. UBA has developed a guide for assessing the sustainable use of chemicals [12] and promotes overarching management approaches such as chemical leasing to identify new avenues for the use of chemicals.

IMPROVED SERVICE – REDUCED CHEMICAL CONSUMPTION

Chemical leasing is a service-oriented business model. Manufacturers or dealers do not sell chemicals – for example a solvent for degreasing a surface – instead, they offer the buyer the function or service along with professional and environmentally sound use, treatment and disposal. The business is based on know-how and no longer on the quantities of chemicals sold. Certain companies have tested the concept for several years – for example in metal processing or in the food industry.

Chemical leasing may contribute to resource conservation and reduction in environmental pollution [13]. However, questions still remain which need clarification, such as: what conditions must be met to keep operational and business secrets? And how leasing partners must shape their agreements to ensure that the benefits to the environment, health and economy are distributed in an equally fair way? The management concept is of interest not only to industrial countries, but also to emerging and developing countries. Since 2004, the United Nations Industrial Development Organisation (UNIDO) has supported this initiative with projects in twelve pilot countries. Examples of experience from the projects are available on the Internet.

PRODUCTS – CHEMISTRY MUST BE SUITABLE

Chemicals can be found in many everyday products, whether in a computer case, clothes and furniture, floor coverings and adhesives or in children's toys, they give shape, colour, durability, consistency and other useful properties. Chemicals are used as additives (for example dyes, plasticisers, flame retardants), but also for the production of materials (e. g. plastics). The selection of materials and additives affects resource and energy consumption and the recyclability of products. Chemicals can enter the environment not only during production or disposal of the products, but also during their use. To achieve sustainability for products, substances must be used at the lowest possible risk. It is important to minimise emissions and inputs into the environment and promote resource-saving manufacture of durable products. UBA is committed to the substitution of hazardous and climatically harmful chemicals.

EXCLUSION OF CRITICAL CHEMICALS FROM PRODUCTS

The replacement of Substances of Very High Concern (SVHC) in products is targeted by REACH over the medium term. Voluntary eco-labelling can help achieve a faster and more far-reaching shift towards non-critical materials. Thus the EU Ecolabel Regulation, which has been in force since February 2010, requires the general exclusion of substances with certain critical properties. Products with the "Euroflower" may contain neither chemicals with CMR, PBT or vPvB properties nor those considered toxic or environmentally hazardous. "Blue Angel" is a similar approach. UBA advocates that manufacturers also avoid respiratory and skin-sensitising substances and substances which may form toxic transformation products during waste treatment [14]. These criteria will lead to exclusion of, for example, teratogenic plasticisers in floor coverings or halogenated flame retardants in plastics for casings. For certain hazardous chemicals, however, there is no technically suitable replacement, so their safe use must be investigated in individual cases as an interim solution.

EMISSION TESTING OF PRODUCTS

Harmful emissions during the utilisation phase can be evaluated using emission tests. Many products, including some building products must undergo an emissions test in Germany in order to be approved for indoor use or to obtain a quality label. For this purpose, the Committee for the Health-related Evaluation of Building Products (AgBB) has developed the AgBB scheme: building products such as floor coverings, paints and adhesives are tested in a test chamber for 28 days and the volatile organic compounds (VOC) emitted assessed according to established procedures. "Blue Angel" also uses this test scheme for various product groups. Recently, odour testing of products has been suggested to be included in the AgBB scheme [15].

Example: wall-to-wall carpets. As recently as in the 1980s, wall-to-wall carpets typically had an intense and unpleasant odour for which the substance 4-phenylcyclohexene (4-PCH) was responsible. This material originated as a by-product from the manufacture of the foam backing and the styrene-butadiene latex adhesive. As fewer and fewer consumers were willing to accept an odour nuisance, which in some cases persisted for months, the industry replaced the foam backing with a textile secondary backing. Although this is still often glued by styrene-butadiene latex, odours nevertheless declined significantly due to the smaller

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CHEMISTRY IN EVERYDAY LIFE
Chemicals can be found in many products of everyday life

amount of adhesive. Since buildings have become more air tight to save energy, this reduction is no longer sufficient. Today, the carpet industry can produce almost odour-free wall-to-wall carpets using melt or dispersion adhesives. A next step in innovation is represented by robust wall-to-wall carpets that do not have to be bonded. This technique takes another step towards sustainability because, in addition to a longer life cycle, there are no adhesive residues to be removed.

MORE TRANSPARENCY BY REGULATED DECLARATION

To visualise the effects of chemicals, there is a globally harmonised system for classification and labelling of substances (Globally Harmonised System – GHS), which is implemented in Europe by the so-called CLP (Classification, Labelling, Packaging). A prerequisite is information and data on the hazardous properties of substances (for example, environmental hazard, explosive or mutagenic properties of a substance) specified by the REACH Regulation. In the future, there will be a directory at the European Chemicals Agency in which the various classifications of chemicals are stored and thus their effects become more transparent to all stakeholders, authorities and ordinary people.

The requirements for declaring chemicals in products have proved to be key instruments. They exclude no substances but create an increased awareness in manufacturers and their customers of the substances used and frequently trigger long-term changes. This allows for consumers to intentionally avoid certain substances. The full declaration which specifies all ingredients e. g. in cosmetics, must be distinguished from the declaration of individual substances with certain functions e. g. in biocides. From UBA's perspective, a full declaration may also be useful for building products and textiles. As a first step, substances of very high concern (SVHC) as per REACH should be stated clearly on the products. To date there is only a legal right for information which presupposes an active inquiry by the consumers.

STRENGTHENING CORPORATE RESPONSIBILITY

A government framework and corporate responsibility are needed to enhance product safety and consumer protection. The chemical industry has taken considerable efforts in the past two decades to improve the negative image caused by hazardous substances in consumer products. These initiatives are part of the success of active and anticipatory self-regulation of the chemical industry. However, they were often introduced as reactions to significant problems that had occurred in the environment, workplace and in the consumers as a result of dealing with chemicals. However, the substitution of hazardous chemicals in materials is no less inherently risky. Sometimes alternatives to harmful chemicals turn out to be unsustainable.

