

Resource Efficiency Challenge



Opinions, Examples, and Management Tools

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Conservative use of the worldwide available resources is a key challenge for business, politics, and society. It is necessary to achieve a balance between the utilization of scarce resources and the necessity of expanding economic growth to emerging and developing countries. Poverty for many and prosperity for a few is not a sustainable economic model.

But we require new approaches in order to counter the excess consumption of valuable resources. The keyword “resource efficiency” points the way to an approach which can help us succeed in creating more awareness for improved efficiency in the use of raw materials. A comprehensive review of methods and strategies for achieving resource efficiency is discussed in this econsense – Forum for Sustainable Development of German Business brochure.

Notable authors from science, management, environmental movements, and business describe a wealth of approaches and examples which demonstrate the potential associated with resource efficiency in a spectacular fashion. One of the main messages of this publication is to take better advantage of this potential. Because an increase in resource efficiency, meaning the frugal use of valuable and often expensive raw materials, has a positive financial effect. Lower raw material costs maintain or improve the competitive position of companies. Who wouldn't want to take advantage of these benefits?

Therefore resource efficiency is increasingly becoming a focus of sustainability, and beyond this publication will take a significant place at econsense – Forum for Sustainable Development of German Business. I would like to take this opportunity to thank all participants for their contributions, and at the same time wish all readers a stimulating read.

Yours sincerely,

A handwritten signature in blue ink that reads "W. Große Entrup". The signature is fluid and cursive, with a prominent flourish at the end.

Dr. Wolfgang Große Entrup

Chairman of the Management Board
econsense – Forum for Sustainable Development
of German Business

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Priv.-Doz. Dr. Lothar Mennicken

Resource efficiency – the potential of research and development

Using raw materials more intelligently and efficiently makes a fundamental contribution to securing Germany as an industrial location and therefore to our prosperity. Raw materials are increasingly scarce on the world markets and are contested. Therefore a high degree of resource efficiency strengthens industry in the global competitive environment. Saving raw materials makes an important contribution to the national sustainability strategy. The federal government has set the goal of doubling raw material productivity by 2020 in comparison with 1994. However, the raw material productivity growth rates achieved in the past few years are too low to achieve the targets. Therefore all involved parties must increase their efforts considerably in the coming years, for example by developing technologies to increase the efficiency in leading raw material intensive markets.

The federal government has initiated promising measures within the framework of the new raw materials strategy: abolishing trade barriers and distortion of competition, the integration of national activities with the European raw materials policies, and a focus on raw materials related research programs.

One key to increasing resource efficiency is the development of new cutting-edge technologies, which is why the federal government has defined this as a central innovation policy objective of the high-tech strategy 2020. With this strategy, the forces of business, science, and research policy are combined and opportunities for developing „green“ lead markets through new solutions and their implementation are tapped. This will accelerate the innovation process for environmental technologies – from research to marketing in national and international leading markets – and will secure Germany’s leading position in environmental technologies.

Activities of the Federal Departments

The Federal Ministry of Education and Research (BMBF) sees itself as the driving force for open-ended science and research focused on solving key future problems. To this end, the research policy framework conditions for science and research are designed so that expertise, innovation, and higher value creation will result.

The BMBF works closely with other involved federal departments: Thus common strategies are developed within the framework of the Interministerial Committee on Raw Materials (IMA) in order to promote the spread of technologies to increase efficiency.

The market introduction and implementation is supported by the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU) through the Centre for Resource Efficiency (ZRE), through networking activities (resource efficiency network) and by subsidising demonstration projects (environment innovation program).

The Federal Ministry of Economics and Technology (BMWi) focuses on increasing material efficiency through consulting and networking of SMEs through its material efficiency incentive program, managed by the German Material Efficiency Agency (demea). If companies have already successfully implemented measures to improve material efficiency, then these companies can apply for the raw material efficiency award which is endowed with 10,000 Euro.

The contribution made by the BMBF is aimed at the areas of raw material related innovation and research policy. In particular, the tool of funding specific projects can be used to react quickly and flexibly to the corresponding research demand by announcing tailor-made funding measures. These measures are generally prepared jointly with relevant stakeholders from science, industry, politics, and associations, for example through expert committees.

Structural activities

In light of the increasing scarcity of raw materials, the BMWi has established the German Raw Materials Agency (DERA) as the central information and consulting platform for German raw materials industry companies. This agency provides consulting services primarily to small and medium-sized operations regarding questions of raw materials availability and current market developments, as well as the sustainable usage and resource efficiency of mineral and energy raw materials.

Also on a strategic level, the Helmholtz Institute Freiberg for Resource Technology – a national R&D competency centre for raw material technologies which will make a key contribution to a sustainable and long-term raw materials supply – was founded by the Federal Minister for Education and Research, Dr. Annette Schavan in August 2011. The institute, currently in the setup phase, integrates the entire value-added chain from the extraction of raw materials to processing and recycling, including sustainability considerations.

Specific project subsidies

Within the framework program “Research for Sustainable Development (FONA)”, the BMBF is funding research and development in particular in the area of “Sustainable Economics and Resources”. The focus is on a system-based approach, with entire value-added chains or life cycles being studied rather than individual processes. In light of the increasing resource requirements of the newly industrialized countries, the primary concern is to develop solutions which are suited to international markets – this also generates opportunities for the successful exporting of technology.

Implementation of the framework program “Research for Sustainable Development” is done by announcing funding measures (specific project funding). The BMBF funds improved raw material productivity in industries which consume a lot of material – such as the steel or cement industries – with the “r² – Innovative Technologies for Resource Efficiency – Raw Material Intensive Production Processes” at around 36 million Euro.

Since smaller and medium-sized businesses often develop efficient technologies tailored to their needs, the BMBF provides new opportunities for easier access to research funds with the initiative “KMU-innovativ: Resources and Energy Efficiency”, in existence since 2007. The BMBF has already allocated 20 million Euro to this measure and expanded the consulting services for SMEs, as well as making the approval process simpler and faster.

Within the framework of the funding focus “Technologies for Sustainability and Climate Protection – Chemical Processes and Material Use of Carbon Dioxide”, industry-oriented research projects on climate protection technologies and to expand the raw material base – and therefore to promote a more conservative use of fossil resources (“no more oil”) are supported. With the help of renewable energy, in the future it will be possible to use CO₂ to produce valuable base chemicals for industry. Such projects are supported with up to 100 million Euro in BMBF funds.

