Keeping the Blue Planet Green
The preservation of our environment is one of the biggest global challenges of our time. The only way to maintain our habitat over the long term is by working together to balance the needs of nature and humankind.

Environmental technologies play a significant role in these efforts. They help us use renewable resources to produce electricity as well as heat. Greentech allows us to use raw materials in a more efficient way and in cleaner production processes. And environmental technologies can free the ground of toxic chemicals and make recycling possible. In short: Environmental technologies are critical for sustainable development.

I would like to invite you to read the following pages and learn more about Germany as a top location for environmental technologies. Many of the ideas used in the greentech sector originate in German universities and companies. By combining targeted funding with strict domestic environmental standards, Germany has created a research environment that rewards innovation. State-funded support of research for the environment is among the highest in the world. The result is visible innovation: Germany, together with the United States and Japan, is the largest exporter of technologies to protect the environment.

We want to stand up and accept responsibility for global climate change and environmental protection and make our know-how available to others. Students as well as researchers from abroad are welcome in Germany. They will find a variety of study programs and research opportunities like in very few other countries. They will also benefit from Germany’s traditional strengths, such as mechanical engineering, and technologies that are cross-disciplinary and open doors to other environmental technologies.

Through international cooperation agreements, particularly with developing and newly industrializing countries, we are doing our part to help as many people as possible by providing access to high-performance environmental technologies and opportunities for gaining experience in environmental management. We know: The more widely modern greentech is spread, the better we can protect the environment we share.

Dr. Annette Schavan, MP
Federal Minister of Education and Research
Where the Environment Meets High-Tech and High Priority

Environmental technologies make up a market that is growing globally and is one of the world’s most innovative. Industry and science are each doing their part to maintain and raise standards of living for the earth’s growing population while ensuring water quality for people and animals and keeping ecological systems intact. Yet there remains high demand for “classic” environmental technologies, such as those used to treat and handle waste, clean air or protect waterways. At the same time, preventative and interdisciplinary technologies are becoming more important. These include technologies for producing renewable energy and those for making production cleaner.

What is remarkable is that a wide variety of knowledge-based industries and services, such as mechanical and automotive engineering, manufacturing and consulting, are setting thematic sectors in which Germany can make a substantial contribution to technological innovation worldwide. All Federal Ministries are working together to implement the strategy. The idea is to deepen cooperation between the private sector and universities as well as research institutes by creating a framework that supports innovation. It has strategic areas of focus, including: promoting interdisciplinary projects, creating international ties and deepening cooperation between science and business in order to turn ideas into market-ready products. One example of moving an idea from the lab to the marketplace is the lotus effect. More than 20 years ago, the director of the botanical institute in Bonn discovered that the lotus plant has a dirt-repellent surface because fluids roll off the plant. The discovery made using an electron microscope helped scientists develop products with the so-called lotus effect – products with dirt-repellent surfaces for cars, planes or trains and even paints for buildings. Given the self-cleaning effect, large amounts of water, energy and cleaning agents can be saved.

Climate Protection

The Federal Ministry of Education and Research (BMBF) commissioned a wide array of stakeholders from science, industry and politics to draw up a comprehensive “High-Tech Strategy for Climate Protection.” Its core is research on sustainable energy supply and utilization as well as an intelligent use of natural resources. To this end, it makes a significant contribution to mobilizing private research efforts and capital. It initiated a number of cross-industry innovation alliances, addressing topics like organic photovoltaic, highly efficient energy storage technologies and wastewater technologies.

A National High-Tech Strategy

The only way to meet the challenges of the future is with the help of innovation. In its High-Tech Strategy, the government identified environmental technology as one of 17 thematic sectors in which Germany can make a substantial contribution to technological innovation worldwide. All Federal Ministries are working together to implement the strategy. The idea is to deepen cooperation between the private sector and universities as well as research institutes by creating a framework that supports innovation. It has strategic areas of focus, including: promoting interdisciplinary projects, creating international ties and deepening cooperation between science and business in order to turn ideas into market-ready products. One example of moving an

Climate and earth system as well as the interactions with society, economy and individuals. And it creates new structures to make climate knowledge available for decisions in politics and investment planning.

Every Fifth Environmental Product

More than 10,000 German companies already offer environmentally friendly products to consumers around the world. This means that nearly every fifth environmental product on the global market can be traced back to Germany. Most of the firms in the sector are small and medium-sized enterprises that are highly specialized, many in the area of waste and wastewater technologies.

German companies lead internationally, due in part to the country’s high domestic environmental standards. These include the Renewable Energy Sources Act that was passed and linked with a market-stimulus measure. Firms took their experience in meeting the standards of the law onto the export market and became leaders in their sectors. And industrial companies have invested hundreds of millions of euros in integrated technologies that help reduce emissions during production. Thus, the country has become an important global partner for coping with the environmental challenges of the 21st century.
A Public-Private Partnership for the Environment

The environment enjoys a strong focus in Germany’s R&D efforts, boosted by years of high-level investment in this area. For example, at the country’s Fraunhofer Gesellschaft applied research centers, which are privately and publicly funded, the majority of projects focus on energy, air or toxins. The Helmholtz Association of German Research Centres also deals with the environment in a great number of its institutes. In particular, the Helmholtz Centre for Environmental Research (UFZ) contributes to solving major challenges in this area. The Scientific Community Gottfried Wilhelm Leibniz (Leibniz Association), a cross-disciplinary group of research institutes, covers new environmental technologies and agronomy with its research activities. Much of the research at the Max Planck Society, which performs basic research, addresses the broad subject of air, climate and the atmosphere.

Germany’s promotion of environmental research is among the strongest in the world. For research into sustainability and sustainable technologies alone, the BMBF invests about 350 to 400 million euros in project funding every year. Germany also focuses on training young scientists and on international scientific exchanges, while its research institutes and companies frequently cooperate across borders, working in EU and/or BMBF-supported networks.

Widening the Flow of Knowledge

For the Federal Government, an important part of promoting R&D programs is supporting the transfer of knowledge about environmental technologies. By spreading information and know-how as widely as possible, Germany can support the quick uptake of the technology and help capture the true benefits of the advances. This brochure highlights how and where knowledge is transferred, such as via the Cleaner Production Web portal about environmental technologies or the TASK DEUS 21 (Decentralized Urban Infrastructure Systems) project.

Through a program funded by the BMBF, partners in the private and public sector cooperate to prevent damage to the environment

- 75% are small and medium-sized companies
- 25% are other commercial enterprises
- 30% are universities
- 15% are research facilities and institutions

Innovations are the key for a sustainable economy

Through a program funded by the BMBF, partners in the private and public sector cooperate to prevent damage to the environment

- 100 joint research projects, 100 million euros, 500 research and science partners, of which:
- 30% are small and medium-sized companies
- 25% are other commercial enterprises
- 40% are universities
- 25% are research facilities and institutions

On a Green Mission

Hans Georg Huber does not just have a business goal. He has a green mission for the blue planet. The German engineer and businessman is helping turn the United Nations Millennium Development Goals into reality. The Millennium Development Goals have been launched to halve the number of people around the world who do not have access to clean drinking water and adequate sewage systems by 2015. The 66-year-old has won many awards, including the German Environment Prize 2006 awarded by the Deutsche Bundesstiftung Umwelt (DBU), a government-based foundation.

Conventional water treatment processes were originally designed for the needs of Europe and are not feasible to implement in developing countries. Huber and his company, Hans Huber AG, set up decentralized water treatment processes directly in the places they are needed without building expensive networks.

Germany’s promotion of environmental research is supported by its extensive promotion of new environmental technologies. It has invested about 350 to 400 million euros in project funding every year. Germany also focuses on training young scientists and on international scientific exchanges, while its research institutes and companies frequently cooperate across borders, working in EU and/or BMBF-supported networks.

Widening the Flow of Knowledge

For the Federal Government, an important part of promoting R&D programs is supporting the transfer of knowledge about environmental technologies. By spreading information and know-how as widely as possible, Germany can support the quick uptake of the technology and help capture the true benefits of the advances. This brochure highlights how and where knowledge is transferred, such as via the Cleaner Production Web portal about environmental technologies or the TASK DEUS 21 (Decentralized Urban Infrastructure Systems) project.

Germany offers a wide variety of possibilities and models for developing environmental technologies, including one at the edge of Germany’s Black Forest. That’s where research institutes and businesses are transforming Freiburg into a “solar” city. Organizations such as the Fraunhofer Institute for Solar Energy Systems, the Solar Info Center and the Solar Settlement work together on projects, creating a magnet for international organizations and companies active in solar energy.