Example: refrigerants for car air conditioners. Today, more than 96 percent of all new vehicles in Germany are equipped with air conditioning. Car air conditioners now contain a partially fluorinated hydrocarbon as a refrigerant (R134a) which significantly contributes to increasing the greenhouse effect. Currently, about 30 percent of global emissions of partially fluorinated hydrocarbons stem from car air conditioning systems. Therefore, this refrigerant was replaced in new vehicles in Europe from 2011 onwards with a less harmful substance. For a long time the automotive industry relied on carbon dioxide (CO_2) as refrigerant, an environmentally friendly and climate-friendly so-

lution with a high innovation potential. After all technical developments had been completed and the new types of air conditioning systems were to be built in large numbers, a chemical producer presented the new refrigerant tetrafluoropropene (R1234yf). However, this material has a number of problems which are hard to solve (flammability, hydrogen fluoride generation in case of fire, long-term stability, lower energy efficiency) [16]. If all cars were equipped with tetrafluoropropene-containing air conditioners world-wide, in the future, several 100,000 tonnes of alga-toxic and stable trifluoroacetic acid, a photochemical degradation product, could be released every year and get into the waters and accumulate there – an unsustainable and unnecessary burden. However, problematic consequences would also result for the global climate if the currently used less expensive R134a but extremely climate destructive material was used as a replacement refrigerant in new equipment. This would not be technically possible for car air conditioning systems currently using CO_2 as the refrigerant.

ESTABLISHING ENVIRONMENTAL STANDARDS IN GLOBAL MARKETS

To shape chemical manufacturing and treatment processes more sustainable, companies need to develop their production processes and use innovative approaches to technology. Corporate investment in environmental policies pays for itself over the medium and long term. Those who manage with smaller amounts of resources such as energy and water can reduce their operating costs thus strengthening their competitiveness. Also, the cost of wastewater and waste gas cleaning is less because if the amount of pollutants can be reduced in advance, the cost of cleaning is less.

The European Union directive on industrial emissions regulates the approval of particularly environmentally damaging industrial installations based on an overarching principle. In view of European harmonisation of best available techniques (BAT), Article 13 of the Directive envisages an information exchange. The technical work is undertaken by technical working groups in which experts from the authorities of the Member States, industry and environmental organisations are collaborating. The results of the information exchange are recorded in BAT reference documents (BREFs) and the approval conditions are specified based on this. In addition to eight BREFs in the chemical industry, a number of other reference documents have been prepared such as those for the textile industry.

The European BAT reference documents can generally be used worldwide. For example, the International Finance Corporation (IFC) – a World Bank subsidiary and the world's largest private lender to industrial projects – created industry-specific guidelines based on BAT. The IFC requires its borrowers to take account of environmental issues in their projects based on these guidelines. Yet those improvements mentioned in the BREFs still do not dominate in emerging and developing countries. Therefore, UBA is not only working at a national and European level but also at an international level on environmental standards for industrial facilities in order to affect a move towards a more sustainable production.

12 CRITERIA TO ESTABLISH THE BEST AVAILABLE TECHNIQUES

- The use of low-waste technology,
- the use of less hazardous substances,
- the furthering of recovery and recycling of substances generated and used in the process and of waste, where appropriate,
- comparable processes, facilities or methods of operation which have been tried with success on an industrial scale,
- technological advances and changes in scientific knowledge and understanding,
- the nature, effects and volume of the emissions concerned,
- the commissioning dates for new or existing installations,
- the length of time needed to introduce the best available technique,
- the consumption and nature of raw materials (including water) used in the process and energy efficiency,
- the need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it,
- the need to prevent accidents and to minimise the consequences for the environment,
- information published by public international organisations.

ENVIRONMENTAL STANDARDS IN TEXTILE AND LEATHER PRODUCTION

In addition to the chemical industry, clothes and shoes are important examples of the globalisation of production and consumption. Their mass production in emerging and developing countries causes considerable problems for the environment and social structures. Thus, for example, regional water resources are heavily contaminated by chemicals used in textile finishing and tanning. Large retailers and brand companies are key players in promoting the application of BATs in emerging and developing countries. They serve as a crucial link between environmental requirements for consumers and producers.

Together with retailers and brand companies and citizens' groups, UBA published the guideline "Environmental standards in the textile and shoe industry" in 2011. Its content is based on European BAT reference documents. The objectives of the guide are to extend the knowledge and cooperation of all companies in the supply chain and harmonisation of environmental standards around the world at a high level. The booklet covers topics such as energy, water and chemicals and specifies saving potentials for these resources. The bottom line for companies is: environmental protection is worth it!

PHARMACEUTICAL AGENTS – DO NOT RELOCATE RISKS ABROAD

An increasing number of pharmaceutical agents threaten the ecosystems and the quality of drinking water: more than 100 pharmaceutical agents have been detected in rivers and lakes, in the groundwater, soil and oceans [17], [18]. Sewage treatment plants only remove small amounts of these substances. Unlike pesticides, pharmaceuticals are used throughout the year and discharged into the environment. They exert their effects in the environment even at low concentrations: the contraceptive hormone ethinyl estradiol has an effect on fish even at a concentration below two nanograms per litre (ng/l) [19].

PHARMACEUTICAL AGENTS
More than 100 pharmaceutical agents have been detected in waters and soils

Environmental effects have so far usually been ignored in research and development of pharmaceuticals. The majority of pharmaceutical agents are difficult to biodegrade and they spend a long time in water, sediment or soil where they still exert their effects. Scientists, supported by UBA, are working on the concept of more sustainable pharmaceuticals that are readily biodegradable (Green Pharmacy). One has already had success with a cancer medicine without impairing its effect [20].