In light of the global responsibility of industrial nations, the BMBF is increasingly emphasizing cooperation with emerging nations: Through the programme “CLIENT – International Partnerships for Sustainable Technologies and Services for Climate Protection and the Environment”, the BMBF is supporting research and development projects in conjunction with Brazil, Russia, India, China, South Africa, and Vietnam – among other things in the areas of sustainable use of resources and climate protection – with up to 60 million Euro.

With its two most recent funding measures, the BMBF is making a key contribution to the sustainable use of strategically relevant raw materials:

- “r³ – Innovative Technologies for Resource Efficiency – Strategic Metals and Minerals” within the “Research for Sustainable Development – FONA” framework program
- “Materials for a Resource-Efficient Industry and Society – MatResource” within the “Material Innovations for Industry and Society – WING” framework program

Subsidising of innovative recycling technologies and substitution strategies in particular is done in order to contribute to the security of supply of rare raw materials which are important to key and future technologies in Germany. Such future technologies are also particularly relevant to the environment, such as indium for thin-film photovoltaic for more efficient generating of renewable energy, neodymium for the permanent magnets in electric generators of wind energy systems and electric motors in e-mobility. The first research projects were started in May 2012.

The BMBF is currently working on a new research program “Raw Materials of Strategic Economic Importance for High-Tech made in Germany”. The goal is to significantly increase research and development along the value-added chain for non-energy mineral raw materials over the next 5–10 years. The funding measures are targeted at universities, non-university research institutes, and companies. The focus is on strengthening applied research and the integration of applied research with basic research. The thematic focus is on those metals and minerals whose availability must be ensured for future technologies and which have a high leverage effect for the economy: Steel stabilizers, metals for the electronics industry, and other high-tech raw materials such as rare earths or platinum group elements – therefore all those raw materials which are required for the manufacturing of leading products in Germany. Raw materials valued at less than 0.5 % of our GDP have the leverage to quickly bring our economy out of a recession or to ensure prosperity in the country. These raw materials are subsequently described as “strategic economic important”. In order to secure the availability of raw materials of strategic economic importance for German industry, research and development activities both in the areas of primary raw materials and in the area of secondary raw materials and recycling are essential.

Three current examples of BMBF funded projects are outlined below.

Project example 1: Resource efficiency through “green” cement

Almost three billion tons of cement are produced worldwide every year and are responsible for five percent of all anthropogenic CO₂ emissions – three to four times as much as the entire CO₂ emissions generated by air traffic. Scientists at the Karlsruhe Institute for Technology (KIT) have developed an innovative method for manufacturing “green” cement, called Celitement®. Comprehensive testing at KIT proves: The new cement has the potential to cut CO₂ emissions during manufacturing in half and to lower the consumption of limestone by two thirds. This is possible thanks to a new manufacturing process which takes place at a temperature of 200°C, instead of the 1,450°C currently required for conventional cement. The climate protection potential is enormous: Worldwide conversion of all cement manufacturing would result in a CO₂ reduction of half a billion tons on the raw materials side alone.

The BMBF supports the accompanying research for bringing this process from the laboratory scale to an industrial scale with 4.3 million Euro. In addition to KIT as the national science centre, the Ulm-based Schwenk Zement KG – notable German construction product manufacturer – and Celitement GmbH are participating in the project. Further development of the process is taking place in a pilot plant on the KIT premises. If the tests are successful, the first production-scale reference plant could be built starting in 2014.

KIT was awarded with the BMWi’s German Material Efficiency Prize 2010 as one of a total of five prize winners for the development of the “green” cement (Celitement).



“Green” cement has the potential to cut CO₂ emissions during manufacturing in half and to lower the consumption of limestone by two thirds.

Project example 2: Resource efficiency using the belt casting process

Another example of how new technologies and materials can reduce the consumption of energy and raw materials is the so-called belt casting technology BCT®, which was developed with BMBF funding of 4.8 million Euro at the Salzgitter Flachstahl GmbH in cooperation with partners from science and industry. The belt casting technology is a technical innovation used to manufacture modern high-strength and ductile HSD® (High Strength Ductility) steel. These types of steel have a high manganese content and are a lightweight, ductile, and at the same time extremely hard high-tech material which can compete with synthetic materials and light metals. Up to 60 percent of the energy used in the casting and hot rolling process steps can be saved with the new process. The production time and material consumption are also lowered, since the casting process can be shortened with belt casting.

Unlike conventional steel production, the liquid steel doesn’t have to cool down first and then be heated up again for further processing. In the course of the research projects, savings are currently being quantified precisely in Salzgitter and the process is being prepared for use at industrial scale. The demonstration system is currently being built with a BMU investment subsidy. This could also benefit the German automotive industry, for example, because the use of HSD® steel could reduce the material requirements and therefore the weight by up to 20 percent. Another advantage: Intelligent

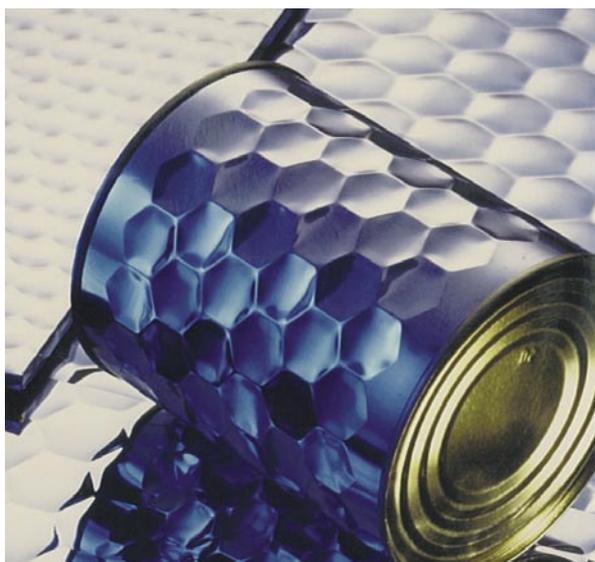
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crumple zones can be realized with HSD[®] steel. During an accident, the steel first deforms in order to absorb the impact energy, then hardens and protects the passenger cab. The safety of cars in accidents is improved in this manner.



For the same part geometry and wall thicknesses, HSD[®] steel (left) exhibits considerably higher energy absorption under the same type of crash loading when compared to the high-strength dual-phase steel (right) commonly used today. This gives the designer greater design freedom in configuring the individual components.

Project example 3: Resource efficiency through lightweight construction



This technique uses known laws of physics for the structural stiffening of thin-walled materials.