Another example: Environmental high technology is being applied in agriculture to develop the science of precision farming. The Pre Agrar project is conducting research to maximize or maintain the level of plant production while reducing the amount of additives, such as fertilizer or pesticides, in locations where this is possible. The focus is on in-depth information gathered by GPS or sensors, for example. Germany is already exporting such technologies to central and eastern Europe.

Germany offers a wide variety of possibilities and models for developing environmental technologies, including one at the edge of Germany’s Black Forest. That’s where research institutes and businesses are transforming Freiburg into a “solar” city. Organizations such as the Fraunhofer Institute for Solar Energy Systems, the Solar Info Center and the Solar Settlement work together on projects, creating a magnet for international organizations and companies active in solar energy.

Another example: Environmental high technology is being applied in agriculture to develop the science of precision farming. The Pre Agrar project is conducting research to maximize or maintain the level of plant production while reducing the amount of additives, such as fertilizer or pesticides, in locations where this is possible. The focus is on in-depth information gathered by GPS or sensors, for example. Germany is already exporting such technologies to central and eastern Europe.
Germany is not just a land of ideas; it also knows how to put ideas into action. The positive impact of its actions and the government’s sustainability strategy, which focuses on preserving the environment for future generations, can be seen in the environmental technology sector. More and more companies in Germany are creating jobs in this area, and they have a talented pool of young professionals to pick from. In fact, some experts expect that the environmental technology industry will be responsible for more sales and employ more people in 2020 than the country’s mechanical engineering and automobile industries combined. Already, the sector employs 3.5 million people full time across Europe.

Global export statistics show that German environmental technologies are in high global demand – and the country has become an acknowledged partner in this crucial sector. The number of jobs in the environmentally-oriented service sector is also growing rapidly, particularly in heavy industries. This confirms the strategic change in the direction of the German and global environmental technology branch: Its focus has shifted from “end of pipe” technologies (i.e., those that deal with waste after it is created) to the development of strategies for an integrated, knowledge-based approach to the environment.

Highly Qualified Young People

In order to meet domestic and international demand for specialized and highly educated young people, Germany’s universities and universities of applied sciences operate more than 315 different courses of study that touch on the environment. These include degree programs in the natural sciences, such as biology, earth sciences and chemistry; planning-related studies, like city planning, architecture, landscaping and open space planning; degree programs with a socio-economic focus, including those in environmental business and technical courses such as environmental protection, environmental engineering, environmental technologies and environmental process technology. Environmental engineering courses are the most popular, making up 48 percent of all course offerings. With so many different opportunities, students can tailor their degree programs to their own interests and focus their work on the environment at almost any German university.

Guides and Scholarships

Students interested in a career related to the environment can get an overview of the offering in a guide called Study and Research on Sustainability in Germany. The comprehensive book covers the latest courses of study and gives an overview of research institutions in Germany that are focused on sustainable development. It portrays 300 programs and their benefits. The guide describes the curricula as well as the jobs that graduates in specific areas are qualified for. In addition, prospective students can find out what pre-requisites are required and how to contact the various programs. Some 50 non-university and 130 university-based research organizations with a focus on sustainable development are presented in the guide.

Germany offers a wide variety of scholarships for environmental studies, such as the International Postgraduate Studies in Water Technologies program (IPSWaT), established in the framework of a BMBF initiative. It is designed to train German and non-German water experts – i.e., the people who will make crucial decisions for their home countries and help build up and spread knowledge on the subject.

In cooperation with the German Academic Exchange Service (DAAD), the Federal Ministry founded a scholarship program called Study and Researching for Sustainability. It is designed to give graduate students and doctoral candidates from selected countries, as well as doctoral candidates from Germany, the chance to study and research abroad.

“The Green Boom”

Thomas Korbun, CEO of the Institute for Ecological Economy Research in Berlin

Mr. Korbun, how would you describe the situation for German green-tech companies? It is very good. Especially the areas of energy-related, integrated environmental protection. Germany is number one worldwide.

What are the challenges?

The biggest challenge is to avoid getting too comfortable with the situation. Other countries are catching up quickly. Environmental protection is not regarded as an obstacle anymore, but as a contribution to sustainable economic activity and sustainable development in general. This represents a great opportunity for Germany — starting out with a lead in the race for the “green boom.”

Which areas of this sector and which professions are the most promising?

There are two main areas: energy efficiency and water and water-saving technologies. The demand for these technologies will grow, particularly in developing countries. However, a forecast for jobs cannot be precise, as the market is extremely heterogeneous. Engineers will certainly be sought after to a greater extent than others. The services sector is also growing ever more important in the course of the “greening” of the markets, since technologies will be increasingly integrated into service concepts.
Exporting Ideas, Conserving Nature - A Journey of Sustainability

Germans are known for their interest in other countries and cultures. It is no surprise then that German businesspeople have taken their products and services – and thus the ideas of numerous scientists – around the world to work together with local partners to adapt German environmental innovations to local conditions.

The result: Germany has a global market share of more than 16 percent in green technology, and this is on the rise. Every year, representatives from the scientific, business and political communities take part in exchanging knowledge. The following tour of examples of German projects around the world illustrates the broad cooperation that is the basis for the success of the German environmental technology sector.

German Technology on Tour

The journey tours readers through the rapidly industrializing countries of Brazil, Russia, India, China and South Africa, since they are contributing a growing share of the global knowledge base and technology.

The central question in these countries is how research and technological development can best be used to support economic development that is both ecologically sound and socially equitable. Readers can join in on this whistle-stop tour of German environmental cooperation projects focused on sustainability and located around the globe.

Chinese Coal Fires

The first stop: China, which produces 2.4 billion tons of coal each year, suffers from nearly uncontrollable coal fires, much like other regions of the world. Experts say that 10 million tons of coal burn in China each year. The fires not only use up an important natural resource; they are polluting the air and increasing the country’s greenhouse gas emissions. An interdisciplinary earth science project supported by the BMBF and its Chinese partner MOST focuses on the development of innovative remote sensing methods. The goal of the scientists is to measure emissions from coal fires and fight and monitor the fires in the northern part of China. At a conference in Beijing in 2005, the idea of joint German-Chinese research on this subject was discussed for the first time. A website is being built to network the research community even further. The first stop is India. Here, the Swajaldhara project sponsored by the GTZ and the German Federal Chancellor’s office. She will work with a Fraunhofer project team to research how Russia and Germany can recycle wooden furniture to make wooden panels, and she will conduct a comparative study of Russian and European standards for wood products.

Russian Wood Recycling

Now, on to Moscow, Russia, where the Fraunhofer Institute for Wood Research (WKI) and Russian partners are working to recycle wood and use the natural resource sustainably. The WKI has an office that certifies local producers of wood materials who want to sell their goods in Europe. The institute hosts a Russian researcher who won a scholarship from the German Federal Chancellor’s office. She will work with a Fraunhofer project team to research how Russia and Germany can recycle wooden furniture to make wooden panels, and she will conduct a comparative study of Russian and European standards for wood products.

Better Use of South Africa’s Energy

South Africa is home to one of the 15 largest cities in the world – the greater Johannesburg area. German private and public partners are working with local counterparts to secure the region’s energy supply and make sure all residents have equitable access to clean, safe energy sources that are produced in an environmentally responsible manner. The partners – including the GTZ, Germany’s technical development agency, and the Institute of Energy Economics and the Rational Use of Energy at the University of Stuttgart – are improving technology and processes to meet their goals. For instance, they are developing modeling tools and action plans for the region.

A strong partner for global challenges

At the end of the journey, you can get an idea of Germany’s commitment to working together with its partners to help preserve the environment and limit the use of natural resources. The technologies touch every part of life – from the production and enhancement of goods, the conservation of nature and the satisfaction of basic human needs, such as mobility or health. The wide application is a natural match for the interdisciplinary character of environmental technologies – an area in which studies show that Germany is particularly strong, has high levels of competence and has taken a position of global responsibility.

Now, join us for a look at Germany’s technologies and projects in the areas of clean water, renewable energy, resource efficiency, cleaner production and contaminated land management. Initiatives that are recognized for their importance to the environmental technology sector.
At the start of the 16th century, Germany began to regulate the quality of its beer, making it among the best in the world. The story for water is not too different. By developing and enforcing the highest quality standards for water cleanliness, Germany promotes innovation and has become an export leader in water technologies.

You’ve heard of our beer purity law? You should see the one for water.
Managing the Most Basic Resource: Water

Water. The basis of human, floral, and animal life. A fundamental element for producing food. A commodity and a human right. Without water, human life on earth would cease to exist. The resource covers 71 percent of the earth’s surface, but 1.5 billion people lack access to healthy drinking water and some 2.5 billion people do not have sanitation facilities. The situation only stands to worsen as worldwide population rises, the planet warms and rampant industrialization continues. In the next 20 years, households around the globe will consume 80 percent more water and companies will use 50 percent more water as well, according to a recent United Nations Environment Programme report. German universities, research institutes, businesses and development agencies are key players in turning this situation around, and in the process, they are boosting Germany’s economy.