Pharmaceutical agents are now being produced, mainly in developing and emerging countries, where problems arise due to high concentrations of the agent in the environment [21]. At one location in India, they are found in river water at the milligram-per-litre range, and in well water at more than 100 times above the European groundwater limit for veterinary pharmaceuticals. As a result, antibiotic resistance genes in humans and animals can proliferate and spread world-wide [22]. In Sweden, experts inform patients about the social and ecological consequences of pharmaceutical production in developing countries [23], [24]. They are looking for ways to consider this when buying pharmaceuticals. UBA supports the Swedish initiative to regulate the environmental impacts of pharmaceutical production at a European level by legislation and guidelines. Therefore, knowledge about the behaviour of these agents in the environment is important. UBA assesses the environmental impact of new animal and human medicines in the approval procedure. The issue of BAT in global markets should be further promoted for which assistance and professional exchange can be offered to authorities in supplier countries in the implementation of environmental standards.

CHEMICAL ACCIDENT IN BHOPAL
Demonstrators remember the consequences on the 25th anniversary of the poison accident

RESPONSIBLE BEHAVIOUR OF THE CHEMICAL INDUSTRY

On 3 December 1984 a fatal chemical accident occurred in the Indian city of Bhopal in a subsidiary of Union Carbide India Ltd. Because of numerous defects, errors and non-functioning safety systems, a gas cloud of 20 to 30 tons of the highly toxic intermediate product methyl isocyanate escaped into the atmosphere. In the first week, at least 2,500 people died and 500,000 were injured, some of them seriously. Many years later, up to 50,000 people were disabled as a result of the accident and there was a higher mortality rate in the population. At the time of the accident, about 700,000 people lived in Bhopal, 130,000 of them in the immediate proximity of the factory. This accident has been the worst chemical disaster to date.

The Bhopal disaster triggered world-wide activities to make chemical plants safer. As a result of a previous incident in the Italian town of Seveso in 1976, Germany created the Hazardous Incident Ordinance in 1980 and the EU the so-called Seveso Directive in 1982, thus establishing an overarching safety law. The Hazardous Incident Ordinance requires a stringent safety policy to prevent accidents or mitigate their effects. Systematic safety analysis studies of industrial production methods and facilities are now standard.

The industry itself has responded to the increasing insecurity and fears of people about the chemical industry and its products to prevent harm. Following the Bhopal disaster, the initiative "Responsible Care" was introduced in Canada which established guidelines and principles for responsible practices by chemical companies. They take into account health, environmental and safety issues both in the development of new products and processes and in dialogues with buyers, processors and users. More than 20 years ago, the Association of Chemical Industry (VCI) pledged the principles of "Responsible Care". The International Council of Chemical Associations published the "Responsible Care Global Charter" at the international level in 2006. Implementation of these policies, however, is at the company's discretion. The Federal Environment Agency welcomes this initiative of the chemical industry, but it also sees the need for making the rules binding because although voluntary agreements can complement regulatory specifications, they cannot replace them.

DEALING WITH RISKS – PLANT SAFETY AND ACCIDENT PREVENTION

Companies where dangerous substances are present or may arise, have the responsibility to prevent incidents such as explosions, fires and release of these substances. Should this happen nevertheless, they must limit the impact. In Germany, this is regulated by the Hazardous Incident Ordinance (12th BImSchV), while the Seveso Directive is valid at the European level. These regulations have been adjusted several times within the sphere of safety technology. Currently, the Seveso Directive is being amended by adapting it to the new legal classification of chemicals. In Germany, reportable events are reported to the Central Reporting and Evaluation Authority for Events in Processing Plants (ZEMA) at UBA. UBA processes the data and makes them available to operators, regulators and the public via the Internet. Increased safety is achieved when companies evaluate and communicate smaller events and near misses.

Given the global reach of the chemical industry, an international harmonisation of safety requirements is imperative. The OECD therefore issues guiding principles for the prevention, preparedness in the event of and control of chemical accidents. It makes recommendations for requirements on the safety culture in companies, safety management, emergency planning and limiting the consequences of accidents, systematic learning from accidents, public participation and international cooperation which have also gained significance for sustainable chemical production outside the OECD member states.

Companies in developed countries must also take responsibility for the safety of their chemical plants in less developed countries. Safety standards must not be lower than in Europe or North America. For this purpose guidelines were developed by the OECD and the Economic Commission for Europe of the United Nations (UNECE). These require the same safety level for local investments as in developed countries. This also applies to German companies.

In recent years, the importance of the theme "environment-related hazards" such as earthquakes, floods and storms has increased for the prevention of major accidents in view of climate change. UBA directs the Working Group "Natech" (Chemical Accidents Triggered by Natural Hazards) of the OECD "Working Group on Chemical Accidents" and will organise an OECD workshop "Natech Risk Management" in 2012. The Commission "Plant Safety" has already adopted the technical rules "Rains and Floods" in which requirements against these hazards are identified taking into account the consequences of climate change.

The development and selection of processes should in particular be checked by companies and, if possible, the risk potential reduced. To achieve this, hazardous substances may be replaced with less dangerous or entirely harmless ones, their amounts reduced thus avoiding dangerous process conditions such as high pressures or high temperatures and facilities and processes simplified. Some examples suggest that the principles of "inherent safety" may be comprehensively implemented and UBA will investigate this issue further.

In accidents involving water contamination, international implications must also be taken into account. UBA is heading a few international river basin commissions and, based on their safety recommendations for accident prevention and plant safety, a guideline for the training of inspectors has been compiled which has been successfully used in both Eastern Europe and in the education of Chinese inspectors. On the occasion of the 25th anniversary of the accident at the Sandoz chemical company, UBA organised in 2011 an international conference under the auspices of UNECE to display the results achieved in this area and identify any remaining gaps.

