

# WHAT MATTERS 2013

➤ Construction and housing: Homes of tomorrow and beyond ➤ Noise: Leaf blowers and engines ➤ Protection of the marine environment: A blue economy – Threat or opportunity for the oceans?

Annual Report of the Federal Environment Agency

Umwelt  
Bundes  
Amt   
For our Environment



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➤ Construction and housing: Homes of tomorrow and beyond ➤ Noise:  
Leaf blowers and engines ➤ Protection of the marine environment: A  
blue economy – Threat or opportunity for the oceans?

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Annual Report of the Federal Environment Agency

# Foreword

## MAKE URBAN CENTRES WORTH LIVING IN!

JOCHEN FLASBARTH

President of the German Federal Environment Agency

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As of 2011, more people worldwide live in cities than in the country. The global consumption of resources, energy for heating, cooling or light, and daily environmental conditions such as air and noise pollution are very much characterised by the way we organise our cities. Although at the beginning of the industrial age, cities were often hostile, dirty and noisy places, they appealed greatly to the rural population. Today, the environmental quality of urban spaces in highly-developed countries has improved immensely. Hence, even in Germany, urban areas have been able to show a small population increase in the past few years.

In many places, there is a lot of potential for the densification of urban centres according to the concept of the ideal compact city with short distances of travel. Attractive urban centres reduce the pressure to take up residence in suburban areas, i.e. in the suburbs and surrounding countryside, where nature and the environment have to give way to new inhabitants. Hence, urban centres that people will want to live in will be able to make a significant contribution to the federal government's goal of reducing the area allotted for human settlement and transportation from 80 hectares daily to 30 by the year 2020.

With its thematic focus on "Livable Urban Centres" for 2013, the Federal Environment Agency intends to contribute to a greater quality of life in urban centres as well as demonstrate to its citizens the attractive aspects of living in urban centres. We will be compiling a practical guide which will assist municipal planners in designing environmentally-friendly urban centres. Another brochure will show the public the advantages and opportunities of living in urban centres.

Living in the city has obvious advantages: Distances to important facilities such as the doctor's office or



the hospital are short; an aspect that is becoming increasingly important especially for an aging population. Even young families benefit from the short distance to a daycare centre or to school. Because these routes can be traveled not only with the family car, but also on foot, by bicycle, with public transportation or a combination of the above, this also helps ease the household budget. However, cities have their work cut out for them where bicycle lanes and public transportation are concerned. Not only must this infrastructure be present, it must also be attractive and modern. This allows the minimisation of noise and air pollution for the urban dwellers. Despite great improvements, pollution levels are above acceptable levels in a number of streets in Germany.

Because more people share the same delivery network, a more compact city also reduces the costs for energy and the drinking water supply. Garbage and waste water disposal can also be handled more efficiently. The situation is different from that in less densely populated suburban or rural areas. Compact building development also reduces energy consumption for heating, as less energy is able to escape. However, even in urban areas, we have to ensure that construction and refurbish-

ment are done paying close attention to energy efficiency, both with new buildings and existing ones. Possible points of contention could arise with regard to the relationship between reduced heating costs and increased rent after refurbishment. Additionally, we must not forget the fact that while compact structural planning has advantages in winter, there is the risk of the urban centre heating up unnecessarily in summer if planning is not executed properly. However, these phenomena are well-known and can be brought under control, not by the installation of even more air conditioners, as in some countries, but instead through intelligent city planning with lots of green spaces; in parks and boulevards or even on façades and roofs. By doing so, we enable people to experience nature in the city itself, thereby increasing its attractiveness.

One of the most pressing environmental issues in our cities is the problem of noise. Traffic noise from cars, railway vehicles and airports located in close proximity to the city is not only annoying for residents, it also leads to serious health issues. This is why making our cities quieter is of primary importance for city planners, engineers and politicians!

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# THE EU AND THE TWO-DEGREE LIMIT

The many advantages of Germany's and Europe's pioneering roles

The European Union aims to be a pioneer in the field of international climate protection. For the second commitment period of the Kyoto Protocol, the EU has committed to reduce greenhouse gas emissions by at least 20 per cent as compared to 1990 by the year 2020. The policy decision remains that the EU will increase its reduction target to 30 per cent more than 1990 in the context of an international climate agreement which demands similar and/or appropriate reduction contributions of industrialised and emerging nations. However, the EU should increase the goal to 30 per cent regardless of such an international agreement. In particular, this will be a significant contribution towards preventing the exceedence of the two-degree limit for global warming. Germany would also benefit economically from ambitious climate protection measures, which would aid in maintaining high exports and creating numerous new jobs. There are currently various measures at the EU level which, when implemented effectively, will enable the 30 per cent target to be reached.



The European Union is of the opinion that it is necessary to reduce global greenhouse gas emissions by 2020 by an even greater degree than the countries of Earth have voluntarily agreed to so far. Only by doing so can we ensure that the two-degree limit for global warming, which was postulated at the UN Climate Change Conference in Copenhagen in 2009, is not exceeded. The EU expressed the same view at the 2012 Climate Change Conference which took place in Doha, Qatar at the end of that year. The European Union negotiated with the goal of advancing all aspects of the climate protection package which was agreed upon at the summit in the South African city of Durban the previous year. This included greater reductions in the time leading up to the year 2020, i.e. in the period before the new global climate treaty takes effect, by which all nations, whether industrialised, emerging or developing countries, are to be bound. [1].

Thus far, in an internal arrangement, all 27 member states of the EU have agreed to reduce their greenhouse gas emissions by 20 per cent as compared to 1990 by the year 2020 [2]. In particular, this is to be achieved by increasing energy efficiency and the use of renewable energy, as well as the continued use of the EU-wide emissions trading scheme. Although the EU has announced that the reduction target will be increased to 30 per cent, if other industrialised countries adopt a similarly ambitious approach, and emerging countries such as China or South Africa make the appropriate contributions, such an agreement was not achieved before the conference in Doha, and could not be reached during the talks there either.

Among other things, a second commitment period for the Kyoto Protocol, lasting until 2020, was decided upon at the Doha summit. Should it be ratified, apart from the European Union, only Australia and nine other countries will be taking part, which amounts to only 15 per cent of global emissions. In light of the fact that the EU had already achieved a reduction of 18 per cent by the end of 2011 as compared to 1990, and that an emissions

- 1 EU position for the climate conference in Doha: <http://www.consilium.europa.eu/homepage/highlights/environment-ministers-set-out-eu-position-ahead-of-doha-climate-conference?lang=en>
- 2 KOM (2010) 265, 26.05.2010: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Analysis of options to move beyond 20% greenhouse gas emission reductions and assessing the risk of carbon leakage <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52010DC0265:EN:NOT>

reduction of 80 per cent is required by 2050, setting 20 per cent as the goal would be sending a weak signal to the international community. Due to the fact that the reduction targets were considered too low, a mechanism was introduced within the scope of the Kyoto Protocol which will enable the parties to the treaty to increase their targets through a simplified process within a period ending in 2014.

The Federal Environment Agency recommends that the EU unilaterally increase its minimum commitment to 30 per cent. This corresponds to an appropriate contribution that will enable compliance with the two-degree maximum limit. Climate researchers are of the opinion that a reduction target of 25 to 40 per cent is necessary by 2020 for industrialised countries. This also reflects the historical responsibility industrialised countries have. According to the Doha resolution, an examination of the targets of the nations involved in the Kyoto Protocol is slated for 2014. The EU should use this opportunity to announce their commitment to a 30 per cent target to the international community. It is still unclear as to how exactly this higher reduction target can be achieved. However, it is clear that revising the EU Emissions Trading Directive will be of key importance.



# WHAT THE EU CAN DO RIGHT NOW

Even though the EU has not yet agreed to the 30 per cent target, there are measures with which greenhouse gas emissions can be increased to a far greater degree than just the agreed-upon 20 per cent. These measures should be implemented as soon as possible even without official political self-commitment. This will first require the stabilisation of EU emissions trading by discontinuing certificates and revising the reduction factor. Furthermore, binding and ambitious measures in the area of energy efficiency should be enacted. These two courses of action alone would increase the EU's internal reduction to 25 per cent. Effective climate protection for the future cannot be based solely on international political requirements; it must also be shaped by ambitious measures implemented on national, regional and municipal levels. Here, a "bottom-up" approach makes sense, whereby initiatives for climate protection are first developed on a local level before being expanded to a regional level.

Overall, these measures must ultimately lead towards transforming the economy into a low carbon economy in which the use of fossil fuels is

gradually phased out and emphasis is placed on increasing energy efficiency and the use of renewable energy sources.

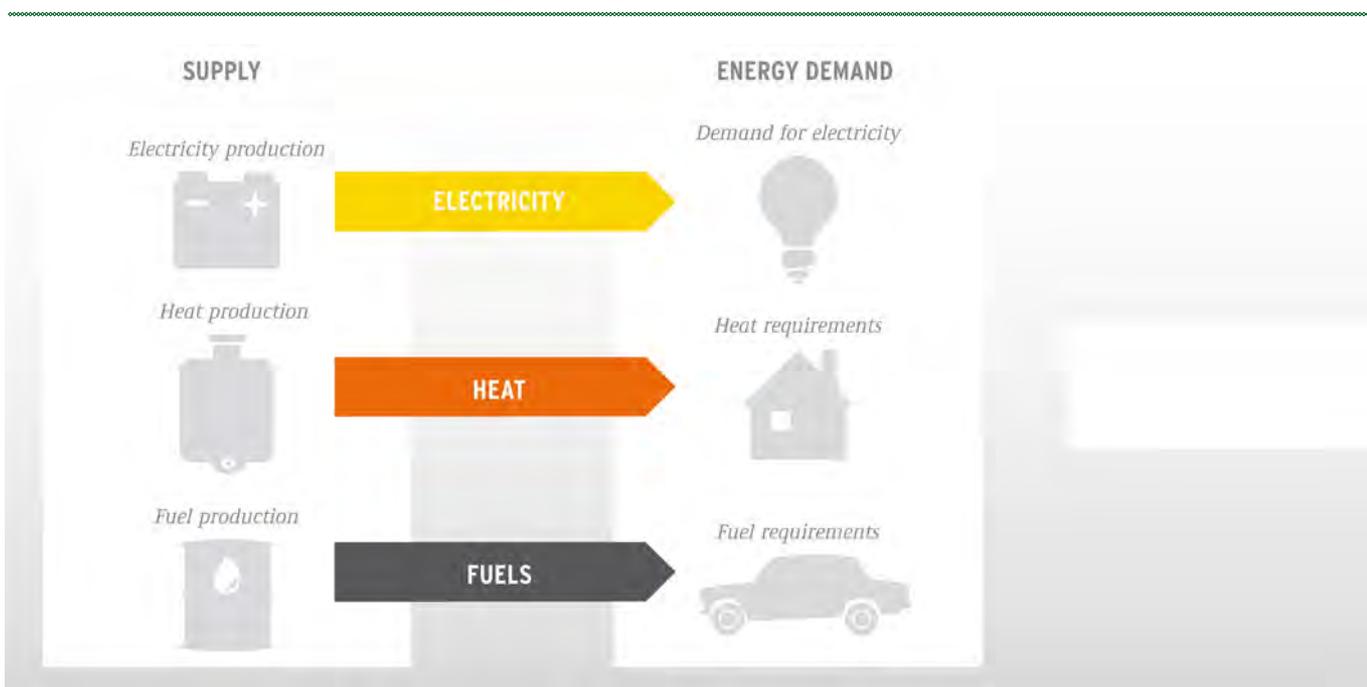
## Sustainable energy supply as a key area

Energy supply accounts for approximately 80 per cent of total greenhouse gas emissions. Hence, restructuring it to the greatest possible extent is the most important step towards achieving ambitious climate protection goals.

This restructuring must be carried out in the next few decades. Long-term scenarios extending to the year 2050 envisage the continuous reduction of energy consumption while beefing up the percentage of renewable energy sources for energy supply in parallel. In the areas of electricity, heating and transportation, biomass and biofuels can only be utilised to a limited extent due to their limited availability and possible negative environmental impact and competition for usage. Hence, scenarios sketching a climate friendly energy system count on increasing electrification of transportation and heating sectors, for example with

Figure 1

## SUMMARY OF VARIOUS SCENARIOS FOR ENERGY SUPPLY [3] [4] [5] [6]



Energy supply accounts for approximately

# 80

# percent

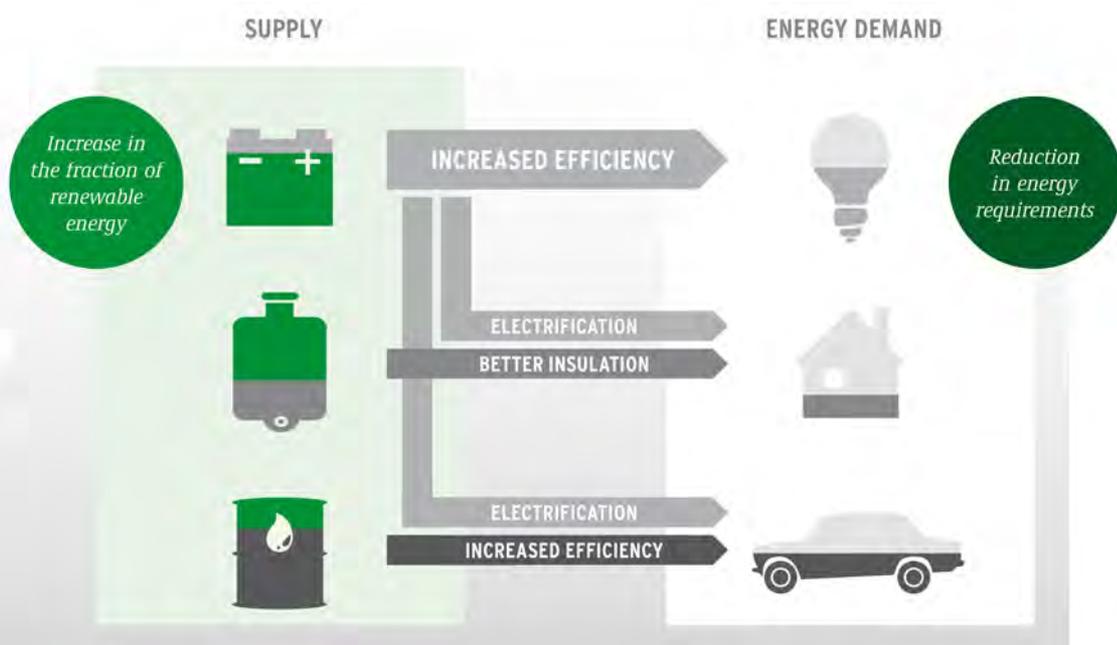
of total greenhouse gas emissions.

electric vehicles and heat pumps. In these scenarios, electricity is generated exclusively or to a large extent from renewable energy sources.

Scenarios that extend to the year 2050 could provide useful indicators as to how Germany's long-term climate protection goals can be achieved and the amount of reductions each sector will

have to contribute. Nevertheless, in such scenarios which span almost four decades, technical and social developments cannot be accounted for in all detail. Therefore, in practice, strategies for the restructuring of the energy system must be able to react flexibly to changes. What follows is an explanation of the components the EU has conceived of for sustainable energy supply.

- 3 European Commission: Impact Assessment Accompanying the Document "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions," Energy Roadmap 2050, Brussels, 2011.
- 4 European Climate Foundation (ECF): Roadmap 2050 – a Practical Guide to a Prosperous Low-carbon Europe – Technical Analysis, 2010.
- 5 Greenpeace: Energy[r]evolution – Towards a Fully Renewable Supply in the EU 27, 2010.
- 6 European Renewable Energy Council (EREC): RE-Thinking 2050 – a 100 Percent Renewable Energy Vision for the European Union, 2010.



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Heating, ventilating, cooling and lighting in buildings consumes approximately

40

per cent

of energy used. In other EU member states this percentage is equally high.

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## More efficiency required

In the EU strategy for sustainable energy supply, increasing energy efficiency is of primary importance. In order to do so, a number of measures have been and will be implemented:

**Energy efficiency directive:** The October 2012 directive has the general goal of increasing energy efficiency in the EU by 20 per cent by the year 2020. The directive obliges energy distributors to cut their energy sales by 1.5% annually from 2014 to 2020. In addition, three per cent of the building area of the central government is to undergo refurbishment each year to improve energy efficiency. New power plants are to be located in the vicinity of areas with high heat requirements in order that they can be operated as part of a cogeneration system (CHP). Existing plants are to be upgraded with CHP as part of modernisation measures [7].

**Building Directive:** Heating, ventilating, cooling and lighting in buildings consumes approximately 40 per cent of energy used. In other EU member states this percentage is equally high. The EU Building Directive prescribes the introduction of energy certificates and energy efficiency indicators, which will make efficiency standards for buildings more transparent. From 2019 (public area) and 2021 (other areas) onwards, new buildings are only to be constructed as “nearly zero energy buildings” [8].

**Top Runners and the Ecodesign Directive:** As defined by the EU, “top runners” are household and other technical devices which save markedly more energy than the average. They must beat the minimum requirements laid out in the EU Ecodesign Directive. The goal is to allow buyers to identify the energy-saving potential when purchasing the device, hence reversing the trend towards higher energy consumption, as is the case in many areas. Heating equipment and installations for heating water have not yet been included in the directive, even though there is a great potential for savings in this area. Germany will be implementing ambitious minimum eco-design requirements and clearly marked labels for energy consumption.

**Climate protection through energy efficiency in the industrial sector:** There is still significant potential for increasing efficiency with economic benefits, especially in less energy-intensive fields. In energy-intensive areas, on the other hand, there is comparatively little potential. The EU has issued several directives, such as the Emission Trading Directive [10], the Industrial Emissions Directive [11], the Ecodesign Directive [9], the Energy Efficiency Directive [7], and the Eco Management and Audit Scheme [12], that are intended to accelerate climate protection in the industrial sector, among others. Energy management systems according to the international standard ISO 50001 are intended to help tap energy savings potentials.

- 7 Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC [OJ L 114, 27 April 2006, p. 64–85 L315 p. 1]
- 8 Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings.
- 9 Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products
- 10 Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emissions allowance trading within the Community and amending Council Directive 96/61/EC
- 11 Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) [OJ EC L 334, p. 17-119]
- 12 Regulation (EC) No 1221/2009 of the European Parliament and of the Council of 25 November 2009 on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS), repealing Regulation (EC) No 761/2001 and Commission Decisions 2001/681/EC and 2006/193/EC [OJ L 342, 22.12.2009, p. 1]



▲  
*The compact city*

There is great potential for savings in the transport sector. CO<sub>2</sub> emissions in this area can be reduced by almost

**40**  
percent

#### European Climate Protection

## CLIMATE PROTECTION IN THE TRANSPORT SECTOR

Modern economies can only function with good infrastructure. Traffic has increased significantly in the past few decades, and it is predicted that this trend will continue. This growth is especially rapid for the transportation of goods due to the increasing division of labor, a shallow level of vertical integration, the sometimes rather large wage differences between different countries, and the overall globalisation of goods traffic. However, passenger traffic is also growing, in part also due to the fact that commuters are traveling increasingly longer distances to work and back, and trips to more distant countries are increasing.

The transport sector accounts for one third of the energy consumption in the EU and is the source of more than a quarter of its greenhouse gas emissions (2008: 29 per cent) [13] [14]. These emissions also continue to increase due to the fact that air and sea travel show high growth rates. The increase in traffic offsets the savings achieved through better propulsion technology, such as more economical engines.

Hence, in its white paper, Transport, the EU has decided to reverse this trend. Transport-related emissions are to be reduced by 60 per cent in comparison to 1990 by the year 2050 [15]. For Germany, this sectorial target has not yet been clearly defined. However, according to the federal government's 2010 energy plan, final energy consumption in transport is to be reduced by 40 per cent in comparison to the levels in 2005 by the year 2050 [16].

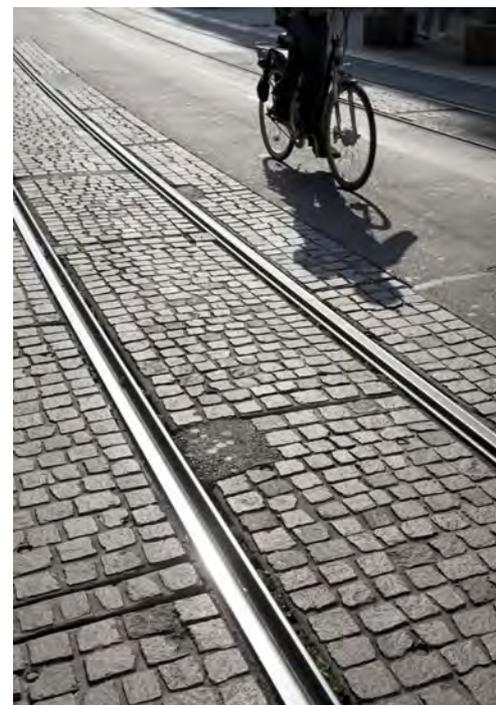
However, the intention is not to restrict mobility in our society and in the economy, but it will be necessary to reduce transportation costs. Hence, the goal is not to prohibit traffic, but instead to reduce distances traveled by remodeling settlement structures. The motto is: "The compact city." Places of work, retail and leisure should be integrated into residential areas as far as possible. Regional production structures are to be promoted.

In addition, all traffic should be converted to use modes of transport that are as environmentally-friendly as possible. Especially for longer distances, the use of cars and trucks should be minimised in favor of trains and buses. In order to provide more incentives for this change, it would be wise to revise the toll system for trucks. In cities, pedestrian traffic, bicycle traffic and public transport will have to receive more visible promotion and be linked together more efficiently.

Furthermore, it is important to increase the efficiency of cars and trucks with improved engine technology and a consistent, lightweight design. In addition, post-fossil energy supply systems for transportation will need to be created and continually refined. In many cases, these systems will require the use of renewable energy, whether directly or indirectly. Some options are, for example, vehicles that are battery-driven or make use of overhead power lines, or vehicles that utilise fuels manufactured with the use of electricity, such as hydrogen or methane.

The Federal Environment Agency aims to make use of sustainable transport systems that advance climate protection and prevent air pollution, but which also reduce noise pollution and are space-saving. There is a great savings potential here. For example, CO<sub>2</sub> emissions in the transport sector can be reduced by almost 40 per cent by 2030 in comparison to 2005. In the project "Renewability" [17], an analytical method was developed which visualises measures and instruments in the transport sector, as well as their effects. The Federal Environment Agency project "Greenhouse Gas-Neutral Transportation 2050" [18] examines if and when a complete substitution of fossil energy sources can be achieved in the transport sector. Due to the interwoven nature of global transportation networks, it will become even more important to view this issue from a transnational perspective.

- 13 European Commission (2011): EU transport in figures. Statistical Pocket-book 2011, p. 111ff.
- 14 European Commission (2011): EU transport in figures. Statistical Pocket-book 2011, p. 121 and 127.
- 15 European Commission (2011): White Paper – Vision of an interconnected Europe. Hin zu einem wettbewerbsorientierten und ressourcenschonenden Verkehrssystem (Towards a competitive and resource-saving transportation system), p. 3.
- 16 Federal Ministry of Economics and Technology (BMWi)/Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (2010): Energy Concept for an Environmentally Sound, Reliable and Affordable Energy Supply, p. 5.
- 17 Project Renewability: <http://www.renewability.de/>
- 18 Project „Treibhausgasneutraler Verkehr 2050“ (Greenhouse Gas-Neutral Transportation 2050), German Federal Environment Agency 2013, not yet published





European Climate Protection

## RENEWABLE ENERGY CONTRIBUTIONS

IN 2009, the EU directive promoting the use of energy from renewable sources (EE-RL) [19] came into effect. It was signed into German law in February, 2011 with the European Community Law Adoption Act for Renewable Energies (EAG EE). According to this law, a total of 20 per cent of total final energy consumption (electricity, heating, fuels) must come from renewable energy sources by the year 2020. For Germany, a target of 18 per cent applies, and for the transportation sector there is a minimum target of ten per cent in the whole of Europe. As part of national plans of action, the member states had to demonstrate which measures and instruments they would be using to achieve the respective national goals defined in the directive. At the end of 2011, all the states presented their first progress reports. According to its report, Germany is on course to reach its target. Subsequent reports will be due every two years. According to the Working Group on Renewable Energy – Statistics (AGEE-Stat),

renewable energy sources already accounted for approximately twelve per cent [20] of total final energy consumption at the end of 2011. Greenhouse gas emissions figures in Germany for electricity, heating and fuels from renewable energy are compiled by the Federal Environmental Agency.

In October 2012, in light of the growing doubt as to the whether biofuels manufactured from food and feed crops were climate-friendly, the European Commission (DG Energy) recommended that the use of such biofuels be limited to a maximum of five per cent [21] in order to reach the 10 per cent goal of the EE-RL. However, the ten-per cent quota will remain in order to provide an incentive to increase production of fuel from waste and residual materials. According to the current proposal, such measures would count twice or four times as much. In addition, a tightening of ecological requirements for biofuels will be taking place earlier; in 2014 instead of 2017.



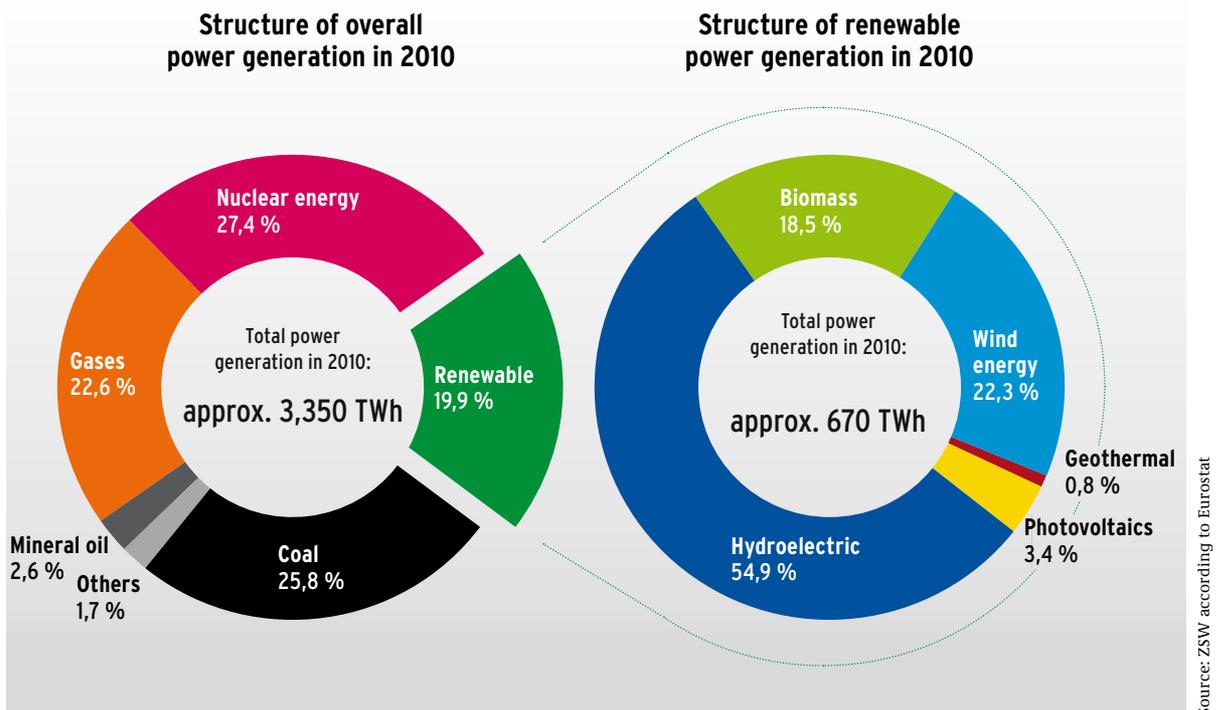
19 Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC [OJ EC L 140/16 of 5 June 2009]

20 Working Group on Renewable Energy – Statistics 2012; renewable energy 1st-3rd quarter 2012 (tentative); <http://www.ag-energiebilanzen.de/view-page.php?idpage=65>

21 This limitation does not directly affect the goal of the Fuel Quality Directive (Directive 2009/30/EC) [30] which intends to reduce greenhouse gas emissions by 6 per cent per energy unit for fuels by the year 2020. As the Commission's recommendation does not currently intend a reduction of the nominal greenhouse gas savings potentials of individual fuel lines due to indirect land use change (iLUC) factors, it could remain an attractive prospect for fuel manufacturers to continue to use conventional biofuels based on food crops in order to reach their goals.

Figure 2

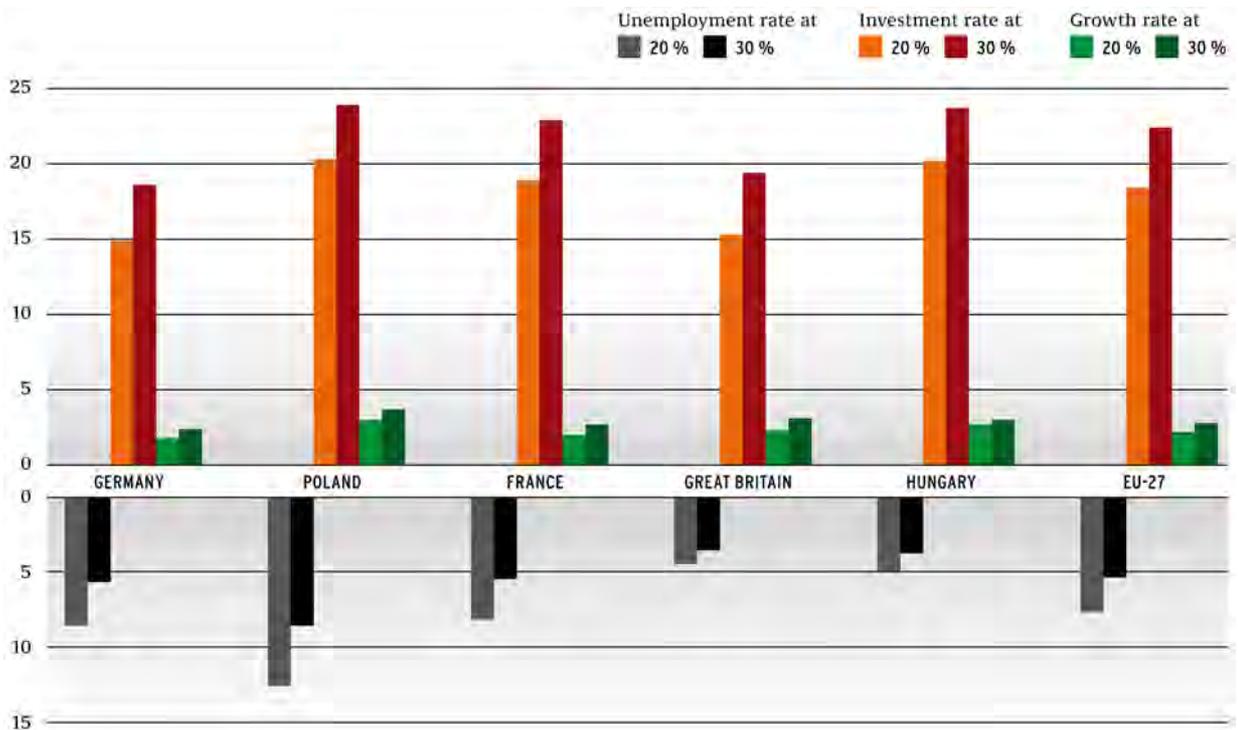
## GENERATION OF ELECTRICITY FROM RENEWABLE ENERGY SOURCES IN THE EU



Others = Industrial waste, non-recyclable municipal waste, pumped storage station etc.  
Solar thermal power plants and tidal energy are not included due to the low per centage they make up.