German Water Expertise Around the Globe

A top goal of German development work is to transfer technical knowledge and build capacity in the water sector through consulting, cooperation and partnerships. Germany has already helped authorities around the world provide access to clean drinking water, stabilize at-risk areas and protect against floods. Research and development are necessary to turn innovation into practical solutions for the benefit of humankind.

In Mongolia, Germany is helping manage water. In Africa, it has worked to produce drinking water. In Indonesia, German teams help pump water from an underground river in a karst area. And in Bangalore, residents are gaining access to sanitation facilities, while human waste is turned into fertilizer or biogas. These are just a few of the projects supported by the government. Germany supports the United Nations Decade of Water with an interdisciplinary approach based on the understanding that sewage treatment and sanitation facilities are essential, and natural resources must be returned to the earth. The water industry has also declared its intent to help protect water resources for coming generations via the German Water Partnership. It represents wastewater disposal companies, engineers, consultants and water treatment plants. But the country does more than just muse about potable water: The government is the third largest bilateral donor in water sector development cooperation; German companies are leading global designers and builders of water-purification and water-management technologies. In addition, Germany contributes to the Global Water Partnership, a UN-associated international network, which has defined the goals of Integrated Water Resource Management (IWRM): to develop and manage water, land and related resources to maximize economic and social welfare in an equitable manner, without compromising vital ecosystems.

Technology and the Market

By developing and enforcing the highest quality standards at home, Germany promotes innovation and boosts the economy. For instance, scientists have developed filters that can kill Legionella and other bacteria. The latest organic membrane and filtration systems clean river and rainwater. And desalinization processes, such as those based on membrane and vaporization principles, can be used to turn seawater or stream water into drinking water.

The global market for water and wastewater disposal will be worth roughly 400 billion euros in 2010. Already today, every fifth export of water technology hails from Germany, and the country ranks first in the water sector among OECD countries. German companies are the worldwide market leaders for measuring, controlling and regulation technologies as well as wastewater technologies. In addition, German companies are market leaders for de-central water provision, with 40 percent of the worldwide market share.

Training and Jobs

Water treatment and provision technologies are not only a big part of the German export market; they make up an important part of the domestic economy as well. Germany invested 7 billion euros in 2006 in domestic infrastructure, creating thousands of jobs and trainee positions in the process. Some 23 technical colleges and universities offer training programs in water-related fields, particularly those focused on the natural sciences, technology and business. Finally, the Federal Government offers scholarships to young, international researchers through the IFS-WT Program, which stands for International Postgraduate Studies in Water Technologies. It lays the groundwork for the future transfer of knowledge and technologies and educates potential decision-makers from around the world.

The German Water Partnership was founded in 2007 but nevertheless represents more than 120 years of experience in water management and water technology. The public-private organization has a strong focus on delivering water technology and helping consumers and institutions improve their management of water resources. Services range from safe water supply to consulting on reforms of the water sector and cross-border water management.

www.german-water-partnership.com
Monitoring and Stabilizing of River Dikes

Floods have become a much bigger threat to people around the world as a result of climate change. Dikes are used to protect people and property, but these constructions are difficult to monitor. Due to age and design, they are not always safe. Even though technology for monitoring dikes is improving, old dikes continue to have weak spots, and these points are frequently difficult to locate.

Modern dikes are made up of three elements: a sealing section on the water side, a supporting section in the center and a drainage section on the land side of the dike. But many of Germany’s dikes are decades or even centuries old and cannot withstand long floods. Germany is developing ways to better monitor dikes so that authorities can evaluate the condition of particular dike sections. Supported by the Federal Ministry of Education and Research, researchers at the Universities of Karlsruhe and Kassel and from the Saxon Textile Research Institute have developed an innovative stabilizing technique for dikes to prevent them from breaching during a flood. Drainage elements are installed at the bottom of the land-side slope of the dike to discharge the seepage from the dike.

In addition, German scientists have developed a way to monitor the moisture levels inside dikes using Spatial Time Domain Reflectometry (Spatial TDR) at critical dike sections. Flat-band cables that serve as sensors are placed inside the dike via a special installation technique. By launching an electrical impulse into the cable at one end, scientists can observe reflected waveforms at the other end and determine the moisture levels of the material along the length of the cable. Called Dike Monitoring with Time Domain Reflectometry (TDR), the project provides online access to information collected by the monitoring system. This potentially allows authorities to evaluate the condition of dikes to make quick decisions about stabilizing them or evacuating residents.

http://philippow.mfpa.de/~tdreich/monitoring

Anaerobic Wastewater Treatment

The anaerobic treatment of highly loaded organic industrial wastewater for biogas production is an established process, and German industry possesses the necessary know-how, technologies and wide-ranging experience in this area. In the absence of oxygen, the organic pollutant in the wastewater is degraded to carbon dioxide and methane, so-called biogas, which can be used to generate electricity or fuel. This type of biological treatment is much less expensive than traditional processes in which oxygen is needed to degrade the pollutant, and running such treatment facilities is cost-effective since no energy is needed for ventilation. In Europe, the anaerobic treatment of municipal wastewater is not economical because of cool temperatures. For countries in tropical and subtropical areas, however, it is more efficient. The Federal Ministry of Education and Research supports a research project AnaKomA, in which researchers are adapting anaerobic treatment plants to warmer climates and developing reuse concepts for the treated water. Since it contains nitrogen and phosphate, the treated wastewater also provides a valuable source of fertilizer.

Partners include researchers from the Leibniz University of Hanover and a company based near Frankfurt, Passavant-Roediger Anlagenbau GmbH. Based on the results of initial tests, scientists developed a robust and simple treatment facility that was tested in Cairo in 2008. Later, the plant will be configured to become more energy efficient. The results of the research and tests were compiled in a database that can be used to design treatment facilities for local conditions, taking into account factors such as climate, the material used to build the treatment plant and electricity prices. Users of the database can find out more about the technology, patents, services and delivery conditions of German industrial partners.

www.isah.uni-hannover.de

“Circular Thinking” in China’s Boom Cities

China’s burgeoning economy and rapid urbanization are putting additional stress on reservoirs and the supply of water to the world’s most populous country. The Chinese government wants to help stop the dumping of about two thirds of all untreated wastewater into China’s rivers, streams and lakes, and begin treating household trash adequately. A project funded by the German Federal Ministry of Education and Research – called Semi-centralized Supply and Treatment Systems for Urban Areas – developed comprehensive concepts for supply and treatment systems in newly planned neighborhoods. The concepts are highly flexible, sustainable, adapted to local needs and semi-central. Semi-central systems apply to more than one settlement but are not comparable to conventional systems that feature central provision across entire cities. China’s cities can grow by 1,000 people a day, putting enormous stress on central supply and disposal systems. Therefore, semi-centralized systems offer flexible strategies to keep up with the growth.

As part of the project, scientists from the Technical University of Darmstadt adapted standard technologies to Chinese needs and developed “modular” concepts that could be combined depending on the needs. These included greywater and wastewater treatment, co-fermentation of sewage sludge and biodegradable organic waste, energy recovery, the supply of potable water and the provision of water to be reused for toilet flushing, irrigation and industrial uses. Researchers put together a package of concepts and technologies specifically suited to China’s needs using technical planning tools as well as non-technical planning tools, which take into account different legal, socio-cultural, ecological and economic conditions. Based on the underlying principle of “from the earth, to the earth,” as well as recycling concepts, the recommendations focused on water reuse, nutrient reuse and energy from wastewater and organic wastes.

www.semizentral.de
A king cobra nearly ended a German-Indonesian water project before it got started. As four researchers crawled into a cave to measure it, they surprised the 2-meter long snake. With the light from their headlamps, the researchers watched as the serpent coiled its neck and sprayed venom toward them. The incident caused the team from the University of Karlsruhe to reconsider the project to bring people in one of the poorest regions of Indonesia an adequate water supply. However, the partners found an innovative solution. The Indonesian government hired a snake charmer who was always first to enter the caves. The project, sponsored by the Federal Ministry of Education and Research of Germany and Indonesia, will bring some 75,000 people in the Gunung Kidul district in the Yogyakarta Special Province of Java the water they urgently need.