PLANT SAFETY

Preventing what must not happen: this is regulated in Germany by the Hazardous Incident Ordinance

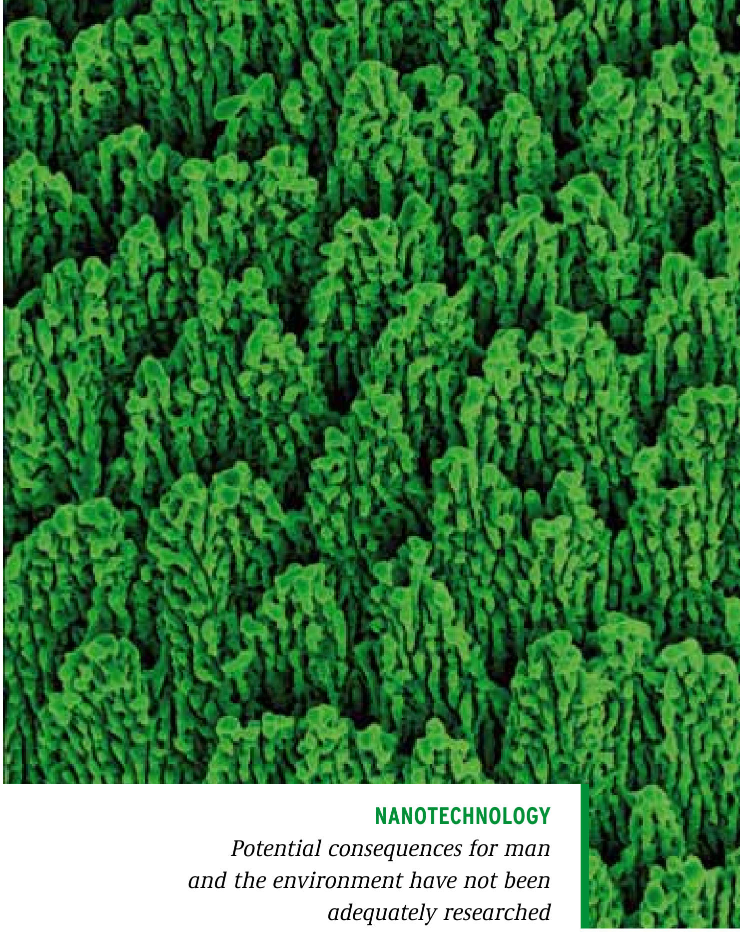
SUSTAINABILITY CHECK FOR PRODUCTS CONTAINING NANOMATERIALS

Nanotechnology is the manufacture of materials of less than 100 nanometres in size and their use in various processes. One nanometre is one millionth of a millimetre. Physical and chemical properties of materials change at this scale which gives rise to new products and applications. To develop nanotechnology responsibly, risks must be avoided and support given to the process of sustainable innovations in the sense of the precautionary principle. For this purpose an integrated approach must be developed based on key fundamentals to enable an adequate assessment of the risks and benefits in spite of possible knowledge gaps. Such an approach may help companies in taking decisions about new technical applications. It will also help authorities in the approval of such products or the funding of research projects.

In its second work period (2009–2011), the Federal Government's NanoCommission developed the basis of a guideline for the comparison of the benefits and risks of nanotechnology products [25]. This should reasonably estimate the benefits and risks of products containing nanomaterials, despite potential gaps in the data. Several criteria in the categories of environment, consumers, employees, society and business must be taken into account, which consider the different phases of the life cycle (production, use and disposal).

Commissioned by UBA, the Darmstadt Öko-Institut (Eco-Institute) has developed a so-called nanosustainability check. This has created a uniform pattern which can identify environmental pressures and reliefs, but also risks and challenges for the launch of products containing nanomaterials. There is an evaluation grid in the centre of this nano-sustainability check that analyses the nanoproducts in comparison to a reference product (a product without nanomaterials, but with the same application). Using 14 key indicators, potential environmental and sustainability risks can be identified. Key indicators include for example the carbon footprint to determine the greenhouse gas potential, energy efficiency, recyclability, health and safety, practical function and life cycle costs.

The nano-sustainability check is primarily intended for internal assessment in companies. Its results provide a basis for discussion and a compass for the strategic optimisation of nanoproducts. These two instruments help the initial estimation of risks and benefits of nanoproducts and promote a transparent and objective discussion. A comprehensive assessment of risks and benefits remains subject to further tools (LCA, regulatory risk assessment). From UBA's point of view these instruments must be adapted to nano-specific issues in the future.



NANOTECHNOLOGY
Potential consequences for man and the environment have not been adequately researched

INITIATIVE FOR THE ADVANCEMENT OF HUMAN BIOMONITORING

Human biomonitoring (HBM) is the best method to investigate the actual physical exposure of the population to hazardous chemicals. It provides a central information and control instrument for health-related environmental protection. HBM provides environmental policy with scientifically sound data on the following questions:

- Whether and in what concentrations substances are absorbed by the human body? And do they place a burden on it over the long term?
- Are certain population groups (e. g. children) particularly burdened?
- Have bans or restrictions on use of substances actually reduced population exposure?

The German initiative for the development of HBM is based on a cooperation agreement signed between the Federal Environment Ministry and the German Chemical Industry Association (VCI) in February 2010. In the next ten years, the VCI will develop suitable detection methods for up to 50 new substances, which UBA will be able to use for studying the impact on the population. There are substances in the centre of the cooperation to which the people in Germany may be particularly exposed to or which may be highly relevant to health, but have not been able to be detected in the human body for lack of suitable detection methods. The first candidates include plasticisers used in plastics and materials used in consumer products.

NANOMATERIALS IN PRODUCTS
The tiny particles serve for example as UV filters in sunscreens

The development of detection methods is a laborious and expensive process. It is all the more remarkable that the Environment Ministry and VCI want to improve the knowledge about the real burden placed by important industrial chemicals on the general population in a unique collaborative project between government and industry. The cooperation will initially be tested in a three-year pilot phase.