The project “KMU-innovativ – Resource Efficiency and Improved Product Properties through the Manufacturing of Specially Structured Metal Lightweight Construction Parts”, coordinated by Dr. Mirtsch GmbH, aims to reduce material usage by strengthening sheet metal with special structures. This technique uses known laws of physics for the structural stiffening of thin-walled materials. This will be used as the basis for developing an innovative process to manufacture sheet metal for automotive industry applications. These sheet metals are distinguished by particularly high plastication reserves and are therefore intended for use in “crash-relevant” body parts.



Reinhard Kaiser

Resource Efficiency! Resource conservation! Raw material productivity!

And now this! Many a disposed reader might groan.

The climate discussion has been ongoing in Germany for 25 years and is also slowly taking effect in the political reality. The energy transition efforts are becoming more defined, and especially are being seized on by more groups. And it's high time.

Climate change is noticeably progressing. The climate goal of limiting the increase in the average global temperature by 2050 to two degrees above the pre-industrial period¹ only seems attainable with extreme energy policy efforts and extreme agricultural policies.

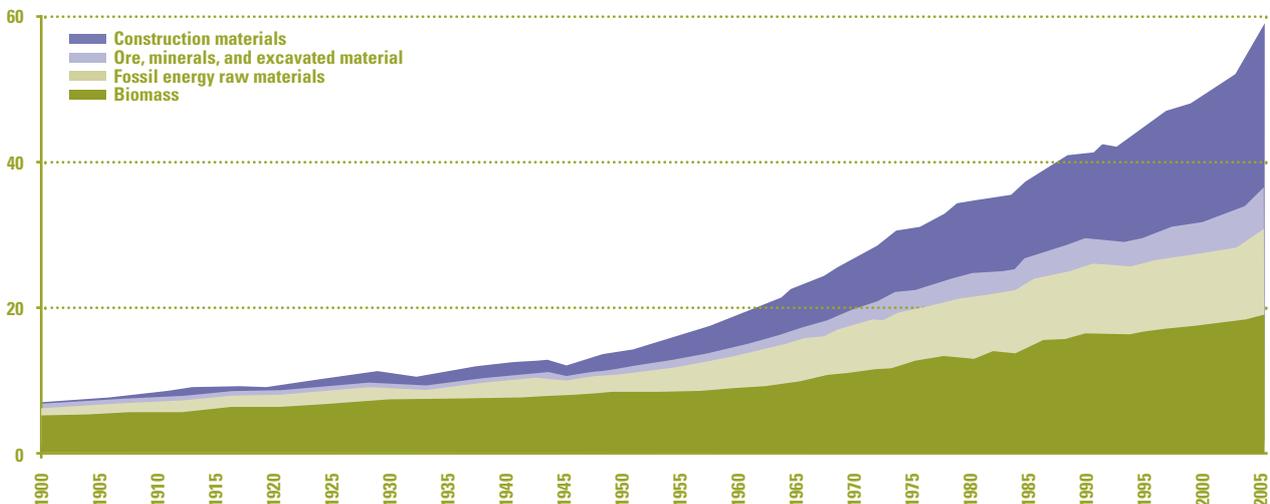
In addition, the catastrophe in Japan has once again put the atomic energy discussion on the (domestic) political agenda, which in truth is full enough already.

And now really clever people are coming and saying: "We don't just have a climate problem – we also have a resource crisis."

Is this really necessary? What more do we want to ask of us and our economy?

The only problem is: These people are right. Ignoring this challenge would be both ecologically and economically costly. This applies in particular in a country which is and wants to remain a highly developed industrial nation.

Worldwide resource consumption in billions of tons



Source: Krausmann et al. (2009): Growth in global materials use, GDP and population during the 20th century, *Ecological Economics* Vol. 68, No. 10, 2696-2705. Legend translated.

The challenges and potential of resource efficiency

We are in the process of overtaking the ecological performance of our planet through our consumption of raw materials and our resource-wasting lifestyle. Add to this the damage done to soils, the prohibitive water consumption which is rapidly growing in many regions, and the reduction in biodiversity. Countless species of plants and animals are facing extinction.

In order to provide an idea of the scale of this problem: If the industrial nations cut their per-capita raw materials consumption in half by 2050 relative to 2006 – which seems to be extraordinarily ambitious by today's standards – and if the developing and emerging nations increase their consumption in the same timeframe to just this low level (and not above it), then the worldwide consumption of raw materials would still grow by 40 % by 2050.² This would still be too much to achieve the climate goal of two degrees!

Since the famous Club of Rome study in 1972³, the topic of finite natural resources has reached public awareness. Naturally the political attention is initially focused on the current critical areas, especially energy issues.

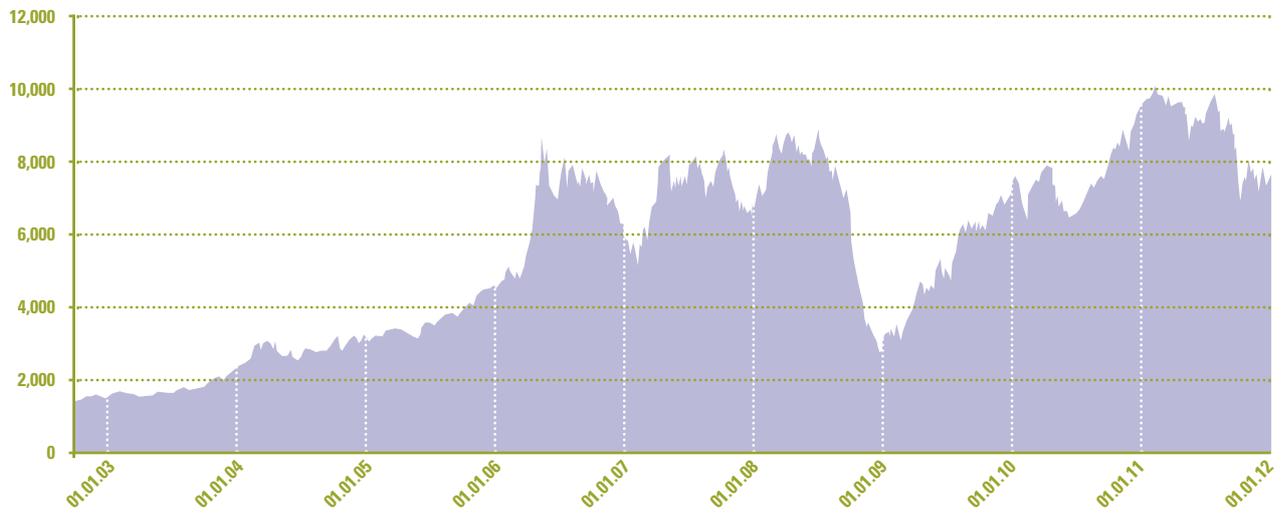
¹ As decided by the signatories' of the UN Climate Change conference in Cancun, December 2010: http://unfccc.int/files/meetings/cop_16/application/pdf/cop16_lca.pdf, CP.16, section I.4

² International Panel on Resources: "Decoupling the use of natural resources and environmental impacts from economic activities", Lead Authors: Marina Fischer-Kowalski and Mark Swilling; 2011. Assumption: 9 billion people in 2050

³ Dennis L. Meadows, Donella Meadows, Erich Zahn, Peter Milling: "The Limits to Growth". Published on 2.3.1972. Michael Angrick provides an interesting perspective on the state of the discussion in Germany: *Ressourcenschutz für unseren Planeten* (resource protection for our planet); Marburg 2008; here pg. 114 ff.