It all started with a survey by a British consulting agency in the 1980s. The agency discovered large deposits of water flowing through connected underground rivers, but one problem remained – bringing the water above ground in a cost-effective manner. In 2000, German researchers from the Institute for Water and River Basin Management at the University of Karlsruhe launched a feasibility study on how to use the available water resources. In 2002, they received funding to build an underground hydropower plant that will pump water to the surface. The project was set to be finished in 2006, but a strong earthquake in the region delayed the work. In 2007, engineers succeeded in damming the underground river in the cavernous and limestone-rich area and put a first turbine into operation. After the work is completed in 2009, the underground hydropower plant, which is located 100 meters below the surface, will spew 70 liters of water per second some 220 meters high, and the water will be stored in a reservoir on top of a hill. Powered by the water in the underground river, the plant requires no additional electricity or diesel to operate and is therefore self-sustaining. The project also includes capacity-building and training elements designed to help the local population operate and manage the plant. Peter Oberle, a researcher at the University of Karlsruhe who has been involved in the project since its inception, said, "Similar systems are used to pump water out of mines around the world, but this is the first to be used to supply water, and it is the largest of its kind."

The interdisciplinary project involves experts in hydraulic engineering, water management, geodesy, geochemistry, material engineering and timber engineering. Partners besides the University of Karlsruhe include the University of Giessen, Herrenknecht AG, KSB AG and private and public organizations in Indonesia. Herrenknecht developed a vertical drilling machine suited to the needs of the cavernous, limestone-rich area. KSB AG developed special pumps to use as turbines. This technology has been developed to bring water to thousands of other people around the world. A new project has been started to introduce integrated water resource management to this region, which includes transport and drinking and wastewater treatment while also considering economic and social aspects.
Whether wind, solar, biomass or geothermal energy, Germans have made a science of capturing nature’s power and putting it to work. The country installs more photovoltaic solar panels than any other, and giant wind turbines dot the landscape from Hamburg to Munich.

Renewables – German engineers trust in the power of nature.
Renewable energy represents an opportunity for humankind to live sustainably—and Germany is doing its part to make this chance a reality. As the global market leaders in many areas of the renewable energy sector, German companies and the research institutes that back them up are bringing clean energy to the world. They are working together with partners around the world to reduce dependency on fossil fuels and increase the use of energy that is constantly restored by nature. New markets created by these technologies should benefit all partners involved.

The Federal Government supports renewable energy technologies through a wide variety of efforts. It passed the Renewable Energy Sources Act (EEG) in 2000, which requires electricity providers to use renewable energy sources and pay pre-set prices for it. The law has helped boost the market for technologies for renewable energy production, such as energy generated from wind, sunlight, biomass and geothermal heat. Many areas of the Federal Government work together closely to promote research and development for renewable energy, including the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, which holds primary responsibility, the Federal Ministry of Education and Research, with its specialist research program, and the Federal Ministry of Food, Agriculture and Consumer Protection, which is in charge of energy from biomass.

Clean Air and Good Jobs

The strategy has already had a positive impact—on the environment and also on the employment rate. Germany has exceeded one of its environmental goals: It had aimed to cover 12.5 percent of its electricity needs with renewable energy by 2010, but the country achieved a rate of 14.2 percent in 2007. This caused the German Parliament, the Bundestag, to raise the goal for 2020 to at least 30 percent. On the job front, the sector employed 250,000 people in 2007.

Wind and Solar Energy

Drive through Germany, particularly its northern part, and you will see dozens of sky-high wind turbines dotting the countryside. Some 20,000 giant wind catchers across the country produce enough megawatts to provide electricity to millions of people. In 2008, Germany produced and used 20 percent of the world’s wind power-generated electricity. Solar energy production is on the rise as well. German companies are the third biggest producers of solar cells, and one of the world’s largest photovoltaic solar parks is under construction in Leipzig. These examples show that Germany puts action behind its ideas about renewable energy.

Biomass and Geothermic Energy

Two other prime sources of renewable energy are biomass and geothermic energy. Fermenting trash or organic waste is a method of energy production that is growing in popularity. In 2007, German biomass energy production would have been enough to supply Berlin’s overall energy needs for one and a half years. Wood-based heating, wood-fueled power plants, biogas plants and plants for fluid biomass and biofuels contributed 5.9 percent of the energy end users needed in Germany.

To help this proportion rise while ensuring adequate food resources, researchers are developing new concepts to keep the balance between food production and energy production from biomass sources in check. One such project is a BMBF-sponsored initiative to support Jatropha-based biofuel production. Finally, Germany is active in the geothermic energy production sector with support from the government. In Mecklenburg-Western Pomerania, the first German geothermic high-output power plant was inaugurated at the end of 2007. It was funded by the Federal Ministry for the Environment. Further plants in Bavaria and in other Länder went into operation as well.

Renewable energy has the potential for growth across all sectors. Some examples of fields of innovation are organic photovoltaics, further developments in offshore wind energy or new systems for storing electricity as a way to compensate for uneven production. These include high-performance batteries based on lithium ion. The Fifth Energy Research Program of the German Federal Government will help speed the process of bringing such technologies to market. In these ways and many more, Germany is a leader in addressing the problem of limited resources and climate change.
Using Sun and Seeds as Renewable Energy

Organic Solar Cells

Organic solar cells (OSCs) are flexible, semi-transparent and extremely inexpensive to produce. Combined with the ubiquity of portable electronics, high energy resources and the environmental threat presented by fossil fuels, they have huge potential for the future. They are, however, currently a niche solution due to their rather limited lifespan and low efficiency. BMBF is sponsoring a research initiative with a number of projects from industry and research institutions. One of them is conducted by Konarka Technologies and is expected to significantly increase the lifespan of OSCs.

The goal of the project is to improve the chemical and structural stability of the cells’ constituent materials and the interfaces between the materials. The mechanisms that lead to the degradation of the cells will be explored further so that a “map” of the paths of degradation and their respective contribution to the degradation of different OSC-cell types can be created. Based on this map, new materials, architectures and production processes for organic solar cells will be developed and evaluated for commercial attractiveness.

There have been many improvements in OSC-technology in the recent past but they have mostly been due to improved packaging of cells rather than an extension of the lifespan of the actual photocative materials. Encapsulation extends the life expectancy of the cells by several orders of magnitude, but has disadvantages including higher production costs, especially for printed solar cells. The demands on the barrier materials are extreme and the barrier qualities of the encapsulation weaken over time. Therefore, significantly higher life expectancy can only be realized by combining high-quality encapsulation with high intrinsic stability of the photoactive materials.

www.konarka.com

Solar Cooling Technology

The need for cooling is growing not only in offices but also in manufacturing, particularly in areas where sensitive machines operate or sensitive products are handled as well as for cooling within the production processes. These cooling needs are higher in summer than in winter due to passive solar gains and higher ambient temperatures in general.

The goal of this project, funded by the German Federal Ministry of Education and Research, is to create industrial solar cold production with a solar thermal powered steam jet ejector chiller. This type of chiller uses steam as a refrigerant and is more efficient than conventional absorption chillers when operated at high primary temperatures and pressures. Concentrating collectors that operate efficiently even at high temperatures are therefore ideal for solar thermal cold production. Parabolic trough collectors can produce the motive steam needed immediately when operated in direct steam generation mode. Therefore a direct coupling of the two technologies is very promising.

The project started by finding a heat transfer medium that provides freezing protection for the collector field in winter but was also suitable for the steam jet ejector chiller. Then a system concept was developed, based on this medium and both components were developed further in order to combine the technologies. They will be built and tested separately and, once successful, a complete system will be designed, installed, monitored and optimized at a test facility. At the end of the project, a functioning pilot plant will serve as a showpiece to help create initial demonstration plants.

www.nachhaltige-innovationen.de/de/595.php

Fuel and Livestock Feed from Jatropha Seeds

The Jatropha is a multipurpose, disease- and drought-resistant plant. Its seeds are rich in oil (ca 35 percent). The seeds are crushed to produce oil which can be converted to biodiesel of high quality through a process called esterification. The biodiesel can be used in standard diesel engines without any modification. However, oil extraction from the seeds is not very efficient at present and the seed meal is toxic to animals and can therefore only be burned as biomass or used as a fertilizer and not used as feed.

That is why this Sino-German project, funded by the German Federal Ministry of Education and Research, aims to enhance the economic viability and sustainability of Jatropha-based biofuel production systems by introducing innovative industrial processes and livestock production systems based on a novel feed that does not compete with human food. The objectives of this project will be achieved through an integrated approach involving groups with complementary skills and expertise from public and private sector institutions from Germany and China. The German project partners will develop better technologies for de-shelling, oil extraction, and the use of oil and shells as an energy source. They will also develop processes to detoxify the seed meal and thus make it a viable feed alternative. Chinese groups will evaluate the use of the resulting detoxified seed meal as a substitute for soy meal in farm animal diets and German groups in fish diets. The German partners will also conduct a financial and economic analysis of the overall system.