SUSTAINABLE CHEMISTRY – INDUSTRY'S ROLE

Sustainability in chemistry is not possible without standards to protect the environment and human health. The concept will only be successful if information on the effects and safe applications of chemicals are known and passed on through their lifespan. The affected companies, organisations, their customers, environmental and consumer organisations, academia and authorities must pursue this objective together. Communication for sustainable management of chemicals is a challenge in the globally networked economy when the issue is the development of a global green economy.

Many chemical companies meet this responsibility. At the same time they invest in research, development and innovation. Large companies are investing in strong brands whose quality and safety are trusted by their customers. The German chemical industry describes itself as a major economic engine of innovation in German industry. It contributes 17 percent to the total expenditure for research and development [26]. Innovations relate to the full range of products, customer and market relations, processes and organisation [27]. At the same time the length of the innovation cycles has shortened in recent years, due both to high economic pressure and higher standards for environmental health. This will also help the growth of sustainability in all areas dealing with chemicals. The increasing demands of customers and the public towards safe and low-risk products constitute the drivers in this respect.

Innovation does not necessarily mean greater sustainability. It is Important that all players in the supply chain agree that the direction of development of innovations must be determined by sustainability targets. However, it's not only technical measures and innovative products that count for the sustainable management of chemicals. It is also necessary for companies to assess their business activities and their overall impacts. They are also responsible for long-term effects on the environment and for labour and consumer protection. For this purpose they must adjust their operational management sustainably and include information on the value chain. Sustainability applies to all sites and thus to social impacts in less developed countries. Here, for example, child labour and damage to health and the environment must be avoided. Industrial standards can help assess and enforce business activities. In sum, sustainable business has a positive effect on competitiveness and the future of the German chemical industry and on employment.

SUSTAINABLE CHEMISTRY – THE ROLE OF ENVIRONMENTAL POLICY

Sustainable chemistry does not succeed automatically despite its economic advantages. Barriers do exist, for example, when available alternatives and their benefits are not known. Long development times, low chances of success, high investment costs and long-term returns are such barriers. Pilot plants or prototypes that have not been adequately tested also have negative effects. Companies switch their production if regulations or broadly agreed standards force them to. Policy must specify the management of chemicals in the supply chains to promote the trend towards sustainable development.

Many environmental problems cannot be solved at the national or EU level, but require global approaches. This is true not only for climate protection or the conservation of natural resources, but also for the sustainable management of chemicals. A global approach is necessary because numerous products are manufactured outside the EU and placed on the European market – without adequate standards for the protection of natural resources, the environment and health. These include the textile and leather industries whose production now takes place for the most part in Asia – often under poor conditions in terms of labour and environmental protection. Textile and leather industries do not really belong to the chemical industry, however, the environmental and health hazards are caused by chemicals. Thus they are an example of production for which the sustainable management of chemicals is of importance.

A remedy can only be achieved in the long run by sophisticated and harmonised global standards within international and recognised binding agreements. They should internationally enshrine legal principles for the protection of the environment and health. To achieve this, the rules of world trade must also be adapted. They must not be limited to the one-sided protection of free trade. The GATT agreement of the World Trade Organisation (WTO) [28] recognises national standards to protect the environment and health if they do not unilaterally provide an advantage to the local economy [29]. This requires an improved cooperation between trade and environmental agreements. The beginning of this happened in 2001 at the Fourth Ministerial Conference in Doha, however even after ten years, the work on the coherence task still remains.

The foundations on which global chemicals management developments are based remain the decisions made in the UN Conference on Environment and Development in 1992 in Rio de Janeiro: Chapter 19 of Agenda 21 describes the environmentally sound management of toxic chemicals, including illegal international transport of toxic and hazardous goods. This global conference produced a number of international initiatives and agreements about chemical safety:

- Globally Harmonised System (GHS) for uniform global classification and labelling of chemicals,
- regulations of the Stockholm Convention on Persistent Organic Pollutants (POPs),
- Rotterdam Convention on Prior Informed Consent (PIC) procedure of the recipient country in exports of chemicals to regulate the international trade in hazardous substances,
- Basel Convention on control of transboundary transport of hazardous waste – and hence of used chemicals – and their disposal.

The Montreal Protocol to protect the ozone layer which regulates ozone-depleting substances has been in existence since 1987. Another international legal instrument will ensure that the entry of mercury into the environment will be avoided from 2013. OECD's programme for environmental, health and safety also plays an important role. The participating states have developed and validated internationally recognised test and measurement methods for chemicals and guidelines for the mutual exchange and acceptance of data (Mutual Acceptance of Data, MAD) since 1971. This establishes conditions for coordinated action to achieve sustainable chemical management for the benefit of industry and authorities.

The Strategic Approach to International Chemical Management (SAICM) is an attempt by the international community to achieve the target defined by the World Summit in Johannesburg – i.e. to reduce the deleterious effects of chemicals on the environment and human health by 2020. Thus a comprehensive, global system of improved chemical safety will be established. The numerous individual initiatives should be merged. Although the instrument is not legally binding, the community of states will evidently find ways for world-wide implementation.

In the future, the various initiatives for sustainable chemical management must be linked at the global level. The aim of the policy should remain to establish high standards for test requirements, evaluation benchmarks, best available techniques and environmental protection practices at the global level for an overall sustainable chemical management.

CONCLUSION AND OUTLOOK

Global management requires an internationally sustainable development of chemistry and a more sustainable use of chemicals. All stages of the life cycle of chemicals, i.e. production, use and disposal, must be carefully examined.

We must question our economic activities and our consumption patterns. For this we can create alternatives or even completely change our habits if they are not viable for a sustainable future.

For this purpose, indicators and benchmarks for assessing the sustainability, sophisticated standards for data requirements, assessment standards and best available techniques and environmental protection are needed at the global level.

In the future, industry must not aim simply at producing and marketing vast quantities of chemicals, instead, function and service must be in the fore as a complete package. This requires a paradigm shift that can be easily formulated, however, this too raises many questions of practice. To find good solutions, the interaction of all stakeholders around the world is needed, as no isolated solutions are possible in a globally interconnected green economy. The affected industries – especially the chemical industry – must play a major role in shaping chemistry as an element of a more sustainability economy. UBA will contribute its knowledge and insights to this process.