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Development of copper prices (US dollars/Ton)



Source: <http://www.finanzen.net/rohstoffe/kupferpreis/chart> (retrieval date: 01.07.2012)

But in addition, a more comprehensive understanding has developed over the last decade surrounding the question of resource efficiency. In the industrial nations, the driving force for this partially lies in an increased ecological understanding, but is primarily due to painful experiences with breathtaking price fluctuations and alarming forecasts for more or less all raw material markets. This has – painful – effects on both raw material exporting and importing countries. Just as an example, the trend for a “harmless” high-volume metal (above graphic).

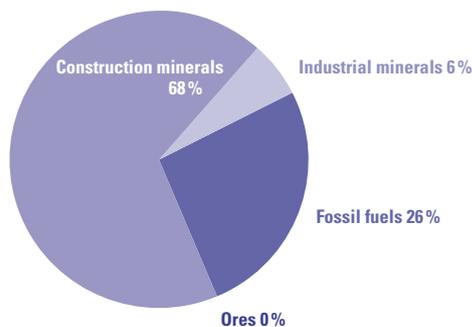
In order to address the causes of these problems, one has to consider the entire life cycle of a resource: From supply (e.g. “Extraction and Processing of the Raw Materials”) to utilization (e.g. “Sustainable Producing and Consuming”) through to ensuring a resupply through recycling (e.g. “Recycling Economy”). The topic of resources has also become an issue for the

German industry stakeholders under the label “security of supply” and has led to great concern, as shown by pertinent surveys. For different reasons, both ecologists and economists discovered a shared interest in handling this topic in a sustainable (i.e. stable during vibrant globalization) and intelligent (i.e. head start through innovation on the world market) manner. The coming months and years will show whether we will work together to develop strategies, and then actually implement these as well.

What are we talking about? In the graphics, take a closer look at the non-biological, non-energetic raw materials (energy policy makers are already spending a lot of time on oil, coal, and gas anyway), in plain English: the ores (or the metals obtained from them), industrial minerals, and construction minerals.

Utilization of domestic extraction of non-biological raw materials in 2007

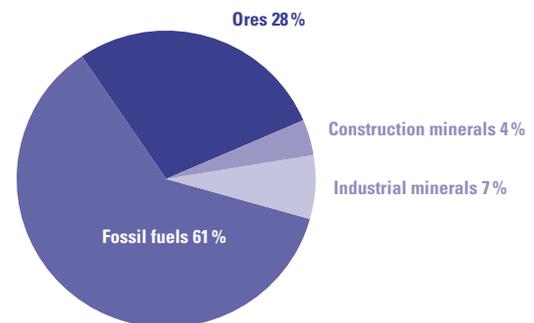
Total amount: 852 million tons
Ores: 434,000 tons



Source: VDI-ZRE, on the basis of Destatis 2009, Tabellen zu den Umweltökonomischen Gesamtrechnungen (tables on the environmental-ecological resource accounting), pg.109

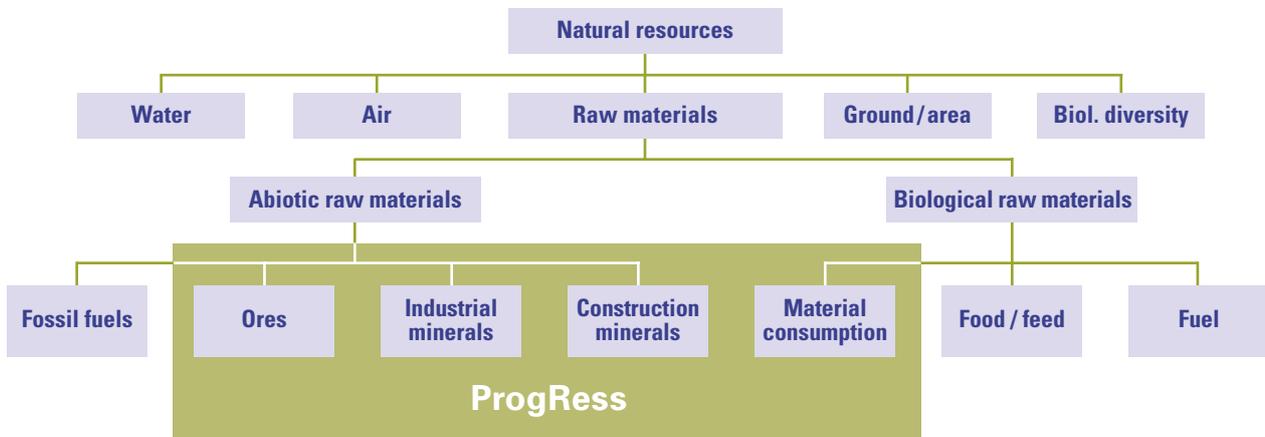
Non-biological raw materials imported in 2007

Total amount: 496 million tons



Source: VDI-ZRE, on the basis of Destatis 2009, Tabellen zu den Umweltökonomischen Gesamtrechnungen (tables on the environmental-ecological resource accounting), pg. 111

Thematic classification of the German resource efficiency program (ProgRes)



Source: Prepared within the framework of the research project "Environmental strategy development – Sustainable Management of political environmental goals and strategies", ffu/IFOK under contract with the BMU, 2011.

The German resource efficiency program (ProgRes)

This domain of abiotic, non-energetic raw materials is the primary focus of the "German Resource Efficiency Program – Program for the protection of natural resources in an ecological-social market economy" (ProgRes). On October 20, 2010, the federal cabinet commissioned the BMU to develop a corresponding draft.⁴ On February 29, 2012, it was enacted by the federal cabinet.⁵ It is the first resource efficiency program enacted by a government in Europe and probably also worldwide.