The processes will be patented and animal feeding guidelines will be published for use by the feed industry and farmers. The results of this project would make German industry more competitive in the areas of renewable energy, sustainable development and environment conservation.

www.jatropha.uni-hohenheim.de
New Frontiers for the Sun

It is a scene most film lovers know by heart: Three outlaws are holed up in a train station in sun-drenched Arizona as Charles Bronson, or “Harmonica,” walks in and asks for Frank. Frank is not there, and a shootout begins. Once Upon a Time in the West is often regarded as a nostalgic goodbye to the Wild West era.

As it turns out, the train station used to film the scene in 1968 was not in Arizona – but in a parched valley in southern Spain. It is a stone’s throw away from Andasol 1, a solar-energy project in Andalusia that could, in the long term, usher in the last days of conventional energy. That, at least, is the vision that German and Spanish partners have for the world’s largest solar power plant: They hope the parabolic trough plant demonstrates a real alternative to conventional energy and will pave the way for renewable energy to take its place.

“The market for renewable energy is a bit like the Wild West. It takes pioneers and technical know-how to make things happen,” said Oliver Vorbrugg, the construction supervisor at the Andasol site who works for Flagsol, a German company owned by Solar Millennium, based in Erlangen. Flagsol and Solar Millennium provided the technology for the plant and linked up with the ACS/Cobra Group, Spain’s largest construction company, which offered its know-how in plant construction, financial backing and regional matters. Together, the partners invested 260 million euros in the Andasol 1 project, including 5 million euros of funding from the European Union to turn the vision of large-scale renewable energy into reality. Initial R&D support came from the German Federal Ministry for the Environment, Nuclear Conservation and Nuclear Safety. The project will be followed by the privately funded Andasol 2 and 3 projects, which are nearby and already under construction. Collectively, the plants represent the world’s largest solar energy plant. The construction of Andasol 1 began in 2006, and operations started in October 2008. The plant features a solar field containing over 200,000 mirrors – arranged in a row, they would extend over a distance of more than 86 kilometers. Parabolic trough power plants, just like conventionally fueled power plants, use a steam turbine connected to a generator to create electricity. However, solar power plants use the sun’s radiation rather than fossil fuels to produce the steam. With a total collector surface of more than 510,000 square meters (roughly 70 soccer fields), the Andasol 1 and 2 plants will provide up to 200,000 people with environmentally friendly solar-based electricity. The plants – Europe’s first parabolic trough plants – will generate 180 gross gigawatt hours of electricity per year. Thanks to their thermal reservoirs, they can even work when the sun is not shining.

The project, based on German renewable energy technology, is already bringing clean electricity to thousands of homes in Spain, and experts at Solar Millennium believe Spain could use solar energy to replace 10 to 15 conventional plants, such as those powered by fossil fuels or nuclear energy. Next in line is Egypt: Solar Millennium is providing the technology for Egypt’s first parabolic trough plant to be ready in mid 2010. What’s more, according to a study by the German Aerospace Center (DLR), 0.3 percent of the Sahara desert would be sufficient to meet electricity demands of the European Union, the Middle East and North Africa using these types of power plants.
It's not true that thinking in circles leads nowhere. It is part of an environmentally sound approach for dealing with human-kind’s limited resources. In Germany, people recognize the variety of opportunities created by using natural resources in an efficient, environmentally friendly and intelligent manner to conserve resources such as water and energy. Many of these technologies work by reusing and recycling materials and putting them back into the production cycle – a perfect example of thinking in circles.

German scientists like to think in circles. It gets them far.
Making the Most of Mother Nature’s Bounty

Walk into nearly any German garden and you will see a prime example of resource efficiency. Most hobby gardeners are avid composters, collecting table scraps and garden waste in compost piles. It is a small example, but it underlines the philosophy behind many high-tech solutions that benefit the environment: Reuse and recycle anywhere you can. In 1996, Germany was among the first countries to pass a law about citizens’ duties to recycle trash and about the fundamentals of the circular economy. A decade later, the country was already benefiting from the recycling regulations that motivated people and businesses to reuse materials and reduce their overall consumption of resources. It reached a 25 percent world market share for recycling technologies, giving small and medium-sized companies supported by the government a leg up on the competition.

Promoting Resource Efficiency
Both domestically and internationally, higher prices for raw materials are raising expectations placed on the environmental technology sector. In Germany, for instance, the government is working towards the goal of doubling energy productivity by 2020 compared to 1990 and raw materials productivity by 2020 compared to 1994 via its national sustainability strategy. Studies say that such improvements can be attained with the help of a wide variety of efficient and clean technologies, including those used for the circular economy, waste management and recycling. In order to meet its goal, Germany wants to break down the perceived link between economic growth and the use of resources by showing that they do not necessarily have to increase at the same rate.

The impulse to achieve innovations in resource efficiency can arise from different areas, for instance material sciences, biotics or biotechnology. Sometimes innovation is even achieved through the intelligent combination of established and proven methods to support sustainability goals in many economic sectors.

Networks and Innovation
Germany’s strategy for increasing the productivity of raw materials is not based only on technology. The government also promotes cross-disciplinary cooperation within companies, across industries and internationally. For instance, Germany initiated networks for innovations in resource efficiency and awards prizes to the organizations that make the greatest strides toward material efficiency. It also supports the goal through its High-Tech Strategy and initiatives such as the “Resource-Intensive Production Processes” research program, which focuses on innovative approaches to the use of raw materials, particularly for companies that depend heavily on them. These include firms in the iron, steel, metal, glass, paper and ceramic processing industries as well as companies that process chemicals and make construction supplies. The sustainable use of resources is not only a German goal, but a European one. That is why the ERA-NET SUSPRISE (Sustainable Enterprise) program bundles research activities across the continent. They are focused on sustainable industrial and business processes as well as product development.

A Growing Market
As it works to curb its own use of natural resources, Germany stands to benefit from a growing market for environmental technologies and services. Demand for recycling services has reached about 55 billion euros worldwide, and the market for recycling technology worldwide is valued at 5 billion euros, for instance. German companies are well positioned to benefit from international growth. Nearly half of all small and medium-sized companies in the sector make more than one third of their sales abroad. And many large companies attribute as much as half of their turnover to foreign customers. These companies expect foreign sales for raw material and material efficiency technologies to rise up to 26 percent while domestic demand is expected to stay constant. These positive developments are not only good for Germany’s economy and for securing jobs, they also help protect the environment we all share.

Resource for Sustainability
The guiding principle of sustainable development has been altered by a better understanding of complex interdependencies between human intervention and natural processes as well as the global dimension of the environment and development. For five years, the BMBF framework program “Research for Sustainability” has been supporting innovative projects and measures that foster sustainable development through knowledge sharing and innovation. The framework program will be extended and continued in 2009. Information on the different fields of action, including resource efficiency, can be found at www.fona.de
Resource Efficiency

Conserving Resources and Using Renewable Ones

Saving Raw Materials and Reducing Pollution in the Production of Steel

Precision in the process of hot rolling steel can save significant amounts of money and resources and protect the environment at the same time. For example: If the width of the steel being rolled out on a rolling line can be kept more consistent by 1 millimeter, this can lead to cost reductions of 500,000 euros per year per rolling line. Similarly significant are strip cambers, deviations in the straightness of a strip, which can cause an uneven thickness of the strip and also significantly interrupt the production process.

In a project funded by BMBF and carried out by VDEh-Betriebsforschungsinstitut (BFI) and EKO Stahl, researchers are conducting trial rollings in order to develop an algorithm that makes it possible to calculate the thickness of the strip. That algorithm is then integrated in the pre-hot rolling process and enabled to automatically adjust the calculation parameters. Thus far, there has been no process to avoid strip cambers, so the researchers plan to start by developing a combined model that includes mathematical and data-based components. In order to integrate it in the controls of the rolling, however, the researchers will also need to develop new measuring techniques to detect the strip cambers. The goal is to create processes and tools that can easily be applied to all hot rolling facilities in order to improve efficiency and avoid unnecessary waste.

Innovative Lightweight Components

Cast parts used in the automotive industry have to comply with high standards in terms of strength, ductility and durability. In order to make such parts lighter without jeopardizing their quality, researchers from Georg Fischer, Sachs Engineering and the Reutlingen University turned to bionics, the application of biological methods and systems found in nature to the study and design of engineering systems and modern technology. The resulting parts can be built using less material, hence conserving resources. As a positive side-effect, they lower the overall weight of the vehicle and thus improve fuel-efficiency. The BMBF-funded project uses bionic processes to calculate a way to minimize the weight of cast car components. They do so by letting the program run itself according to a specific strategy. Similar to the load-adaptive growth principles of trees or bones, stress-optimized components are being constructed that require less material. Randomized algorithms based on the evolutionary principles of natural organisms are used for further component optimization and eventually arrive at the best possible solution. Specific parts that are to be optimized as part of the project are hinge bearings, wheel trunks, transverse control arms and engine components like pistons, connecting rods and crankshafts. The goal is to achieve a weight and cost reduction of up to 20 percent, which could save Georg Fischer 10,000 tons of material a year, which in turn would mean a reduction in emissions of 37,460 tons of CO₂ a year and energy savings of 126.5 GW h/year.