Figure 3

## ECONOMIC EFFECTS OF A 30 PER CENT REDUCTION OF GREENHOUSE GAS EMISSIONS IN THE EU AS COMPARED TO 20 PER CENT



Source: PIK 2011

### European Climate Protection

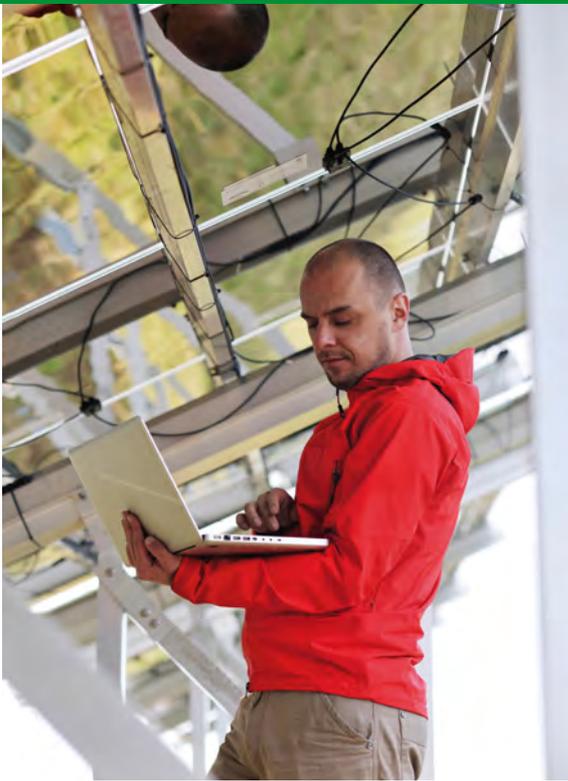
## AMBITIOUS CLIMATE PROTECTION BRINGS GROWTH AND JOBS

In particular, ambitious climate protection provides considerable economic advantages. In light of weak growth predictions for the euro area and growing regional economic disparities, this is a chance to initiate an impetus for sustained investment in low-carbon technologies within the European Union for long-term transformation towards a low-carbon economy by sending the relevant markets a clear political signal. Studies indicate that this will also create up to six million additional jobs [22] [23].

Furthermore, the European Union's energy requirement, and its dependence on fossil fuels, can be reduced by two thirds by the year 2050 with the use of energy efficiency measures. Almost 90 per cent of all savings measures are economically lucrative, as the savings from energy costs outweigh the required investments [24].

According to the Commission's analysis, investment costs for an ambitious decarbonization will total 270 billion euro annually for the next 40 years. This would require investment costs of approximately 1.5 per cent of the EU's GDP, which would be required in addition to the accrued total investment costs of 19 per cent of the EU's GDP in 2009, which would simply correspond to the total investment activity at the pre-crisis level.

In return, this would mean annual expenditure savings of up to 320 billion euro annually due to the decrease in the use of coal, oil and gas [25]. For private homes alone, cost savings of up to 100 billion euro annually are possible, in particular from buildings and heating systems. In the industrial sector, savings of up to 40 billion euro annually could be achieved up till 2050, primarily due to the implementation of efficiency technologies



with a wide spectrum of use, such as in steam and hot water production or in engine applications. In the transport sector, technological advancements for cars and trucks will be key factors in allowing energy requirements to be halved. Due to reduced fuel consumption, up to 200 billion euro per year could be saved up till 2050 [26].

Policies that systematically promote higher energy efficiency would simultaneously reduce dependence on crude oil, coal and natural gas imports, the prices of which are rising and fluctuate a great deal. At the same time, they promote competitiveness in the relevant technologies on an international level.

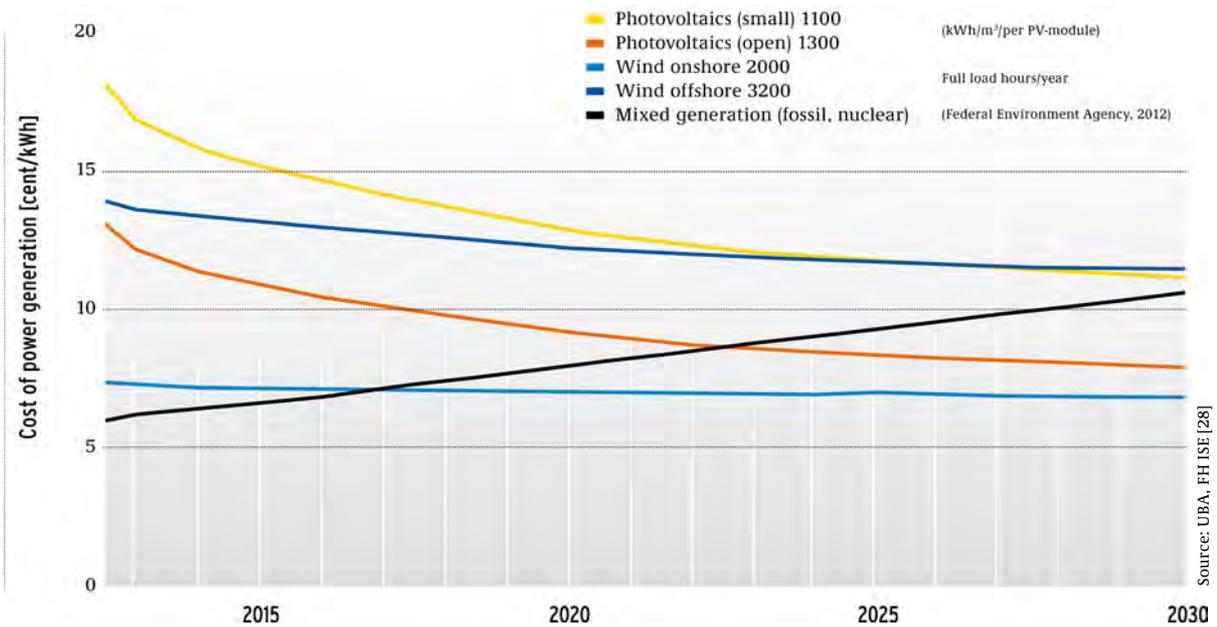
The prime movers for employment will be investments in energy efficiency and the resulting cost savings and improved competitive advantage. The development of renewable energy will also have a positive effect. Between 2004 and 2011, the number of jobs in this sector has more than doubled, increasing from 160,000 to 382,000. In the year 2009 alone, between 70,000 and 90,000 new positions were created. Projections predict that the development of renewable energy in the EU will result in slightly positive growth effects up till 2020, and more than compensate for the loss of jobs, for example in energy-intensive sectors. In the building industry, investments totaling 20 billion euro annually up to 2020 will be able to create up to 500,000 jobs in the area of building operations. In the energy sector, up to a total of 400,000 additional jobs can be created by 2020 [27].

- 22 Jaeger, C; Paroussos, L; Mangalagiu, D.; Kupers, R.; Mandel, A. and Tàbara, J. (2011): A New Growth Path for Europe. Generating Prosperity and Jobs in the Low-Carbon Economy. [http://www.pikpotsdam.de/members/cjaeger/a\\_new\\_growth\\_path\\_for\\_europe\\_\\_synthesis\\_report.pdf](http://www.pikpotsdam.de/members/cjaeger/a_new_growth_path_for_europe__synthesis_report.pdf)
- 23 A Roadmap for moving to a competitive low carbon economy in 2050, KOM (2011) 112 final.
- 24 Boßmann, Tobias; Eichhammer, Wolfgang; Elsland, Rainer (2012): Concrete Paths of the European Union to the 2°C Scenario: Achieving the Climate Protection Targets of the EU by 2050 through Structural Change, Energy Savings and Energy Efficiency Technologies. Fraunhofer Institute for Systems and Innovation Research (ISI), Karlsruhe, [http://www.isi.fraunhofer.de/isi-en/e/projekte/bmu\\_eu-energy-roadmap\\_315192\\_ei.php](http://www.isi.fraunhofer.de/isi-en/e/projekte/bmu_eu-energy-roadmap_315192_ei.php).
- 25 European Commission (2011) A Roadmap for moving to a competitive low carbon economy in 2050, p. 11
- 26 European Commission (2011) Impact Assessment. A Roadmap for moving to a competitive low carbon economy in 2050, p. 121–125
- 27 European Commission (2011) Impact Assessment. A Roadmap for moving to a competitive low carbon economy in 2050, p. 90

Up to  
200  
 billion  
 euro could be saved  
 annually up to the  
 year 2050 by reducing  
 fuel consumption.

Figure 4

## COST OF POWER GENERATION FOR RENEWABLE ENERGY IN GERMANY COMPARED WITH POWER GENERATION FROM FOSSIL FUELS



### European Climate Protection

## GREEN GROWTH MARKETS OF THE FUTURE

Environmental technology will contribute over 20 per cent of Germany's GDP in 2025, an increase from 11 per cent in 2011. In 2011, the global market volume for environmental technology and resource efficiency was 2,044 billion euro. According to the new GreenTech Atlas, the six leading GreenTech markets will achieve a total volume of approximately 4,400 billion euro by the year 2025 [28]. This corresponds to an average annual growth of 5.6 per cent. The world market for environmentally-friendly energy, which includes renewable energy, efficient power plant technology and energy storage facilities, is one of the most significant green future markets. In 2011, this world market volume was 313 billion euro per year, and it is predicted that this will increase to 1,060 billion euro by the year 2025. This would mean an average annual increase of 9.1 per cent [28]. This is where renewable energy plays a central role. The various types of renewable energy are key technologies for the energy supply of the

future and are hence extremely relevant economically. Countries that advance the development of renewable energy have a competitive advantage in these markets.

Prognoses also show that power production costs for renewable energy will sink markedly in the next few years, while the cost of using fossil fuels to generate electricity will continue to increase (see Fig. 4). In Germany, by the middle of the current decade, wind energy on land will cost about the same as electricity generated with fossil fuels. Today, wind energy already costs only slightly more than electricity generated with fossil fuels—a mere 7.5 cents more per kilowatt hour [29]. As an evaluation of German, European and international studies has shown, using renewable sources to generate electricity should not only be part of climate protection, but also part of cost management for the future [30].



28 German Federal Environment Agency: GreenTech Environmental Technology Atlas for Germany Made in Germany 3.0; <http://www.greentechatlas.de>

29 FH ISE (2012), Kost C., Schlegl T., Thomsen J., Nold S., Mayer J., Stromgestehungskosten erneuerbarer Energien. (Cost of electricity by source: Renewable energy sources) [http://www.ise.fraunhofer.de/de/veroeffentlichungen/veroeffentlichungen-pdf-dateien/studien-und-konzeptpapiere/studie-stromgestehungskosten-erneuerbare-energien.pdf/at\\_download/file](http://www.ise.fraunhofer.de/de/veroeffentlichungen/veroeffentlichungen-pdf-dateien/studien-und-konzeptpapiere/studie-stromgestehungskosten-erneuerbare-energien.pdf/at_download/file) (in German)

30 German Federal Environment Agency 2012, Sustainable electricity for the future. Cost and benefits of transformation to 100 per cent renewable energy

31 Fatih Birol, IEA, source: ENDS Europe, 4 February 2013

### European Climate Protection

## THE IDEAL OPPORTUNITY FOR THE GERMAN EXPORT ECONOMY

In light of the growing global population, which is predicted to hit 9 billion by 2050, as well as the accompanying scarcity of resources and rapidly advancing climate changes, current industrial societies will have to be restructured in order to maintain life as we know it on this planet. If Germany develops and implements innovative solutions for environmental and climate protection, this will also present excellent opportunities for its export-oriented economy, especially if competition from the Far East and the USA are considered. Germany will be able to build on its leading position in the green world markets and win the race for future markets, enabling it to secure long-term sustainable growth and prosperity.

In order to do so, it will be necessary for Germany to improve its climate control instruments and its legal framework. This will comprise the expansion of renewable energy, promoting energy-efficient building refurbishment, the creation of low-emission mobility structures, the further development of the EU Emissions Trading Scheme, and of especial importance, the phasing out of subsidies that are detrimental to our climate. The EU alone distributed 274 billion euro in climate-damaging subsidies in 2009. This is 2.1 per cent of its GDP. This

sum had increased by 200 billion or approximately 70 per cent by 2012 [31].

In the long term, the economic framework must be designed such that external costs are entirely internalised in the pricing.

The practical experience that Germany has gathered in the course of the energy revolution is interesting for many countries of the world. Via political and technological cooperation, including collaborations in other countries which are currently planning a restructuring of their energy sector, Germany can provide its experience and knowledge and show that a switch to a low-carbon way of life and economy is possible and also brings economic advantages. The international transfer of knowledge and technology should be boosted in order to publicise successful developments. For example, companies could be convinced to contribute towards climate protection if it could be demonstrated to them that climate protection measures are linked to positive economic effects. In order to do so, transparent reporting on actual CO<sub>2</sub> savings achieved, and the relevant instruments which would allow for such reports, should receive active support.

01

# CONSTRUCTION AND HOUSING

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*“People need to feel comfortable in their homes. Ideally, this can be achieved through a combination of environmentally friendly construction and sustainable use of the building.”*

**Dr. Bettina Rechenberg**

*Head of the Department of “Sustainable Production, Resource Conservation and Material Cycles”*

# HOMES OF TOMORROW AND BEYOND

A key component of climate and land conservation,  
the energy revolution and health



Buildings consume a large portion of the raw materials and energy used in Germany. A consequence of this is the genesis of great stresses on health and the environment. The German Federal Environment Agency (UBA) is developing strategies to solve the resulting complex problems. High-quality thermal renovation of existing buildings is the key to this, complemented by the cleaner production of building materials. An ambitious policy on chemical substances is indicated to solve the problem of pollution load for interior spaces. In its own building and renovation projects for 2013, the UBA will demonstrate what modern, sustainable construction might look like in practise.



▲  
*25 million tonnes of cement flow into the construction sector every year.*

The topic “Construction and Housing” is of outstanding significance for the environment, climate and health. But it carries a high emotional charge as well. The media bring up the topic on a regular basis. Apart from serious information, for example about the interrelationship between climate change, the increasing occurrence of extreme weather events and damage to buildings, their presentation is somewhat misleading. An NDR (North German Broadcasting) report entitled something like, “Thermal Insulation: The Madness Continues,” had the public in an uproar.

Actually, however, these relationships are often complex. Environmental research, in particular, must take that into account. Otherwise, the isolated solution of one component of the problem

can lead to new problems elsewhere.

UBA experts are working hard to meet the latest challenges in the field of Construction and Housing as they arise by means of the climate and energy policies of the federal government. They are identifying new research areas and developing solutions to be integrated into legislation and practise. The UBA advises politicians, citizens, associations and other institutions. It also promotes the development and implementation of environmental innovation in business and environmental groups.

The following is an overview of the problem areas in construction and housing, as well as strategies for their solution.

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In 2007, around

# 110

# petajoules

were consumed for the production of cement alone. This corresponds to the annual energy output of more than three power plants, each with a capacity of one gigawatt.





- 1 Bundesministerium für Wirtschaft und Technologie, Referat III C 3 (The German Federal Ministry of Economics and Technology, Division III C 3), Energiedaten, Berlin, 25.1. (2012)
- 2 Umweltbundesamt (Federal Environment Agency) (Ed.) (Hrsg.), Energieeffizienz in Zahlen, Dessau-Roßlau 2011

### Construction and Housing

## BUILDINGS AS ENERGY CONSUMERS

Buildings account for a high proportion of total energy consumption. In Germany, a good third of total final energy consumption is used in the provision of heating and hot water in homes, industry and commerce (2010: 3192 petajoules or 35 per cent). [1] Renovation of existing buildings and using efficient building services such as lighting, heating and ventilation, can thus make a significant contribution towards saving energy and greenhouse gas emissions. The specific final energy consumption for heating and hot water in households most certainly tends to decrease. However, up to now, the rate has not been sufficient to reach climate goals and meet the objectives of the energy strategy. Considering the growth of residential areas (2.7 million square metres in 1990 to 3.3 million in 2007), the decrease in absolute energy consumption is clearly too slow.

Fossil fuels, such as natural gas, heating oil and electricity from fossil fuel power plants, are still the predominant sources of heating and hot water, and their use places a burden on the climate. The aim must therefore be to reduce these burdens

by decreasing heating demand and shifting to climate-friendly energy sources (particularly renewable energy). Another sphere of activity has come about as a consequence of the unfavourable trend in household electrical consumption. Energy consumption for electrical appliances, cooking and lighting has risen by 21 per cent in recent years, specifically from 1996 to 2007, from 1076 kWh per person to 1302 kWh [2]. In contrast, the climate protection goals of the Federal Government provide for a decline in electrical power consumption.

In order to improve the energy balance in the construction and housing sector, the manufacturing of construction products must also be considered. The cement, steel, glass and ceramic and non-ferrous metals industries, which are very significant in this sector, are all very energy intensive. In 2007, approximately 110 petajoules were consumed for the production of cement alone. This corresponds to the annual energy output of more than three power plants, each with a capacity of one gigawatt.



### Construction and Housing

## GREAT POTENTIAL FOR SAVINGS

The potential savings for fuel and electricity are great, as numerous studies show. Accordingly, by the year 2030, greenhouse gas emissions for the provision of heating and hot water will be reduced by approximately 36 per cent (100 million tonnes of CO<sub>2</sub>) and the final energy consumption by 35 per cent (1030 petajoules) compared to the base year, 2008, if climate protection measures are consistently taken [3].

The emphasis should be on high energy efficiency standards as well as the renovation of old buildings; the development of new buildings is already technologically well advanced. These days, buildings can be constructed in such a way that enables them to produce more energy than they consume in the course of a year, thanks to effective insulation and the local production of heat and electricity from renewable sources. These concepts, however, need to be further developed in future, so that an energy-plus house generates surpluses, and not only on the annual balance sheet, whereupon the power grid is used as “unlimited intermediate storage.” Demand and consumption must be brought into agreement as closely as possible. Some options for achieving this are through shared supply in larger community units or the use of shared (thermal, electrical) storage.

Besides the well-known power-based energy-plus housing concepts, there are numerous practical alternative concepts in which the balance sheet

shows an excess of electricity and heat being produced over the required amount. All future energy-plus housing concepts will take the interaction with the environment and the effect on the power network load into consideration, because of the very high local supply of renewable energy.

In many cases, existing buildings can be renovated so radically that the demand for non-renewable primary energy for heating, hot water, lighting, ventilation or cooling is reduced by 90 per cent (“Factor-10-renovation”). As has been demonstrated in pilot projects [4], this is already economically viable with good planning and implementation of the measures.

In the energy concept which the federal government launched in 2010, and in the key points for the accelerated implementation of the “energy revolution” savings targets for buildings, it was decided that an initial reduction of 20 per cent in the demand for heating, compared to that of the base year (1990), should be reached by 2020. In the long term, by 2050, an almost “carbon neutral” stock of existing buildings can be achieved. Carbon neutral means that the buildings have very low energy demands, and any outstanding energy demand is met primarily with renewable energy.

The aim is to double the annual rate of renovation for existing buildings, which is currently less than one per cent of the constructed area. To that

end, the Federal Government increased the annual funding for the 2012 CO<sub>2</sub> Building Renovation Programme in two tiers to 1.8 billion euro per year after having previously made drastic cuts. The federal government is also looking into household-independent financing for promoting thermal renovation in 2015. In addition, a “renovation roadmap” for buildings will be developed.

Essentially any type of renewable energy is available for future heating supply in the building sector. Among those alternatives, solar thermal energy, geothermal energy (near surface via use of heat pumps, and possibly, deep geothermal energy), ambient heat and, up to a certain proportion, the use of biomass or products thereof, are worthy of consideration. Methane or hydrogen could also contribute in the medium term, with the help of excess electricity produced by means of renewable energy sources. Methane gas can be stored in the gas grid and then burned, for example, in efficient cogeneration plants. The decentralized use of wood, for example in pellet heating systems or firewood plants, today often forms an economical and climate friendly way to use biomass. Given the limited availability of wood, however, a cost increase for wood is expected in the medium to long term, placing a prioritization of non-biomass-based fuels at centre stage, at least in the medium term. Owing to the regulations of the Federal Emissions Control Act, the environmental and health impacts from combustion plants will be reduced to a minimum in conformance with the state of the art. For older plants, there is still a large potential for energy savings and a reduction of pollutant emissions.

Changing weather conditions due to climate change should also be accounted for in the sustainable energy strategy for the planning, construction and equipping of buildings. With this in mind, homes should be adapted, for example to the higher heat load in the summer months, with such targeted measures as passive cooling, shading options or façade greening. If buildings are not planned to be “cool” from the outset, energy consumption could rise again due to more frequent use of air conditioning. [5]

In addition to the reduction of energy consumption during building use, another great potential lies in the development of energy-saving technologies for the manufacture of building products. In the case of the particularly CO<sub>2</sub>-intensive production of cement, for example, this is estimated at around 50 per cent. The increased use of “CO<sub>2</sub> storage” lumber as a building material relieves the greenhouse gas balance. The best lumber often has a local source.

- 3 Matthes et al., Politikszenerarien für den Klimaschutz VI, draft, December, 2012
- 4 Schulze Darup, Burkhard: Gebäudesanierung mit Faktor 10, Deutsche Bundesstiftung Umwelt, Osnabrück 2011
- 5 See Bettgenhäuser et al., Klimaschutz durch Reduzierung des Energiebedarfs für Gebäudekühlung, Umweltbundesamt, climate protection Nr. 10/2011, Dessau-Roßlau 2011. Brunner et al.: Bauen, wenn das Klima wärmer wird, Zürich 2007. Voss and Pfafferott, Energieeinsparung contra Behaglichkeit? Forschungen des BBR 121, 92 S., Bonn 2007

*Building with wood – the best from sustainable forests of the region*





The UBA recommends requiring the passive house standard for new buildings starting in

# 2016

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## THERMAL RENOVATION OF BUILDINGS: WHAT MUST BE DONE

If the energy revolution is to be a success, it must be embedded in society as a whole. [6] All citizens, institutions and companies can contribute to energy savings, whether through the use of more efficient heating systems and domestic appliances, efficient heating and insulation of older buildings, or corresponding measures in industry and commerce. However, multiple obstacles stand in the way of this great potential for rational energy use [7]. Among these are

- ▶ a lack of information, motivation and support,
- ▶ higher acquisition costs of efficient products, sometimes with a long payback period, or allocation of costs and benefits to various stakeholders (for example, landlord and tenant),
- ▶ Risk aversion in the use of efficient new technologies,
- ▶ Inadequate monitoring of the regulations.

A vast array of instruments will be needed in order to achieve the federal government's objective of having a virtually carbon neutral stock of buildings in Germany by 2050:

- 6 Umweltbundesamt (UBA) (Ed.), Energie-  
wende – Aufbruch ins neue Zeitalter,  
in: UBA Schwerpunkte 2012, S. 12 ff.
- 7 Kaschenz, Helmut et al.: Stromsparen:  
weniger Kosten, weniger Kraftwerke,  
weniger CO<sub>2</sub>, Umweltbundesamt, Des-  
sau-Roßlau 2007
- 8 Umweltbundesamt (UBA): Rechtskon-  
zepte zur Beseitigung des Staus ener-  
getischer Sanierungen im Gebäudebe-  
stand, Texte 36/2009, Dessau-Roßlau  
2009



#### **Ambitious standards for energy-efficient buildings:**

The requirements of the Energy Savings Ordinance (EnEV) should be gradually increased even further. For new constructions, the UBA recommends the stipulation of a passive house standard from 2016 onward. Renovation with Passive House components should take place no later than 2018. The federal states must also be more vigilant about ensuring that the requirements are implemented in practise. Additionally, the German Development Bank's (KfW) "Energy Efficient Renovation" programme should be endowed with at least two billion euro per year by 2020, as far as possible. It also makes sense to find means for the independent financing of the KfW programme and create tax incentives for energy-efficient renovation. An ambitious renovation schedule that is meaningful for the entire building stock, and combines regulatory elements with a long-term funding strategy, should be set. It is the opinion of the UBA that individual measures, such as window replacement, are only eligible for funding if they are communicatively integrated into the medium-term "building-specific renovation roadmap" leading to a complete thermal renovation of the building.



#### **Adjustment of the tenancy law:**

The tenancy law must strike a fair balance of interests between tenants and landlords after thermal renovation. One example would be rent increases, within an appropriate time period, which would be offset by the fall in consumption costs. The heating-cost-neutral alternative to the levying of contracting costs in the wake of the last tenancy rights amendment is a model for this. Furthermore, the thermal facilities and condition of the buildings should be a greater consideration than the criteria used for determining value and rental increases in the usual local reference rent [8]. The latest amendment to the tenancy law regulates the initial steps. Of primary importance, however, will be the further reduction in the disincentives which set the reference rent system against thermal upgrades. Modernization must be more worthwhile, for example by restricting the current option of enforcing rent increases even without any improvements to the leased property.



#### **Higher proportion of renewable energy:**

The Renewable Energy Heat Act stipulates that in new construction, a proportion of the energy required for heating or cooling must be met with non-fossil energy. The UBA recommends making this mandatory even with a major renovation of old buildings. Regardless of that, renewable energies in the building sector must continue to be strongly encouraged in conjunction with measures to improve energy efficiency. The Market Incentive Programme and the KfW Building Renovation Programme conjointly address Efficiency and Renewable Energy.



#### **More cogeneration:**

The federal government would like to double the proportion of combined heat and power (CHP) in German power generation to 25 per cent by 2020. The applicable CHP law shall accordingly foster the construction and renovation of highly efficient cogeneration plants, the construction of thermal and cooling pipes and the storage of heat and cold. UBA recommends a comprehensive and continuous monitoring of the law in order to be able to detect, at an early stage, whether the ambitious development goal can be achieved with it, and whether additional measures need to be taken.



▲  
*Just one consequence of climate change: Flooding*

#### Construction and Housing

## ADAPTING BUILDINGS TO CLIMATE CHANGE

Buildings are built to last 50 years or more. Climate research scenarios for the period between 2021 and 2050 predict an increase in temperature of between approximately one and 2.5 degrees Celsius compared to the reference period of 1961 to 1990. By the end of the century, depending on the development of emissions, a warming of three to four degrees is likely. There will be fewer frost days and twice as many hot days as there are now, with maximum temperatures of over 30 degrees, in some regions, up to 30 days per year. The number of tropical nights will also increase, as will the number of nights in which the temperature does not drop below 20 degrees Celsius. Extreme weather events such as dry spells and droughts, heavy precipitation, tempests, hail and thunderstorms are likely to increase significantly. The frequency of heavy winter rainfall in coastal areas could double by the year 2100. The bottom line is that significantly more flood damage must be expected, unless adaptations for this are greatly improved.

Housing and construction planning, as well as the actual construction of new buildings and renovation of old buildings, present a significant challenge if the future climate changes on this scale.

As of yet, there are hardly any generally applicable guidelines, technical rules or standards to control the adaptation to such a change.

Since 2012, in consultation with the panel of experts for the German Institute for Standardization's Environmental Commission, the UBA has been systematically reviewing the need to change rules and standards with a view to the changing climate.

The federal government addresses this problem in its own jurisdiction. The federal government's "Adaptation Action Plan" of 2011 requires, among other things, that in future, new construction and the renovation of properties owned by the Federal Government be examined to determine whether the building should be adapted to the consequences of climate change, in particular with regard to extreme weather events. The "Sustainable Building Rating System" (BNB), developed and made mandatory for federal buildings, presents guidelines for this. One of the components of the evaluation system is the criterion, "Resistance to Natural Disasters." The effects of wind, heavy rainfall, hail, snow, wet winters and floods will be examined in accordance with this [9].

# CONSTRUCTION MATERIALS AS AN ENVIRONMENTAL FACTOR

The construction sector is one of Germany's most resource-intensive economic sectors. The total construction and civil engineering inventory, including infrastructure, includes the storage of about 60 billion tonnes of mineral-based building materials. More than 500 million tonnes [10], including some 25 million tonnes of cement [11] are added every year. In addition, six million tonnes of steel per year [12] and approximately 500,000 tonnes of copper [13] are installed, with considerable resources being consumed for their production.

Approximately 200 million tonnes of waste are generated as a result of the construction and demolition of buildings and infrastructures [14]. These quantities are already recycled for the most part, however not often in such a highly sophisticated manner. They are sometimes used only for back-filling operations or as road beds instead of for the preparation of high-quality building materials. A redirection seems necessary in the medium term, because some of the previous recycling options, such as the construction of new roads, will only be able to play a minor role in the use of the 60 million tonnes produced annually.