An important driving force was that the federal government wants to achieve its self-imposed goal established in the German Sustainability Strategy (NHS) from 2002⁶. The NHS specifies that: Germany's raw material productivity will be doubled by 2020 in comparison with 1994.

The raw material productivity is the ratio of the GDP (in Euro) to the consumption of raw materials (in tons)⁷, not including biotic raw materials.

As the figure below illustrates, our raw material productivity has improved considerably since 1994, but we are still quite far under the running target.⁸ Greater effort is required in order to meet the NHS goal, and we want to tackle this now.

⁴ Decision about the federal government's raw materials strategy, <http://www.bmwi.de/BMWi/Navigation/Service/publikationen,did=365186.html?view=renderPrint>. Here: pg.15, last paragraph.

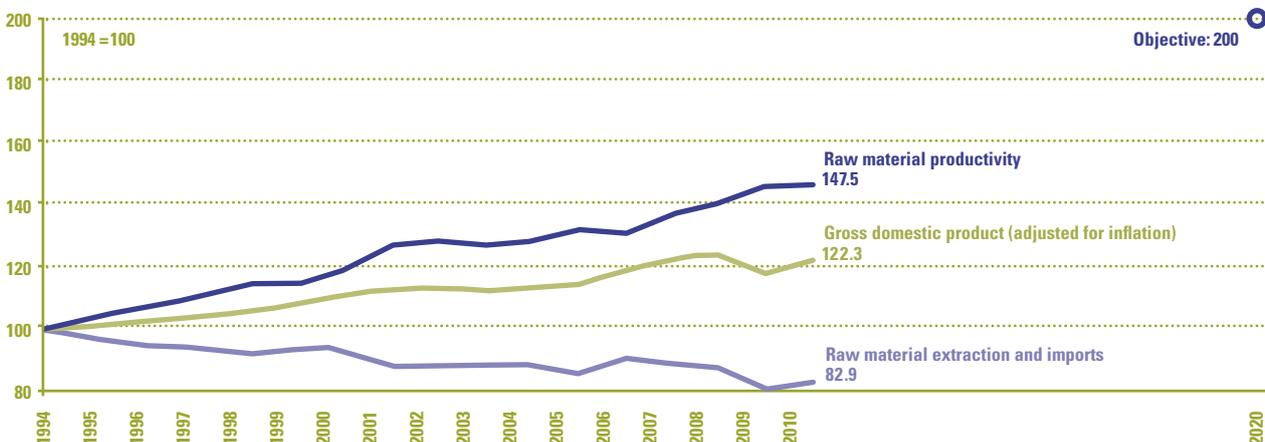
⁵ The program and all associated opinions available to us: http://www.netzwerk-ressourceneffizienz.de/detail/entwd/index.html?no_cache=1&beitrag_id=345&bid=6.

⁶ Cabinet decision dated 17.4.2002. http://www.bundesregierung.de/nsc_true/Content/DE/_Anlagen/2006-2007/perspektiven-fuer-deutschland-langfassung_property=publicationFile.pdf/perspektiven-fuer-deutschland-langfassung. Here: Section D.1.1, pg. 93.

⁷ technically correct expression: The denominator is the "Direct Material Input" (DMI).

⁸ In order to have followed a linear progression, in 2010 an increase of 61.5 % instead of 47.5 % would have been required. If the current trend continues until 2020, an increase of 77.2 % instead of 100 % would be reached.

Raw material productivity and economic growth



Source: DeStatis, 2010 Indicators Report.

The potential of the three big domains: Raw material policy, producing & consuming, recycling economy

ProgRes describes the challenge, defines 20 approaches for action, and, by way of example, analyses four material streams⁹ and five spheres of activity which extend across material streams.¹⁰

The raw material policy is about the implementation and ongoing development of the raw materials strategy enacted by the federal government on October 20, 2010.¹¹ A key step – ongoing since October 2010 – is the continuous development of the German commodity agency (DERA) at the Federal Institute for Geosciences and Natural Resources (BGR) in Hannover¹² as a service provider for the federal government and for German industry. Furthermore, development of a research institute for resource technology was started in 2011 in Freiberg.¹³

The development of raw material partnerships with selected supplier countries is being planned as a new form of foreign trade cooperation; this process has already been started with Mongolia and Kazakhstan. These partnerships are not only intended to be about contractually securing unrestricted market access to raw materials (“freedom from discrimination”), but about an integrated policy package which also takes the development interests of the partner country, the local ecological, social, and political interests (e.g. transparency) into account as well as the German need for security of supply and planning reliability.

Producing and consuming is an area on which the program places a lot of emphasis. A significant increase in direct operational efficiency consulting and integrating of these perspectives with the energy efficiency efforts is intended to be a key element for a dynamic development of resource efficiency in practice. It is unbelievable just how successful this consulting is at the participating companies – and how little this information is spreading by word of mouth. “Dispelling inhibitions” is an important and difficult topic here.

Increased use of existing systems such as EMAS¹⁴ and initiatives related to standardization can make important contributions to efficiency. This is associated with technology policy efforts, especially in the area of research:

Targeted innovation is to be promoted in a variety of ways. Within the framework of research and subsidy programs, several federal government departments are supporting corresponding efforts of individual companies and institutions which develop technology.¹⁵

Incorporating efficiency concepts into the design of new products is obviously desirable, but making this the norm is difficult. In advance of this, the concept of efficiency has to become a much larger component of overall education, and in particular of the education of engineers, civil engineers, and architects. When it comes to consumption, the focus has to be on e.g. creating better awareness and especially

on information for consumers, such as increased use of the blue (resource) angel.

At least energy efficiency is an issue for public procurement. At the latest since the Meseberg decisions of the federal government in August of 2007¹⁶ and between the federal and state governments, intensive efforts are under way in order to achieve further improvements in this area in a targeted manner and with wide-ranging effect.¹⁷ Gaining the support of public market power for resource efficiency would be a big step forward and would also create additional innovation incentives. In its resource efficiency policy decision from March 8, 2012¹⁸, the German Bundestag laid out a clear path on how to proceed.

One characteristic of the resource efficiency topic is that there are already an amazing number of committed initiatives and excellent approaches, whose stakeholders often know little or nothing about one another. It turns out that most of the incentives – no matter how well thought out they might be – largely linger in the Berliner Overhead of politics and associations, delight in the beacon projects and outstanding discrete achievements of trailblazing companies, but don't develop any noticeable broad effects. In order to achieve improved integration, coordination, and in the end propagation is therefore an important goal of the “ProgRes” project.