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(IV 1.1 "International Chemicals Management")

CONTRIBUTING SECTIONS:
II 1.2 "Toxicology, Health-related Environmental Monitoring"
III 2.1 "General Aspects, Chemical Industry, Combustion Plants"
III 1.4 "Substance-related Product Issues"
III 2.1 "General Aspects, Chemical Industry, Combustion Plants"
III 2.3 "Plant Safety"
IV 2.2 "Pharmaceuticals, Washing and Cleansing Agents"
IV 2.3 "Chemicals"

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THE FEDERAL ENVIRONMENT AGENCY

CITIZEN INQUIRIES, VISITORS, BOOKS

Informing the public about virtually all aspects of environmental protection is a prime responsibility of the Federal Environment Agency (UBA). People have been showing a great interest in obtaining information on a wide variety of environmental issues for many years. More than 100,000 requests reach UBA's Citizens' Service annually. Most of them can be answered by the information material made available by UBA: each year about one million brochures, leaflets and booklets are distributed. The remaining questions are answered by the Citizens Service's six-member team in cooperation with UBA's experts.

Citizens' inquiries from 2005 to 2011

Year	Number of inquiries to the Citizens Service
2005	103,743
2006	109,931
2007	114,180
2008	100,829
2009	132,766
2010	102,019
2011	107,131

Since June 2011, a number of UBA's topics have also been available by calling 115, the general phone number for inquiries to public authorities. Information provided by UBA via this government hotline includes issues such as air quality in Germany, disposal of energy saving lamps as well as access to environmental information under the Environmental Information Act. The government hotline number 115 was launched by the Federal Government and provides wide-range information on services by municipalities and by authorities at federal and Federal State level. The aim is to answer people's inquiries, if possible, on the first call in a standardised form and independently of regional competencies.

115
IHRE BEHÖRDENNUMMER

Source: D 115

VISITORS FROM HOME AND ABROAD

The number of visitors demonstrates the interest of ordinary people towards UBA as a scientific authority. In 2011, about 4,500 guests, including 90 delegations from abroad, inquired about ecological, aesthetic and energy-efficiency aspects of the Agency's office building in Dessau-Roßlau. The curvy building with its characteristic multi-coloured façade is a shining example of an environmentally friendly and accessible way of building and has become a landmark of the Bauhaus city.

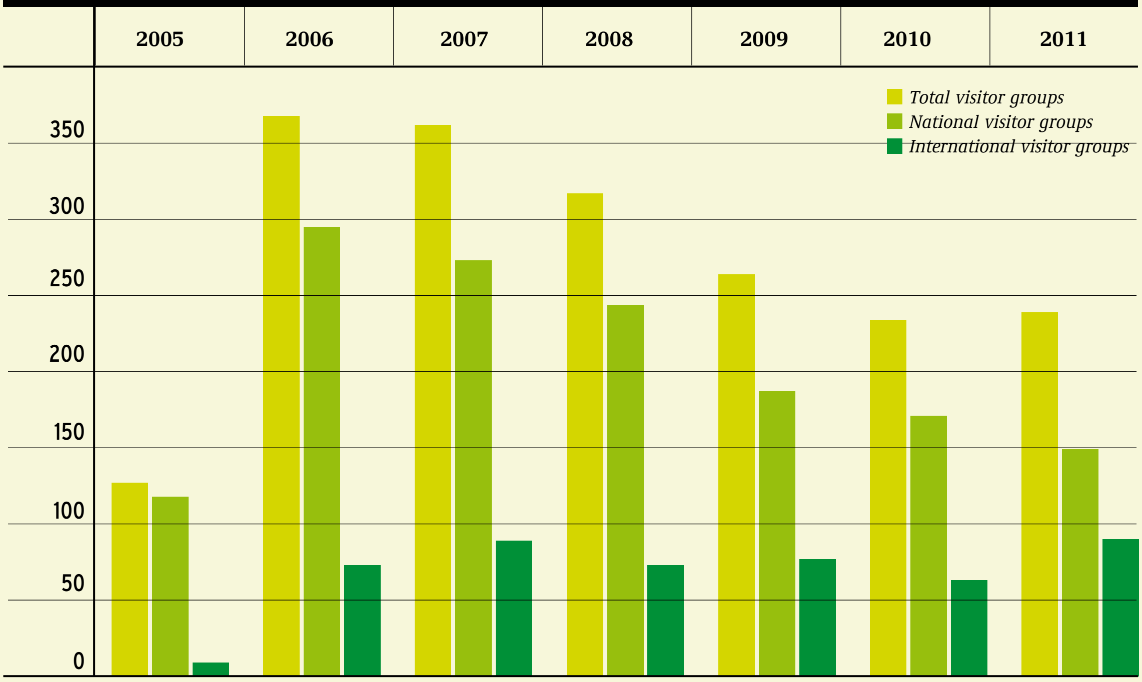
UBA's office building also enjoys popularity as an event venue. The Auditorium, which seats up to 380 visitors, and the Forum are often used for conferences and cultural events such as exhibitions, readings and concerts. The 1st Natural, Animal and Environmental Protection Day on 7 May and the Annual General Meeting of the Society of the Friends of the Dessau-Wörlitz Garden Landscape on 21 May 2011, which drew about 300 visitors, are some of last year's highlights.

THE LIBRARY: CONCISE ENVIRONMENTAL KNOWLEDGE

With over 400,000 items of media, UBA has the largest library among the German-speaking countries. It provides up-to-date information and extensive literature to Agency staff and the general public. It covers a wide range of subjects from general to specialist literature with relevance to the environment – chiefly in printed form. But the number of electronic media such as e-books, e-journals is steadily increasing and the library is being converted into a hybrid library with the aim of positioning it successfully as a specialised library and meeting the users' expectations. All titles can be viewed via the Internet in Opac, the library catalogue.