- 9 See Aktionsplan Anpassung des Bundes: [www.bmu.de/klimaschutz/downloads/doc/47641.php](http://www.bmu.de/klimaschutz/downloads/doc/47641.php)
- 10 These are mostly gravel, sand and crushed natural stone, of which, in 2008, around 500 million tonnes were used. Source: BGR
- 11 Figures from VDZ: <http://www.vdze-ment.de/1300.html>
- 12 Source: Stahlfibel des Stahlinstituts VDEh, 2007
- 13 Eigene Abschätzung mit Zahlen aus dem World Copper Factbook 2010 der International Copper Study Group, [www.icsg.org](http://www.icsg.org)
- 14 This construction and demolition waste accounted for 58.2 per cent of Germany's total waste generation in 2008. The largest portion of this waste group was approximately 111 million tonnes of excavated soil, stones and dredged material. Mineral-based construction waste included approximately 58 million tonnes. Source: [www.kreislaufwirtschaftbau.de](http://www.kreislaufwirtschaftbau.de)

Figure 1  
**CONSUMPTION OF RAW MATERIALS**  
 in the German construction sector in million tonnes per year



Source: ProgRes, self-evaluation





### Construction and Housing

## HOUSES AS RAW MATERIALS STORAGE

In a resource-poor country like Germany, buildings and infrastructure are important potential storehouses for secondary raw materials. The content of iron and steel, copper, aluminium, zinc and the numerous precious metals that are accumulated there approaches the amount of worldwide annual mining output for the respective commodities. The importance of this storage as a source of raw materials will continue to grow significantly, especially in Germany. The vacancy rate of apartments is forecast to rise significantly after 2050. This can be explained by the general decline of population in East Germany and ongoing migration to West Germany. The demolition of buildings should therefore be expected to increase in future. In some particularly afflicted regions, the flow of building materials from the residential building stock already exceeds the incorporation of new materials. By 2050, this should be the case in many parts of Germany. In the longer term, therefore, the demolition of buildings will be a source of raw materials throughout Germany. Planning authorities and businesses will have to make adjustments for this.



▲  
*Scrap Dealers' Eyes Light Up  
During Demolition*

Consequently, the building sector will see a growing potential for the increased substitution of primary raw materials. The UBA is analysing the reasons for the current high demand and developing strategies to facilitate the economical and careful handling of raw materials. These include tools for a more material-efficient planning of buildings and the use of construction products made of recycled materials. In addition, research into more economical technologies for product manufacturing will be encouraged.