Resource conservation has already been defined as an objective in the Closed Substance Cycle Waste Management Act since 1994.¹⁹ The amended version of the Closed Substance Cycle Waste Management Act (KrWG) which came into force on June 1, 2012 has reinforced this concept. We expect the same from the “framework directive” on which the BMU is currently working and which seems highly technical to outsiders: It is intended to combine updates to and streamlining of the Groundwater Directive and Soil Protection Direc-

⁹ Phosphorous, indium, gold, plastic waste.

¹⁰ Bulk metals, uncommon rare earths and other critical metals, sustainable construction, photovoltaic, electromobility, information and communications technologies, renewable raw materials in the chemical industry.

¹¹ <http://www.bmwi.de/BMWi/Navigation/Service/publikationen,did=365186.html?view=renderPrint>.

¹² http://www.bgr.bund.de/nn_322882/DE/Themen/Min__rohstoffe/Rohstoffagentur/kontaktbuero__node.html?__nnn=true.

¹³ http://www.hzdr.de/db/Cms/a./FWB/dgn/download/Helmholtz-Institute-Freiberg-for-Resource-Technology,-HZDR,-TU-Bergakademie-Freiberg,-Director-Prof.-Jens-Gutzmer_PDF-Print-32948-de.pdf. Founded in August 2011.

¹⁴ EMAS: Eco-Management and Audit Scheme. www.emas.de.

¹⁵ Introductory consulting on the subsidy environment is provided, among others, by the VDI-ZRE, <http://www.vdi-zre.de/>.

¹⁶ 23. August 2007. http://de.wikipedia.org/wiki/Integriertes_Energie-_und_Klimaprogramm Here: No. 8. Energy efficient products.

¹⁷ “Alliance for sustainable procurement”. http://www.bundesregierung.de/nsc_true/Webs/Breg/nachhaltigkeit/Content/___Anlagen/2010-12-07-bericht-allianz-bmwi,property=publicationFile.pdf/2010-12-07-bericht-allianz-bmwi.

¹⁸ http://www.netzwerk-ressourceneffizienz.de/to_go/detail/entwd/index.html?no_cache=1&beitrag_id=346&bid=497.

¹⁹ Law to promote the recycling economy and to ensure environmentally compatible removal of wastes dated September 27, 1994, §1: “The purpose of the law is to promote the recycling economy in order to conserve natural resources and to ensure the environmentally compatible removal of wastes”.

tive with a new „Alternate Building Material Directive“ which will regulate the utilization (recycling) of already used building materials (e.g. from demolition) in a practical manner.

When it comes to the implementation of EU guidelines as well as German initiatives, in the future there will still be many approaches to try and reduce the demand for new raw materials through recycling and to come closer to achieving the long-term goal of a recycling economy – to have a closed material cycle. This raises difficult questions: How does one get old cell phones from grandma’s dresser into recycling? They contain 40–60 times more gold than gold ore. How do we get old cars into recycling programs, instead of primitive systems in developing countries which are damaging to the environment and harmful to health? This question comes up especially in light of the fact that in the future, about 15 kg of rare earths will be used in electric cars.

This area of the recycling economy holds enormous potential. The need to act is correspondingly large, which the BMU is very much aware of.

Outlook

The decision on ProgRess in the cabinet should not be the end of our work, but much rather the prelude to it. In 2012 we want to work with the leading departments and interested social groups to design a careful, smooth implementation process in which the numerous parties provide mutual support and strengthen one another. We see the potential for many “win-win” situations and are delighted to see how many parties have been insistently active in this field for years or even just a short while. All 16 states and 24 associations, organizations, and institutions have presented their own resource efficiency activities in an appendix to ProgRess. Continuing these activities and further developing them is a key factor for increasing resource efficiency.²⁰

Ideally, the ProgRess implementation debates will produce clear project definitions for the next legislative period and the medium term in addition to the things we need to tackle immediately, i.e. in 2012/2013. We are also hoping that the inquiry committee “Growth, Prosperity, Quality of Life” of the Bundestag²¹ will point the way in this regard.

Resource efficiency is targeted innovation. Innovation always means change, disturbance, deciding against something “one has always done this way”. Advancing this sort of thing is known to be a task which – although it does promise much success – also requires a lot of patience and frequently very strong nerves. On February 29, 2012, the federal government decided to review the implementation and continued development of the ProgRess resource efficiency program every four years, and the German Bundestag has at the same time obligated the federal government to report on it every four years. We are curious to see what results and successes we will be able to present on February 29, 2016 in the “First Progress Report on the German Resource Efficiency Program”.

²⁰ Federal Chancellor Angela Merkel at the 3rd CDU/CSU parliamentary party raw materials convention on Wednesday, 25.04.2012 in Berlin: “(...) A second matter we are following with great interest is the question of efficient use of raw materials. This is primarily a matter for business; we can only support it politically. As the federal government, we have set ourselves the objective of doubling the macroeconomic raw material productivity in Germany by 2020 in comparison with 1994. The “ProgRess” resource efficiency program which we enacted at the end of February also promotes this objective. I do believe that Germany is certainly a worldwide role model in many areas with its recycling economy and efficient use of resources. We were able to reduce the consumption of raw materials by 11.2 percent between 2000 and 2010 while at the same time achieving considerable economic growth. This goes to show: We can decouple economic growth and the consumption of resources from one another. Before Mr. Tajani takes the podium, I would still like to say that we very much welcome a common European approach and a common European raw materials strategy. This rests on three pillars: secure access to raw material deposits in other countries, sustainable production of raw materials from European sources, and also what has become a trademark for Germany, namely resource efficiency and the recycling economy (...).”

²¹ <http://www.bundestag.de/bundestag/ausschuesse17/gremien/enquete/wachstum/index.jsp>.



Dr. Thomas Gäckle

Resource efficiency of products from the point of view of raw material policy

Energy and raw material prices have risen considerably over the past few months. Market observers and raw material experts assume that developments in China and India in particular as well as specific technology-related new demand profiles could also lead to changes in the supply structures. We have to prepare for this and develop concepts in order to meet our raw material requirements in the future.

In addition to securing the supply of primary raw materials and expanding the recycling industry, the sparing use of resources is also continuing to gain importance. Incremental improvements in resource efficiency, meaning the ratio of resources contained in the finished product relative to the amount of material, energy, and time required for manufacturing, are required. In accordance with this definition, this can be achieved either by reducing the resource consumption while maintaining a constant output, or by increasing the output for a constant input. Material consumption is a major factor in increasing efficiency. This also includes raw materials in particular.