The Dessau, Berlin and Bad Elster branches offer plenty of room for quiet private study and intensive group work. The environment library organises special activities to bring environmental issues close to children and young people. The library has trained specialists in media and information services for many years. About 14 trainees are regularly trained at UBA's three library sites.

Visitor groups in UBA from May 2005 to December 2011



Source: UBA

ART AND ENVIRONMENT

For more than 25 years, the Federal Environment Agency (UBA) has regularly invited artists to present environmental work at the Berlin-Grunewald branch and, since 2005, in Dessau as well, and to contribute to the dialogue between environmental science, environmental politics and art. This collaboration means to us that we will have to enter into a programme of developing new forms of perception and knowledge for our themes. Many artists in their work are now dealing with the global threat of climate change, the wasting of resources, excessive consumption, the destruction of the rainforest or biodiversity loss, to name only a few problem areas. In the social process of communication about future opportunities and sustainable development in our society, the artists' work has a special status: they can sensually express and communicate ideas, visions and existential experience in a universally understandable language, in symbols, rituals, signals and images.

LOOKING BACK ...

The exhibition "Recommended to mimic – Expeditions in aesthetics and sustainability" which was shown in spring 2011 at UBA's premises in Dessau and in Bauhaus, raised awareness of the fact that sustainability does not develop without the arts and sciences: they teach thinking in terms of transitions, temporary solutions, models and projects. More than 40 creative people from Germany and abroad showed artistic practices that contribute to the preservation of the planet, have an influence on consumer awareness and are economically viable. The boundaries between art, science, environmental action and technical invention were fluid. In his installation "Avatar incarnation cRdxXPV9GNQ", Michael Saup for example visualised the harmful carbon dioxide emissions generated by the unrestrained use of the Internet. The melting ice sculptures of Néle Azevedo, a native of Brazil, and the "World Climate Refugee Camp" of Herman Josef Hack pointing to the growing number of climate refugees created direct impressions of the consequences of climate change. Various contributions such as "Cars to bicycles" by Folke Köbberling and Martin Kaltwasser were dedicated to re- and up-cycling of products. The Swiss artist Cornelia Hesse-Honegger showed accurate drawings of mutated insects (especially bed bugs) she had collected in the vicinity of nuclear power plants. "Adopted" by Gudrun F. Widlok is one example of an unusual social project, mediating a symbolic adoption of European singles by large Ghanaian families.

For the 2011 summer holiday season, UBA presented Andrea Böning's works in the exhibition "out at home II" in Dessau, reflecting critically on the significance of nature and landscape in tourism and modern leisure culture. Andrea Böning re-organised image clichés and stereotypic character systems, ironising and visualising them in this way. It was the realms of camping and indoor climbing from which the artist took materials, shapes and surfaces for the presentation at UBA to re-arrange them in an irritating fashion using photography and installation. Snow-covered mountain ranges were superimposed by stunted palms of artificial holiday paradises in collages; climbing walls with colourful handles, mimicking mountain slopes, created spheres in space; sewn-together tents without entrances and exits were transformed into sculptures and miniature landscapes in installations.

ON THE BEACH

Andrea Böning deliberates on the significance of nature and landscape in tourism

WATERLINES
A blue line simulates the forecasted rise in sea level in Martin Jehnichen's photographs

... AND FORWARD
In the "Urban GREEN & Urban CULTURE" exhibition from February to March 2012, the environmental artist Dieter Magnus from Mainz showed built contributions and ideas for sustainable urban development. At the same time he envisages the artist's role in the urban area as a designer of urban spaces and as an initiator and mediator of city planning games with citizens and students. The exhibition illustrated the connection between art and nature on 45 panels using examples from past and present and visions for the future. The exhibition started in Dessau and will travel throughout Europe for several years. In the summer of 2012, UBA will show the results of this year's international Herford Recycling Design Award. The award has been sponsored by the Recycling Working Group since 2007 and is the only nationwide competition which addresses resource conservation and carbon reduction in design. The spectrum of sought-after developments ranges from decorative items, furniture and clothing/textiles and accessories. The aim is to discover the "hidden meaning of things discarded" and make them usable.

For the autumn, an exhibition of Martin Jehnichen's works is being planned. The Leipzig photographer's project "Waterlines" visualises the expected global rise in sea level: on Jehnichen's photos, a laser projects a blue line to show the height of the forecasted water level in 2100. This line runs right through the middle of our lives – through the life of the Amsterdam clerk, the Maldives fisherman and the life of the Xing family on China's east coast. What does one metre sea level rise mean for the cities of Hamburg, New York, Buenos Aires, Maputo, Jakarta, Hong Kong, Tokyo? What will our coasts look like and how will river valleys change? In addition to an artistic investigation of this threat, Jehnichen also intends to produce records. Towns, villages and countryside will be destroyed or will disappear in a rather short period of time. A specific documentation of the current state of these areas is part of the photo project. As "work in progress", pictures will be made in 30 places around the world in the next two years. The blue line will cut through landscapes, families and homes. It will not stop before cultural monuments, infrastructure projects, dams or fields. The venue is a mobile shipping container which will be placed at the entrance of UBA's office building in Dessau.

IMITATION RECOMMENDED
On an expedition into the world of sustainability

SUSTAINABLE CONSTRUCTION

Buildings contribute significantly to CO_2 emissions and use a large amount of resources. Therefore the Federal Environment Agency (UBA) wants the construction and operation of its buildings and property to become a model for other developers in the public sector in terms of environmental protection and sustainability. All building and reconstruction projects fulfill or exceed the requirements that UBA demands from third parties in various action areas. Thus UBA pursues the standard of zero-energy or plus-energy buildings that produce as much or more energy than they consume over the year. Of equal importance is to make best use of the building to conserve resources. To make sustainable building a success, these requirements must be considered throughout the entire process from design to operation. Comprehensive monitoring can ensure the success and quality of the projects.