## MATERIAL EFFICIENCY INCREASES

The potential for the use of recycled materials in construction is far from exhausted. Research indicates that: by 2020, one quarter of the quantities of sand and gravel required for the construction of residential buildings could be obtained from demolition waste, and by 2050, more than a third. To be better able to use existing buildings as a resource, a local materials register should be administered, and the building contractors should record the material composition of their buildings, and other demolition-relevant information, in building passports for subsequent owners or the eventual planning of demolition and recycling.

~~~~~  
If cement clinker is produced in a rotary kiln at a significantly lower process temperature and with a reduced calcium content, a high energy and CO<sub>2</sub> savings can be achieved. It is approximately

**50**  
percent.



Next, it is important to expand the knowledge base on the structure of "secondary raw material storage" in building stock, in the form of what is often referred to as urban prospecting. On this basis, buildings should be demolished selectively and with consistent waste processing in order to obtain the highest quality recycling material possible for use in construction and civil engineering.

To support this development, it is advisable to stipulate a minimum percentage of recycled material, for example in the construction of public buildings. A groundbreaking development for the new construction of municipalities and federal states is the cooperation agreement for this purpose which the state of Rhineland-Palatinate concluded, along with the City and County Association, Construction Industry and the Architectural and Engineering Chamber, in October 2012 under the title "Circular Economy Alliance in Construction."

The UBA welcomes agreements like this and provides guidance and support for corresponding construction projects. In recent years, as part of pilot projects, some buildings in south-western Germany have been constructed with an increased percentage of recycled concrete. This has enabled a clear demonstration of the environmental benefits. The UBA is currently reviewing whether the use of recycled aggregates in building construction could be promoted by taxing the use of primary construction materials.

Another way to reduce the environmental impact is the development of new resource-efficient construction materials, for example, in the cement industry. The production of one tonne of conventional cement clinker produces about 900 kilograms of carbon dioxide. Approximately 80 per cent of this amount is caused by the decarbonation of limestone. The rest is primarily due to fuel usage, and to a lesser extent, to the combustion of organic components in the raw material.

If cement clinker is produced in a rotary kiln at a significantly lower process temperature and with a reduced calcium content, energy and CO<sub>2</sub> savings of about 50 per cent can be achieved. There is already a good example of an environmentally friendly cement clinker substitute with "Celitement."

# LAND TAKE BY SETTLEMENT AND TRAFFIC

Land take by new housing and commercial sites, roads and other infrastructure is still very high. In 2010, despite the economic crisis, new housing and transport areas grew by 78 hectares per day. Therefore, the National Sustainable Development Strategy's goal of limiting the growth of housing and transport areas to 30 hectares per day by 2020 still requires massive political efforts. The demographic changes that lead to declining population and unused residential buildings, in many regions, does very little to change this. Moreover, the designation of new areas for commercial and retail space in the open countryside is intensifying the vacancy rate in already existing commercial parks and, increasingly, also in urban shopping centres.

Urban sprawl, infrastructure development and the associated landscape fragmentation also result in the loss or deterioration of natural open spaces, which are important for the conservation of biological diversity and for recreational purposes. Most of the losses are agricultural areas, and with them, often fertile soils, which are thus also precluded from future agricultural production. Soil sealing is another problem. This adversely affects the soil functions, the water balance and the microclimate. Added to that is the denaturation of land and soils through the exploitation of raw materials such as sand and gravel for construction purposes. Currently, around 3.9 hectares are excavated per day for the extraction of mineral resources.



A variety of environmental problems arise from land take for human settlement and transport. Urban sprawl causes growing material and energy consumption for the construction, operation and maintenance of buildings and infrastructure. This also leads to additional waste, noise and pollutant levels. Urban sprawl also generates additional traffic.

There is a wide range of instruments that can be used to achieve the 30-hectare target. Sensible approaches include the consistent focusing of land-use planning on land protection, a reform of land acquisition taxes and real estate taxes, and the improved use of funding instruments. The UBA is currently exploring the costs and benefits of the internal and external development of settlements, the potential for housing construction



In 2010, despite the economic crisis,

**78**  
hectares

per day were converted into settlement and traffic areas.

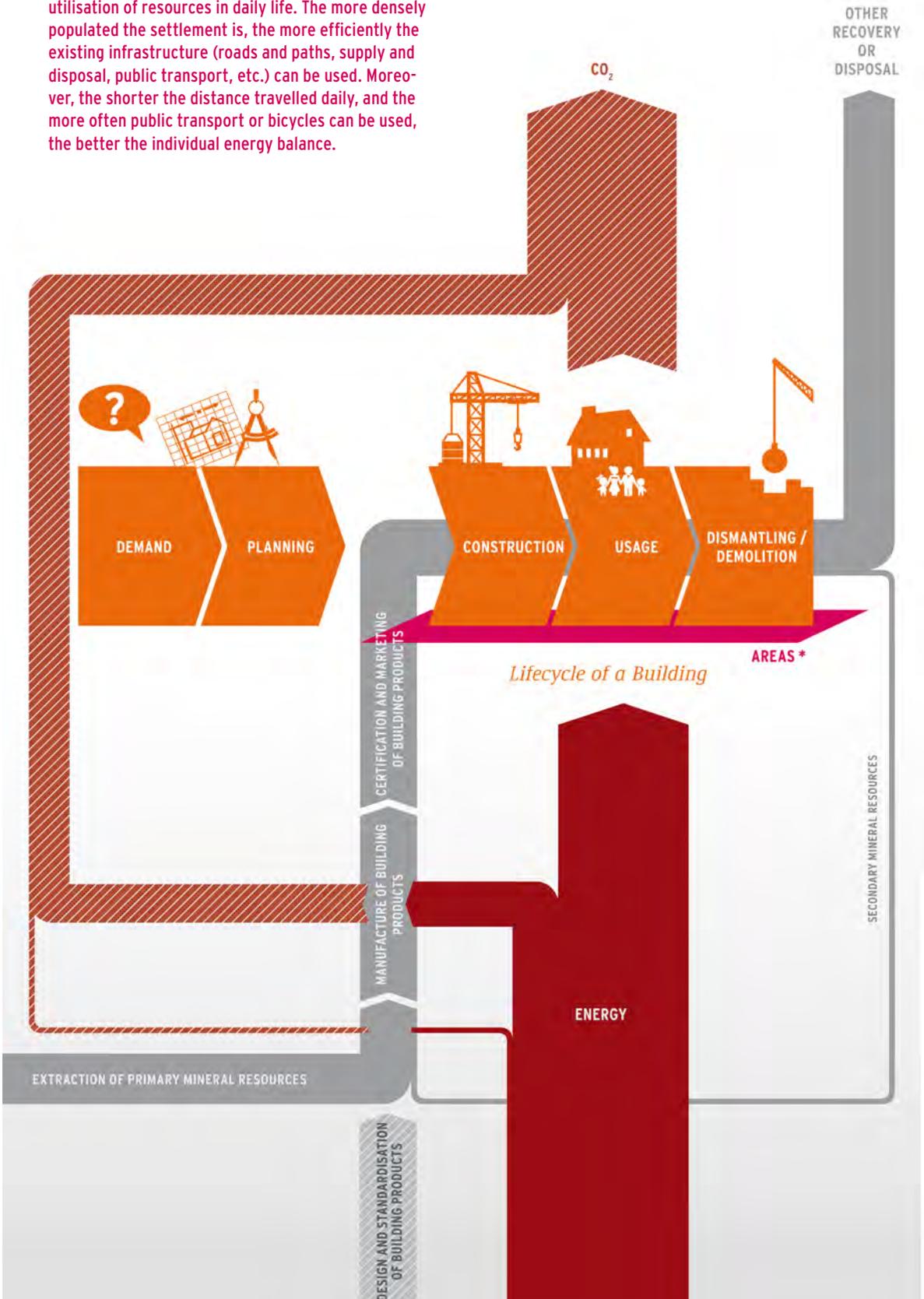


Figure 2

## WHY DO WE REQUIRE RESOURCES?



The choice of location significantly affects the utilisation of resources in daily life. The more densely populated the settlement is, the more efficiently the existing infrastructure (roads and paths, supply and disposal, public transport, etc.) can be used. Moreover, the shorter the distance travelled daily, and the more often public transport or bicycles can be used, the better the individual energy balance.





▲ *Liveable City Centres: The key to land and resource conservation*

on brownfield sites in regions with increasing or decreasing populations, and innovative tools such as the trading of land certificates.

An amendment to the Building Code (BauGB) is currently going through the legislative process. Its objective is to curb the consumption of land at the expense of natural spaces and agricultural lands and instead to promote the “internal development” of cities and towns.

Internal development describes the goal of creating and developing new buildings and functions within existing built up areas. Particularly suitable for this purpose are vacant lots in older building sites as well as new building sites which have already been developed but are only partially built up. Former industrial and commercial areas or redevelopment sites which are no longer in use, for example, post logistic sites, railroad land or barracks complexes, can also be added to this list. Further potential for reuse and redensification are vacant retail and office properties, convertible lofts and, if compatible with environment and neighbourhood, adding new stories to existing buildings or placing additional buildings on plots that have been previously undersaturated.

Research projects conducted by the UBA as well as the Federal Research Ministry (“Refina” programme) have shown that these land reserves can amount to up to a third of the available building space in municipalities. However, a prerequisite for the use of this potential is that municipalities be aware of them and create the planning and organisational conditions to be able to put these

sites to use. This includes the establishment of a land and property information system, targeted communication with the land owners, and the set up of urban plans for internal development. If necessary, financial support programmes should also be launched.

For the amendment to the Federal Building Code, the UBA has submitted a set of proposals for the promotion of internal development of settlements. The two most important proposals have been incorporated into the Federal Government’s draft and they are also supported in a statement made by the Federal Council. The draft specifies that urban development is to take place primarily through internal development measures (§ 1 Building Code, Clause 5, sentence 3 new), and any need for the conversion of agricultural land or forest must be substantiated (§ 1a Building Code, Clause 2, Sentence 4 new). Thereby, the possibilities for internal development, particularly in brownfields, vacant buildings and vacant lots, have to be taken into account.

Another starting point for supporting land conservation would be for the legislation of environmental impact assessments to include the designation of unpopulated areas as “protected goods” in their repertoire of measures. This would mean that the transformation of land by all plans and programmes for which a Strategic Environmental Assessment (SEA) has to be carried out, and for all projects subject to an Environmental Impact Assessment (EIA), must be accurately determined and presented. If there are locally or regional specific land conservation targets, the environmental



assessment would also show whether they have been met.

The European Commission's current draft of the amendment to the EIA Directive expands the list of protected goods to include the items of "biodiversity" and "natural resources." Another provision is to complement the previously established

concept of protected "soil" in future with that of protected "land" (in the sense of "unpopulated land"). The European Commission's rationale is that the consumption of land for settlement at the expense of open space ("land take") endangers both the objectives of soil conservation and biological diversity and those of resource conservation and resource efficiency.

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## THE TRADING OF LAND CERTIFICATES

An innovative tool for land conservation would be the trading of land certificates, an idea conceived in analogy with the EU Emissions Trading Scheme. The basic approach is that each municipality would always require such certificates if they wanted to make use of new land outside the limits of existing settlements, but not for conducting internal urban development.

The municipalities are thereby allocated, free of charge and according to a certain population key, as many certificates as are needed to meet the 30-hectare goal nationwide. If a municipality does not need its certificates, it can sell them to other municipalities that need more certificates than they have been allocated.

Outcome: Urban development on greenfields takes place where the benefit is particularly high, whereas municipalities who sell their certificates can use the proceeds, for example, to finance recycling of brownfield sites, upgrades to the energy efficiency of public buildings or renewable energy investments.

In autumn of 2012, the UBA started a highly realistic simulation game in which selected municipalities are experimenting with "trading land." Behind this model project is a corresponding declaration in the Federal Government's coalition agreement of October 2009. Subsequently, within the framework of a research and development project FORUM, a concept for the implementation of this model project has been worked out in cooperation with urban planners, economists and representatives of municipalities, regions and provinces. The aim of FORUM was to design a model project at a reasonable cost and in as practical a manner as possible for the municipalities that volunteered to participate.

In the framework of the ongoing realistic simulation game, the municipalities are supported for the necessary inventories e.g. in identifying the potential for internal development and in the comparative cost-benefit analysis for internal vs. external development. As an additional support for the project, as of 2013 in the framework of the climate protection initiative, the German Federal Environment Ministry has set up a new component, "climate-friendly land management," as part of the municipal funding programme. Additionally, the eligible mandate of the "climate protection manager" is broadened to include land management.



### Construction and Housing

## BUILDINGS AND HEALTH

From the perspective of health, the housing and construction sectors deserve a great deal of attention. Building regulations specify that a building must be designed and constructed in such a manner “that it will not pose a threat to the hygiene or health of their occupants or neighbours” during its entire life cycle [15]. The goal, therefore, is to minimise all risks that exist, e.g. for employees in the production of building materials or the construction and demolition of houses or risks that may arise while living and working in the buildings.

From the perspective of health and environmental protection, emissions of dust, waste water, carbon dioxide and other gases are a priority when it comes to the production of building materials such as bricks, cement and steel. A large portion of the emissions in these areas come from the use of fossil fuels. During the use phase of a building, organic compounds (VOCs and SVOCs etc.) may be released into indoor air from building products, furniture and other products used indoors. Because Germans stay indoors around 80 per cent of the day, these emissions can lead not only to unacceptable odours, but also to health risks.

There are a number of other problematic substances, including particulate matter which is generated, for example, in small furnaces or with certain home improvement work. Other particular causes for concern include plasticisers in PVC flooring, environmentally harmful flame retardants in foam insulating materials, biocides in cladding and roofing materials, and organic pollutants and heavy metals in synthetic turf made of scrap tyre granulate. Contaminated construction prod-

ucts present a risk to health and the environment over the entire life cycle. It is therefore important to minimise contaminant levels and emissions “from cradle to grave.” The European Union relies on regulatory measures for this purpose and requires minimum technical standards, such as the Industrial Emissions Directive (IED) and the REACH regulation.

In Germany, the Committee for the Health-Related Evaluation of Building Products (AgBB) already defined the requirements for minimising noxious VOC and SVOC emissions from building products in 2000. The AgBB, whose office is located in the Federal Environment Agency, developed an assessment scheme for VOC emissions from construction products relevant to indoor spaces. The Deutsches Institut für Bautechnik (German Institute for Construction Technology, DIBt) integrated this assessment scheme in its approval guidelines in 2005. Meanwhile, the suitability of all types of floor coverings, varnishes for wood floorings and floor covering adhesives for most indoor spaces must be established by DIBt. In future, the direct integration of a health evaluation into the European construction product standards is expected to follow for further product groups.

Above and beyond that, other vehicles are needed to create demand-side transparency such as making information available to the purchasers and processors of construction materials, for example through the “Blue Angel” eco label or voluntary environmental product declarations for building products (“Environmental Product Declarations”).



15 Regulation (EU) No. 305/2011 Laying Down Harmonised Conditions for the Marketing of Construction Products, dated 9 March, 2011



### Construction and Housing

## INFORMATION ON POLLUTANTS

One way to improve the availability of information on the environmental characteristics of construction products is offered by a new EU regulation which will become effective in the European Union in July, 2013. It harmonises conditions for the marketing of construction products in the European Union (Construction Product Regulation, CPR) and should promote the exchange of goods throughout the EU. The regulation incorporates some recommendations submitted by the European Network of National Environmental Agencies (“EPA Network”). These are particularly reflected in two “basic requirements” for construction works with the titles “Hygiene, Health and the Environment” and “Sustainable use of Natural Resources” These define issues of general public interest for which the EU Member States may lay down rules that must be respected in the free circulation of construction products in the single European market.

The network has also been successful with other proposals that have been incorporated into the regulation by the European Parliament and by the EU Council. This includes ensuring that users are informed of the presence of substances of very high concern (SVHC) in the context of the CE marking on a construction product, if they are contained in concentrations of more than 0.1 per cent.

Whether or not only safe building products are actually marketed in future depends on the shaping and implementation of the regulation. The European Commission has the opportunity to supplement it as needed by means of “delegated acts.” It can thus specify, for example, the essential char-

acteristics of a construction product which the manufacturer has to declare in a “performance declaration” as a prerequisite for the CE mark. In addition, the Commission would have the leverage to set threshold values or performance categories for harmful emissions or contents.

To ensure that all users of construction products in the EU have access to information on hazardous substances contained in or released from construction products, it is necessary for the European Commission to actually put its new capabilities into practise. If the European Commission does not lay down the essential characteristics related to hazardous substances, the declaration of performance would be drawn up according to a catalogue of essential characteristics in the EU Member State where the product is intended to be placed on the market. This is unsatisfactory from the standpoint of environment and health, since, until now, only few countries request or demand information on environmental and health issues.

Therefore, it should be regarded as very positive that the new EU regulation at least requires standard information on SVHCs used in construction products. For the present, until 25 April 2014, the Commission is bound to check whether the obligatory substance declaration is to be extended beyond SVHCs. The UBA considers it important to implement the disclosure requirements of the EU environmental legislation in the performance declaration for construction products in future, particularly where there are already harmonised requirements throughout Europe.

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## “REACH” ALSO APPLIES TO CONSTRUCTION PRODUCTS

Construction products are also generally subject to chemicals legislation which either completely bars the use of problematic substances or attaches conditions to their use. The most important regulatory framework for this is the REACH regulation. It requires the gradual registration of all the substances used in Europe by chemical manufacturers. Specifically, this registration includes an investigation of the ecotoxicological properties of the substances and a description of how and where they can be used safely.

SVHCs (Substances of Very High Concern) may be subjected to a general authorisation requirement for all uses or be restricted from certain uses. Consumers also have a right to information, if a product contains more than 0.1 per cent of an SVHC, and they can request this information from the manufacturer or the vendor

Additionally relevant for construction is the “Regulation on Persistent Organic Pollutants” which also contains prohibitions for certain chemicals



## BETTER LIVING WITH NOISE CONTROL

Noise is another important environmental factor which can affect the quality of living. The primary source of noise pollution, particularly in metropolitan areas, is traffic. Along with the minimization of pollution, adequate sound insulation plays a major role in the sustainable conservation of human health. In principle, measures to reduce noise at the source should take precedence. Where noise pollution persists despite these efforts, it is advisable to carry out noise protection. The UBA recommends that plans for building renovation include new windows which not only ensure good thermal insulation, but also provide significant noise reduction, as the additional costs of window replacement are comparatively low in any case.



16 BBK, THW, DWD, UBA: Auswertung regionaler Klimaprojektionen für Deutschland hinsichtlich der Änderung des Extremverhaltens von Temperatur, Niederschlag und Windgeschwindigkeit, Offenbach 2012

◀  
*Proper Ventilation:  
Open the window fully for up to  
30 minutes twice a day, in winter,  
for a shorter time.*

## WHAT SHOULD BE DONE FOR OPTIMAL INDOOR AIR QUALITY

People in Central Europe spend most of the day in closed rooms, and most of that time in their homes or workplaces. For health and wellbeing, it is therefore important to reduce indoor pollutants, to the greatest extent possible. In earlier decades, hazardous chemicals such as wood preservatives, pentachlorophenol (PCP), formaldehyde and asbestos were at the forefront of the debate. These play virtually no role today, due to government regulations and prohibitions, with the exception of formaldehyde exposure. This chemical continues to cause certain problems, because in the meantime, wood and wood-based materials are being increasingly used for the purposes of resource-efficiency in construction. These materials may sometimes be bonded with formaldehyde-based adhesives.

Currently, substances such as volatile organic compounds (VOC) and semi-volatile organic compounds (SVOC) present the greatest problems for indoor air. VOCs can emit from solvents which are added to paints, varnishes, adhesives, cosmetic and cleaning agents, or are released from construction products into indoor air. Building products and household items, such as plastic containers to which plasticisers have been added, and electronic devices that contain flame retardants are also sources of SVOCs.

Burning wood in fireplaces or using sooty candles generate, in addition to the SVOCs, polycyclic aromatic hydrocarbons (PAHs), which are harmful to health, as well as dust and soot. Ultrafine particulate matter, consisting of very small dust particles, is the most highly problematic type of dust, because it is inhaled and can then spread throughout the body. There are many sources of dust. Even simple household appliances such as toasters and ovens emit fine dust particles during their operation. The UBA is currently con-

ducting a research project to investigate the chemical and physical composition of these types of dust from indoor sources and how they affect our health.

VOCs and SVOCs end up in the air particularly after renovation and rehabilitation work. This is especially problematic if the buildings are simultaneously very airtight and insufficiently ventilated. In this way, energy-saving construction, in which the focus is on low heat loss through the airtight sealing of windows and doors, can create problems. However, this is not an argument against this method of construction. Rather, care must be taken to ensure adequate ventilation, so that CO<sub>2</sub> or chemical substances do not accumulate in undesirable concentrations in indoor air, and to prevent mould formation. If this is not ensured through properly maintained ventilation systems, the residents need to modify their airing habits (regular airing by fits and starts). Low-emission and low-odour building materials and products, paints, adhesives, etc. and furnishings make a significant contribution to healthy indoor air.

The approval of construction materials in Germany is carried out by the German Institute for Building Technology in Berlin. Since 2005, the products have had to meet health criteria with regard to gaseous emissions. To date, this has not yet been implemented consistently for all types of products. The German Committee for the Health-Related Evaluation of Building Products (AgBB), whose office is located within the UBA, issues guidelines for the testing and limitation of emissions. In the meantime, a range of low-emission building products is marked with the "Blue Angel" environmental label. The consumer can be confident that they meet the higher standards.



## BLUE ANGEL FOR EXTERNAL THERMAL INSULATION COMPOSITE SYSTEMS

External thermal insulation composite systems (ETICS) are used for the insulation of building façades. They consist of at least four layers: a layer of adhesive or mechanical fastening with rails or anchors, an insulating layer, a reinforcing layer of plaster and fabric and a top coat of plaster.

For ETICS the Blue Angel label requires that all used materials exhibit the lowest possible emissions in their production, during their period of use, and during waste disposal. The use of biocides against algal growth, for example, is not permitted. To meet the complex requirements, it is not sufficient to merely check the components of the insulation systems (composition assessment). From a material perspective appropriate construction products can, in fact, be used in an inappropriate design, manually installed in an inappropriate manner, or damaged during installation. The consequence is that the desired environmental objectives, energy conservation and climate protection, are not reached.

The "Blue Angel" eco label defines minimum criteria for quality assurance and the standards-compliant implementation of work, stability and durability, optical properties, and the provision of information.

## UBA LEADS BY EXAMPLE

In 2013, the UBA is pushing four separate projects that will serve as models for the reduction of CO<sub>2</sub> emissions and the efficient use of resources. The plan is to attain all four "gold" seals of approval according to the "Rating System for Sustainable Building" for Federal Buildings (BNB).

- ▶ At the UBA Berlin-Marienfelde branch, a new office building ("House 2019") will be constructed for approximately 30 employees. It will be a timber construction made of local raw materials, and will be one of the first federal buildings with an even energy balance. The energy for electricity will be provided by a photovoltaic system on the roof. The electricity generated will serve for heating by means of a heat pump, which extracts thermal energy from the groundwater.
- ▶ The UBA is planning its annex in Dessau as a zero-energy house, and from the standpoint of sustainable construction. Here, renewable sources will provide even more energy than the house consumes in total.
- ▶ In the renovation of UBA's Berlin building at the Grunewald forest, there is a focus on needs-based air-conditioning and control of laboratories through highly energy-efficient systems engineering. The building will comply with the new construction standard of the amended Energy Conservation Regulations (EnEV 2009). To achieve this is particularly challenging, because the façade of the building is under the protection of historical buildings and monuments.
- ▶ The new building for the UBA air measuring point on the Schauinsland mountain in the Black Forest is being run as a zero-energy house. The energy necessary for the measurement and system operation should be generated entirely on-site.



Every German consumes an average of

**1,000**  
**tonnes**

of raw materials in the course of his life-time (of which 2 tonnes copper, three tonnes aluminium, 40 tonnes steel, 105 tonnes oil, 235 tonnes coal, and 540 tonnes stone, gravel and sand).

Source: BGR

# 02 NOISE





*“One in two people in Germany are disturbed or affected by noise. But noise is not only a disturbance, it also poses a threat to human health. We are working on finding solutions for improving people’s quality of life.”*

**Uwe Brendle**

*Head of the Department of  
“Transport and Noise”*

# LEAF BLOWERS AND ENGINES

The fight against noise requires everyone's involvement.



Whether it is the whine of leaf blowers, the roar of traffic accelerating at the lights, or the thunder of engines at full throttle, noise has now become an environmental problem virtually everywhere. It is impacting on people's health and well-being. Noise has been identified, for example, as contributing to the increase in cardiovascular disease. The increased level of noise is primarily the result of an increased volume of traffic. There are, however, a whole series of measures which can reduce noise pollution, from low-noise car tyres to whisper brakes for freight trains to strategies to avoid use of transport. It is especially important to involve the general public as much as possible in the fight against noise.



Noise is a pollutant, which has only a localised effect but which is common almost everywhere in Germany as it affects so many areas.

Many people are exposed to high levels of noise that adversely affect their health and quality of life. Noise is now experienced virtually everywhere and around the clock, in towns and in the country, day and night. As a result of large-scale infrastructure projects such as the construction of new airports or the expansion of existing ones, there is much greater political, scientific, and public awareness of the issue of noise.

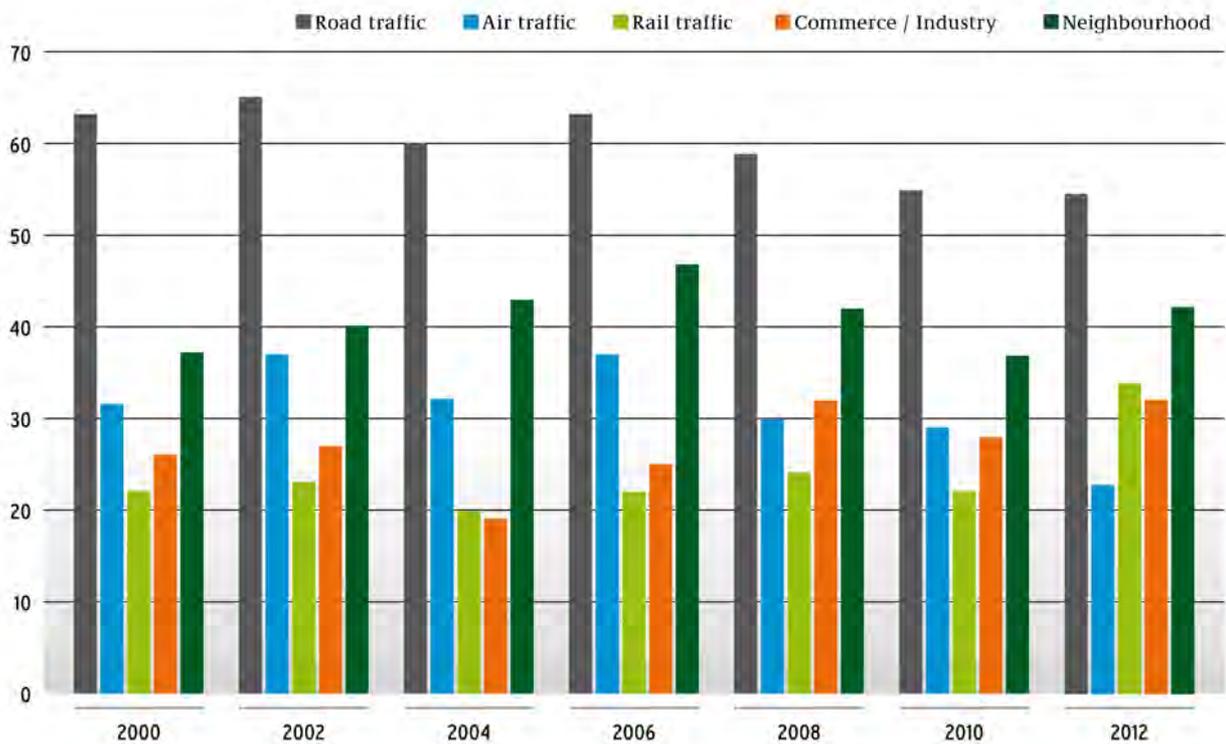
Not all sound can be automatically classified as noise. Various factors unrelated towards the level of sound generated also play a role in classifying sound as noise. For example, have the people themselves joined in the celebrations? Or has the neighbour organised a celebration without prior warning? People's attitude to the neighbour is equally important. Is their attitude generally positive or negative? It is therefore not just the physical aspects of sound that play a role. Feelings, attitudes, and individual dispositions as well as the information associated with the sounds are also very important factors. This is clear from the dif-

ferent meanings of the words "sound" and "noise." Whereas the word "sound" refers purely to its physical and acoustic properties, the word "noise" results from the cognitive processing of sound. Any sound that may result in disturbance, annoyance, impairment, or injury is characterised as noise. In certain circumstances, this can also include sound that is perceived as pleasurable, such as loud music, which can also cause physical injury.

To a certain degree, noise is a pollutant, which has only a localised effect unlike other pollutants but which can be found virtually everywhere as there are so many areas in Germany that are affected by it. One of the primary reasons for this is the increase in the volume of traffic. There has also been an increase in sources of noise, of which leaf blowers or large public events are just two examples. Furthermore, people in general are much more aware of environmental issues and especially with regard to noise. Even low levels of noise can result in strong reactions if it becomes known that they are avoidable.

Figure 1