High-Performance Building Materials Made from Renewable Resources

Researchers of the Dresden University of Technology, in cooperation with HESS Wohnewerk, the Institute for Applied Science in Civil Engineering (IaFB) and the GWT Dresden, set out to investigate, develop and construct high-performance composite wood structures (HHT). Since wood is a renewable resource, such a material could become a sustainable alternative to similar steel and reinforced concrete-based products, which are currently predominant. The idea is to improve the performance of wood constructions by combining compressed wood with fiber-reinforced plastics and technical textiles. This improves the wood structures in terms of stiffness, strength, ductility and durability. The applied techniques have thus far only been used in other industries like textiles production or aviation. In the medium term, the researchers hope to introduce highly reliable composite wood structures in real-world applications and pave the way for a new image of wood in the construction industry.

www.georgfischer.com
www.bfi.de
www.iafb.de | www.tu-dresden.de
Neatly nestled near Lake Geneva, Constantin Group is one of three companies in Switzerland that sorts PET bottles for recycling. It does so with the latest sorting technology from Germany—machines with high-tech sensors that meet the rising worldwide need to recycle and reuse resources. Interest in these technologies is set to increase as commodity prices rise and environmental regulations tighten.

The Swiss have long prided themselves on the majestic scenery of their country, so recycling is a trait that is important to the population: Some 77 percent of PET bottles bought in Switzerland are returned for recycling, a mammoth organizational achievement. That means millions of bottles per year that are used for juice, water and other beverages must be sorted and brought to recycling facilities, yet another large-scale accomplishment.

“Years ago, we sorted everything by hand. This was labor intensive and led to errors in product sorting. And, of course, the amount of sorting we could perform was limited,” said Roger Constantin, the head of Constantin Group. Now the company from Switzerland uses three high-tech sorting machines from the German company RTT Systemtechnik, a spin-off of the Technical University of Zittau. With sensors, the machines make it possible to sort 7,500 tons of different types of bottles each year with only ten employees. If bottles were still sorted by hand, the company could sort only about 2,000 tons a year. Constantin said, “We chose the machines from Germany because they were among the best technology available and they don’t take up too much space on the factory floor.” He uses three machines—two that sort based on color recognition and one that sorts using cameras.

The technology used in the machines has been given a seal of approval from the German Society for Plastic Recycling (DKR). Bottles are put into the machines on a conveyor belt and sorted. After this process, they are pressed into huge balls of plastic to reduce the overall volume that needs to be transported. The pressed plastic balls weigh 270 kilos and measure 120 x 60 x 60 centimeters. A company in the business of recycling then processes 100 percent of the balls to make new PET-bottles, resulting in about 60 to 70 percent recycled material in an average new PET bottle. Just imagine if millions of PET bottles were produced without recycled material.

This story illustrates how Germany has successfully established itself on the international market for recycling technologies. It all started with laws that required households to separate their trash for recycling, the well-known German “dual system.” Germany is now a leader in the production of technology used directly by waste-removal companies to separate all types of waste and raw materials, which benefits the circular economy.
We start to clean even before things get dirty.

Germany did not invent the concept of Cleaner Production, but the country has embraced the principles with the same enthusiasm that lies behind its notoriously clean sidewalks. Many German companies have internalized the idea that by reducing waste and emissions during the production phase, they can not only help the environment, but can also become more competitive in the process.
Balancing Economic and Environmental Interests

The cross-disciplinary strategy of Cleaner Production enables each company to assess and optimize the resources it uses for business and production. The overall result of these integrated technologies: lower costs for the company and a cleaner environment.

Maximizing production while minimizing the resulting waste and emissions – this is the focus of Cleaner Production, a term coined by the United Nations Environment Programme (UNEP) in 1989. The idea is to optimize processes and use raw material efficiently – a goal that can only be met with a cross-disciplinary approach.

In Germany, both the government and companies actively support corporate environmental responsibility through Cleaner Production. Projects focus on protecting the environment and transferring knowledge and expertise. The government links the many actors interested in Cleaner Production as well as companies that work with related technologies. The first step usually involves an analysis of the waste and emissions that are systematically created by all industrial and business processes across divisions and disciplines in a company. For some companies, this may include diverse functions such as procurement, production, production cleanup, warehousing and shipping.

Analyzing Across the Supply Chain

The common procedure for Cleaner Production is to examine each individual process to understand how much energy is used and how much waste is produced. For example, companies add up each kilometer supplies must be shipped and how much electricity is needed for air conditioners for servers. This gives firms a comprehensive overview of all the various energy sources they rely on and how much they use of each resource. In many cases, the information also helps improve business and industrial processes, thus reducing costs.

Once companies have created a “balance sheet” that documents their material flow and energy use, processes can be changed to reduce their impact on the environment. For example, many firms have found that they can reuse the wastewater they produce in one production process for other production processes. This saves the organization money and cuts back on the total amount of fresh water needed. Other examples: Companies have discovered that they can substitute harmful paint with water-soluble paint or capture heat and then reuse it. To help more companies perform the analyses they need, and to highlight the benefits of Cleaner Production, the German Federal Government supports knowledge-transfer initiatives such as an information portal called Cleaner Production Germany, which is available in German, English and Turkish. It features thousands of project reports about how firms changed and improved processes for the benefit of the environment – and the bottom line. It is a showcase for the world about German Cleaner Production know-how.

Another initiative is PIUS (www.pius-info.de), which provides small and medium-sized companies with practical information about Cleaner Production techniques by telling the stories of users who worked with some of the 25 partners. Also, the BAUM initiative works to educate and sensitize companies, institutions, politicians and citizens about the environment and sustainable development. Finally, the German business community has established a forum for sustainable development – econsense. Its objective is to optimally apply social responsibility. In addition, years of support by the BMBF in integrated environmental protection in select sectors of the economy have resulted in innovations that not only help the environment, but also create economic advantages.

Embraced Internationally

Cleaner Production techniques and a cross-disciplinary approach to protecting the environment are catching on around the world. Already in 2005, a study from the Centre for European Economic Research (ZEW) showed that 77 percent of companies in Germany, France, Japan, Canada, Norway, Hungary and the United States are using integrated environmental protection methods. In Germany, companies are so enthusiastic that they make up one third of all the participants in the European Union’s Eco-Management and Audit Scheme program, also known as the Eco-Audit. It is a management tool for companies and organizations for evaluating, reporting on and improving environmental performance. There is good reason for the excitement; Cleaner Production often leads to decreased costs and therefore higher profits and enhanced competitiveness. It is a win-win situation: While consuming less energy and resources, companies will also save money.

The Cleaner Production Germany portal is backed by the Federal Government and includes literally thousands of examples of Cleaner Production techniques in action. It is designed to improve access to environmental solutions and German organizations which offer them. Cleaner Production Germany includes project reports in more than a dozen areas, including biotechnology, motor vehicles and surface engineering. The site also offers links to associations and technology providers.

www.cleaner-production.de
Efficient, Cleaner, More Sustainable Production

Sustainable Production of Flexible Slabstock Polyurethane Foam

In recent years, flexible foam has found a multitude of uses due to its wide range of different forms and the resulting properties. That is why researchers are developing an integrated process for the sustainable production of polyurethane flexible foam slabstock or block foam.

The material is produced by mixing the two basic chemical ingredients polyol and isocyanate and additional substances and then placing the mix on a conveyor belt, where the physical and chemical foaming of the mixture takes place. The characteristics of the foam’s product and processing qualities differ widely depending on the choice of ingredients and additives as well as the foaming agents used. Many uses of block foam require it to be flame retardant and there are strict regulations regarding the emission of organic substances from the foam. But the development of mixtures and processing techniques is very complex and hardly feasible for single companies. Among the project partners are a manufacturer of slabstock production facilities, an additive producer, a slabstock manufacturer as well as companies that recycle polyurethane (PU). The goals of this project were: manufacture of secondary polyols for use in PU-flexible foams, the development of low-emission additives, especially of catalysts and foam stabilizers, halogen-free flame retardants, investigation of the impact that the new raw materials and additives have on the characteristics of the foams, and the development of an integrated process as well as the production of demo components for different industries.