RECONSTRUCTION AND REFURBISHMENT OF THE OFFICE BUILDING IN BERLIN

The Federal Agency for Building and Regional Planning put out an urban design tender in August 2010 for the reconstruction and refurbishment of the office building in Berlin on behalf of the Federal Office for Real Estate Management and UBA. In February 2011, the winners were announced and commissioned to carry out the project. In addition to spatial and functional aspects, the building should achieve the new building standards stipulated by the amended Energy Saving Ordinance (EnEV 2009). To ensure consistently good and healthy working conditions for UBA's staff, materials in the existing building will be critically examined and environmentally sensitive building materials selected. Also, the building's substance will be protected to maintain the high standards of monument protection.

The installation of laboratories represents a particular challenge. Their typically high energy consumption will be reduced as much as possible by energy-efficient equipment and on-demand control of laboratory operations in building automation. The aim of this project is the gold quality seal, the highest achievable of the "Sustainable Building Rating System" (BNB) of the Federal Government which has so far been limited to new building projects. Therefore, another task is to define a gold standard level in the current planning process for refurbishment in various action areas.

EXTENSION BUILDING IN DESSAU-ROSSLAU

In Dessau-Roßlau, an extension office will be built to cope with about a hundred new jobs. For this, a plot adjacent to UBA's current site was purchased in 2010. Similar to the existing building, the extension should become a model project for sustainable construction. The objective is to build at least a zero-energy or even a plus-energy building. In December 2011, the State Office for Building and Construction put out a multi-disciplinary design tender. From a preliminary qualification competition, up to 25 design collectives of consulting architects and engineers have been invited to submit a design bid for this task. The winners of this contest will be announced in August 2012. The new building is scheduled for completion in 2015.

NEW GARMENT

The office building in Berlin-Grunewald will be completely refurbished and modernised

Design image (View from the patio) byGeneralplanungsgesellschaft mbH

BUILDING 2019
The total energy for the operation of the new office building will come from renewable sources

ZERO-ENERGY BUILDING IN BERLIN-MARIENFELDE

The construction of a replacement office building at the Marienfelde site in Berlin started with laying the foundation stone on 7 November 2011. This branch accommodates water research laboratories and associated offices. The “Building 2019” should emerge at minimum as a zero-energy building using timber panel construction technology which meets the requirements of the European Union’s Directive on overall energy efficiency of buildings, valid from 2019. In May 2010, the planned building received the prize of “Climate Protection Partner of 2010” from the Berlin Chamber of Commerce and Industry. Power will be supplied by photovoltaic and heat pumps that use the energy content of water provided for ponds. In addition to high quality requirements in terms of energy, great emphasis is placed on ecological aspects: non-toxic building materials will be used and the entire structural work, including façade, will be made of wood, a renewable raw material. To quickly achieve optimum operation and meet the targets, UBA will perform comprehensive energy monitoring. The building will be completed by the end of 2012 and provide space for 30 employees in attractive offices.

ENERGY REFURBISHMENT OF MONITORING STATIONS

In addition to these projects, UBA’s monitoring stations will be brought to the latest energy standard by 2015: thermal protection of the building and efficiency of equipment should be improved and power should be mainly generated on site by photovoltaic systems. The first photovoltaic systems are already working in Neuglobsow and Waldhof, another plant will follow in Westerland at the end of 2011. In addition to energy enhancements, areas will be used more efficiently due to the improvements, thus floor space can be reduced. The Schauinsland and Zingst monitoring stations should get new buildings to meet zero-energy building standards. Although the number of jobs in the monitoring stations rises and the demand for working comfort increases, these improvements will reduce energy consumption and the release of emissions. Continuation of EMAS (Environmental Management and Audit Scheme) at all sites will also cover other action areas (resource efficiency, material efficiency, water, waste, emissions, biodiversity) and promote the continuous monitoring and improvement of the environmental situation within the management and operation of the buildings.

FACTS AND FIGURES

The Federal Environment Agency is Germany's central environmental protection authority. Established in Berlin in 1974, the Federal Environment Agency has had its headquarters in the Bauhas city Dessau-Roßlau since May 2005. It has – in addition to the administration department – five divisions with 13 departments and employs nearly 1,500 people in about 1,124 posts on 13 sites – seven of them measurement stations of our own Air Monitoring Network. They are manned by 432 civil servants and 692 employees. Nearly 800 people are employed in Dessau-Roßlau. Besides "pure" scientific work, the enforcement of environmental law – for example the Chemicals Act or the Greenhouse Gas Emissions Trading Act – and providing information on environmental protection issues are other key areas of our daily work. The Federal Environment Agency is partner and Germany's contact point for numerous international institutions, for instance the World Health Organisation (WHO) and the European Environment Agency.

Budget of the Federal Environment Agency

	Expected in 2010 in 1,000 Euro	Expected in 2011 in 1,000 Euro
I. Budget of the Federal Environment Agency		
I.1 Total expenditure	**101,689**	**102,938**
To		
Personnel	68,246	66,643
Investment	3,925	3,539
Administration	29,240	32,395
To		
Scientific publications and documentation	429	434
Environmental information and documentationsystem (UMPLIS)	5,468	4,862
Information technology	6,246	6,927
I.2 Services provided to Federal Institutes and third parties		
Federal Institutes (actual expenditure)	-	-
EU, others (actual expenditure)	-	-
II. Managed funds transferred from other chapters for distribution		
To		
Investments towards pollution abatement	167	-
Allocation of funds for research projects (UFOPLAN)	21,700	25,000
Environmental Specimen Bank	4,331	4,331
Grants to associations, federations, etc.		
support for institutes	1,279	1,279
support for projects	6,077	5,834
Educational measures	1,020	950
Environmental protection consulting for countries in Central and Eastern Europe and the Newly Independent States (NIS)	2,250	2,100
International co-operation	603	480
Sum total of funds transferred for distribution from other chapters	37,427	39,974

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