## NOISE ANNOYANCE IN GERMANY IN %



### Noise

## NOISE DOESN'T JUST GET ON PEOPLE'S NERVES

The Federal Environment Agency regularly conducts representative surveys to assess the impact of noise in Germany. According to the survey carried out in 2012, around 54 % of those interviewed complained of being disturbed or annoyed by road traffic in the vicinity of their homes. Rail traffic was the second most common source of noise generated by transport. Nationally, almost one in three people complained of being affected by noise from rail traffic. Slightly more than a fifth of the population are disturbed by aircraft noise. According to the survey, however, noisy neighbours are also an important source of noise. Just under 42 % of people complained of being affected by noise from their neighbours (see Fig. 1).

Noise doesn't just affect subjective well-being and quality of life but also sleep. This results not only in changes in sleeping patterns and in an increase in the number of times people wake up but also in increased secretion of stress hormones and in elevated cardiovascular risk factors. A large European study has demonstrated, for example, a statistically verified correlation between stress caused

by road traffic noise and night-time aircraft noise on the one hand and high blood pressure on the other. People greatly affected by noise are more likely to have higher blood pressure than those living in quieter areas. The special significance of night-time aircraft noise has been demonstrated in a study conducted in the vicinity of the Cologne/Bonn airport. It showed that the number of prescriptions made out for people exposed to night-time aircraft noise was higher than in the general population.

A further analysis of the data with regard to the risk of developing cardiovascular and mental disease revealed that even continual low levels of sound of 40 decibels (dB(A)) increase the risk of disease. An extensive Swiss study found that the risk of myocardial infarction rises with increasing levels of stress caused by aircraft noise. In its Night Noise Guidelines for Europe, the World Health Organisation (WHO) also recommended that night-time noise not exceed an average sound level of 40 dB(A) to avoid adverse effects on health. The correlation between noise and cardiovascular disease



including myocardial infarction has been clearly shown by this and other results of research into the effects of noise. Therefore, the question now is no longer whether noise results in disease but the extent to which it does so.

In addition, noise has an adverse effect on children's linguistic development and mental capacities. This has been proved by a study conducted in three EU countries. The study investigated the impact of noise from traffic on children's cognitive performance and health. The results revealed that aircraft noise can impair children's reading ability and memory capacity.

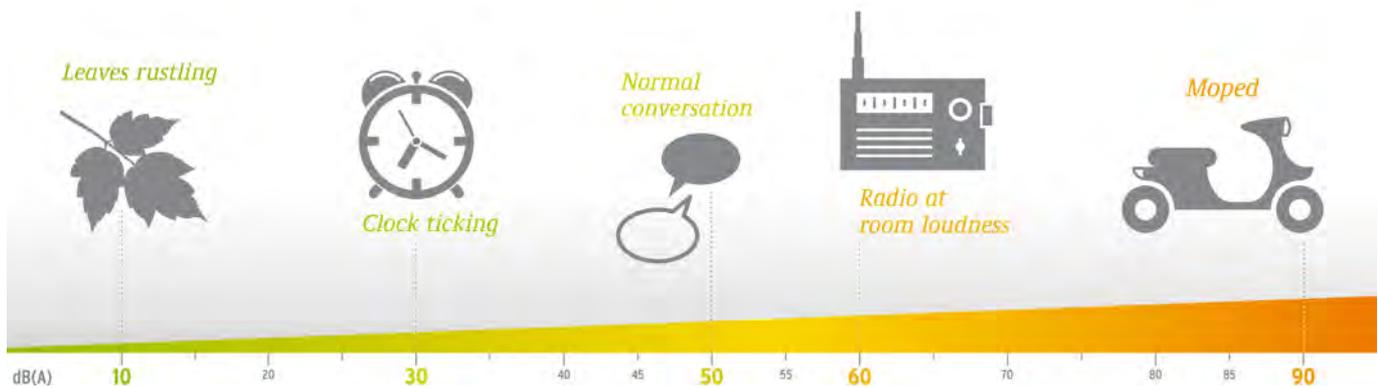
The far-reaching health effects of noise have prompted the WHO Regional Office for Europe to develop a concept for the consequences of the various effects of noise. This concept was published in 2011 in a document entitled "Burden of Disease from Environmental Noise."

In this document, dose-effect relationships were identified for cardiovascular disease, sleep disturbance, annoyance, reduced performance in children, and tinnitus (ringing in the ears). The noise-induced burden of disease in the general population for the various sources of noise was calculated based on the distribution of the population in relation to the different categories of noise. This is expressed in DALYs (disability adjusted life years). The frequency of disease is weighted using factors that take into account both the severity



Figure 2

## MAXIMUM SOUND PRESSURE LEVELS in dB(A)

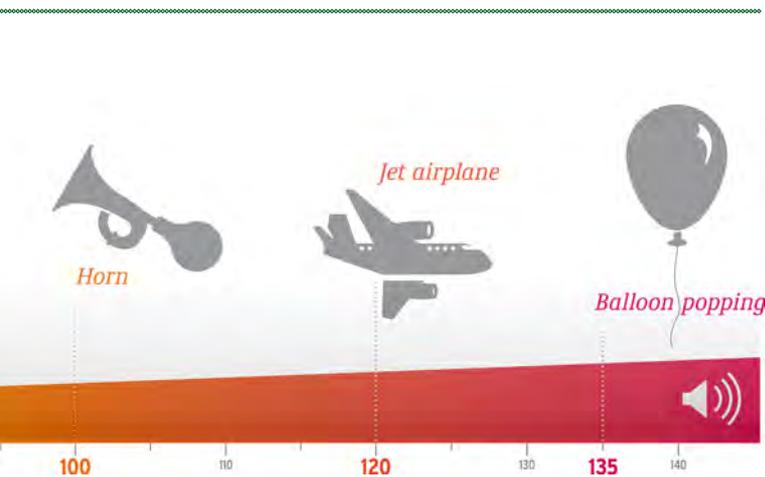




and the duration of the impairment. Using this concept, the WHO has calculated that 61,000 “healthy” life years are lost every year in Western Europe as a result of cardiovascular disease induced by noise from traffic. If sleep disturbance and annoyance reactions are included, the loss is even above one million life years.

Finally, the cost implications also need to be considered. Noise causes considerable financial loss, from health expenditure, for example. The European Commission estimates the cost of traffic noise in the EU at around 40,000 million euro annually, 90 % of which is due to road traffic.

### Potential effects of individual sound pressure levels



30 dB(A)

Problems going to sleep, disturbed sleep

45 dB(A) / Night

Cardiovascular risk

50 dB(A)

Problems learning and concentrating

55 dB(A) / Day

Cardiovascular risk



Noise

## NOISE ABATEMENT INTERNATIONAL

An essential aspect of European noise abatement policy is the establishment of harmonised (uniform) pan-European noise thresholds for vehicles, domestic appliances, and other products that create noise. The Type Approval is usually used for vehicles and a corresponding compliance assessment for other products. A manufacturer who wishes to place a new product on the market must first demonstrate compliance with the noise threshold in a prototype of the product. The manufacturer must subsequently carry out regular checks on random samples to ensure that products in regular production also comply with the noise threshold. Within the framework of market surveillance, however, there are practical problems.

Harmonised noise thresholds have been established for buses and for passenger and freight vehicles since 1970. The thresholds have been made more stringent several times and were last amended in 1996. Measurements have shown, however, that the marked lowering of the threshold values has had only a slight effect on the amount of noise the general population is exposed to. One important reason for this discrepancy is that the procedure used to measure noise as part of Type Approval only inadequately reflects the amount of noise actually created in normal traffic conditions. It is only when vehicles are tested for Type Approval that they create markedly less noise. In normal traffic conditions, the fall is only slight. The United Nations Economic Commission for Europe (UNECE) has therefore developed a new procedure to measure noise, which will serve as a basis for new noise

threshold values expected to be introduced by the EU before the end of 2013. The Federal Environment Agency has calculated that the new threshold values under discussion, taking into account the expected increase in the volume of traffic, will only result in a reduction in noise of around one decibel. For a greater and faster reduction in noise, the thresholds for tyres in particular must be made more stringent again.

The EU is also currently amending the testing procedures and noise thresholds for motorcycles. The new regulation contains a number of fundamental improvements to noise abatement even though the thresholds themselves are largely unchanged. The amended provision, for example, makes it more difficult to manipulate replacement silencers and makes it easier to monitor road noise during traffic checks. It is anticipated that the new EU regulation will be adopted before the end of 2013.

Thresholds for the rolling noise of tyres were first introduced in 2001 with the European Tyre Directive 2001/43/EC. Since then, these thresholds have been made more stringent by Regulation 661/2009/EC, which also stipulates thresholds for wet grip performance and rolling resistance. A labelling requirement for these three properties has been in force since 1 November 2012. The new label is similar to the energy consumption label for domestic appliances and makes it easier for car owners to consider the environmental properties of tyres when buying new ones.



▲  
*Freight trains must also produce less noise. Setting track access charges based on noise emissions may help to achieve this.*

Under the Directives on rail traffic across Europe, the EU Commission has established pan-European noise thresholds for new types of rolling stock in the Technical Specifications for Interoperability (TSI). The most important consequence of the noise thresholds is that particularly noisy rolling stock fitted with cast iron block brakes is no longer permitted. The challenge is now to replace these brakes in especially noisy freight wagons in the current rolling stock with quieter braking systems. As a financial incentive for rail operators to refit such rolling stock with quieter brakes, the intention is to set track access charges in Germany and the EU according to the level of noise emissions. This would mean freight would be transported by rail more cheaply with quiet freight wagons than with noisy ones.

International standards for permissible noise emissions in new types of aircraft are set out in the aviation agreement of the International Civil Aviation Organisation (ICAO) (see: Annex 16, volume I). Apart from the noise thresholds for different aircraft which these must comply with at three precisely defined measuring points following a prescribed starting and landing procedure, this regulation also stipulates how the measurements should be assessed. As of 2006, new commercial aircraft have been required to comply with a ten decibel lower noise threshold value (total value at the three measuring points). The noise emissions for many aircraft, however, are well below this new threshold. There is therefore a pressing need to lower the threshold once more. With the support of Ger-

many, the Environmental Committee of the ICAO is currently investigating various options for lowering the noise threshold. The Federal Environment Agency is making an important contribution to this work.



## Noise thresholds for lawnmowers and construction machinery

The EU Directive (2000/14/EC) on the use of outdoor equipment stipulates uniform labelling of the sound power level of a broad range of machinery and equipment responsible for noise, from construction machinery to garden equipment to containers for rubbish collection. The Directive also establishes noise thresholds for 22 product groups.

The primary goal of the European EcoDesign Directive (2009/125/EC) for energy-using and energy-related products is to reduce the energy consumption of products, such as domestic appliances, for example, by a series of ambitious requirements. The product-specific regulations, however, also partly include requirements that govern the maximum permissible sound power level of the individual products. In addition, the purpose of regulations governing energy consumption labelling is to provide consumers with standardised information about the energy consumption and other properties of a product, including noise emission. To date, implementing measures have been planned for 46 product groups, of which 16 are already in force. The noise thresholds established so far, however, are not very stringent as virtually any product available on the market complies with them.

Table 1 summarises the current noise emission regulations.

In 2002, to improve the noise situation in Europe, the EU issued the Environmental Noise Directive (2002/49/EC). It became law in Germany in 2005. The aim of the Directive is to reduce environmental noise and to prevent an increase in noise in areas which are traditionally quiet. This first requires mapping the level of noise pollution in different areas and then introducing specific measures to reduce it. The EU Directive envisages progressive implementation of its provisions. The first stage involved initially only motorways and major trunk roads, major railway lines, and various major airports with a high volume of traffic as well as large conurbations. Since 2012, noise levels in all conurbations and on all major transport routes in Europe need to be recorded. In Germany, this involves 71 conurbations with around 24.5 million inhabitants, 44,000 kilometres of motorways and major trunk roads, 13,700 kilometres of major railway lines, and all eleven major airports. In each case, the noise levels need to be determined over the course of the entire day and separately at night-time. To ensure comparability of the results, uniform pan-European indicators are used, the day-evening-night noise indicator (LDEN) and the night noise indicator (LNight).

Table 1

## NOISE EMISSION REGULATIONS FOR VARIOUS SOURCES OF NOISE

| Noise type                             | Source of noise                          | Scope         | Regulation                                                                                                                                            |
|----------------------------------------|------------------------------------------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Road traffic                           | Passenger/freight vehicles               | Europe        | 70/157/EEC                                                                                                                                            |
|                                        | Motorcycles                              | Europe        | 97/24/EC                                                                                                                                              |
|                                        | Tyres                                    | Europe        | 661/2009/EC<br>1222/2009/EC                                                                                                                           |
| Air traffic                            | Aircraft                                 | International | ICAO, Appendix 16, volume I                                                                                                                           |
| Rail traffic                           | Rolling stock                            | Europe        | TSI Noise (2011/229/EU)<br>HS TSI Rolling stock (2008/232/EC)                                                                                         |
| Industrial/commercial/leisure Products | Facilities                               | Germany       | Federal Immission Control Act Products                                                                                                                |
|                                        | Machinery and equipment                  | Europe        | Directive 2000/14/EC                                                                                                                                  |
|                                        |                                          | Germany       | 32nd BImSchV                                                                                                                                          |
|                                        | Energy-using and energy-related products | Europe        | Directive 2005/32/EC<br>Directive 2009/125/EC                                                                                                         |
|                                        |                                          | Germany       | Energy-using and Energy-related Product Act (EVPG)<br><br>Energy Consumption Labelling Act (EnVKG)<br>Energy Consumption Labelling Regulation (EnVKV) |

The first stage of noise mapping provided data for a total of 3,723 communities in Germany. It is clear from the data even in this first stage that large parts of the general population are affected by noise. Just the data for the motorways and major trunk roads included in this stage show that

around 6.8 million people are exposed to noise levels of above 55 dB(A). Considerable annoyance and disturbed communication can occur at such levels. The current second stage of noise mapping covers significantly more areas and so provides an even more comprehensive picture of noise pollution.

Figure 3

## PEOPLE AFFECTED BY ROAD TRAFFIC NOISE

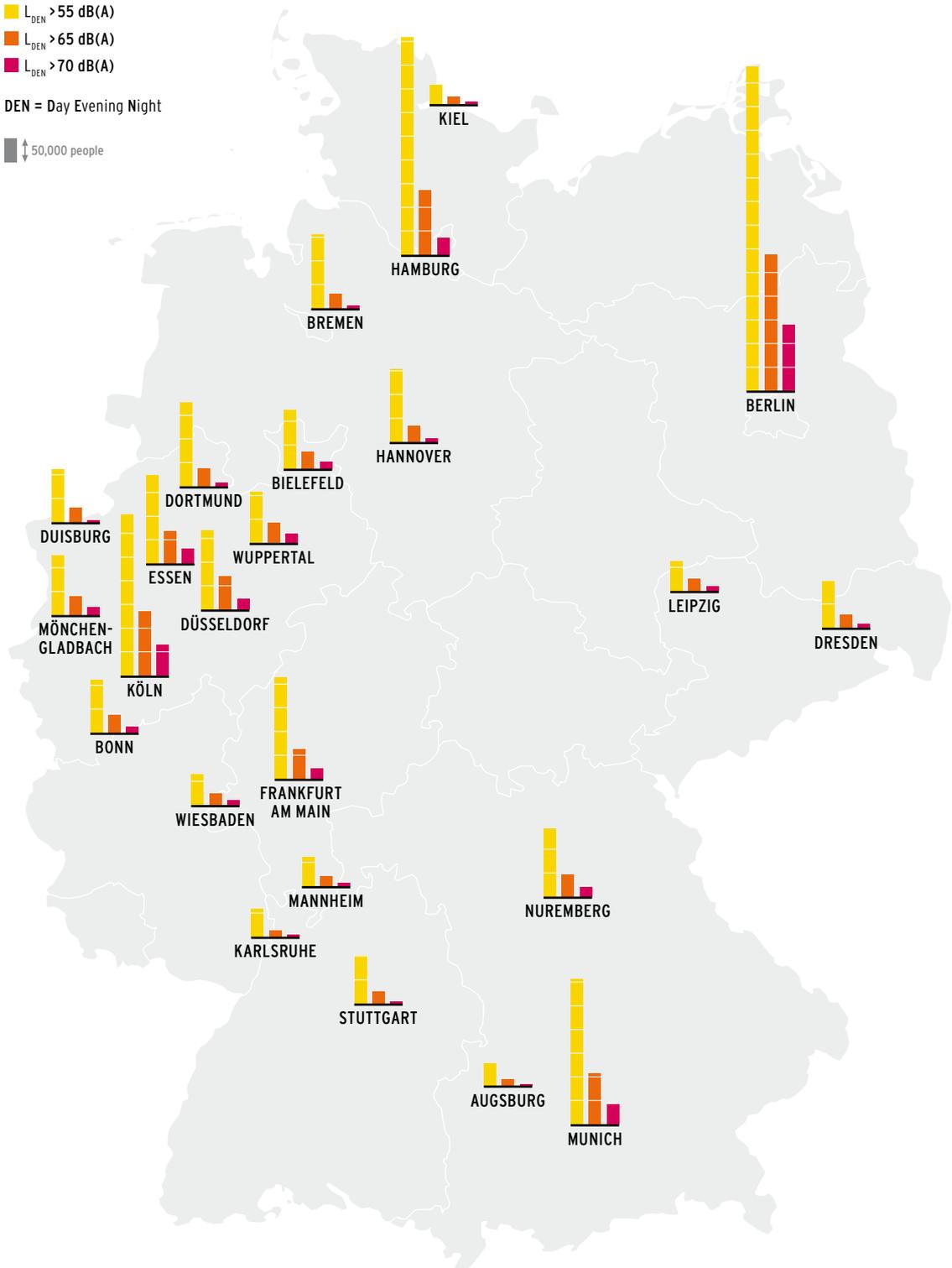
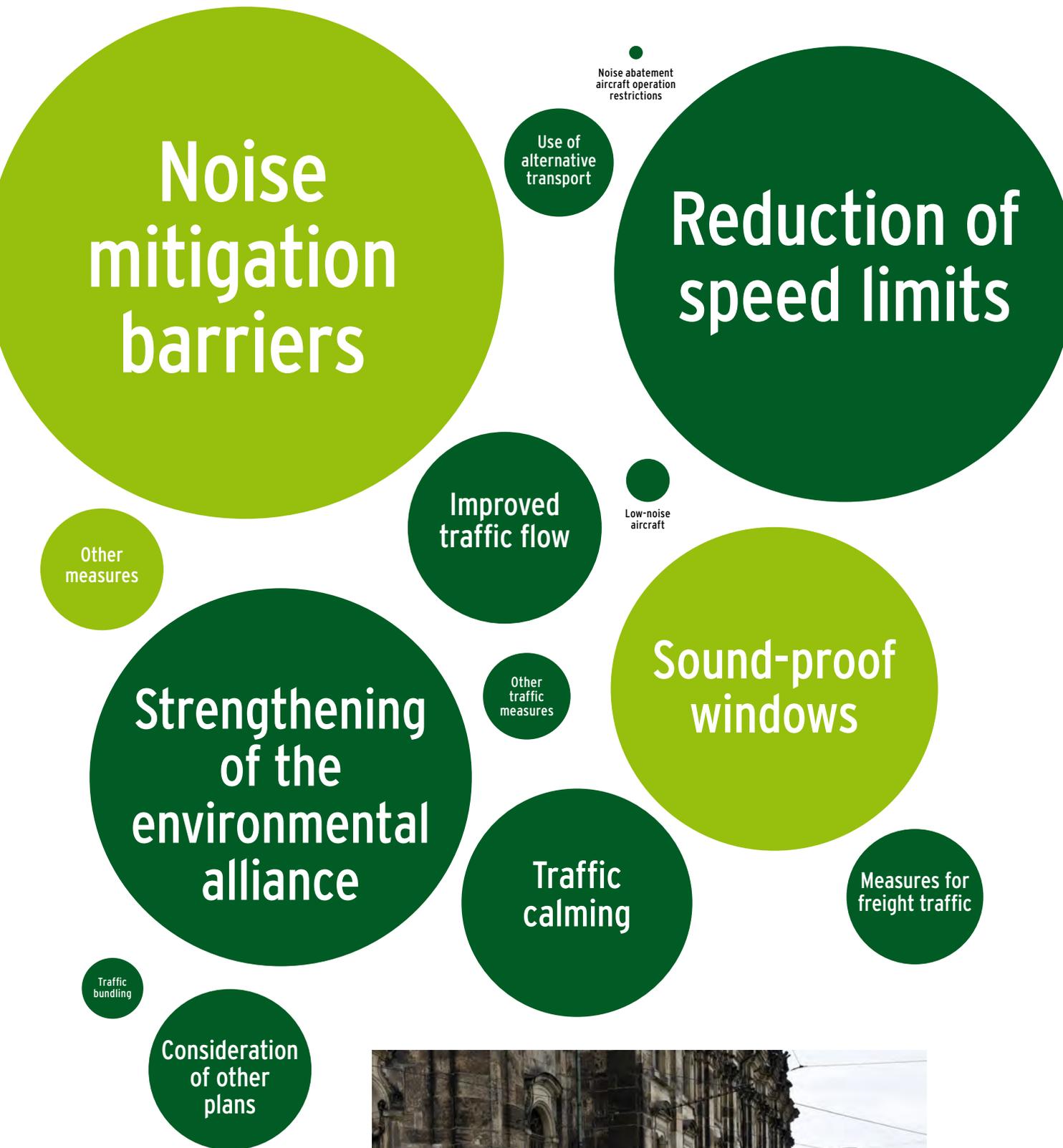


Figure 4

## FREQUENCY OF NOISE MITIGATION MEASURES SPECIFIED IN NOISE ACTION PLANS



Source: Federal Environment Agency (UBA), Noise Appraisal 2010: Investigation of the decision-making criteria for the stipulation of noise reduction measures in noise action plans in accordance with the Directive on Environmental Noise 2002/49/EC, texts no. 78/2011



# Road surfacing and rails

Urban development measures

Parking planning

## Construction of new roads

The noise maps serve as a basis for establishing noise action plans with the active collaboration of the general public. In other words, they help plan and implement specific noise mitigation measures as broadly as possible. This primarily involves communities targeting the most widespread source of noise, road traffic. The range of measures adopted is very broad. Measures range from long-term strategic approaches to traffic reduction to measures that can be taken in the short term such as local speed limits or bans on heavy freight vehicles driving through specific areas. Figure 4 shows the frequency of measures mentioned in the noise action plans.

Drawing up noise action plans can involve other areas. Many noise mitigation measures, for example, also have an impact on traffic safety, traffic flow, and road network capacity. Moreover, traffic control measures frequently have a positive effect on particulate or nitrogen oxide pollution. For

these reasons, even closer collaboration between town and traffic planners as well as environmental organisations is required. It should be their common purpose to enable movement, especially in towns, that requires the least possible use of motorised individual transport, i.e. to design movement within an area that is more sustainable. It is well known that finances are restricted and so, wherever possible, towns and communities should form alliances specifically to deal with these issues in their area. This would allow joint management of infrastructure and so would result in cost savings.

Apart from the reduction of existing noise pollution, however, the Environmental Noise Directive 2002/49/EC has a further important aim, to protect “quiet areas.” At present, however, there are no clear criteria to define such areas, either at EU level or at a national level. This is a source of concern in many communities. It is also the reason why discussion of this issue is still not very widespread. At the same time, access to nearby recreational areas in which people can “find peace and quiet” is an important consideration in selecting accommodation in densely populated towns and cities. Other factors apart from noise pollution also play a role in the subjective perception of what constitutes a “quiet area.” For this reason, communities which designate areas as quiet areas do not usually base their decision solely on the level of noise pollution.

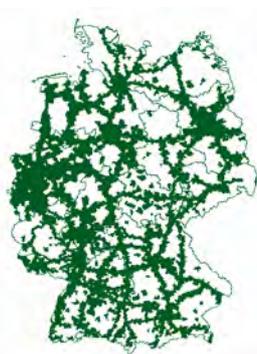
An especially important goal of the Environmental Noise Directive 2002/49/EC is to record and assess levels of noise pollution using uniform criteria. At present there is still no harmonised pan-European assessment procedure for this purpose. The European Commission has charged the Joint Research Centre (JRC) with the development of such a procedure. Various working parties, with the participation of experts from member states, have worked on establishing the basis for this procedure. The Federal Environment Agency has not only coordinated the work of the German experts but has also actively contributed to the work of the working parties. In a second phase, the aim is to create the databases needed to apply the procedure in the various member states and to test the assessment procedures that have been developed. The European Commission plans to publish the harmonised assessment procedures in time for noise mapping in 2017.



30 km/h is quieter than 50 km/h. The noise level falls by two to three dB(A).

#### Noise

## NOISE ABATEMENT POLICY IN GERMANY



The general population is exposed to a high level of noise pollution due to a variety of different sources of noise. Inner city roads with a high density population and a high level of noise pollution are a major problem. Noise mitigation measures can be differentiated according to the area they target: the source of

the noise, the transmission path of the noise, or the place of immission. Measures that act on the source of the noise include low-noise engines. An example of a measure targeting the transmission path of the noise is the installation of noise mitigation barriers. Any potential reduction in the level of noise, however, that might result from the use of such barriers very much depends on the place of immission. In addition, they impede people's view and can be a source of annoyance. Measures at the place of immission include the use of sound-proof windows, which reduce the volume of sound entering the building. They are only effective, however, when closed and so offer no protection for the immediate surroundings of a house, such as the garden and balcony. In general, noise mitigation at the source is preferable to all other noise miti-

gation measures, being more effective and usually more cost-effective too.

The noise emitted by vehicles primarily consists of engine noise and road/tyre noise. The latter is caused by the action of the tyre on the road surface and is unrelated to the type of engine used in the vehicle. The level of noise emitted depends on the properties of the tyre and the road surface and increases with the speed of the vehicle. The engine noise is different for the different types of engine but only dominates at low speeds. At higher speeds, on the other hand, the noise emitted is primarily determined by the rolling noise. Current low-noise road surfacing can reduce noise emissions by two to four dB(A), depending on the previous road surfacing used. This surfacing is not usually any more expensive than conventional surfacing. Time-consuming and expensive construction methods such as open-pore asphalt offer even better noise reduction. A further example are the tyres. In general, "quiet" tyres are no more expensive than "noisy" tyres and perform equally well.

A reduction in speed also results in a fall in noise levels; slower is quieter. If the highest permissible speed is reduced from 50 to 30 kilometres per hour, the level of noise emitted falls by two to three dB(A). If no acceleration is involved when a vehicle

is driving past, the maximum noise level emitted can even fall by up to seven dB(A). A speed of 30 km/h is therefore an important noise mitigation measure and allows better integration of road traffic in an urban environment. This is especially the case if a speed of 30 km/h is maintained constantly (all traffic lights are green at this speed). Driving at a constant speed also reduces the emission of pollutants.

Moreover, slower is also safer. In many places, therefore, the introduction of a 30 km/h speed limit has become routine, and 30 km/h zones have become established in the mind of the general population. In Munich, over 80 percent of the urban area has a 30 km/h speed limit. In Berlin, a maximum speed of 30 km/h or less has been set on around three-quarters of the road network. In the interests of the local residents and road safety, the intention here is also to limit the maximum speed to 30 km/h more often on noise-sensitive sections of motorways and major trunk roads.

The introduction of 30 km/h zones prompted many towns and cities and communities to examine the whole traffic situation and to develop environmentally friendly transport concepts compatible with their city's or town's needs and resources. This also included fundamental consideration of the importance of roads and streets for the city's or town's ecology, its overall appearance, and the quality of life in towns and cities and in communities. Roads and streets are, after all, more than just through roads and parking places for vehicles. They are also places where people communicate and congregate. The reduction of the maximum permissible speed to 30 km/h may therefore be a sensible noise mitigation measure not just in residential areas but also on urban motorways and major trunk roads, especially at night-time. To allow a 30 km/h speed limit to be introduced on more roads and streets, however, requires better regulation.

Electric and hybrid vehicles can also contribute to the reduction in road traffic noise. This only applies, however, in situations in which engine noise is greater than the rolling noise, i.e. when driving off, at low speeds, and when accelerating fast. It is the goal of the Federal Government that there will be a million electric vehicles in use in Germany by 2020. As things stand at the moment, however, this would result in a reduction in noise pollution by road traffic of only around 0.1 dB(A), and would therefore not solve the problem of road traffic noise in urban agglomerations. There is, however, considerable noise mitigation potential in vehicles that often have to stop and start in built-up areas, such as delivery vans and buses providing local public transport as well as mopeds and motorcycles.



It is the goal of the Federal Government that by 2020 there will be

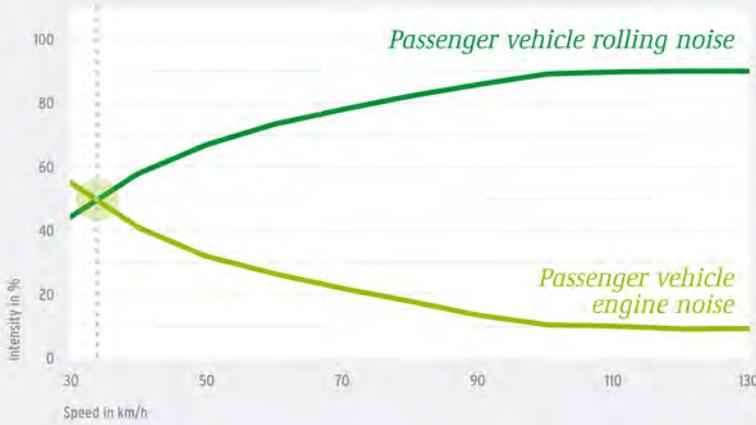
**1.0**  
million

electric vehicles in use in Germany.

Figure 5

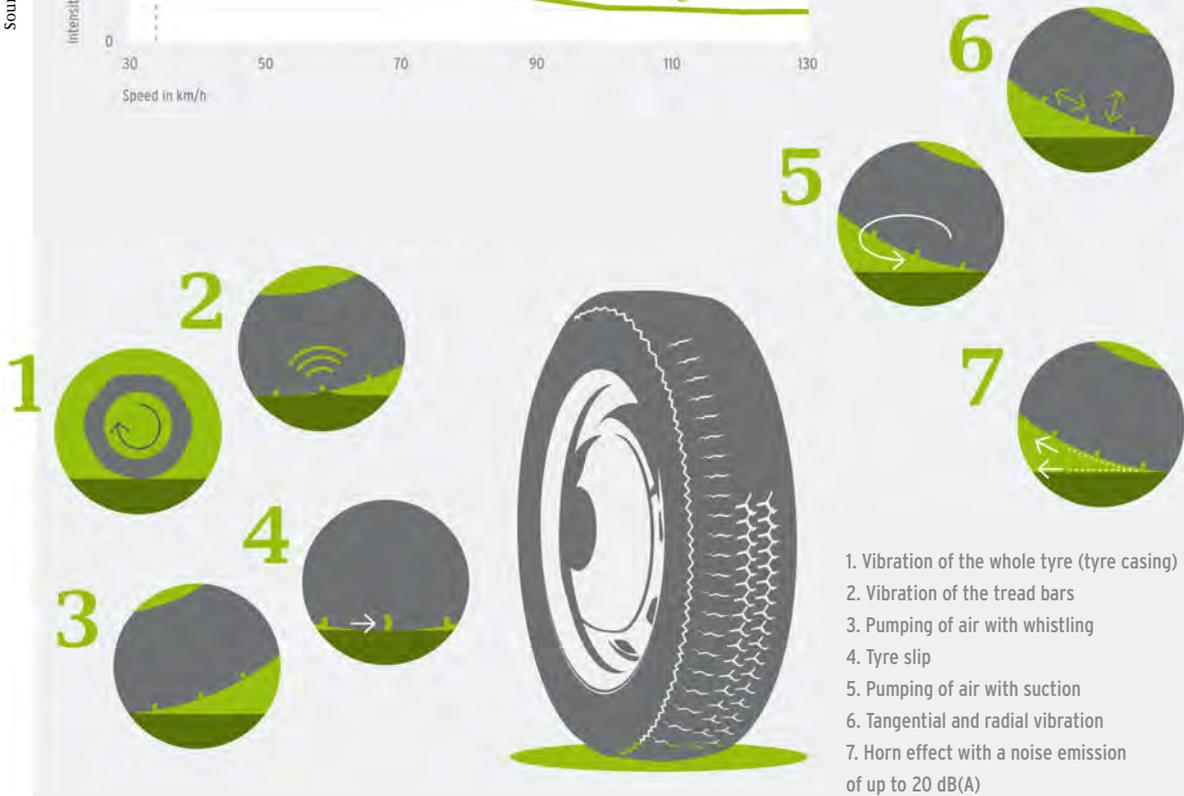
# THE USE OF WHISPER ASPHALT MAKES CARS NOTICEABLY MORE QUIET

## ROLLING NOISE AS A PROPORTION OF THE TOTAL NOISE EMISSIONS OF A PASSENGER VEHICLE ON SOLID STANDARD ROAD SURFACING

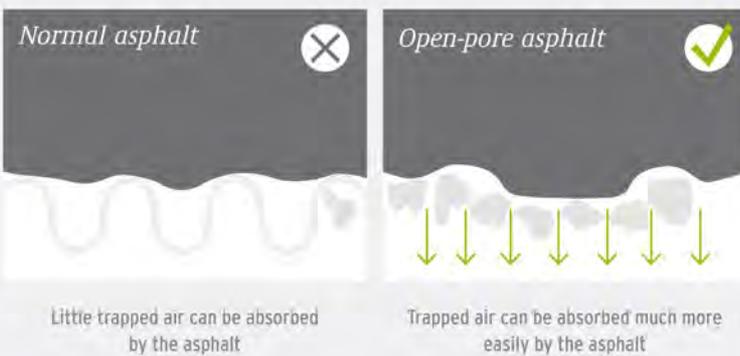


At speeds above 30-40 km/h, tyre noise dominates. It is even louder than engine noise.

Source: Beckenbauer



## COMPARISON OF THE EFFECT OF SOLID AND OPEN-PORE ROAD SURFACING



Open-pore asphalt is especially suitable for trunk roads and motorways.

It reduces noise emissions by 6-8 dB(A) in comparison with normal asphalt.

Source: Prof. Radenberg, Ruhr University Bochum; own illustration



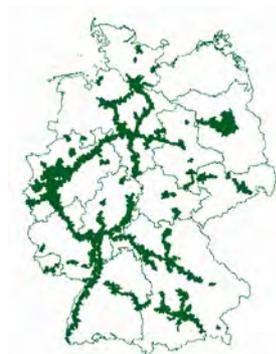
▲  
The replacement of brake blocks on noisy freight wagons is especially effective.



▲  
On the left, a traditional cast-iron brake block; on the right, a modern composite brake block

## Noise

# THE ACHILLES HEEL OF RAIL TRANSPORT



Unlike road traffic noise, which occurs virtually everywhere, rail traffic noise is much more localised to individual transport corridors. However, depending on the type of train and the volume of trains, very high levels of noise can be generated, especially along freight corridors on which most

of the rail traffic is at night. One example is the Middle Rhine Valley, which is part of the European freight corridor between Rotterdam and Genoa. In many places along this corridor, the noise levels are essentially higher than those considered desirable to maintain good health. The noise caused by rail traffic is therefore the ecological Achilles heel of the railway. However, there is still clear potential for the reduction of noise emitted by rail traffic.

The main source of the noise emitted by rail rolling stock at low speeds is the engine; at moderate speeds, it is the wheel-rail contact; and at very high speeds, it is aerodynamic noise along the length of the rolling stock. The most important factor for the general population in terms of noise pollution is the rolling noise. It occurs as a result of areas of roughness on the running surface of wheels and rails and is emitted by them. The measures therefore involve preventing the forma-

tion of such areas of roughness on wheels and rails and reducing the emission and transmission of noise. In the case of the rails, it is also important that they are as smooth as possible. Over the past few years, there has already been progress in this respect. New sanding processes allow the manufacture of smoother rails, which has already been tested under the German economic stimulus package, Konjunkturpaket II. Measures to reduce noise emission are rail absorbers and shields as well as wheel absorbers and optimised wheel geometries.

But the most important measure, and also the most cost-effective one, is refitting noisy freight wagons. This involves replacing the cast iron brake blocks previously used with modern composite brake blocks, which do not roughen the surface of the wheels to the same extent and which therefore result in a quieter rolling noise. In the case of new freight wagons, only the use of such braking systems is permitted in any case, or of disc brakes, such as on modern railway carriages.

The establishment of ambitious noise thresholds is something that is necessary, but it does not include current freight wagons, which typically have an operating life of 30 to 40 years. In terms of noise abatement, however, they are the central problem. There is an urgent need to refit them with quieter braking systems. To achieve this, the Federal Environment Agency is committed to the establishment of track access charges set according to noise emission levels.

►  
*The Federal Ministry of the Environment recommends that flights not operate between 10:00 at night and 6:00 in the morning at airports located near towns or cities.*



## Noise

# AIRCRAFT NOISE AFFECTS MANY



It is not just ground-based transport that is the cause of considerable noise pollution. Many people are also affected by aircraft noise. Unlike with road and rail traffic, in the case of aircraft, a building has no quiet side shielded from noise, where people can sleep, for example. Protecting people

from aircraft noise at night is therefore especially important. A sufficiently long period of undisturbed sleep is essential for mental and physical rest. Although there are individual differences in sleeping behaviour, people on average need eight hours of unbroken sleep. The Federal Environment Agency therefore recommends that there should be no regular flights from airports close to towns and cities between 10:00 p.m. and 6:00 a.m.

The flight path can also have a considerable impact in terms of aircraft noise on people living near airports. The Federal Agency for Air Traffic Control (BAF) is charged by law with the establishment of flight paths. The Air Traffic Act stipulates that regulations governing the establishment of aircraft operations that are especially important to protecting the general population from aircraft noise be issued in consultation with the Federal Environment Agency. Every year, many flight

routes requiring assessment by the Federal Environment Agency with regard to their noise impact are changed or newly introduced. One particularly large and challenging task was assessing the flight routes system for the new Berlin Brandenburg (BER) airport. German Air Traffic Control (DFS) had presented detailed proposals for a new flight path system. The Federal Agency for Air Traffic Control, charged with the establishment of flight routes, had then presented these to the Federal Environment Agency for consultation.

Numerous national and international studies have shown that noise can disturb communication and relaxation and can be a considerable source of annoyance. The risk of illness also grows with increasing noise pollution. In assessing the flight paths, therefore, the Federal Ministry was primarily concerned with ensuring that the impact on the general population was kept to a minimum. To assess the various different flight path systems, empirical noise pollution curves were used which established a statistical correlation between the levels of noise (dose) on the one hand and the resulting degree of annoyance (effect) on the other. Weighting functions were then derived from dose-response curves which enabled an objective assessment of the flight routes systems.