The German Government's raw material policy

As a leading industrial nation and high-tech location, Germany is almost entirely dependent on imports for both energy raw materials and metals. In addition to economic feasibility and environmental compatibility, security of supply in particular plays an important role for the federal government when it comes to energy and raw material policy. As in all areas of economic policy, the underlying principle is one of sustainable development.

Raw material policy is an integral part of economic policy. Within the federal government, the Federal Ministry of Economics and Technology (BMW) holds primary responsibility. But raw materials also involve many other areas of policy, such as foreign policy, European and trade policy, but also energy, research and development, and technology policy, and last but not least environmental and development policy. Thus raw material policy is also an integrated task which can only be tackled effectively in close cooperation with the business community.

Since the first raw material summit in 2005, the federal government has been working very closely with the Federation

of German Industries (BDI). In order to coordinate German raw material interests, the Interministerial Committee on Raw Materials (IMC on Raw Materials) under the direct responsibility of the BMW was established by the Federal Chancellor in 2007. In addition to the responsible federal departments, the BDI (which bundles questions and interests of industry) is also represented on this committee. The work of the IMC on Raw Materials was the focus of the report on raw material policy which was submitted to the Standing Committee on Economic Affairs of the German Bundestag by the federal government in March of 2009.

At the EU level, the federal government has initiated a long overdue discussion about a common EU strategy for the supply of non-energy raw materials.

Raw materials dialogue and raw materials strategy

The situation on the international raw material markets is increasingly defined by an overall rise in demand. Combined with intransparent and sometimes oligopolistic supply structures, this leads to strongly fluctuating and generally increasing prices and supply shortages. In response to these developments, the former Federal Minister of Economics, Rainer Brüderle, initiated a dialogue on raw materials with business two years ago. Within the course of this dialogue, three working groups developed results which formed the basis for the raw materials strategy enacted in October 2010. Thus the federal government has initiated a coherent strategic concept which takes Germany's high dependence on imports of non-energy mineral raw materials into account.

It places particular emphasis on access to raw materials. Within the framework of its EU presidency, Germany has also anchored the topic of raw materials at the EU level. Since then the elimination of distortions to trade on the raw material markets has been a permanent part of the EU trade policy agenda and has also been explicitly highlighted in the EU raw materials initiative. Germany continues to advocate efforts to expedite the elimination of trade barriers for raw materials on the multilateral, EU-lateral, and national level.

The federal government's raw materials strategy emphasizes the policy principle that businesses themselves are responsible for securing their supply of raw materials. It supports business in the continued diversification of sources via numerous supporting measures, such as its instruments to promote its raw materials policy and funding for research. Important elements of the raw materials strategy also include improving the efficiency of raw material and material use and increased recycling.

Raw material partnerships are also part of the raw materials strategy. They aim to improve the supply of raw materials for Germany's economy and at the same time to support the partner countries in their sustainable economic and social development. In this way, the federal government aims to back the

private sector's raw material activities. Operating under the umbrella of the raw material partnership, German companies conclude private agreements on their own responsibility. The first raw material partnerships with Mongolia and Kazakhstan have already been agreed.

The new German Mineral Resources agency (DERA) at the Federal Institute for Geosciences and Natural Resources (BGR), which the Federal Minister of Economics Rainer Brüderle also founded in October 2010, should be highlighted as well. Its raw materials information system in particular is intended to create greater market transparency, thereby contributing to a better decision-making basis for business.

The key goals of the raw materials strategy also include transparency and good governance in the extraction of raw materials. In resource-rich developing and emerging nations in particular, corruption needs to be fought in order to support sustainable utilization of resources. Therefore the federal government is advocating internationally coordinated transparency requirements for raw materials companies and supports the Extractive Industries Transparency Initiative (EITI).

The instruments of guarantees for foreign trade and investment have been improved, so that the commercial risk of foreign investments can also be insured in addition to the political risk. The founding of further offices of delegates of German industry and commerce in Africa will help German companies to secure raw materials. Funding programmes also contribute to increasing material and resource efficiency.

Domestic raw material potential

If we take a broad view of raw materials, Germany is by no means (as is often suggested) a „resource-poor country“. Our country's mining companies play a leading role worldwide when it comes to potash, brown coal, and special clays. In addition, mining in Germany is currently experiencing something of a renaissance: the Lausitz copper deposits in Spremberg have been explored by drilling and seismic testing in the past few years. The mine project at this site is currently in the planning and approval phase, which is running in parallel with the technical and commercial feasibility study. And applications for exploration permits were also recently submitted to the responsible agencies in Saxony, Thuringia, Saxony-Anhalt, Hesse, and Lower Saxony, and many of these have already been approved.

The use of domestic raw materials is very important for the national economy. The supply from domestic deposits secures and improves the economic structure, and it creates and maintains jobs.

Research and development (R&D) also plays an important role in the recovery of domestic raw materials. With funding programmes such as the Joint Industrial Research programme (IGF), INNO-KOM-Ost, and in particular the Central SME Innovation Programme (ZIM), the BMWi helps to meet

relevant R&D requirements at small and medium-sized enterprises (SMEs). The intent is to discuss concepts for the use of domestic raw materials in good time not only with research management, but also with the existing research facilities and the bodies responsible for mining and raw materials.

This is because the research results must find their way into commercial applications in the form of innovations as quickly as possible – in the interest of the competitiveness position of German companies.

Material efficiency

At approx. 43 %, materials are the biggest cost factor in manufacturing and are more than twice as high as personnel costs at 21 %. In its 2011 analysis, the Fraunhofer Institute for Systems and Innovation Research ISI found that surveyed companies could on average reduce their material consumption in production by 7 % by taking advantage of the already existing technological possibilities. The total estimated cost savings amount to around €48 billion. Medium-sized businesses in particular are often unaware of these opportunities to cut costs.

In response, the BMWi implemented the BMWi innovation credits (go-Inno) funding programme. The „Raw Materials and Material Efficiency“ module is intended to help companies identify opportunities to reduce the use of raw and other materials and to precisely locate these potential savings. The funding is also intended to encourage companies to engage in more and ongoing efforts to improve their raw material and material efficiency and recycling activities. The BMWi innovation credits cover 50 percent of the cost (max. €80,000) for external consulting services by authorized consulting companies. The SMEs which receive consulting benefit significantly from the advice on material efficiency. The costs fall quickly and effectively and by a considerable amount – a solid €200,000 per year and company, on average. This allows companies to increase their profit margin in addition to implementing sustainable conservation of resources (materials and raw materials) and conserving the environment. The energy required for processing and transport of the raw materials and materials is also reduced. Other cost-reduction opportunities also arise in addition to the reduction in material costs, e.g. when it comes to the transport, energy, or disposal costs.