The potential benefits of this project include a reduction of manufacturing waste through conversion into secondary polyols, a reduction of the primary use of raw materials due to the reuse of these polyols, and a reduction of emissions during the use of block foam products due to the use of lower emission stabilizers and catalysts.

www.nachhaltige-innovationen.de

Robust Sensor Networks for Eco-Efficient High-Temperature Processes

The goal of the joint research and development project HotSens is to make high-temperature processes in machines, facilities and vehicles more efficient both economically and ecologically. For this purpose, networked multi-sensor regulators are needed, and HotSens wants to develop and test them.

If there was a way to monitor and regulate ongoing high-temperature processes, energy could be preserved and emissions lowered. One prerequisite for that, however, are sensors that can operate without cooling in these hostile environments. The new class of sensors is intended to enable measurements of relevant parameters at temperatures between 350 and 850°C. This will make it possible to adjust ongoing processes, which in the past could only operate in an unregulated or stochastically regulated manner. Powerful online diagnostic systems for life-cycle monitoring of the systems could then be developed as well.

The technology will help design new, environmentally friendly control and security technologies in the automotive industry, engineering and plant construction. It will lower nitric oxide emissions in a sustainable manner and reduce energy and raw materials consumption.

www.itw-chemnitz.de

Application of Supercritical Fluids Replaces Organic Solvents

Organic solvents are used widely to extract biological agents. A project funded by the BMBF and coordinated by the Fraunhofer Institute for Environmental, Safety, and Energy Technology (UMSICHT) sets out to explore the possible use of supercritical fluids instead. The best-known practical example of the extraction of biological agents using supercritical liquids is probably the extraction of caffeine from unroasted coffee beans. While this process is well-established, supercritical carbon dioxide could be an environmentally friendly alternative for many other extraction processes. However, a better understanding of the physical and chemical processes involved needs to be developed before this is possible.

The specific goal of this project is research on the extraction of biological agents from plant matrices, specifically from red clover, sage and rapeseed, and the treatment of heterogenic matrices like wood or paper, which is possible with hydrophobic substances by means of supercritical carbon dioxide. During the course of the extraction and treatment experiments, researchers will explore the impact of a wide variety of parameters on the matrix and the products. These include the impact of varying matrix properties, process/operation modes, pressure, temperature and mass/volume flow rates of the supercritical fluid. The results will find later industrial applications in cosmetics, food production and construction as well as in sectors like the chemical, pharmaceutical and textile industries.

www.supercritical.de
Rich in natural resources and home to the world’s largest rainforest, Brazil has long been the focus of environmental activists and activities. In 2005, a foundation was established in a nature reserve in São Bernardo do Campo (in the state of São Paulo) by BASF, a German chemicals company, in cooperation with GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit), Germany’s government-backed international development agency. The reserve covers 290,000 square meters and is recognized by UNESCO as part of the Brazilian biosphere.

Called Espaço ECO Foundation, the organization helps companies preserve the environment by introducing Cleaner Production as well as sustainability tools. BASF donated the land and makes available its environmental tools, including the so-called Eco-Efficiency Analysis tool. It helps companies identify ways to reduce the impact of production on the environment. For instance, the tool has been used to help companies switch from harmful processes to more eco-friendly ones.

“Our aim is to balance environmental and economic factors in production processes – for example to manufacture cost-effective products with the smallest possible amount of raw material and energy, as well as minimized emissions,” said Sueli Oliveira, Coordinator of Eco-Efficiency and Socio-Eco-Efficiency at Espaço ECO. She added, “The Eco-Efficiency Analysis tool represents a significant step in saving Brazil’s environment as well as establishing a sustainable regional economy.” Espaço ECO has consulted with many different Brazilian companies, including petrochemical group Braskem, the market leader in Latin America for thermoplastic resins.

The company’s products – many made from thermoplastic resins like polyethylene, polypropylene and PVC – are used in everyday items such as backpacks, packaging, automotive components and computer parts. Braskem’s environmental standards are in line with ISO regulations, but the company was still interested in identifying Cleaner Production methods that could save it money and benefit the environment. At the Camaçari PVC plant in the northeastern part of Brazil, in the state of Bahia, the company analyzed the production of thermal resins. The company concluded that certain gas emissions should be eliminated to improve the ecological efficiency of its processes, and it has implemented some changes.

In another analysis, Braskem determined it could reduce greenhouse gas emissions by using ethanol from sugarcane fermentation to produce ethylene, instead of relying on petrochemical, raw-material based processes. The analysis used different factors such as liquid effluent neutralisation, sugarcane bagasse burning and its use as a source of energy as well as the distance of suppliers to find out if the sugarcane process would really benefit the environment. The Eco-Efficiency Analysis tool can be used by all sorts of companies to embrace Cleaner Production methods and make strategic production decisions. Based on a giant database, the software tool calculates monetary costs and adds up the environmental impact of processes to give a fuller picture of the true costs. It has been used in United Nations-supported projects, for example in the textile industries in Morocco and Egypt. In one case in Morocco, a textile dying company analyzed its production processes and then decided to introduce a different chemical that allowed it to use less water in production.
They say Germany is neat ‘n’ clean – they haven’t seen its cleanest part.
Brownfield Management: Bringing Sites Back to Life

Countries around the world face the problem of contaminated land. In Germany’s industrial heartland in the western Land of North Rhine Westphalia as well as other regions, the country has tackled the problem. Upon reunification with the GDR, Germany had to do the same for thousands of acres of additional land. Its strategy was to give private businesses the incentive to rectify the land while guiding its redevelopment. For this purpose, it created national uniform criteria to assess contaminated properties, thus helping the private sector manage the risks and costs of cleanups. Because of this positive experience, Germany has become a sought-after partner for other countries faced with cleaning up contaminated sites.

The previous chapters have shown that Germany meets the obligations of sustainable business with its clean technologies. The country also takes responsibility for the land contamination of the past.

At the same time, Germany supported research in innovative technologies to extract hazardous substances from the subsurface in a cost-efficient manner. These activities made Germany a leader in turning around polluted sites, or megasites, tracts of land that are contaminated on a large scale by multiple sources. One example is the Bitterfeld site in the Land of Saxony-Anhalt at which more than 2,000 contaminants were identified and remediation costs have reached approximately 180 million euros to date.

International Recognition and Cooperation

Compared to other countries, Germany is particularly advanced in its cleanup efforts and has developed technical solutions that make cleanups economically feasible. Its scientists work together with researchers from other European countries and North America in order to develop new methods for contaminated land management. Research activities focus on technologies for partial source removal and use of natural attenuation processes for contaminant reduction in groundwater.

Decontamination Methods

Decontamination methods can be broadly categorized as in-situ or ex-situ measures. By applying in-situ measures, it is not necessary to dig up soil or to pump groundwater, whereas ex-situ remediation involves removing soil and groundwater followed by post treatment and/or disposal of contaminated materials. A typical in-situ approach is the use of soil vapor extraction techniques in combination with conductive or electrical heating, such as steam-air injection, thermal wells, and heating with electromagnetic waves or electric currents. The in-situ approach can reduce costs substantially, since the post treatment of contaminated soil or groundwater is omitted.

Germany is focusing its research efforts on the development of effective in-situ technologies.

R&D and Training

To support the development of cost-saving remediation technologies for contaminated site cleanups, the German government pooled about 100 million euros of national funding from 1998 to 2008. Funding was allocated to research initiatives such as KORA (Retention and Degradation Processes to Reduce Contaminants in Groundwater and Soil) and RUBIN (German Permeable Reactive Barrier Network), which developed in-situ clean-up techniques for groundwater. The initiatives show the importance placed on the research, development and implementation of a wide range of decontamination methods. A career in environmental sciences is becoming increasingly attractive as the general public becomes more and more aware of the problems associated with contaminated soil and groundwater. Most German universities offer degrees in environmental science or coursework such as geology, geo-ecology or chemistry.
Cleaning up Megasites with Complex Contaminations

The groundwater in Bitterfeld is contaminated with organic hydrocarbons over an area of 25 square kilometers at a depth of 40 to 60 meters, including an estimated 250 million cubic meters of groundwater. Such a megasite poses a major risk for human health and ecosystems. Experience has shown that complete soil and groundwater remediation is neither ecologically nor economically efficient in the case of such large sites. The goal of the project SAFIRA, led by the Helmholtz Centre for Environmental Research (UFZ), was therefore to develop innovative technologies for the economical remediation of complexly contaminated groundwater.

For the project, a list of fundamentally suitable treatment technologies was drawn up and initially tested in the laboratory. Then a pilot plant was built, consisting of 5 subsurface shafts with a depth of 23 meters each. A total of 20 reactors were placed in the shafts to investigate the feasibility of eight different approaches for in-situ groundwater remediation. In particular, different approaches were tested for the efficient removal of multiple contaminants from the groundwater. These included the use of a metal catalyst for the oxidative destruction of pollutants, the operation of combined redox reactors and the biological treatment of contaminants in anaerobic/aerobic systems. The reactors were positioned perpendicular to the local groundwater flow direction and operate in a flow-through mode with contaminated groundwater from the site, which is collected by 10 horizontal wells.