The extensive analyses yielded different flight routes systems for the day and night time which had the lowest noise impact at those times on the



The Federal Ministry of the Environment would like to promote the development of technologies to reduce noise emissions for particular product groups under the environmental eco label of the Blue Angel.

Noise

## LEAF BLOWERS ET AL.

It is not only the recording and assessment of noise from traffic that has become an issue for the general public but also increasingly products such as lawnmowers. Here, both the development of technology to reduce noise emissions and the promotion of low-noise products are equally important. Initially, this can only be achieved with targeted product information which allows consumers to see very quickly how quiet an appliance is and take this into consideration when deciding on what product to buy. In addition, the Federal Environment Agency would like to promote the development of technologies to reduce noise emissions for specific product groups under the environmental eco label of the "Blue Angel." The intention is to encourage competition between the manufacturers of products that emit noise for the best available noise reduction technology. The Blue Angel catalogue of requirements for individ-

ual products contains stringent criteria covering virtually all areas of environmental protection. The criteria for awarding the Blue Angel eco label therefore also include noise emission requirements for various product groups.

The Ordinance on Protection against Noise from Machinery and Equipment (32nd Federal Immission Control Order – BImSchV) stipulates that much machinery and equipment can only be used in noise-sensitive areas at certain times. The use of these products, for example, is not permitted on Sundays and public holidays and between eight o'clock at night and seven in the morning in residential areas. In the case of particularly noisy machinery and equipment, such as leaf blowers, for example, their use at certain times is even more restricted in residential areas.



# NOISE REDUCTION IN CONURBATIONS

In a country such as Germany with a dense population and high volumes of traffic, large parts of the general population are affected by noise. The tools currently available for effective noise reduction still need to be used more effectively and in a more targeted manner. A clear reduction in the negative effects of noise emitted by road, rail, and air traffic can only be achieved by the coordinated application of a variety of individual tools, from vehicle and road and track technology, to fiscal measures, to traffic and town planning.

In a comprehensive concept for noise reduction, measures to limit noise emissions based on state-of-the-art technology play a particularly important role together with a reduction in the use of transport (slogan “city of short distances”) and greater use of more environmentally friendly means of transport. These measures “at the source” have an impact everywhere and in this respect have priority before noise mitigation barriers or soundproof windows, which only have a local impact. The goal of noise reduction tools is to make vehicles, their operation, and the roads or tracks on which they travel all quieter. With this in mind, noise thresholds in particular must be consistently adjusted to take into account advances in technology. The development of technology, in turn, must be actively supported and tax incentives used to create further technological potential for noise reduction in the future.

An essential part of a modern transparent noise reduction strategy is the direct involvement of as many members of the public as possible. People know full well what the local noise issues are and often already have a clear idea about how they can be resolved. Better use needs to be made of this local knowledge. Research into the impact of noise has shown that noise is often perceived as less loud if people are directly involved in the decision-making process. The mutual trust of those involved in the process is also a very important factor. A series of investigations have shown that there is a correlation between the trust people have in the goodwill of those in positions of responsibility, or conversely their lack of trust in them, and their annoyance reaction. Trust is therefore key to the acceptance and successful implementation of noise reduction measures. Once trust has been established with those affected, the likelihood of the relevant measure being effective is that much greater.

The Federal Environment Agency supports discussion of the issue of movement and noise that takes into account environmental factors and sustainability. The issue requires discussion at all levels of society about the future development of our towns and cities and rural areas and about protecting both people and the environment. The Federal Environment Agency supports and encourages this discussion with information, analyses, and assessments.

Leaf blowers are very popular, but also very loud. Their use in residential areas is therefore restricted by the 32nd Federal Immission Control Order (BImSchV).

# 03

# PROTECTION OF THE MARINE ENVIRONMENT

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*“To me, the sea means a fresh breeze, salt and the sun on your skin, seagulls crying and a view all the way to the horizon. We need to find environmentally compatible solutions for the visible and invisible stresses on the oceans.”*

**Ulrich Claussen**

*Head of Section*

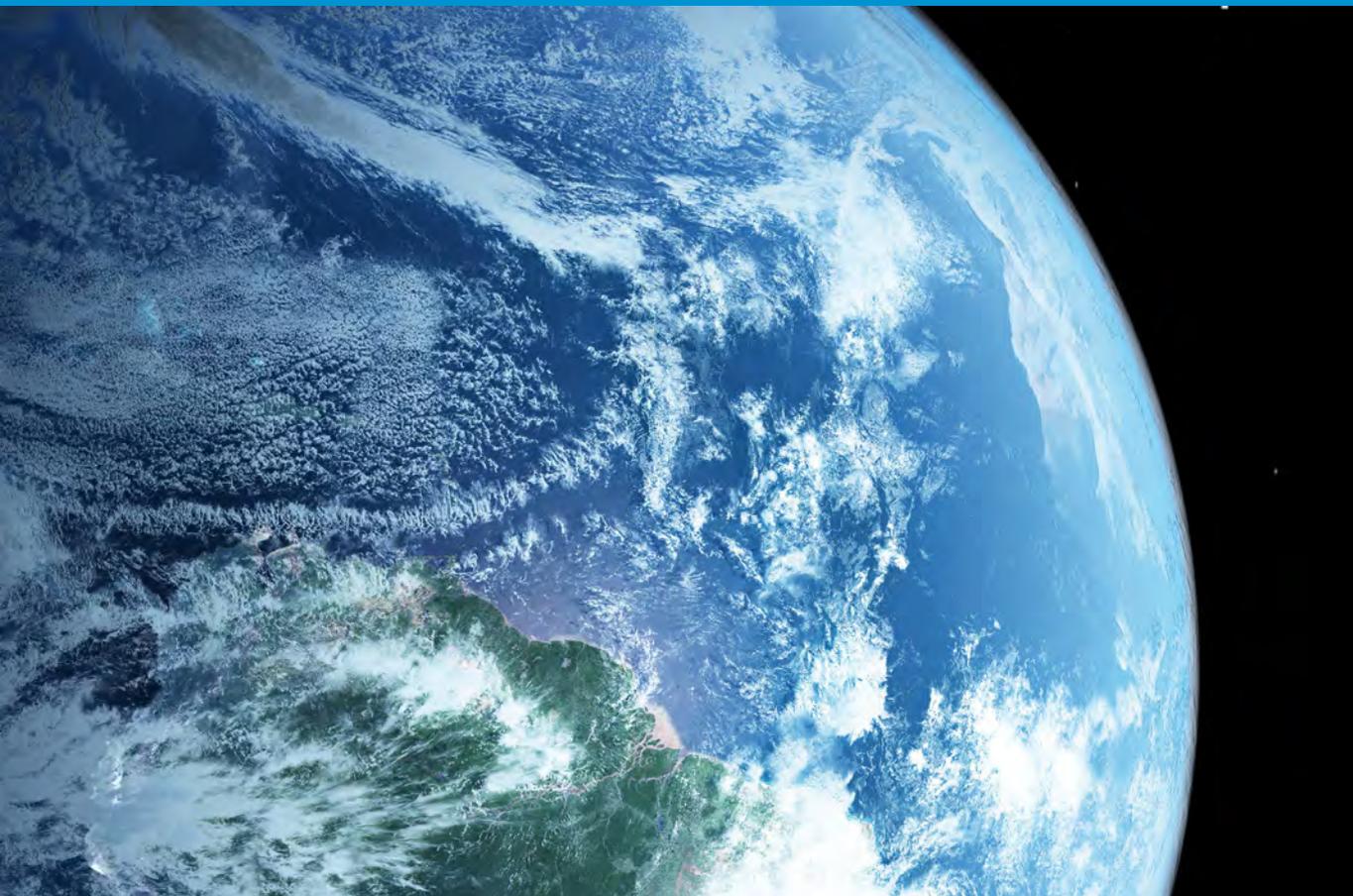
*“Protection of the Marine Environment”*

# THE BLUE ECONOMY - THREAT OR OPPORTUNITY FOR THE OCEANS?

Overfishing, entrophication, contaminants and litter are threatening the oceans. but there are solutions



Today, healthy oceans and clean coastal waters are more important than ever. They are sources of food and raw materials, places for people to relax, habitats for countless species and transport routes for world trade; moreover they act as “buffers” for the global climate. The seas also act as a reminder of the long-term effects of human activities on the planet. The challenge for the future is to reconcile the constantly increasing utilisation demands of the “Blue Economy” with the protection of the marine environment. “Ecological boundary conditions are intended to limit the risks. Sustainability and the ecosystem approach must underpin any actions. The protection of the marine environment is of key importance for mankind, and as a result, is worth any and all investment.



According to statistics from the EU Commission, the “Blue Economy” currently provides

**5.4**  
million

jobs in Europe alone, and records a gross added value of around 500 billion euros. Ecological boundary conditions are needed to limit the risks for the environment.

The earth is the “blue planet”. In images of the planet from space, it is clear to see that blue is the dominant colour: more than 70 % of the Earth’s surface is covered by oceans. From such a distance, the oceans seem to be in good condition. However, looking at the oceans in more detail, in some cases considerable impairments, in particular close to the coastline, are perceptible. There are still many almost unaffected zones on the high seas, but even here, activities such as shipping and raw material extraction take place or have an impact on the environment.

The condition of the world’s oceans has been described and evaluated in many scientific studies since the 1980s – on a local, national, regional and global level. This has led to a broad knowledge base on how human influence directly or indirectly impacts on the oceans. It has become clear that disturbing the ecology of the oceans has negative effects on their productivity and utilisation. According to statistics from the EU Commission, the “Blue Economy” currently provides 5.4 million jobs in Europe alone, and records a gross added value of around 500 billion euros. An increase to seven million jobs and 600 billion euros, respectively, is forecast by 2020. Ensuring that this growth is underpinned by ecological boundary conditions is thus gaining great importance.



▲  
*Saltwater fish – one of the most important sources of food worldwide*

#### Protection of the marine environment

## OVERFISHING, EUTROPHICATION, CONTAMINANTS AND LITTER

What is the state of the oceans? What are the biggest problems? What will be the consequences in terms of use of the oceans?

Overfishing is the most serious intervention in the marine ecosystem. Fishing quotas that are too high and non-sustainable fishing methods interfere, sometimes to a great extent, with the marine food webs. Without improved fisheries management and reduced quota, there is a threat of significant damage to the oceans, one of the most important sources of food on the planet.

The high input of nutrients and contaminants, which is occurring globally, is a further serious problem for the ecology of the oceans. These get into the oceans via rivers, direct discharge or via the atmosphere. The nutrients lead to overfertilisation (eutrophication), while the contaminants accumulate in the food web and, if fish from

affected areas are consumed, can also impact on human health. Generally, ecosystems adapt quite slowly to reductions in the input of substances.

Significant quantities of nitrogen, sulphur and other contaminants are released by shipping. These harm the atmosphere, but significant quantities also end up in the oceans. In addition, time and again, there are accidents involving ships or oil or gas rigs, and these cause severe ecological damage both locally and to the whole region. Measures intended to prevent pollution are often effective too late as in case of the Deep Water Horizon oil platform catastrophe in the Gulf of Mexico.

The stress on the oceans is intensified by the constantly increasing global need for resources. By now, this need makes mineral resources in the deep sea economically attractive, although their

*Algal bloom in the Baltic Sea*



exploitation would pose great risks from an ecological perspective. This is where stringent regulations are needed in order to protect the respective ecosystems.

A further problem is the litter that accumulates in the oceans. Durable plastics are particularly harmful as they take hundreds of years to break down. Such plastic not only spoils beaches, it also endangers marine organisms that take it for food and swallow it, or become entangled and are strangled. As they degrade, plastics emit toxic and endocrine disruptive additives such as plasticisers, which can enter the organism. For these reasons, too, marine litter has meanwhile gained major attention worldwide.

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## The “quiet ocean” no longer exists.

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However, it is not just that the oceans are still misused as sinks for pollutants and litter; noise pollution is also increasing as a result of shipping, fishing, drilling for oil and gas, extracting mineral resources and the construction and operation of energy production facilities at sea. Information on this issue is improved by noise mapping, which shows, unmistakably, that there is no “quiet ocean.”

Climate change also has an effect on the status of the oceans. The increasing CO<sub>2</sub> concentration in the atmosphere leads to acidification in sensitive marine areas, which has a negative effect on calcifying organisms including diatoms, sea snails and coral reefs. For a long time now, increasing water

*Not a ray, but the remnants of a plastic bag*



temperatures have brought about changes in the oceans’ ecosystems, as signalled by the migration of cold-loving species northwards. Moreover, climate change affects particularly sensitive regions such as the Arctic. The retreat of the Arctic sea ice, for example, allows for new shipping routes and speculation about easier access to mineral resources. This is connected to severe ecological risks for the affected regions.

The oceans also play a role in combating climate change. Many countries, including Germany, are focusing on the development of offshore wind mills in order to produce energy in a more ecologically acceptable manner. This is principally to be endorsed. However, for this to work, stringent ecological boundary conditions are required to protect e.g. marine mammals and birds. Far more scepticism is exercised in regard to geo-engineering concepts which aim to boost the capacity of the ocean as a “CO<sub>2</sub> sink.” “Ocean fertilisation” has been discussed for a long time, as a means of achieving this. The idea is to promote the growth of micro-algae which fix carbon dioxide and, once they have bloomed and sunk to the ocean floor, remove it from the atmosphere, at least for a certain amount of time. Major doubts as to the viability and harmlessness of such a manipulation of nature persist.

Promising approaches for resolving most of the stated problems have been developed on a regional and global level. Progress has been made in implementation, but not to a great enough extent to achieve a reversal in the current trend. The population would support politicians in any ambitious attempt at protecting the marine environment. Surveys in the EU generally indicate a great willingness to spend more money in order to keep the oceans unimpaired.



Protection of the marine environment

## THE PROBLEM AREAS

### Air pollutants resulting from shipping

The shipping sector is booming. Around 90 per cent of the global transport of goods, measured by weight, is transported by ship. Passenger transport is also on the increase; for example, cruises are gaining in popularity. Seafaring ships are mostly run on heavy fuel oil, the residual oils from refining. This fuel contains significantly more sulphur and other pollutants, including heavy metals, than fuels used on land. The ships' exhaust gases, which contain sulphur dioxides (SO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), and particulates including soot, damage the ecosystem through acidification and eutrophication. Furthermore, they are partly responsible for respiratory and cardiovascular diseases. In addition, soot particles accelerate climate change: Deposits of the dark particles on light-coloured areas of ice and snow reduce the amount of sun-

light that is reflected and thus accelerate the melting of the ice. This effect will get worse if shipping increases within the Arctic Zone.

So far, the International Maritime Organisation (IMO) has only set limits regarding the sulphur content in diesel fuel for ships and regarding the NO<sub>x</sub> emissions in the exhaust gas, as part of the International Convention for the Prevention of Pollution from Ships (MARPOL 1973/78; Annex VI). However, these provisions are not sufficient to reduce the emissions from seafaring ships to the required extent. The most important factor is the quality of the fuel, which needs to be further improved. Germany's Federal Environment Agency (Umweltbundesamt, UBA) recommends phasing out the use of heavy fuel oil in the long term. If ships used clean diesel fuel, then exhaust gas treatment technology, which has been standard



- 1 Wasserwirtschaft in Deutschland [Water Resource Management in Germany], 2010
- 2 Anfangsbewertung der deutschen Nordsee nach Artikel 8 der Meeresstrategie-Rahmenrichtlinie [Initial Assessment of the German North Sea in accordance with Article 8 of the Marine Strategy Framework Directive], BMU, 2010

## DANGER FOR THE NORTH AND BALTIC SEAS

The EU Marine Strategy Framework Directive cites shipping as a source of pollution to in the marine environment. The North and Baltic Seas are particularly at risk as they are among the most densely travelled sea regions in the world. In the event of accidents, fuel (gas oils, diesel) and cargo (e. g. crude oil, chemicals) can leak into the ocean. There has been a positive development in the illegal discharge of oil, which over recent years, despite an increase in shipping, has decreased, a result of intensified checks in ports and increased airborne surveillance particularly in coastal waters [1].

An accepted indicator of the level of oil pollution from shipping in the marine environment is the number of oil-covered seabirds washed up on beaches. Victims of ship transport are mostly common scoter and eider duck. The OSPAR Commission has set an ecological quality objective for the North Sea, according to which the number of oil-covered seabirds must not exceed a specified limit. This objective is currently not being adhered to in most regions of the North Sea [2].

in land vehicles for a long time, could be fitted on ships as well. An alternative would be to use liquefied natural gas (LNG), which produces far fewer pollutants on combustion.

Regions that are particularly sensitive from an ecological perspective are already better protected by their designation as Emission Control Areas (ECAs). In these areas there are more stringent limits on nitrogen oxides and/or on the sulphur content in the ships' fuel, specifically a maximum of one per cent sulphur as opposed to 3.5 per cent. From 2015, the sulphur limit will fall further to 0.1 per cent. For the time being, the stricter limits for SO<sub>x</sub> and NO<sub>x</sub> only apply around the coast of North America. Nevertheless, ships in the North and Baltic Seas must still adhere to the stricter sulphur limits.

Around 90 per cent of the global transport of goods, measured by weight, is transported by ship. Emissions from seafaring ships must decrease significantly.

## Deep sea mining

Deep sea mineral resources are increasing in importance due to the severe global demand and the rise in metal prices. In this context, the most important types of resources are manganese nodules (polymetallic nodules), cobalt-rich iron and manganese crusts, massive sulphides and metaliferous sediments. The manganese nodules are of particular interest, economically speaking, due to their comparatively high content of copper, nickel and cobalt. In the case of massive sulphide deposits, precious metals such as gold and silver as well as trace metals such as indium, tellurium, germanium, bismuth, cobalt and selenium are of particular relevance alongside the non-ferrous metals (copper, zinc and lead).

Deep sea mining (see figure 1) has a sizeable effect on ocean habitats and ecosystems:

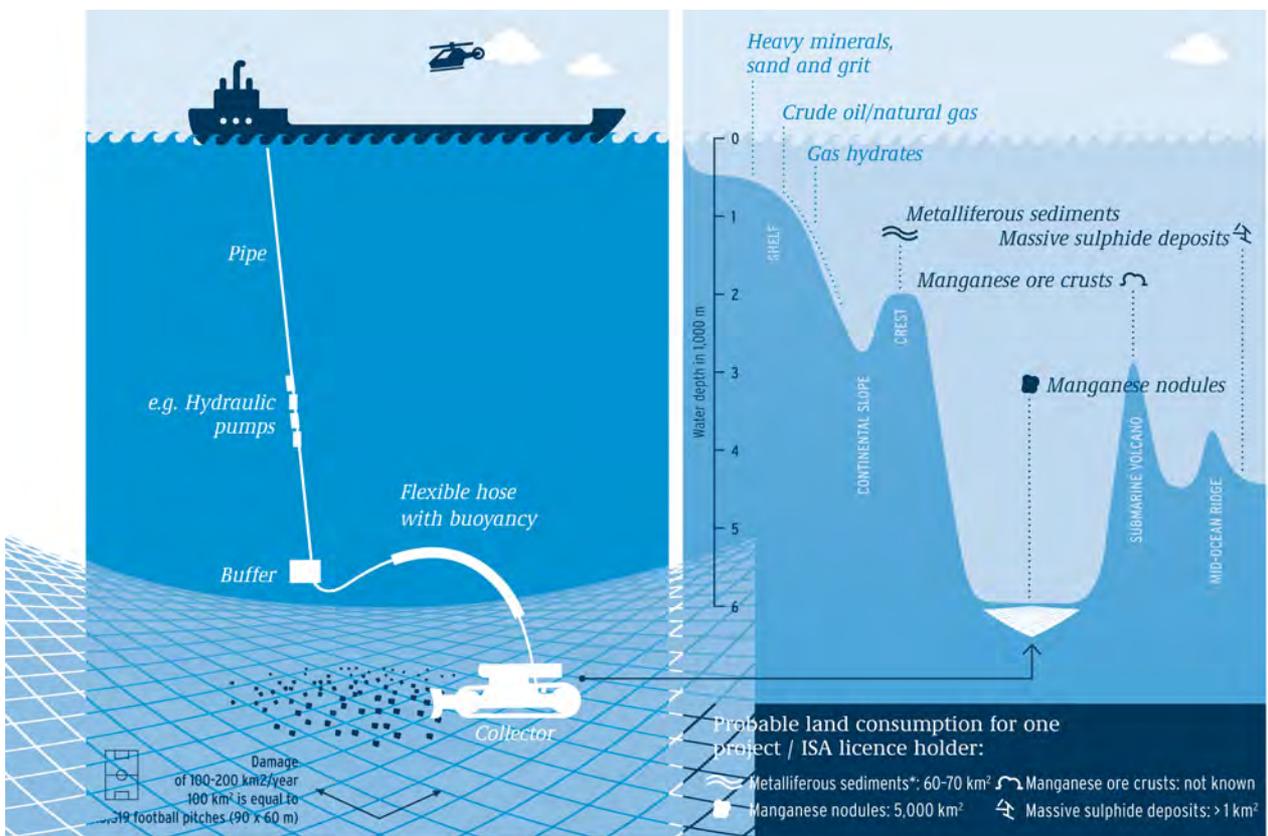
- ▶ Environmental damage on and in the seabed through use of mining equipment: along with the nodules, entire ecosystems will be completely removed from their habitat. Recolonisation will not be possible as the nodules will be missing as habitat.
- ▶ Formation of sediment plumes, which are stirred up by the use of mining equipment, drift along the seabed and sediment in the direction of the current. This can result in organisms that live on the sea floor, such as sponges, being covered by the sudden sedimentation.
- ▶ Formation of additional sediment plumes at the surface or at medium water depth as a result of discharging tailings (transport water lifted together with the manganese nodules, which contains fine grains). Pollutants contained in the water will then be distributed through

▶ Manganese nodules contain copper, nickel or cobalt



Figure 1

## DEEP SEA MINING



the ocean and, depending on their properties, may enter the food web. Phytoplankton can be harmed by this turbidity.

As a result, the German Federal Environment Agency recommends the development and application of stringent environmental standards for mining metalliferous resources from marine environments, in order to limit the potential ecological risks. For example:

- ▶ Environmental impacts should be limited to the seabed and the water layer just above the seabed.
- ▶ Potential mining areas should be "leapfrogged," if they are located too close together, in order to enable resettlement of exploited areas.

- ▶ The formation of sediment plumes at the sea floor should be minimised using technical means to bring about a quick deposition of fine-grained sediments that are stirred up, for example by cladding the mining equipment.

The UN Convention on the Law of the Sea states that marine areas outside the exclusive economic zones (EEZs), and hence also any mineral resources located in the seabed in these areas, belong to mankind as a whole. The International Seabed Authority (ISA), founded in 1994 and based in Kingston, Jamaica, authorises the allocation of licences for exploration and exploitation, and monitors deep sea mining projects (see figure 2). It has drawn up initial guidelines (mining codes) for prospecting and exploring manganese nodules, massive sulphide deposits and ore crusts, which also include extensive environmental requirements.

Figure 2

## LICENCES FOR EXPLORATION, LICENCE APPLICATIONS AND PRELIMINARY SURVEYS FOR MARINE METALLIC RESOURCES IN INTERNATIONAL WATERS

Source: International Seabed Authority, ISA



There are already more than

**15,000**

**ship crossings**

through the Arctic recorded annually, posing significant dangers to the region's sensitive ecosystem. Responsible behaviour is vital.





### The Arctic under threat

As a result of global warming, the Arctic is undergoing a drastic change. The increasing rate at which the giant polar icecap is melting has far-reaching consequences for the ecosystem of the Arctic and for the people who live there. It opens up new possibilities for economic uses, which can, however, create conflict between ecological, social and economic interests.

As far back as 2004, more than 15,000 ship crossings through the region were recorded annually [3]. Ships and their crews face particular hazards in the region due to the extreme weather conditions and reduced chances of rescue. Accidents also pose a particularly high risk to the sensitive ecosystem. A further problem is caused by soot particles emitted in the ships' exhaust gases, which are deposited directly on the ice and increase melting due to reduced reflection of the sun's rays.

It is still many years until the north-east and north-west passages, having become ice-free, will be seen as standard shipping routes. Nonetheless, ecological boundary conditions should be established now for ship traffic in order to limit the risks to the environment. Banning heavy fuel oil as a fuel and for bunkering, as is already the case in the Antarctic, would be an important first step. However, it is not only the shorter shipping routes

that are gaining in importance. The declining sea ice cover also enables access to oil and gas deposits under the sea, as well as to minerals such as gold, zinc, coal and iron. It is estimated that there are billions of barrels of fossil oil in the Arctic. The neighbouring countries of Russia, the USA, Canada, Denmark and Norway are already preparing to exploit these resources. The first approvals have been granted. Drilling in ice-covered regions and very deep water presents serious dangers to the environment, however. Currently, neither industry nor governments are able to manage the ecological risks.

The risk of accidents and contamination of the Arctic Ocean increases with the use of ships for transport and with the operation of drilling rigs and pipelines in the region. The technologies used to extract resources are not safe; questions about liability in the case of accidents have not been clearly answered; there are no sufficient precautionary measures in place to prevent oil leakages. Oil that leaks out is almost impossible to capture and, at polar temperatures, will take an incredibly long time to break down. A disaster such as that which occurred in 2010 at the Deepwater Horizon oil platform in the Gulf of Mexico would probably present a severe ecological catastrophe for the Arctic spanning decades. The German Federal Environment Agency therefore recommends a moratorium on mining for resources in the Arctic.

## Protection of the Antarctic

The Protocol of Environmental Protection to the Antarctic Treaty (PEP) states that the Antarctic and the waters south of 60° south latitude are a nature reserve dedicated to peace and science. According to the Protocol, any activity in the Antarctic is subject to an authorisation. In Germany, the Federal Environment Agency (UBA) is the German competent authority. Within the framework of the Antarctic Treaty Consultative Meeting (ATCM) and its Committee for Environmental Protection, UBA plays an active role in further developing comprehensive environmental protection in the region.

UBA and the German Federal Agency for Nature Conservation (Bundesamt für Naturschutz, BfN) are jointly campaigning for the designation of Marine Protected Areas (MPAs) in the Antarctic, which aim to preserve biological diversity, habitats and unique biotopes, in order to curb the increasing destruction of ecosystems. The South Orkney Islands Southern Shelf MPA, designated as such in 2009 by the Commission for the Conservation of Antarctic Marine Living Resources, was the first high seas MPA in the Antarctic. More should follow in East Antarctica and the Ross Sea. UBA and BfN support the implementation of these decisions by the ATCM, so as to create a comprehensive network of MPAs in the Antarctic Ocean.

Global warming in parts of Antarctica is leading to the disappearance of colonies of certain penguin species in many places. At the same time, other species of penguin are extending their range further towards the south. In order to make sense of this phenomena, it is necessary to observe the colonies and changes over a large area. A pilot study by UBA shows that it would be possible to carry out Antarctic-wide monitoring of this kind using satellite images together with modern analysing techniques.

The globalised world presents a range of new challenges to the environment of the Antarctic. Just like all other human activity in the region, the increase in individual and adventure tourism, including cruises, places additional stress on the sensitive ecosystem. As well as the fuel and lubricants on board the ships, which could, in the event of an accident, enter the sensitive Antarctic environment in an uncontrolled way, litter and waste water accumulating on the ships also present a risk to the marine environment. UBA is therefore supporting ecologically responsible cruise and yacht tourism based on agreements under international law and, together with other signatories to the treaty, has drawn up guidelines for yacht cruises in the Antarctic. These were passed by the Antarctic Treaty Consultative Meeting in 2012. UBA is also developing further suggestions



UBA Visitor Guidelines for the Antarctic

for sustainable tourism in the Antarctic, in part as a contribution to the work of the ATCM for an internationally agreed strategy on tourism for the Antarctic, and will present these to the relevant international working group at the ATCM. UBA supports the Polar Code, which is being drawn up by the International Maritime Organisation and will set out regulations for ship design, marine equipment and operation, and for environmental protection in the polar regions as a whole.



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## Ocean fertilisation is too dangerous to experiment with in our seas.

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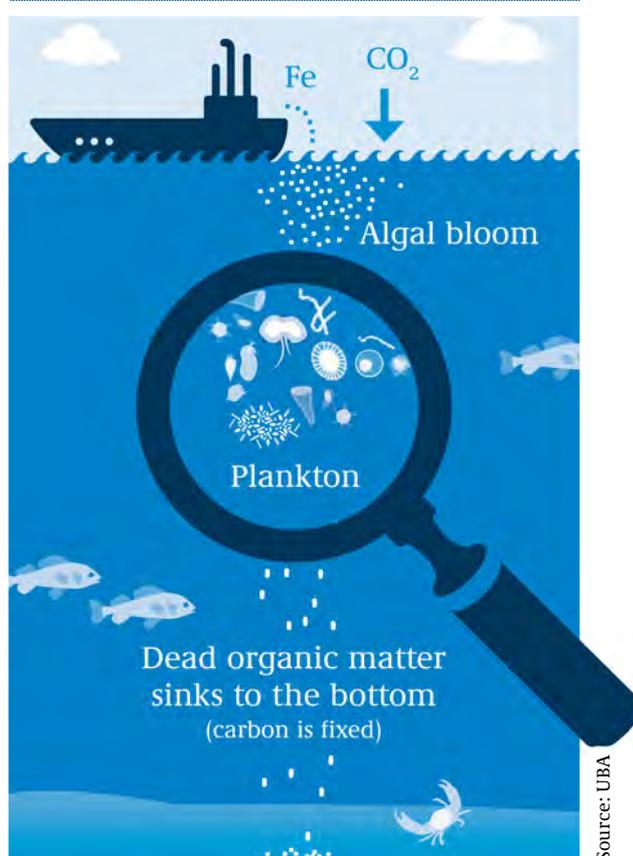
### The problem of ocean fertilisation

The term geo-engineering encompasses concepts aimed at curbing climate change through large-scale intervention in global ecological processes. One widely discussed method is ocean fertilisation. The idea: adding iron compounds to sea water to create large scale algal blooms. The CO<sub>2</sub> taken up by the phytoplankton will then be transported to the seabed when they die, and will thus be stored in the depths of the ocean (figure 3) and, until a potential remobilisation, will no longer have an effect on the climate.

In order to test this idea, researchers have so far carried out 14 fertilisation experiments worldwide. However, the optimistic hypotheses as to the potential of this procedure could not be confirmed. Furthermore, it was shown that it was very likely to cause incalculable damage to the marine ecosystem. The fertilisation would interfere hugely with the biogeochemical cycles and the very complex functioning of marine ecosystems. The accumulation of dead algal biomass in the water column and on the sea floor can lead to a shortage of oxygen, causing organisms to suffocate and die. The experiments showed that fertilisation with iron can promote the development of toxic algal species which, through the production of toxins, can have undesirable negative effects on fish and on human health through consumption of poisoned shellfish and fish. In a current position paper, UBA reaches the conclusion that, at the present time, there are serious doubts as to the efficacy of ocean fertilisation, and that the risks thereof must be investigated further ([www.umweltbundesamt.de/wasser/themen/downloads/meere/positions-papier\\_ozeanduengung.pdf](http://www.umweltbundesamt.de/wasser/themen/downloads/meere/positions-papier_ozeanduengung.pdf)).

Figure 3

## THE PRINCIPLE OF IRON FERTILISATION

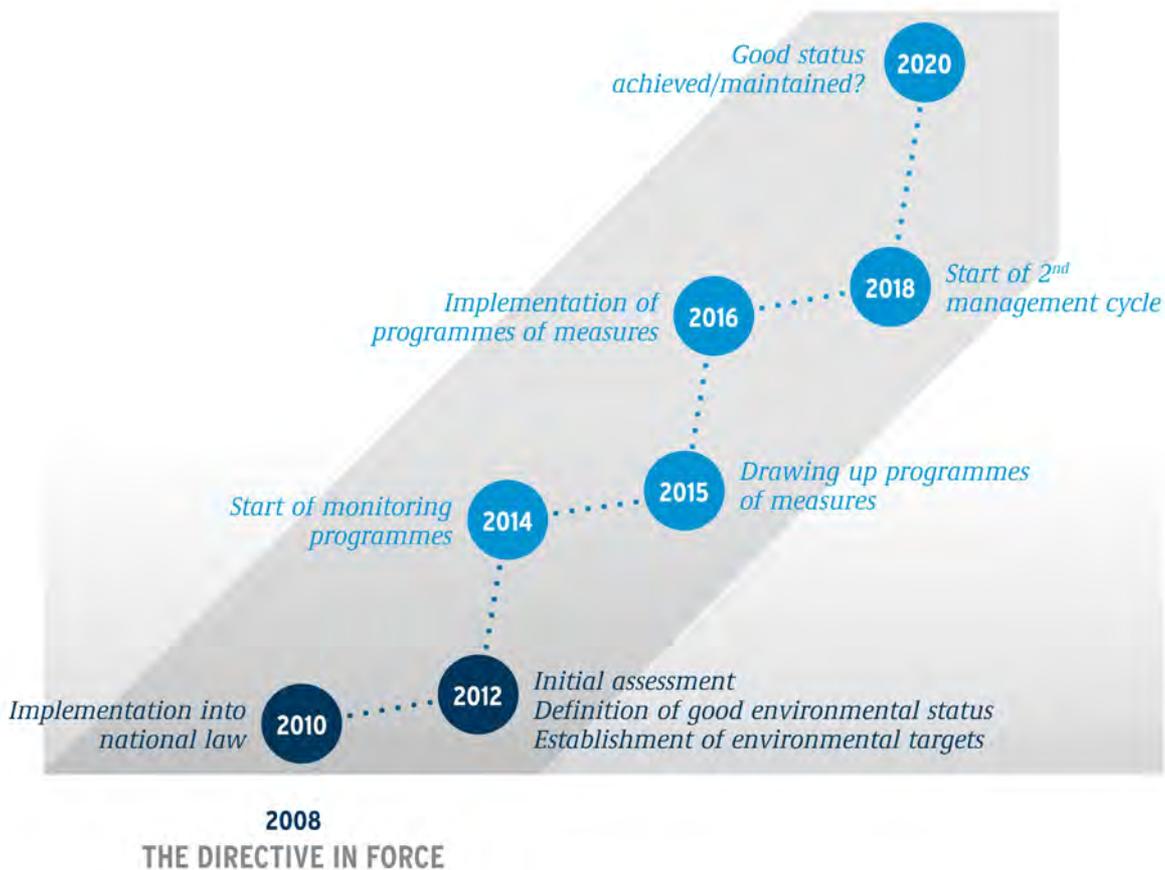


Due to such reservations, there have been tight restrictions regarding large-scale iron fertilisation projects since 2008. In that year, the signatories to the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter adopted the politically significant resolution that only research projects should be allowed in the field of marine fertilisation. In the summer of 2012, Australia and Korea presented a proposal providing for a legally binding ban on marine fertilisation with the exception of research projects, and including a regulatory framework for future marine geo-engineering methods. Specific projects will only be approved if they are judged to be quite safe. The proposal will be negotiated at the Meeting of Contracting Parties in October 2013.

The need for further legally binding regulations is highlighted by the actions of one North American company that, in July 2012, contrary to the regulations of the London Convention, introduced 100 tonnes of iron fertiliser into the Pacific Ocean near the island of Haida Gwaii off the west coast of Canada. This took place at the request of the native inhabitants, who financed the experiment and hoped to see an increase in salmon harvests following the algal bloom.

Figure 4

## MSFD MANAGEMENT CYCLE



### Protection of the marine environment

## PROTECTION OF THE MARINE ENVIRONMENT IN EUROPE

The EU Marine Strategy Framework Directive (MSFD) creates a unified framework of regulations for the member states to achieve or maintain good environmental status of the marine environment by 2020.

Many habitats and species in the German parts of the North and Baltic Seas are not in good status at all. Various types of biotopes, phytoplankton, fish stocks and seabirds are particularly affected. The negative effects of fishing, eutrophication, contaminants, litter and noise must be further reduced. Gaps in knowledge and deficiencies in methodology must be settled in the coming years. This was the conclusion arrived at by the German Federal Government and the Federal coastal states (Küstenländer = Schleswig-Holstein, Hamburg, Bremen,

Niedersachsen, Mecklenburg-Vorpommern) in their joint reports on the implementation of the Marine Strategy Framework Directive in Germany ([www.meeresschutz.info](http://www.meeresschutz.info)), produced in 2012 under public participation.

The reports evaluate the current status of German marine waters, describe the desired “good environmental status” and set environmental targets for achieving or maintaining such status. These reports form the basis for the programme of measures that Germany must compile by 2015. Indicators play a key role in monitoring the environmental targets and measures. Determining these indicators is the centre of the current work to draw up a monitoring programme, which must be delivered to the Commission in 2014.



▲  
*Toxic algal bloom might cause vomiting and diarrhoea*

Protection of the marine environment

## SEVERE PROBLEMS OF EUROPEAN SEAS

### Eutrophication must be reduced

Eutrophication refers to excessive enrichment of marine waters with nutrients (overfertilisation). The nutrients phosphate and nitrate, which stem predominantly from agriculture, are introduced into the North and Baltic Seas primarily via the rivers. In the case of nitrogen, around three quarters of the input is carried by rivers, with the remaining quarter transported via air. Nitrogen compounds come from agriculture (including ammonia produced by animal housing), shipping, transport and industry.

The initial assessment carried out in accordance with the EU Marine Strategy Framework Directive came to the conclusion that, at present, eutrophication is the greatest ecological problem for both the German North and Baltic Seas, next to fishing. It leads to a series of negative effects on marine ecosystems, resulting in both mass propagation of the smallest algae and altering the species composition of the phytoplankton. Algal blooms of the

foam building alga *Phaeocystis globosa* is particularly common on the beaches of the southern North Sea. Waves whip the algae cells into foam which is then blown onto the beach by the wind. In the Wadden Sea there are regular blooms of toxic algae; the poison might cause vomiting and diarrhoea in humans. Turbidity of the water as a result of algal blooms also has a negative effect on macrophyte vegetation. In the North Sea – Wadden Sea region, the amount of sea grass had drastically decreased since the 1980s; since 1994 a revival has been observed due to the decreasing eutrophication. A drop in the quantity of bladder wrack has been recorded in the Baltic Sea.

In stratified waters of the North and Baltic Seas, during summer, sinking algal biomass and the resultant microbial breakdown are the reasons why oxygen is often lacking and hydrogen sulphide is produced in the water layers close to the sea floor. As a consequence, creatures living on and in the sea floor die if they are not able to escape.

In past decades, great efforts have been made to reduce nutrient inputs into the North and Baltic Seas. Since 1985, the emissions, losses and discharges into the rivers of the German North Sea catchment area have been reduced by 48 per cent for nitrogen and by 73 per cent for phosphorus. For the German Baltic Sea, the reduction is 50 per cent for nitrogen and 76 per cent for phosphorus. These results can primarily be traced back to improved waste water treatment plants and the introduction of phosphate-free detergents. In the meantime, they have also allowed some of the effects of eutrophication to slowly diminish. Nevertheless, it is not possible to give a general all-clear.

Particularly in the case of nitrogen, the reductions have stagnated in recent years. This is predominantly a result of insufficient measures in agriculture. The upcoming reform of EU agricultural policy (CAP) will decide, among other things, whether it will be possible to more effectively reduce discharges of nutrients from the agricultural sector in future. Since animal production plays a particularly large role in this context, every individual citizen can also contribute to reducing the problem by moderating his/her consumption of meat.

UBA campaigns at national and international level for further reducing the inputs of nutrients, for example in the context of the HELCOM Baltic Sea Action Plan. Appropriate objectives are expected to be set at the Ministerial Meeting by Contracting Parties of HELCOM in October 2013.

### **Germans are willing to pay for the protection of the Baltic Sea**

The EU Marine Strategy Framework Directive provides for cost-benefit analyses to be carried out in the preparation of programmes of measures. The German Federal Environment Agency has had a methodology drawn up for this purpose. This has also taken into account an analysis of willingness to pay carried out by the international research network BalticSTERN ([www.mtt.fi/dp/DP2012\\_1.pdf](http://www.mtt.fi/dp/DP2012_1.pdf)). This analysis indicated that citizens of the countries neighbouring the Baltic Sea are prepared to jointly spend around four billion euros per year to improve the ecological status of the Baltic Sea. So, for example, the 1,500 Germans selected as representatives for the study were willing to pay 27 euros per person per year for measures to combat eutrophication. According to these calculations, a healthy Baltic Sea is worth, in total, up to one billion euros annually to the German people. This is related to the high recreational value that the Germans ascribe to the Baltic Sea. Of those asked, 83 per cent responded that they had visited the Baltic Sea at least once.



1,500 Germans selected as representatives were prepared to pay an additional

**27**  
**euros**

per person per year for measures to combat eutrophication of the Baltic Sea.



◀  
*When the farmer fertilises the sea: excess nutrients in the sea frequently stem from agriculture*

### Reform of EU agricultural policy

The upcoming reform of the EU Common Agricultural Policy (CAP) for 2014 to 2020 will provide more opportunities, in the opinion of UBA, for reducing emissions of nutrients arising from agriculture and thus reducing eutrophication in European Seas. For example, the standards for soils, in terms of the good agricultural and ecological status to be maintained, could be made more stringent in order to reduce erosion and improve the humus content and structural stability of the soils. This would reduce the run-off of nutrients into bodies of water. Another potential measure would be the creation of wider buffer zones along water bodies and to offset this measure against the existing duties to provide ecological priority areas. An extensive use of these areas, for example as permanent grassland would then still be possible. Finally, by providing more financial support for the second pillar of the CAP (means for rural development) and corresponding co-financing through the Federal States, more money could be provided to make up for the decrease in land available for agriculture as a result of environmental constraints (compensatory payments). This could accelerate the implementation of river basin management plans, among others, in line with the EU Water Framework Directive.

The Agriculture Commission (Kommission Landwirtschaft, KLU) at the German Federal Environment Agency has prepared and published numerous further suggestions for improved environmental protection within the scope of the CAP reforms which were also presented to the European Parliament. ([www.umweltbundesamt.de/uba-info-medien/4217.html](http://www.umweltbundesamt.de/uba-info-medien/4217.html))

4 Fließner, Annette; Rüdell, Heinz; Jüring, Heinrich; Müller, Josef; Neugebauer, Frank; Schröter-Kermani, Christa: Environmental Sciences Europe 2012, 24:7

### Persistent pollutants do not belong in the sea

The initial assessment according to the EU Marine Strategy Framework Directive established that pollutants are still traceable in areas of the German North and Baltic Seas, to some extent in concentrations of ecotoxicological significance [4]. Persistent, bioaccumulative and toxic substances (PBT) in particular are to be found in the marine environment, decades after they have stopped being used. Nevertheless, banning substances does work; there is a downward trend in concentrations of chemicals such as DDT, lindane and TBT. In their place are new pollutants which are being measured in increasing concentrations. One example is perfluorooctane sulfonate (PFOS) [4], a very toxic and persistent chemical which accumulates in living organisms. A particularly worrying fact is its persistence in human blood and breast milk. Per- and polyfluorinated compounds are still used in many daily products due to their specific properties. For example, they are used in non-stick coatings for pans, as waterproofing for clothes, in foam fire extinguishers or for processing paper during manufacture. UBA believes it is necessary to minimise emissions of per- and polyfluorinated chemicals into the environment, and is preparing legislation for this purpose in accordance with EU chemicals regulation.

Under the Stockholm Convention, there is a worldwide ban or restriction on the use of persistent organic pollutants, so-called POPs. This also reduces the release of these persistent, bioaccumulative substances which can be transported over long distances into the sea. UBA is national focal point for the Stockholm Convention and is actively carrying out research to identify new potential POPs.

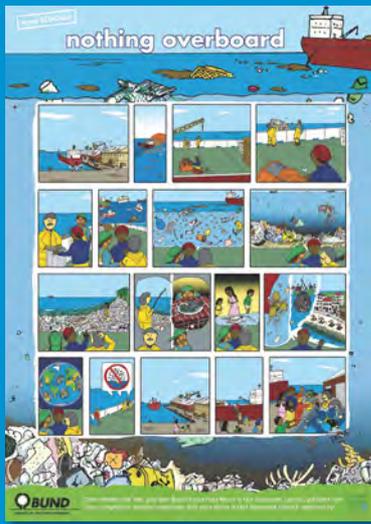
Environmental quality standards for any pollutants identified as relevant are derived under the EU Water Framework Directive and also under the EU Marine Strategy Framework Directive (MSFD). Evaluations of the substances will be supplemented by investigating the biological effects. Bioaccumulative substances accumulating in marine organisms, are also significant in evaluating the risks to human health. High levels of pollutants are recorded in fatty fish in particular. As a result, the MSFD urges that the pollution of fish and seafood used for human consumption also be considered and assessed.



### **A conscious fight against marine litter**

Three quarters of the litter in the oceans are plastics taking centuries to degrade. There are now around 13,000 pieces of plastic debris floating per square kilometre of the oceans' surface. It is estimated that each year this plastic, in particular packaging material and waste from fishing and shipping, such as pieces of nets or ropes, kill around one million seabirds and a further 100,000 marine organisms as they get entangled, strangled or swallow the litter thinking it is food. Another problem is that species can be introduced into new habitats drifting on fragments of plastic. Micro-organisms are not capable of completely

decomposing plastics. In addition to large pieces of litter such as plastic bottles and bags, an increasing quantity of microplastics has been observed globally in gyres, sediments and on beaches. "Microplastics" refer to pieces of plastic smaller than five millimetres. These are in part secondary fragments which originate from the breakdown of larger pieces of plastic such as packaging material, but also primary plastic particles that are manufactured in microscopic sizes. The latter include granulates, for example, which are used in cosmetics and hygiene products, in abrasive blast cleaners in shipyards, or as carriers for active ingredients in medicines; but they also include base pellets for further processing, and textile fibres.



▲ Winner of the BUND comic competition  
 “Nothing overboard”: N & O Bartoschek

Microplastics have also been found in faecal samples from common seals and grey seals in the Wadden Sea in Lower Saxony. These are predominantly granulates from cosmetics such as exfoliants or toothpastes, and textile fibres which are not completely removed by waste water treatment plants.

The EU Marine Strategy Framework Directive provides for the monitoring of marine litter on beaches, on the surface of the water, in the water column, on the sea floor and in marine organisms. Special mention is made of microparticles of less than five millimetres in length, and in particular of microplastics.

The German Federal Environment Agency is currently designing, financing and supervising several research and development (R&D) projects on marine litter. So, for example, a pilot monitoring project is planned which will cover all necessary marine compartments and relevant biological effects. The project will investigate, among other things, sources, pathways and drift trajectories of the litter, in order to be able to develop effective countermeasures.

UBA is furthermore supporting and supervising relevant projects carried out by the environmental associations BUND (Friends of the Earth Germany) and NABU (Naturschutzbund Deutschland, Nature and Biodiversity Conservation Union). BUND is carrying out the pilot project “Juist: plastic-free island environment,” and also aims at both raising awareness of the topic of litter with ship crews and port operators, and jointly developing action plans, not least through its comic competition “Nothing overboard.” NABU organised Germany’s first “Fishing for Litter” initiative, in the Baltic Sea

ports of Heiligenhafen, Sassnitz and Burgstaaken. This saw fishermen collecting litter from the sea disposing it of at the port, free of charge and in an ecologically responsible way. The aim of this project was to raise environmental awareness in the region and to spread innovative approaches to dealing with litter. NABU is continuing its work on this topic and is currently in the process of putting the logistics in place for a similar Fishing for Litter initiative in Lower Saxony. The follow-up project “Regional measures against the littering of the North and Baltic Seas” is due to start in September 2013.

Each year, approximately

# 6.4 million

tonnes of plastic waste end up in the sea. This figure needs to fall dramatically.

Source: National Academy of Sciences (NAS). Assessing Potential Ocean Pollutants: A Report of the Study Panel on Assessing Potential Ocean Pollutants. National Academy of Sciences, Washington DC, p. 419–422.

Figure 5

## HOW LONG DOES IT TAKE LITTER TO DEGRADE IN THE SEA?



Each year 100,000 marine organisms die as a result of being entangled in or strangled by bits of plastic



## RIO+20: The ocean should no longer be a waste dump

The importance of the seas was also a key topic at the UN Rio+20 summit in 2012. The big conference took place in the Brazilian city of Rio de Janeiro in June, exactly 20 years after the first UN Earth Summit in the same place. The outcome of the summit, which was supposed to bring “sustainable development” forward on a global level, was a disappointment for many observers. Although general targets were set for the necessary changes to the economy and society, hardly any specific steps for implementation were decided on. Included among the noteworthy targets in the “Future we want” outcome document is the reduction of litter entering the sea. Article 163 of the document reads as follows: “We further commit to take action to, by 2025, based on collected scientific data, achieve significant reductions in marine debris to prevent harm to the coastal and marine environment.”

In the run-up to Rio+20, the UN Environment Programme (UNEP) together with the US federal agency NOAA (National Oceanic and Atmospheric Administration) initiated the Honolulu Strategy, a global strategic action plan to combat marine litter. The German Federal Environment Agency was also involved in developing this plan. On behalf of the Federal Ministry for the Environment and in collaboration with the Directorate-General for the Environment of the European Commission, UBA hosted the International Conference on the Prevention and Management of Marine Litter in April 2013, in order to make a European contribution to implementing the Honolulu Strategy and the Rio+20 resolution. The goal is to develop regional action plans for reducing and avoiding further littering of the European marine regions of the Baltic Sea, the North-East Atlantic, the Mediterranean and the Black Seas.



◀  
*Harbour porpoise*

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## Low-noise surroundings are vital for toothed whales, such as the indigenous harbour porpoise, as they use echolocation.

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### **Taking action against underwater noise pollution**

In water, sound propagates considerably much further than it does onshore. A functioning and healthy sense of hearing is of vital importance to many marine organisms such as fish or marine mammals. Low-noise surroundings are important, particularly for toothed whales, such as the indigenous harbour porpoise, as they use echolocation. The animals rely to a large extent on hydro-acoustic signals for orientation, communication, foraging, reproduction and evading predators.

Noise pollution in the marine environment has increased in recent years due to human activities. The causes for this include construction and operation of oil and gas platforms and of offshore wind farms, exploration of resources using seismic technology, the increase in commercial shipping, and the use of sonar in fishing and by the military. The negative biological effects could be many and varied, starting with disturbing the animals and causing them to flee and extending to temporary or permanent loss of hearing, and in extreme cases even to death.

There is currently insufficient knowledge as to the actual scale of noise pollution in the North and Baltic Seas. UBA is therefore facilitating a research and development project to develop software that enables individual and overall assessment of natural and anthropogenic noise events in these areas. The aim is to depict their distribution and spread

using interactive maps. Based on this, it should be possible to display the biological effects of recorded noises, both individual and cumulative, on selected marine organisms.

Methods are currently being worked on that will enable monitoring of intermittent medium and low frequency noise events typical in the construction of offshore wind turbines, and of continuous low frequency noise events, such as those caused by shipping. In the frequency range of between ten and 300 hertz, the natural sound level of the oceans has been increased by 20 to 30 decibels by ship transport alone. The International Maritime Organisation has therefore developed recommendations for reducing noise caused by ships. When the criteria for awarding the Blue Angel eco label for environmentally friendly ship design were revised, criteria relating to underwater noise were included.

In order to achieve a reduction in noise pollution in the seas, it has been deemed necessary to specify appropriate, compulsory criteria for controlling noise from the various acoustic sources. Moreover, an improvement in the technology of pile driving for offshore wind turbines is necessary, for example. In Germany, a dual criterion for controlling noise from pile driving has proven itself suitable for preventing damage to harbour porpoises on the basis of current information (see also “Sustainable offshore wind power”).



▲  
*Construction of an offshore wind power plant*





▲  
*Tuna fish in a net*

and an increase in fish stocks through appropriate management. By 2015 or 2020, a yield level is to be reached which allows for the maximum possible sustainable yield. The introduction of a voluntary system of transferable fishing quotas will be facilitated, together with the development of multi-year regional management plans for individual stocks. The ministers further advocated the inclusion of a human rights clause in fisheries agreements with third countries. UBA would welcome the implementation of these elements.

On 6 February 2013, the European Parliament vote for an ambitious reform of the EU fisheries policy was passed with a clear majority. This includes, among other elements, a gradual ban on discards, and strict alignment of quotas with scientific targets, determined several years in advance. The Parliament must now negotiate the details with other EU members states in the Council of Ministers so that the reform can come into effect. Nonetheless, some member states, with the fishing nations of France and Spain leading the way, have been arguing for exceptions and a delayed implementation of the proposed measures.

Marine aquaculture, which is largely confined to

predatory fish species, cannot provide a viable alternative to meet the growing demand for fish. Until a change to other species takes place, marine aquaculture is also dependent on wild fisheries, which provide key feed components in the form of fishmeal and fish oils.

UBA is in favour of the certification of fisheries products from environmentally sound fisheries, and therefore supports the work of the Marine Stewardship Council (MSC). In order for consumers to be certain that a product bearing the blue and white MSC logo is actually from a sustainable fishery, every company in the supply chain has to meet the MSC standard for traceability. With UBA's support, the amount of wild-caught fish certified in this way in Germany has already increased significantly, from 1,191 products in April 2010 to the latest figure of 3,984 in February 2012, more than a three-fold increase. Other fishing enterprises were also won over to assessment by the MSC standard, and more importantly, the message about sustainable fishing has reached many people in the German-speaking world. Another project, addressing the sustainable consumption of fish in catering outlets, canteens, restaurants and fish mongers in Germany, started in April 2013.

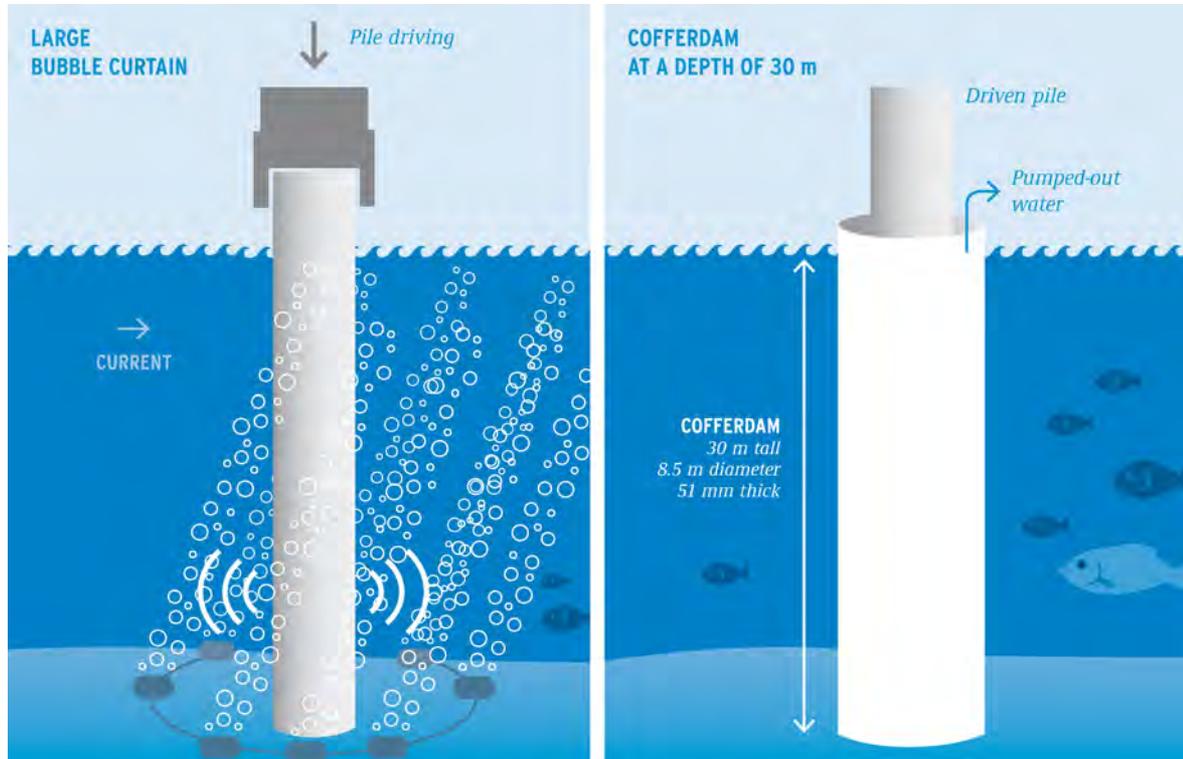
- 5 OSPAR 2010. Quality Status Report. London: OSPAR Commission.
- 6 HELCOM 2010: Ecosystem Health of the Baltic Sea 2003–2007: HELCOM Initial Holistic Assessment; Baltic Sea Environ. Proc No. 122
- 7 Communication from the Commission to the Council concerning a consultation on Fishing Opportunities for 2013, COM(2012) 278 final 07.06.2012
- 8 European Commission 2009. Green Paper. Reform of the Common Fisheries Policy. COM 163 final Brussels.
- 9 SRU 2011. Sustainable Management of Fish Stocks. Statement on Reforming the Common Fisheries Policy. No. 16 ISSN 1612–2968



▲  
*MSC logo – currently on 3,984 products*

Figure 6

## NOISE PROTECTION IN CONSTRUCTING OFFSHORE WIND FARMS



Already tested: noise reduction in pile driving using bubble curtains, drainable “cofferdams” or hydro-sound dampers.

### Sustainable offshore wind power

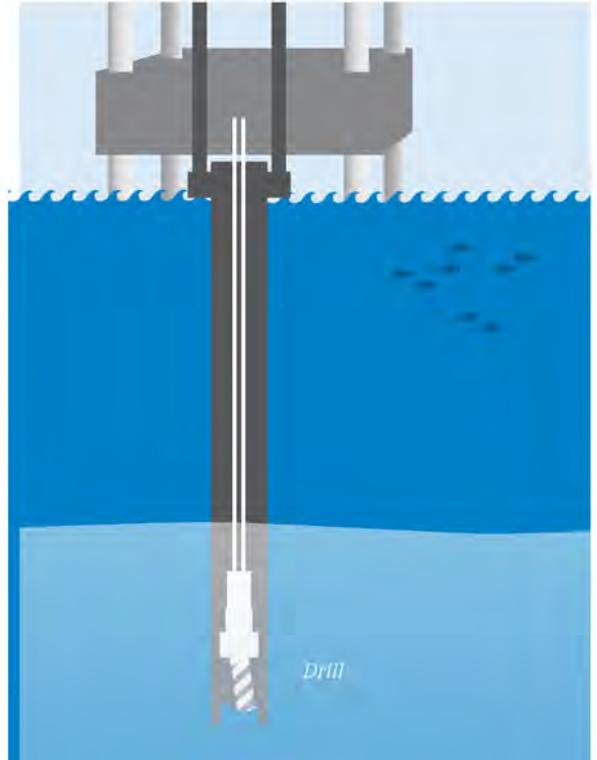
The German government’s energy plan envisages the construction of offshore wind power plants with a capacity of 25,000 megawatts (MW) by 2030. As of January 2013, there were 71 offshore wind turbines operating in Germany, with a total power of 298.3 MW. These include the Alpha Ventus offshore wind farm and the wind turbines installed to date in the BARD Offshore 1 field in the North Sea and in the Baltic 1 wind farm in the Baltic Sea. There are currently six offshore wind farms under construction, which comprise a total of 320 turbines with a capacity of approximately 1,500 MW. This production capacity is sufficient to provide electricity for over 1.5 million households. 26 wind farms have already been approved

in the German exclusive economic zone (EEZ) in the North Sea, and three in the German EEZ in the Baltic Sea. So far, four wind farms have been approved in the coastal waters of the North and Baltic Seas.

When connecting offshore wind farms to the land-based electricity network, the greatest consideration must be paid to protecting the environment. To this end, it is recommended that cables be bunched, along or parallel to existing lines, taking the shortest possible route, and where possible, outside Natura 2000 protection areas. In order to transport the wind energy, converter stations in which the electricity produced as 3-phase current is converted into direct current are built at sea. This current is transmitted via high-voltage

Figure 7

## DRILLING METHOD



DC transmission systems (HVDC) in the seabed and then overland to the nearest feed-in point. Constructing and operating the offshore wind farms must also be carried out in an environmentally responsible manner, as far as possible, and in accordance with the EU Marine Strategy Framework Directive target of bringing the seas to a “good environmental status” by 2020.

Approvals for offshore wind farms are granted in line with the German Offshore Installations Ordinance (Seeanlagenverordnung); the provisions of the Federal Nature Conservation Act (Bundesnaturschutzgesetz) and the requirements of the EU Habitats Directive and the Birds Directive also apply. The decision is founded on a broad-based programme of investigation into the ecological effects of building and operating the installation. The following effects, among others, are considered relevant:

- ▶ Risk of collision and barrier effect of turbines, and loss of stopover sites and feeding sites for birds;
- ▶ Damage to hearing, behavioural changes and extensive migration of marine mammals such as the harbour porpoise as a result of the noise from pile driving;
- ▶ Changes to nearby benthic ecosystems as a result of the turbine foundations.

To protect migratory birds, UBA recommends providing lighting for offshore wind energy turbines, in line with demand. In nights of high migration when the weather is bad and visibility is poor, the permit authority reserves the right to have the turbines temporarily switched off after having evaluated the situation. The German government is currently working on a noise control concept for reducing the noise produced in building offshore wind farms in the German North Sea EEZ. To avoid damage to the flagship species that is the harbour porpoise, UBA recommends noise control values based on a dual criterion of a sound exposure level of 160 decibels and a peak sound level of 190 decibels at a distance of 750 metres. The Federal Maritime and Hydrographic Agency (BSH) has adopted this recommendation and stipulated it as a limit value in the permit notification. In order to adhere to these values, new technical measures for reducing noise must be developed, or existing measures optimised. Some noise reduction

technologies used in pile driving, such as bubble curtains, hydro-sound dampers or drainable “cofferdams” have already demonstrated their sound-reducing effects. However, these methods have not yet achieved a state in which they can ensure compliance with the limits set by the BSH. Alternative methods for installing foundations, such as drilling instead of driving, should likewise be developed and investigated.

In addition to producing renewable energy, the construction of offshore wind farms could potentially have positive effects in terms of nature conservation. The zones in question could become safe retreats for fish, as presumably no bottom trawling will be carried out. Benthic fauna, especially long-lived species, which are negatively affected by bottom trawling, will also benefit from the loss of this type of fishing. UBA recommends that the anticipated positive effects of this are not prematurely thwarted by new types of exploitation, such as bottom-set gillnet fisheries or longline mussel farming, before a comprehensive evaluation has taken place. Furthermore, investigations of offshore wind farms to date have observed and predicted that the foundations will be settled by e.g. algae and shellfish. Many experts see this as a positive development which will increase the variety of species. However, there are also those who fear the predominantly sandy seabed will become rocky.

# THE FEDERAL ENVIRONMENT AGENCY

IN PROFILE





## GUARANTEES OF ORIGIN FOR RENEWABLE ENERGY SOURCES

### The Federal Environment Agency's Register of Guarantees of Origin

Although electricity itself is colourless, consumers have a choice of many different energy products and can, for example, choose green power. This can comprise pure hydro power, a mix of different renewable energies or even include a portion of energy generated by high-efficiency gas or steam turbines. Therefore, green power can be defined as a power company's product that has been produced either completely or predominantly by environmentally friendly means.

Consumers need to be sure that the green power that they purchase really has been produced in an ecologically sound manner. To this end, there has been an important change this year: On 1 January 2013, the Federal Environment Agency (UBA) introduced the Register of Guarantees of Origin (HKNR). Power companies offering green power have to be

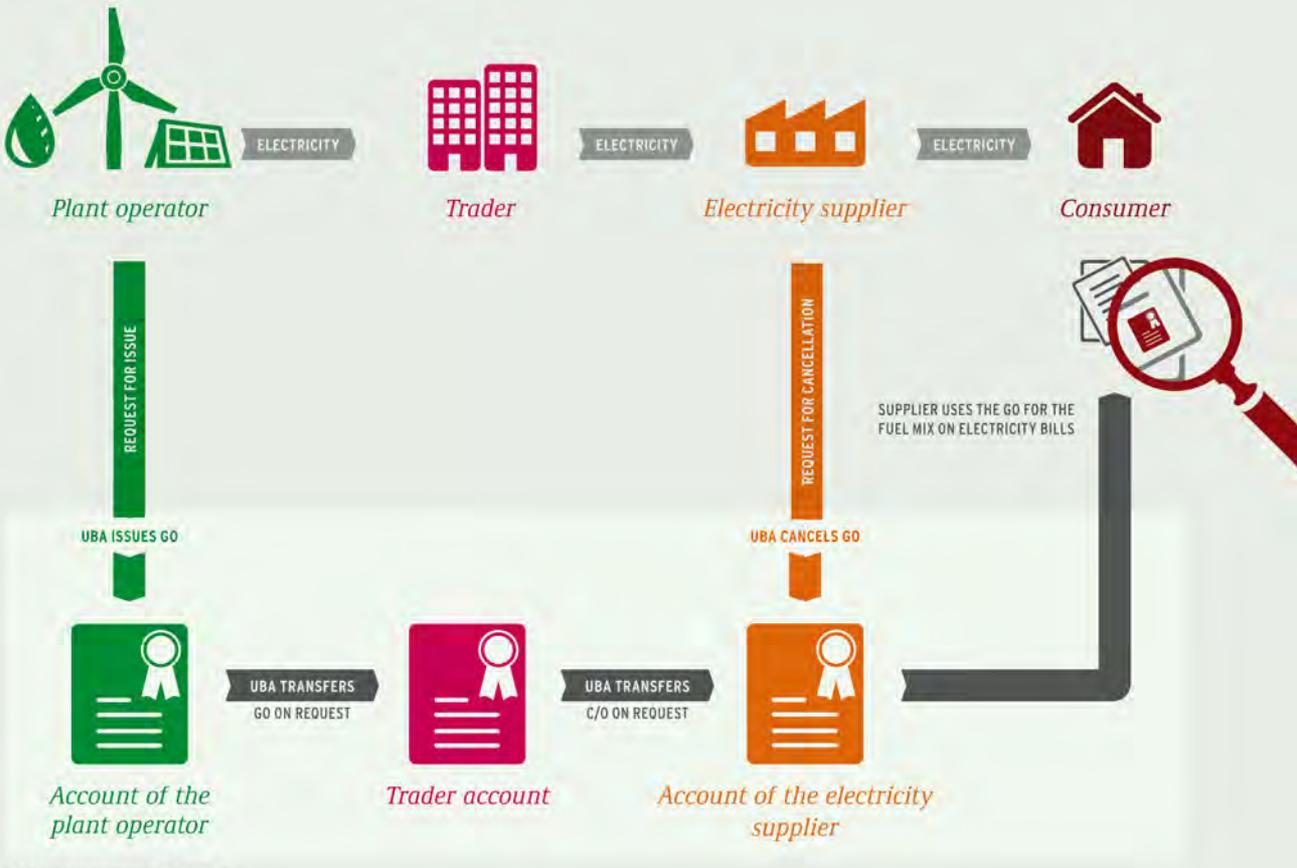
registered here. Within their account they have to cancel GOs in an amount corresponding to green power they have sold. By means of this system, Germany implemented the European Renewable Energy Sources Directive (2009/28/EC).

In doing so, the UBA is contributing to increasing confidence in the booming green energy market. Consumers can now be confident that the electricity that their provider supplies as green power really does come from renewable sources and that the applicable amount has been fed into the grid.

The Guarantee of Origin (GO) is an electronic document. It makes no claims about the quality of the power; it solely certifies how and where each megawatt hour (MWh) was produced. At the same time, the document ensures that the same "renewable

Figure 1

# REGISTER OF GUARANTEES OF ORIGIN AT THE FEDERAL ENVIRONMENT AGENCY (UBA)



GO = Guarantee of Origin

electricity” cannot be marketed to the energy consumer more than once. The UBA only issues one GO per MWh, monitors the electricity’s “whereabouts” and cancels the GO once the corresponding amount of electricity has been supplied to the end user.

### One GO per megawatt hour

How does the register work? The description above provides an outline of the system. Every generator of renewable power who is not directly funded by the Renewable Energy Sources Act (EEG) may apply for UBA to issue a GO for every megawatt hour generated. The Guarantees of Origin are then credited in the energy producer’s account. When the power is sold, the UBA transfers the GO to the buyer’s account. When the electricity has been supplied to an end user, the UBA cancels the exact same number of Guarantee of Origin in the supplier’s

account. The supplier then discloses this power as green energy in the mandatory disclosure provided for the customer. The UBA checks the disclosure in order to ensure that this process proceeds correctly.

The energy supplier only uses the cancelled GOs one time for purposes of the disclosure. This disclosure obligation is governed by paragraph 42 of the German Energy Industry Act (EnWG), which says that the electricity supplier must provide the end user with important information relating to his/her purchase of electricity. As a result of this regulation, all customers’ bills include a disclosure to indicate the sources from which the supplied electricity originates. This information is also to be found on suppliers’ websites, combined with details of the average German “energy mix,” with the proportions of energy generated from coal, nuclear power, natural gas and renewable energy also presented. This enables easy comparison between electricity products.