Targeting Contaminants

At a contaminated site in Harburg, the groundwater is located at great depth and the contaminated soil is very inaccessible, making the site unsuitable for conventional monitoring and remediation techniques. That is why a KORA-initiative project backed by the BMBF sets out to evaluate if natural attenuation and retention processes in the groundwater are sufficient to assure that the contamination does not threaten an adjacent water protection area.

Because groundwater analysis using conventional wells would be very expensive at the site, the scientists focused on the direct-push-method, a faster, more flexible and much cheaper version of conventional drilling, which they refined to reach greater depths. The wells are turned into multi-level measuring points to take samples continuously at different depths. This allows researchers to analyze the vertical distribution of the contaminants very accurately. They concluded that the contamination source will disappear completely in about 40 years, that the plume is stable and that sources of drinking water downstream are not being compromised. These findings allow the authorities to decide if natural attenuation will suffice or active remediation measures are needed.

Analyzing, Cleaning and Preserving the Soil

Groundwater Remediation with Alcohol

In the mid-1980s it became clear that countless aquifers around the world are contaminated with organic compounds, such as aromatic and aliphatic hydrocarbons or chlorinated hydrocarbons. In order to remove these, scientists looked at a technology developed by the oil industry, which pumped alcohols and surfactants into the ground to lower the interfacial tension of the oil-water system, thus allowing them to exploit the oil more efficiently.

In a project funded by the BMBF, scientists from the Research Facility for Subsurface Remediation (VEGAS) at the Institute of Hydraulic Engineering, University of Stuttgart, and at the Institute for Hydromechanics (IfH), University of Karlsruhe, are looking into a similar approach to remove LNAPL (Light Non-Aqueous Phase Liquid) and DNAPL (Dense Non-Aqueous Phase Liquid) from contaminated aquifers. They do so using a groundwater circulation well (GCW) to inject an alcohol cocktail into the aquifer that mobilizes the contaminants and makes them soluble. Then groundwater is pumped back to the surface and treated to separate contaminants for disposal and alcohols for reinjection. With this technology, more than 90 percent of the contaminants can be removed and the experimental findings allow researchers to design specific alcohol cocktails suitable for the remediation of a specific contamination.

Targeting Contaminants

At a contaminated site in Harburg, the groundwater is located at great depth and the contaminated soil is very inaccessible, making the site unsuitable for conventional monitoring and remediation techniques. That is why a KORA-initiative project backed by the BMBF sets out to evaluate if natural attenuation and retention processes in the groundwater are sufficient to assure that the contamination does not threaten an adjacent water protection area.

Because groundwater analysis using conventional wells would be very expensive at the site, the scientists focused on the direct-push-method, a faster, more flexible and much cheaper version of conventional drilling, which they refined to reach greater depths. The wells are turned into multi-level measuring points to take samples continuously at different depths. This allows researchers to analyze the vertical distribution of the contaminants very accurately. They concluded that the contamination source will disappear completely in about 40 years, that the plume is stable and that sources of drinking water downstream are not being compromised. These findings allow the authorities to decide if natural attenuation will suffice or active remediation measures are needed.
In September of 2007, seven researchers from Leipzig caravanned more than 1,500 kilometers to a polluted mega site in Ploiesti, Romania, as part of a symposium on contaminated land management. When they arrived at the outskirts of the city after two long days on the road, the group found a police car and two officers waiting to escort them to the site as a friendly gesture. The group accompanied the researchers and their truck full of sensitive equipment for measuring soil contamination so they could attend the symposium.

During the symposium, the scientists demonstrated techniques for measuring contaminants in the soil and groundwater to 100 participants, including employees of national, regional and local environment ministries. The symposium was the third event on contaminated land management organized through a partnership between the Land of Saxony-Anhalt and Romania. Using initial results from measurements taken the first day, Peter Dietrich, the head of the Department of Monitoring and Exploration Technologies, gave feedback to attendees in a lecture on the second day. The report was among the first to look at the exact contaminant makeup of the soil near an oil refinery on the outskirts of Ploiesti, a city of 250,000 north of the capital Bucharest. The area has a high concentration of contaminants in the soil and water – so much that tar can be seen seeping out of the ground. Tar, a byproduct of oil processing, covers a drainage basin, and layers of tar have shown up in basements and garages in other parts of the city and pedestrian tunnels have been blocked by sludge. Like at many contaminated sites, residents are exposed to poisons if they use the land for grazing farm animals or foraging for mushrooms. Before the German team arrived, contamination levels were unknown, and Romanian authorities were investigating options for removing the waste. The project is designed to build the capacity to measure and treat contaminated sites together with Romania. The Department of Monitoring and Exploration Technologies at the UFZ is developing ways to gain an adequate and accurate picture of natural systems as the first step in the clean-up process. To create efficient and comparatively fast assessment tools, it has combined techniques used in a variety of research areas, such as geophysics, hydrogeology, remote sensing and biodiversity.

For instance, working together with Romanian partners, researchers demonstrated the effectiveness of an approach that combined Direct Push technology with geophysical exploration methods and chemical analysis. Direct Push measurements require a special probe to be inserted into the earth. Geophysical exploration is akin to using an ultrasound to see the organs of the human body. “It’s just like in medicine,” says Dietrich, adding, “We first have to find the problem, and that’s not so easy. Doctors poke their patients with needles while we pierce the earth with probes to measure seismic, magnetic and electromagnetic signals. But we’ve often got a long road to travel before we get to this point.”
Contents

Preface  5
Introduction  6

Technology Chapters

Water  14
  Introduction  16
  Projects  18
  Feature  20

Renewable Energies  22
  Introduction  24
  Projects  26
  Feature  28

Resource Efficiency  30
  Introduction  32
  Projects  34
  Feature  36

Cleaner Production  38
  Introduction  40
  Projects  42
  Feature  44

Contaminated Land Management  46
  Introduction  48
  Projects  50
  Feature  52

Picture Credits  55
Links  56
Publication Information  58
Cleaner Production Germany
www.cleaner-production.de

Econsense – Forum for Sustainable Development of German Business
www.econsense.de

Federal Environment Agency (UBA)
www.umweltbundesamt.de

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)
www.bmu.de

Federal Ministry of Education and Research (BMBF)
www.bmbf.de

Federation of German Industries (BDI)
www.bdi-online.de

FONA – Research for Sustainability
www.fona.de

Forschungszentrum Jülich Energy and Environment
www.fz-juelich.de

Fraunhofer Institute for Chemical Technology (ICT)
www.ict.fraunhofer.de

Fraunhofer Institute for Environmental, Safety and Energy Technology (UMSICHT)
www.umsicht.fraunhofer.de

Fraunhofer Institute for Interfacial Engineering and Biotechnology (IGB)
www.igb.fraunhofer.de

Funding Agency: Deutsche Bundesstiftung Umwelt (DBU)
www.dbu.de

Funding Agency: Project Management Jülich Environment and Sustainability
www.fz-juelich.de/ptj/umwelt-nachhaltigkeit

German Energy Agency
www.dena.de

German Environmental Information Portal
www.portalu.de

Germany Trade & Invest
www.gtz.de

German Water Partnership
www.german-water-partnership.com

Guide: Study and Research on Sustainability in Germany
www.leitfaden-nachhaltigkeit.de

High-Tech Strategy for Germany
www.hightech-strategie.de

Integrated Water Resources Management
www.wasserressourcen-management.de

IWWM-Net – Networking Water Research
www.iwwm-net.eu

KORA
www.natural-attenuation.de

PIUS
www.pius-info.de

Potsdam Institute for Climate Impact Research
www.pik-potsdam.de

Helmholtz Centre for Environmental Research (UFZ)
www.ufz.de

Research in Germany – Land of Ideas (Environmental technologies)
www.research-in-germany.de/environmental_technologies

Risk Management of Extreme Flood Events (RIMAX)
www.rimax-hochwasser.de
Published by
Federal Ministry of Education and Research, Basic Policy Issues,
Internationalization Strategy, 53170 Bonn
Internet: www.bmbf.de
E-mail: bmbf@bmbf.bund.de

Creative Conception, Copy and Layout
Scholz & Friends Berlin

Note
Unless specified otherwise, these pages contain the most up-to-date information available as of February 2009, the copy deadline. However, the publisher takes no responsibility for the accuracy of the information. For queries or suggestions, please contact: info@research-in-germany.de
Bonn, Berlin 2009
Keeping the Blue Planet Green

German ideas for sustainable solutions in environmental technologies