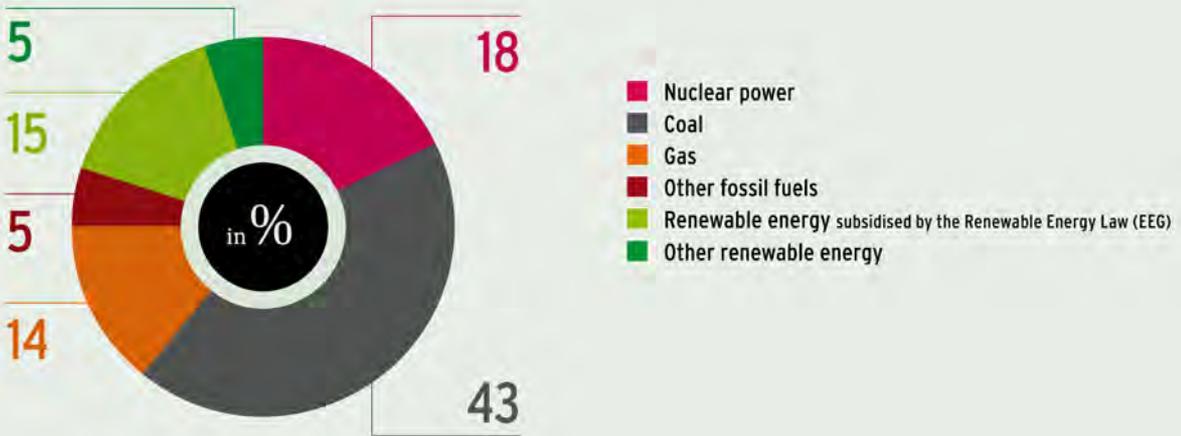
▲  
Water power plant



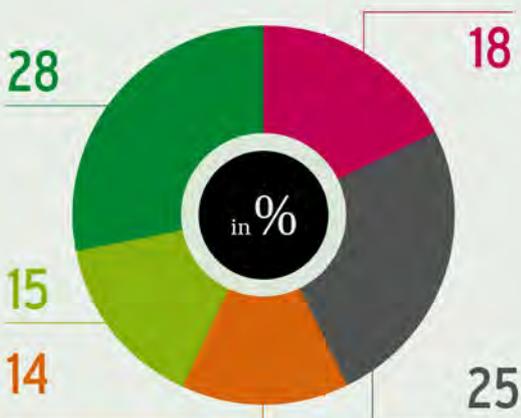
▲  
Wind power plant

Figure 2

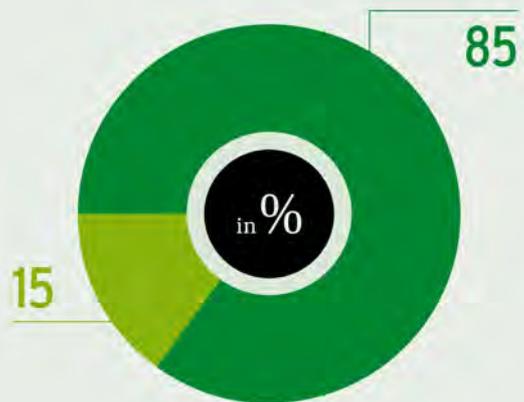
## ENERGY MIX IN GERMANY 2011



## GREEN ENERGY PRODUCT OF THE EVU SAMPLE



## ENERGY MIX OF THE EVU SAMPLE





▲  
*Geothermal power plant*

In figure 2, it can be seen in the left-hand pie chart that renewable energy sources appear twice. One is a depiction of the renewable energy that is financed by all electricity customers via the Renewable Energy Sources Act levy. This share is the same for all consumers in Germany: disclosing doesn't depend on the electricity tariff. In addition, green power consumers also obtain renewable energy that has been produced without funding through the Renewable Energy Sources Act. In the diagram, this is labelled as "other renewable energy sources." This power requires the electricity supplier to cancel an identical number of GOs in the register of the UBA.

The GO doesn't just help consumers: it is also useful for producers of green power. The new regulations increase the market value of that power generated from renewable sources that wasn't funded via the EEG. This makes investment in renewable energy more attractive.

### **An advantage for green energy labels**

The Guarantees of Origin primarily provide information about the quantity and origin of the green power. They don't provide any evaluation of the ecological quality of the energy production process. However, green energy labels are able to make use of certain pieces of obligatory information, such as for example the age of the power plant, to provide an evaluation of the product's quality. The UBA offers the operators of the power plants the opportunity to voluntarily provide additional informa-

tion on the GOs, in order to describe the manner of production in more detail. In doing so, GOs provide further important information that the auditor is able to use when assessing the quality of a product.

One of these possible pieces of additional information, "linked supply," relates to the manner of distribution. It proves that the electricity provider is supplying both power and GO to the same end customer. This must be confirmed by an environmental auditor. In contrast, the usual procedure in today's energy market is that energy and GOs are traded separately. In other words, the energy bought and supplied isn't usually the same energy that is indicated on the GO. This procedure meets legal requirements, but as a rule, doesn't satisfy those of a typical green energy consumer.

Other types of voluntary information that have to be confirmed by an environmental auditor relate to, for example, the construction and operation of the power plant. This could prove that a hydroelectric plant is operated in a particularly environmentally friendly manner; perhaps with protection of fish and management of deposits. In dialogue between the UBA and business, it has become clear that environmentally conscious consumers, and above all, the certifiers of green energy, place increasing value on this information.

The quantity of green power produced, along with its market share, is constantly increasing. But even today, there is no consistent definition of green power, and the term hasn't yet been legally defined. Opinion is divided as to what constitutes qualitatively high value green power. Yet investment in the further expansion of plants for generating power from renewable sources, beyond what is funded by the Renewable Energy Sources Act, can be considered a sign of its intrinsic quality. Furthermore, additional indicators of quality, such as environmental sustainability in the installation and operation of power generating plants can only increase in importance. The system of GOs enables these advantages to be proven.

Ultimately, consumers must decide which green power they wish to buy. The UBA recommends that consumers enquire with their energy provider as to how the green energy was sourced. For example, this could be linked to the Guarantee of Origin, or could have been supplied with a GO from a foreign country, whereas the purchased power doesn't actually originate from the plant named. Consumers should also be aware that the supplier discloses electricity on the basis of all power delivered to its end customers. It is categorically not possible to assign power to individual customers.

▲  
*2013 is the year of wind*



# TRACE SUBSTANCES IN THE ATMOSPHERE

## Our air quality monitoring network measures long-range transboundary and global air pollution

The UBA's air quality monitoring network comprises seven so-called clean air/background stations, each situated far away from the main emission sources. These stations measure the concentrations of trace substances in the atmosphere and in precipitation (rainwater). In doing so, the UBA fulfils national measuring and reporting obligations under EU legislation and international treaties, for example, the Geneva Convention on Long-range Transboundary Air Pollution (CLRTAP), the international Global Atmosphere Watch Programme (GAW) and the marine protection conventions OSPAR and HELCOM. This series of reliable measurements, some of which have been carried out for decades, documents the successes of international clean air policy, for example, the decline in air pollution by sulphur dioxide and particulate matter. But they also show the problems which continue to this day, such as the increase in the concentrations of greenhouse gases.

### Compliance monitoring of air pollutants

The compliance monitoring of air pollutants in Germany is predominantly a task for the German federal states. It is mostly focused on towns and cities, close to the sources of emissions. This is carried out in all EU member states, based on a common legal framework, namely the EU Air Quality directives 2008/50/EC and 2004/107/EC. These directives were transposed into German law by means of the 39th provision of the Federal Emissions Control Act (39. BImSchV). Among other things, these directives define where measuring stations are to be located, which parameters are to be measured, by which methods and at what temporal resolution. They also stipulate limit values and target values. The main purpose of this monitoring is to ensure that the population is protected from air pollution.

The tasks, objectives and measuring parameters of the UBA's network of air quality monitoring stations differ substantially from those of the federal states.

The UBA is primarily interested in long-range transboundary or globally transported air pollution. This is why its monitoring stations are operated far away from significant sources of emissions.

Already in the 1960s and 1970s, it became clear that sulphur dioxide emissions from central European industrialised nations had caused the acidification of Scandinavian waters. A piece of important knowledge stems from this time: Atmospheric pollutants don't just contaminate the air locally or only in their country of origin. They can be transported hundreds of miles in the atmosphere, some of them even globally. Combating transboundary air pollution, along with the effects caused by its deposition to the ground, therefore requires international collaboration.

To this end, Germany cooperates with other countries within the framework of international treaties:

- ▶ The Geneva Convention on Long-range Transboundary Air Pollution (CLRTAP) focuses on "classic" air pollution ([www.unece.org/env/lrtap/welcome.html](http://www.unece.org/env/lrtap/welcome.html))
- ▶ The most important international monitoring programme within the CLRTAP is EMEP (European Monitoring and Evaluation Programme, [www.emep.int](http://www.emep.int))
- ▶ The CLRPAP also includes the international monitoring programme, Integrated Monitoring, which deals with the effects of transboundary air pollutants on ecosystems ([www.environment.fi/default.asp?contentid=398672&lan=EN](http://www.environment.fi/default.asp?contentid=398672&lan=EN))
- ▶ The Global Atmosphere Watch (GAW) programme focuses on climate affecting parameters ([www.wmo.int/pages/prog/arep/gaw/gaw\\_home\\_en.html](http://www.wmo.int/pages/prog/arep/gaw/gaw_home_en.html))
- ▶ Protection of the marine environment in the north-east Atlantic is regulated by the OSPAR commission ([www.ospar.org](http://www.ospar.org))
- ▶ Protection of the marine environment in the Baltic Sea is regulated by the HELCOM commission ([www.helcom.fi](http://www.helcom.fi))
- ▶ The EU Air Quality directives require the monitoring of air pollutants at background sites (<http://ec.europa.eu/environment/air/quality/legislation/directive.htm>)

These international treaties have three important objectives: to protect ecosystems from long-range transboundary air pollution, to protect the climate and to improve understanding of atmospheric processes.

## Even “clean air/background sites” are polluted

The UBA’s air quality monitoring network can carry out its most important task, gathering data on long-range, transboundary, Europe-wide or even globally transported air pollutants and climate gases in “clean air/background areas” only. Therefore, the monitoring stations are situated as far away as possible from conurbations/major cities and local sources of emissions such as power stations, heavy industry and main transport axes. They are distributed in the country in such a way as to represent typical geographical and orographical conditions in Germany, to the extent possible. They contribute to much more extensive European and indeed worldwide monitoring networks.

Technicians work at each of the seven monitoring stations. Each station is comprised of a building and a measuring field. The buildings house offices and laboratories along with the heart of each site, the core measuring room equipped with numerous automatic air analysers. One or more sampling inlets are used to suck in ambient air, which is continuously and permanently analysed by the automatic instruments. The measuring field has equipment for collecting particulate matter, precipitation (rainwater) and specific air pollutants. Samples are taken frequently, for example, daily or weekly, and sent to a central laboratory to be analysed.

In recent years, the UBA has invested in all seven stations in order to improve their structure, architectural engineering, energy efficiency, occupational safety, fire safety and measuring equipment technology. This was necessary in order for all sites to be certified under the EU’s Eco-Management and Audit Scheme (EMAS). The network’s central offices and laboratories in Langen, in the federal state of Hesse, achieved this in 2005 and all monitoring stations followed in 2011.

The UBA’s comprehensive measurement programme comprises chemical and physical analysis. Gaseous air pollutants, particle-bound air pollutants and air pollutants in precipitation (rainwater) are analysed. Specifically, the measuring programme comprises the following parameters:

**Gases:** SO<sub>2</sub>, NO, NO<sub>2</sub>, NO<sub>x</sub>, ozone, VOCs, carbonyls, NH<sub>3</sub>, HNO<sub>3</sub>, PAN, Hg, POPs

**Gases that affect the climate:** CO<sub>2</sub>, CH<sub>4</sub>, SF<sub>6</sub>, N<sub>2</sub>O, H<sub>2</sub>, CO

**Particulates:** Mass: PM<sub>10</sub>, PM<sub>2.5</sub>, PM<sub>1</sub>, Composition: Ions (NO<sub>3</sub><sup>-</sup>, SO<sub>4</sub><sup>2-</sup>, Cl<sup>-</sup>, NH<sub>4</sub><sup>+</sup>, Na<sup>+</sup>, K<sup>+</sup>, Ca<sup>2+</sup>, Mg<sup>2+</sup>), Heavy metals (Pb, Cd, As, Ni, Co, Cu, Fe, Mn, Sb, Tl, V, Zn), EC/OC, POP; distribution of ultra-fine particulates  
Rainfall: Amount and contents (for the calculation of deposition); pH, conductivity, ions (NO<sub>3</sub><sup>-</sup>, SO<sub>4</sub><sup>2-</sup>, Cl<sup>-</sup>,

NH<sub>4</sub><sup>+</sup>, Na<sup>+</sup>, K<sup>+</sup>, Ca<sup>2+</sup>, Mg<sup>2+</sup>), Heavy metals (Pb, Cd, As, Ni, Co, Cr, Cu, Fe, Mn, Sb, V, Zn), Hg, POPs (PAHs, PCBs, organochlorine pesticides)

**Meteorology:** Atmospheric pressure, temperature, humidity, wind speed and direction, UV radiation, global radiation, turbulence parameters, mixed layer parameters, amount of precipitation

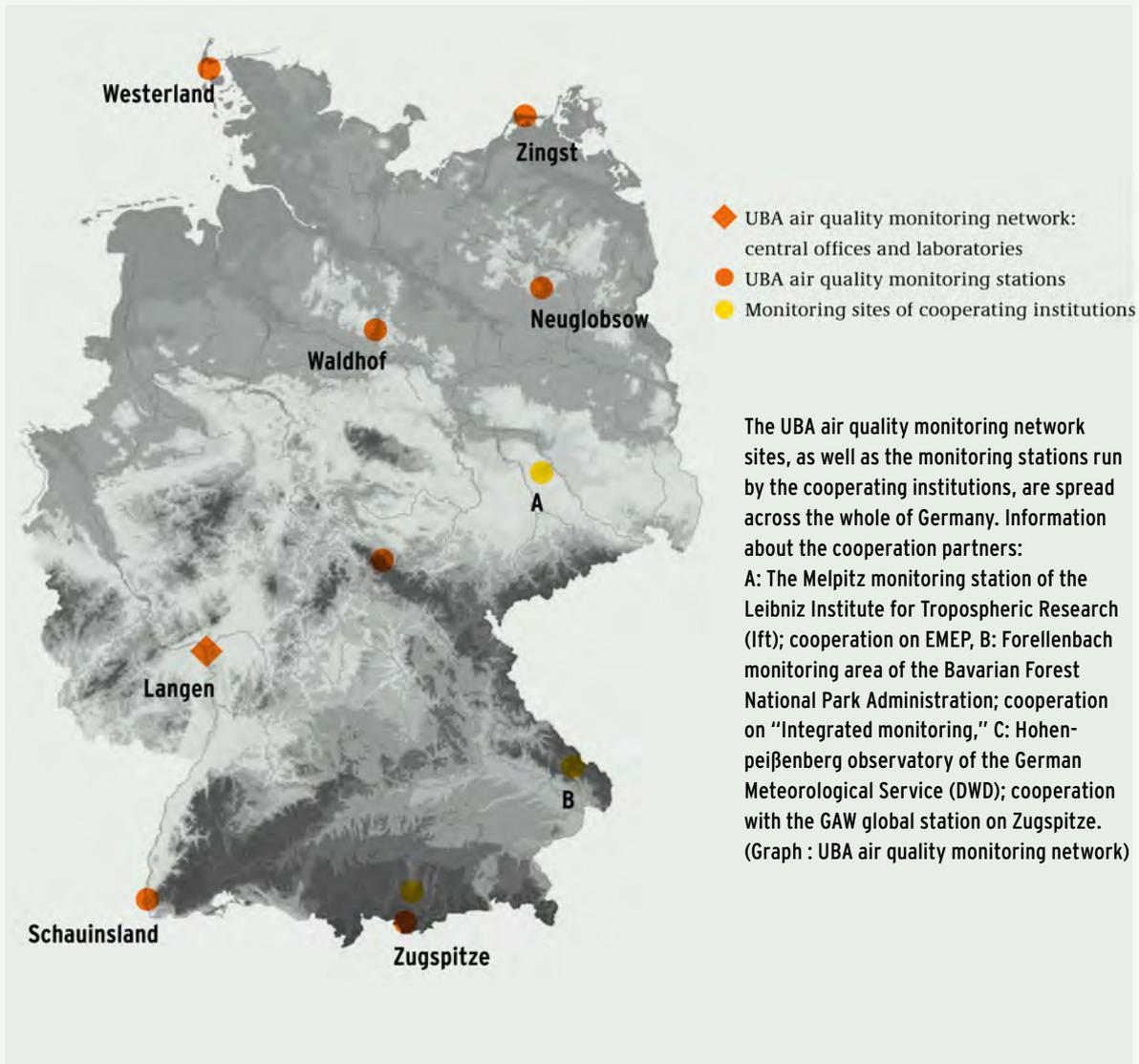
The Integrated Monitoring programme involves the observation and measuring of meteorology, air chemistry, precipitation chemistry (in open spaces and woodland), stem flow, soil water chemistry, groundwater chemistry, surface water chemistry, foliar chemistry, leaf litter chemistry, microbiology, forest growth and crown condition, fish, vegetation, composition of vegetation, lichen, bird inventory and phenology.

## Reliable long-term measurements

Since measurements began, in the mid-1960s, the UBA has taken over 130 million measurements. This amount increases by approximately 3.6 million values per year. The complete values are stored in uniform format in a database, along with details of where, when and how the measurements were taken. In turn, the information enters the central databases of the international monitoring programmes. These data records are then used for reports, model calculations, general information purposes and for policy advice.

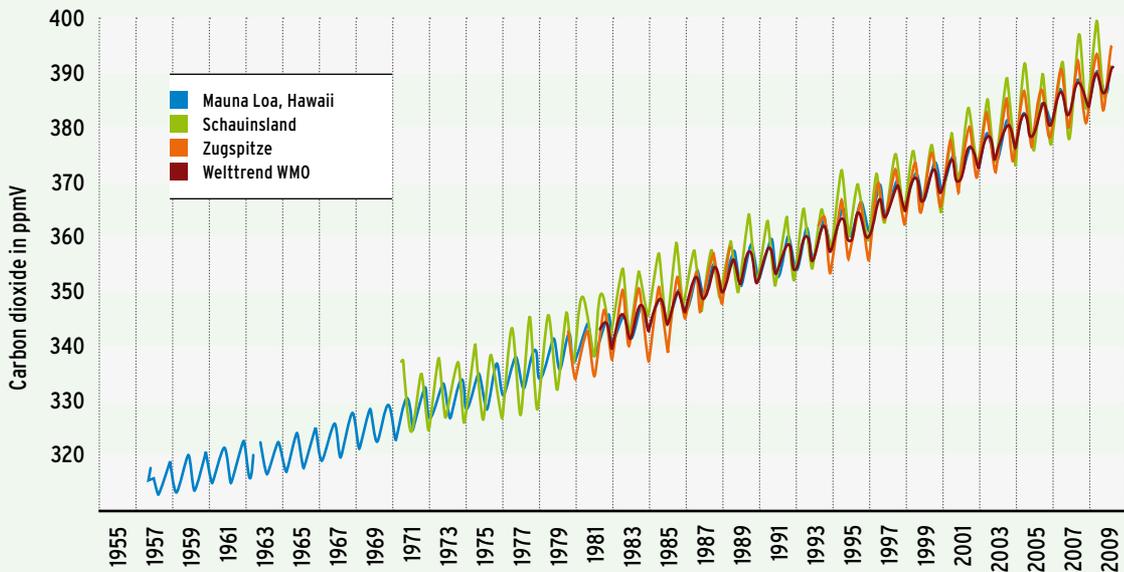
Maintaining such a series of measurements, stretching back decades, consisting of similar readings in high temporal resolution and with as few gaps as possible, necessitates a large amount of effort for the purposes of quality management (QM). Indeed, the international measurement programmes comprise an array of relevant guidelines. However, the UBA’s own quality management procedures go above and beyond these. They encompass the entire processing chain: from collecting the samples to details of the equipment and measuring methods used and finally, the generated values themselves.

Along with carrying out these long-term measurements for the international monitoring programmes, the UBA also conducts research and development work. This enables us to better understand the processes of atmospheric chemistry, to improve measuring technology and analytical methods and also to obtain information about atmospheric pollutants that have been little observed up until now. Indeed, two of the three international measuring programmes (EMEP, level 3 and GAW) explicitly demand special measurements for the purposes of research. To this end, the UBA’s air quality monitoring network cooperates with universities and other research institutions.

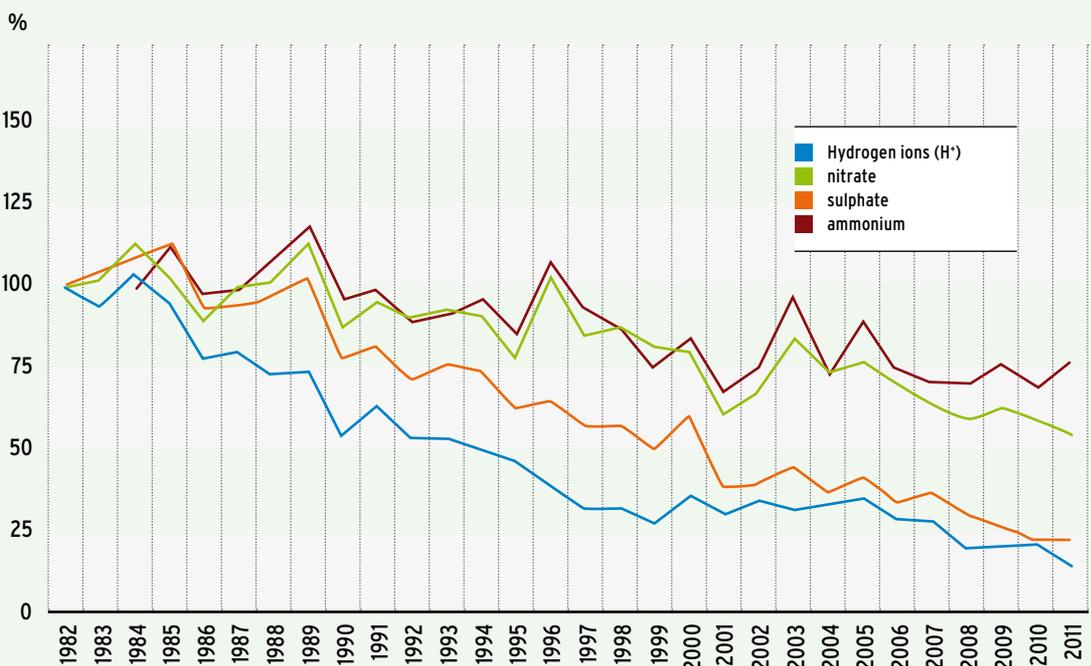


The UBA Waldhof monitoring station located in northern Germany (Lüneburg heath). In the foreground, you can see the measuring field with sampling equipment for particulate matter and precipitation (rainwater). In the background you can see the station building where the core measuring room, laboratories and offices are located. The monitoring platform in front of and above the station building is used for speciated mercury measurements.

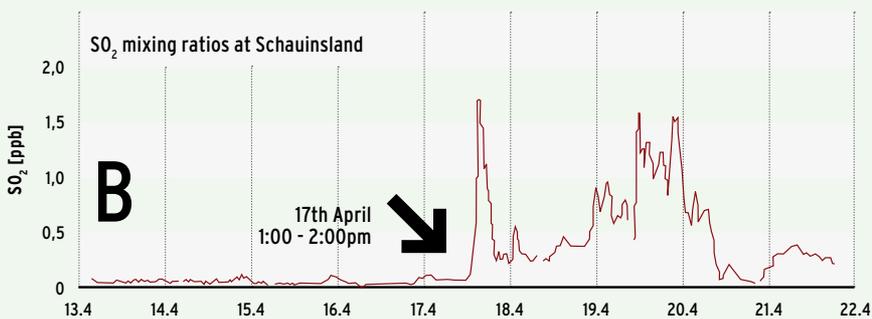
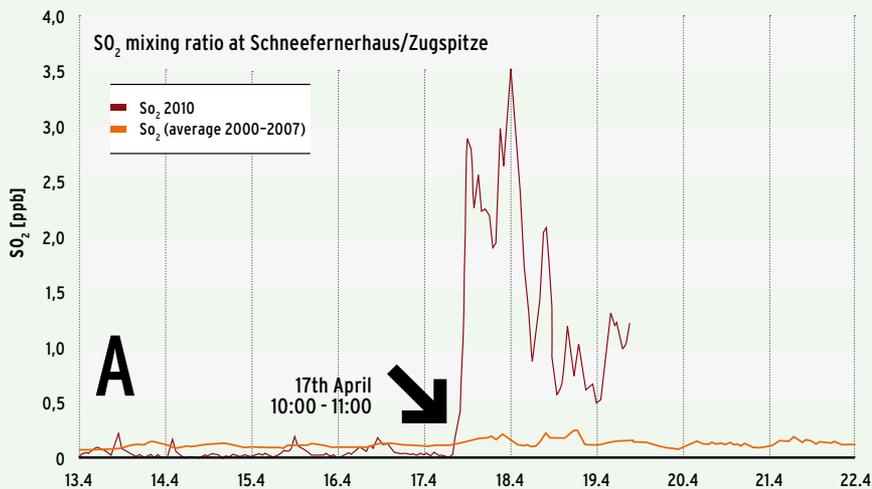




Time series of the greenhouse gas carbon dioxide at the UBA monitoring stations Schauinsland and Zugspitze compared to the worldwide trend (WMO = World Meteorological Organisation of the UN) and compared to the longest worldwide CO<sub>2</sub> time series of measurements at Mauna Loa (Hawaii). The averages of the series of measurements correspond closely. The influence of continental anthropogenic CO<sub>2</sub> sources and vegetation as a sink affected the considerably stronger annual variations at the two continental sites Schauinsland and Zugspitze with lower CO<sub>2</sub> concentrations in the summer and increased CO<sub>2</sub> levels in the winter. (Graph: L. Ries, UBA)



The development of ion concentrations in precipitation at the monitoring stations of the UBA air quality monitoring network from 1982 to 2011. The deposition of long-range transboundary transported acidifying ions into ecosystems has been falling considerably since 1982. The precipitation-weighted annual averages of the UBA monitoring stations at Westerland, Waldhof, Deuselbach/Hunsrück (since 2004 only a sampling site) and Schauinsland, scaled to 1982, are presented. 1982-1999: daily "bulk" samples, 2000-2011: weekly "wet-only" samples. (Graph: K. Uhse and E. Bieber)



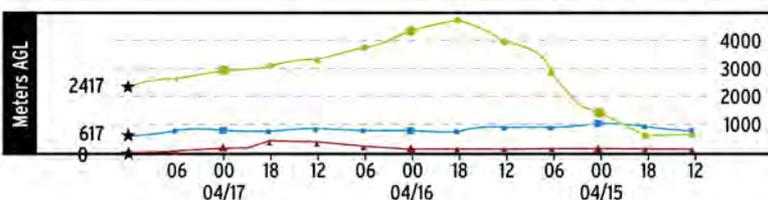
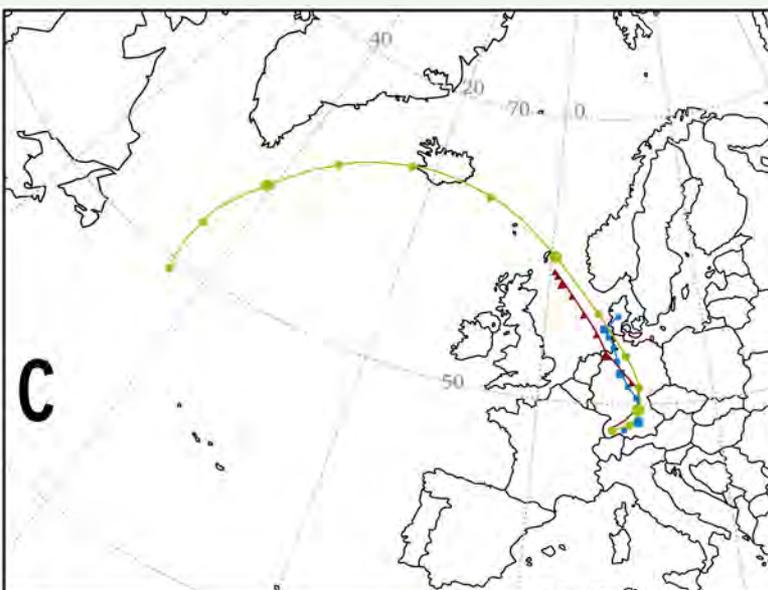
### The Eyjafjallajökull volcano in Iceland

The measuring devices at the UBA monitoring stations do not just measure man-made air pollution. Every now and then, natural phenomena or trace substances from extraordinary sources come into the (air monitoring) network. Examples of this include the traditional North-German Easter bonfire, dust from the Sahara, from the steppe of South-East Europe or from volcanic eruptions.

On 17 April 2010, measuring instruments firstly at Zugspitze (A) and later at Schauinsland (B) detected an extraordinary and enormous increase in sulphur dioxide concentrations. The calculated trajectories of the higher air masses led precisely to the volcano Eyjafjallajökull in Iceland, which was erupting at that moment and releasing large quantities of volcanic gas and ash into the upper troposphere.

Large parts of European airspace had to be closed for air traffic due to the uncalculable risks associated with the volcanic ash cloud. The UBA monitoring stations also registered the volcanic dust particles on the one hand as increased particulate mass concentration and on the other hand by the typical changes to the chemical composition caused by volcanic ash, for example increased iron and manganese content. (Source: UBA air quality monitoring network)

NOAAHYSPPLIT MODEL  
Backward trajectories ending at 1200 UTC 17 Apr 10  
GDAS Meteorological Data





## THE GERMAN ENVIRONMENTAL SPECIMEN BANK

Monitoring the environment by means of samples taken from humans and the environment

### Travelling back in time to protect the environment

In Germany, the first legal regulations to protect mankind and the environment from chemicals were introduced in the 1970s. Both politics and science sought a way to monitor the success of these new laws. As a result, the German Environmental Specimen Bank (UPB) was set up.

In the event of critical chemicals being found at the monitoring stations, today's environmental specialists are able to use the UPB's historical samples as evidence. Much like travelling back in time, they are able to analyse the pollutants in samples taken many years ago. The results show them whether the chemical pollutants in the samples are increasing or decreasing over time. Depend-

ing on the results for any given chemical, politicians can be requested to act, or the all-clear can be given.

How does this work in practice? Under the leadership of the UBA, every year, environmental experts systematically collect specimens from humans and from the environment. Afterwards, all samples are stored at extremely low temperatures so that they remain unchanged. They can then be used as historical evidence to be analysed at any time.

For many problem chemicals, the specimen bank has already generated unique time trends. It is also well-equipped for the future: Over half a million samples are stored in the archives, ready to be used in future analyses.



### IMPORTANCE

The environmental specimen banks are of particular importance due to the collection, characterisation and storage of specimens, which can be used at any time as ecotoxicological and toxicological evidence. These specimens allow the retrospective examination of substances which were unknown at the time of the sampling, could not be analysed or may have been deemed non-hazardous.

### ROLE

The national environmental specimen bank is an important instrument in environmental policy. It creates a basis of evidence about the state of the environment and the chemical burden of the German population. The environmental specimen bank makes it possible to check the effectiveness of environmental policy measures from the past and to answer questions which may arise in the future.

### CHARACTERISTICS

Ecologically-representative environmental samples and human specimens are collected, biometrically or anatomically characterised, examined for a selection of relevant chemicals and stored. The specimens include fish, bird eggs, mussels, plants as well as earth and suspended solids. They are supplemented by whole blood, blood plasma and urine from humans.

The long-time storage of specimens is performed under conditions which virtually rule out biological and chemical changes over many decades.

## THE GERMAN ENVIRONMENTAL SPECIMEN BANK

# 500,000 specimens

are stored in the archives



Figure 1

## WHAT KIND OF SAMPLES ARE STORED IN THE SPECIMEN BANK? FIVE EXAMPLES:



### EARTHWORM

(*Lumbricus terrestris*,  
*Aporrectodea longa*)

Complete unwashed body of an adult earthworm. Collection of samples takes place every year, between October and mid-December.

Earthworms live in soil, where they help the process of decomposition in organic material, such as foliage. They play a part in the complex processes of soil formation and the nutrient cycle. By means of their ecological function, their abundance, their low sensitivity to chemicals and their potential for accumulating pollutants, both types of earthworm are ideal for the specimen bank.

### HUMAN WHOLE BLOOD

One sample collected per year.

Blood is an excellent matrix for the monitoring of chemicals. It circulates through the whole body and remains in equilibrium with the human organs and tissues that store chemicals. Whole blood consists of several components, namely plasma and the cellular constituents. Natural and xenobiotic substances are distributed in these components by various means. The whole blood is taken from people in four German university cities: Münster, Greifswald, Halle (Saale) and Ulm.



### BREAM

(*Abramis brama*)

Musculature, liver and blood from 8 to 12 year old fish. Samples are collected every year, in late summer, after the conclusion of the spawning season.

Bream predominantly live in shoals in slowly-flowing or still waters. They feed on the waterbed, particularly on worms, larvae, snails and small mussels, but also on plankton and plants. They are particularly suitable for specimen collection as they are widespread, the population is stable and they tend not to migrate very far. As bream are eaten by humans, they also have a direct relevance to the human food chain.



### EUROPEAN HERRING GULL

(*Larus argentatus*)

Egg contents. Samples are collected every year during the main breeding season, which occurs from April to May.

The European herring gull mainly feeds in the sea, but in close proximity to the coast. It eats fish, mussels and crustaceans. Therefore, it is an important indicator of the concentration of pollutants in the marine ecosystem. It is also particularly suitable for monitoring in the specimen bank due to a number of factors: it is widespread on the coasts of the North and Baltic seas, occurs in stable populations and its breeding grounds are easily accessible. Moreover, gulls are used in monitoring programmes worldwide, providing excellent opportunities for the comparison of pollutant levels.



### BLUE MUSSEL

(*Mytilus edulis*)

Entire soft body. Specimens are collected every two months in the mud flats and twice yearly, in June and November, in the Baltic sea. At the end of the year, the monthly samples are combined to make a yearly sample.

The blue mussel is widespread in the North and Baltic seas and counts among the most important of the edible mussels. In marine ecosystems, blue mussels are herbivores, obtaining nourishment by filtering the flowing water. They have a good absorption and accumulation rate for many substances, meaning that they are relatively resistant to pollutants. This makes them a preferred species in national and international monitoring programmes. But there are also other reasons for this: their settled mode of life and therefore faithfulness to their habitat, their wide distribution and ready availability.



Figure 2

## HOW IS SPECIMEN PREPARATION CARRIED OUT?

### ENVIRONMENTAL SAMPLES

Sampling by the University of Trier (biota), Fraunhofer IME (soil) and Free University Berlin (suspended solids)



### HUMAN SAMPLES

Sampling and storage carried out by the Fraunhofer IBMT

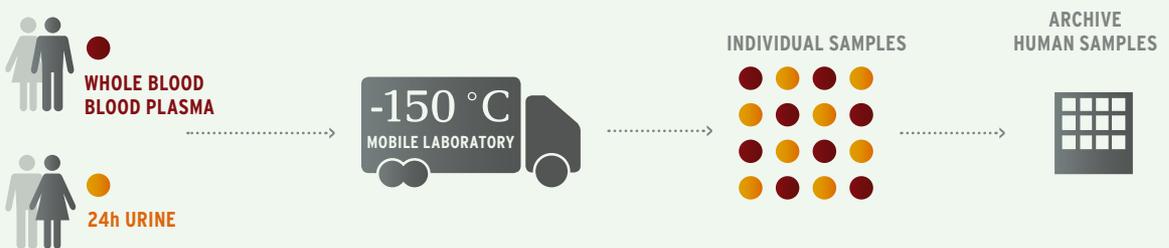
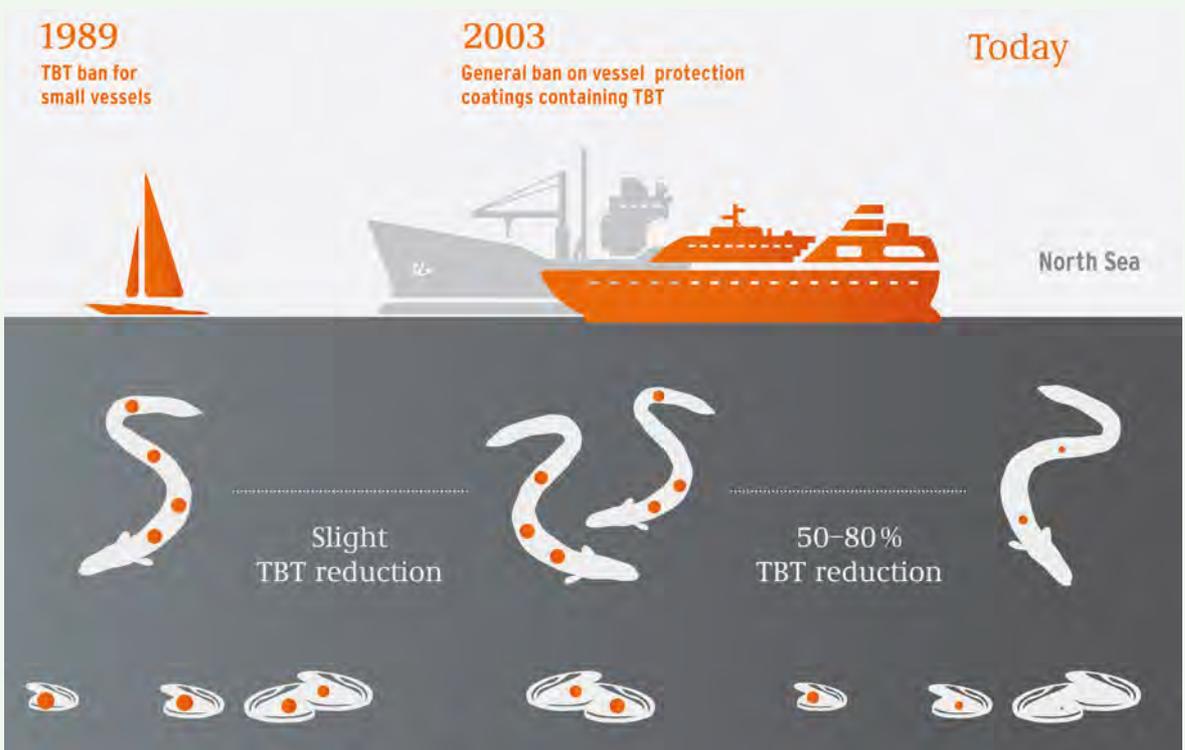


Figure 3

## THE ENVIRONMENTAL SPECIMEN BANK EXAMINES THE TBT IN BAN ON SHIP PAINT





# FACTS AND FIGURES

The Federal Environment Agency is the central environmental authority in the country. Founded in Berlin in 1974, the Federal Environment Agency has been located at the Bauhaus city of Dessau-Rosslau since May, 2005. In addition to a central division, it has five specialist divisions with 13 departments and employs almost 1,450 people in 1,101 positions at 13 sites of which seven are monitoring stations of its own air monitoring network.

These positions are occupied by 402 officials and 699 employees. Nearly 860 people are employed in Dessau-Roßlau. Alongside the “pure” scientific work, the focus of everyday work is also on the implementation of environmental laws, for example the Chemical or Greenhouse Gas Emissions Trading Act, and providing information to citizens regarding environmental issues. The Federal Environment Agency is the partner and German point of contact for countless international organisations, such as the World Health Organisation (WHO) and the European Environment Agency.

Table

## UBA BUDGET

|                                                                                                                                               | 2011 target<br>in 1,000 Euro | 2012 target<br>in 1,000 Euro |
|-----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|------------------------------|
| I.1 Total expenses                                                                                                                            | 102,938                      | 106,261                      |
| of which                                                                                                                                      |                              |                              |
| personnel expenses                                                                                                                            | 66,643                       | 65,009                       |
| Investment expenses                                                                                                                           | 3,539                        | 3,052                        |
| Administrative expenses                                                                                                                       | 32,395                       | 37,170                       |
| i. e. for                                                                                                                                     |                              |                              |
| scientific publications and documentation                                                                                                     | 434                          | 439                          |
| IT and documentation systems (UMPLIS)                                                                                                         | 4,862                        | 5,273                        |
| IT                                                                                                                                            | 6,927                        | 6,685                        |
| I.2 Orders for Federal Agencies and Third Parties                                                                                             | 2,939                        | 2,244                        |
| II. For the management of transferred funds from other capital                                                                                |                              |                              |
| i. e. for                                                                                                                                     |                              |                              |
| investments to reduce environmental pollution                                                                                                 | -                            | 64                           |
| Awarding of research projects (UFOPLAN))                                                                                                      | 25,000                       | 30,000                       |
| Subsidies of the Environmental Specimen Bank                                                                                                  | 4,331                        | 4,331                        |
| to associations, societies and other groups                                                                                                   |                              |                              |
| Institutional sponsorship                                                                                                                     | 1,279                        | 1,279                        |
| Project sponsorship                                                                                                                           | 5,834                        | 6,372                        |
| Information measures                                                                                                                          | 950                          | 700                          |
| Consultation for environmental protection in the states of Central and Eastern Europe as well as the Commonwealth of Independent States (CIS) | 2,100                        | 2,250                        |
| International cooperation                                                                                                                     | 480                          | 525                          |
| Total transferred resources to be managed from other capital                                                                                  | 39,974                       | 45,521                       |

# PUBLICATIONS BY EMPLOYEES

## A

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## EUROPEAN CLIMATE PROTECTION

### Text written by:

Dr. Steffi Richter  
Head I 2.1

### Specialist areas:

E 1.6  
I 1.4  
I 2.2  
I 2.4  
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I 3.1

## CONSTRUCTION AND HOUSING

### Text written by:

Til Bolland  
Research Assistant  
III 1.4 und III 2.2

### Specialist areas:

I 1.3, I 1.4, I 1.6, I 1.7  
I 2.3, I 2.4  
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III 1.4  
III 2.2  
Z5

## NOISE

### Text written by:

Dr. Rene Weinandy  
Leiter I 3.3  
Thomas Myck  
Leiter I 3.4

### Specialist areas:

II 1.5

## MARINE CONSERVATION

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Ulrich Claussen  
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### Specialist areas:

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