The processes in companies are complex and SMEs often lack the required personnel and financial resources. Over 200 qualified external material efficiency consultants support companies nationwide. They help to uncover and unlock potential savings in raw materials and materials. Half of the measures suggested by the consultants were implemented by the companies during or immediately after the end of the initial consultation, entailing investments of less than €10,000 in each company. A current analysis of feedback

from companies which received consulting services shows that over 90 % of them are satisfied or very satisfied. The German Material Efficiency Agency (www.demea.de) is the contact partner for the "Raw Materials and Material Efficiency" module of the BMWi innovation credits.

Recycling and Supply of Raw Materials

The use of secondary raw materials is also required for the permanent supply from European sources. The EU raw materials initiative also demands this approach. The fact that they are effectively "domestic raw materials" is not the only advantage of secondary raw materials; recovering them is generally also much more energy efficient and less expensive. Germany plays a pioneering role in this regard.

Increased recycling is an important component of the raw materials strategy. In view of this, the federal government enacted a new Closed Substance Cycle and Waste Management Act on March 30, 2011. This implements amended EU waste framework directives and advances the Germany's high environmental and disposal standards. By regulating by-products and end-of-waste criteria, the new five-level waste hierarchy and the requirements for nationwide separate collection of recoverable wastes, the policy environment for recycling has been improved significantly. The law came into effect on June 1, 2012.

In order to take advantage of the recyclable fraction of residual waste as well, the federal government is planning the nationwide introduction of a recycling bin for private households. The legal basis for this is established by the new Closed Substance Cycle and Waste Management Act. In order to develop nationwide principles for the concrete implementation, various research projects were carried out on the contents as well as the organization and financing of the recycling bin. The results were presented on February 28, 2011 at the Federal Environmental Agency (UBA). The simulation exercise requested by the Bundesrat (second chamber of the German parliament) in this regard, which is intended to bring about a corresponding revision of the Packaging Ordinance, was concluded last year. The next step is a consultation of programmatic „Theses on the Recycling Bin“, which should follow the legislative procedures this fall. For the BMWi, it is important that the new regulations allow competitive access to recyclables.

Germany has the world's highest recycling rate for some materials such as copper at 54 %. But the recycling rates of other important raw materials are also quite impressive. Examples include 35 % for aluminium, 59 % for lead, 90 % for steel, and 20–25 % for cobalt. The recycling rate of the main waste streams is considerably higher, at 60 % overall. Scrap vehicles are recycled at a rate of 90 %, waste paper at 86 %. Recycling rates of 88 % are achieved for construction and demolition waste.

These are considerable successes, which were not only achieved through laws and regulations but primarily through the hard work of the recycling industry. The availability of efficient and commercially viable technologies is essential in this regard.

Technology and Efficiency

The degree of energy and resource efficiency is ultimately determined by the degree to which the technology used has been developed, i.e. by innovations. The federal government supports efforts to develop technologies which are cost-effective and which allow for the optimal application and use of material. Technology policy therefore emphasizes the development and implementation of key technologies. Important examples include energy technology, material and nanotechnology, optical technology, and environmental technology.

In addition, companies involved in processing receive incentives to increase material efficiency through various programmes and networks. Every year, four companies and research institutes are distinguished with the German Raw Materials Efficiency Prize by the BMWi for their exemplary solutions to improve raw material and material efficiency. The close partnership between applied research and business is the key to solving many problems. One crucial aspect is to take account of the need for recycling and disposal of products early on during the product development stage. The goal needs to be that products can be recycled efficiently and in an environmentally friendly manner at the end of their useful life. The raw materials contained in the products should if possible be fully reused again. In this manner raw materials can be returned to the economic cycle.

Expert circles are currently discussing whether greater consideration should be given to material and resource efficiency aspects during implementation of the Ecodesign Directive, which presently focuses on energy consumption. This raises numerous questions: Is it possible to find meaningful indicators and evaluation standards for the material and resource use in product design and manufacturing? To what degree can lawmakers control the design of products? How can the tension between government guidelines and entrepreneurial freedom of product design be eliminated? These and other questions should be explored in a dialogue between manufacturers and application-oriented scientists before any decision to apply the Ecodesign Directive to matters of material and resource efficiency.

A one-hundred percent recycling economy is not attainable under economically feasible conditions, but it does reduce our dependence on primary raw materials. The recycling economy concept thus makes an important contribution to security of supply. Nowadays the recycling of important industrial raw materials is an essential part of an integrated

resource economy. In fact, the recycling sector plays an important role not only in terms of security of supply, but also as a dynamically growing industry. In Germany, approx. 250,000 people are employed in the disposal industry, which achieves annual sales of approx. €40 billion.

Material and resource efficiency are key concerns of industrial policy and German industry and support both economic and ecological goals: saving costs and material, gaining competitive advantages, positive labour market effects, and therefore positive effects on the environment and climate. Raw material taxes or duties are occasionally proposed to stimulate resource efficiency, but these are not a suitable tool in the light of the international competitiveness of German companies. They would lead to the relocation of facilities and jobs and would thus actually be counterproductive.

The German economy must continue to be able to reliably supply itself with raw materials at appropriate prices. This is a prerequisite in order to maintain industrial value creation, especially in a high-tech location like Germany.

Government makes a significant contribution to this by putting the necessary policy framework in place.



Antonio Tajani

A sustainable product policy for Europe

Introduction

Europe is facing an unprecedented economic and social situation since the end of World War II. Along with the urgent need to create new jobs and boost our competitiveness, Europe has to confront other vital challenges: the ageing of European citizens in a context of growing world population; increasing pressure on availability of raw materials and energy supplies as well as the need to counter climate change and preserve ecosystems.

World population is increasing at a pace of 70 million people per year. By 2020, Europe will depend on imports for the 80 % and 90 % of its needs of natural gas and oil respectively. In 2030, global energy consumption will double. Also as a consequence of emerging countries' economic growth, two billion people will reach a per capita income level between \$10,000 and \$30,000. The consumption of goods will increase exponentially, and so will the demand for energy and raw materials.

These are formidable challenges that Europe must tackle with a common effort. Nevertheless, they should also be seen as the opportunity for a positive sea-change, as the chance to attract new demand for goods and services, and to create more jobs. If Europe wants to take this opportunity, politics should play its part, aiming at a new industrial revolution.

The new revolution, boosted by adequate technological developments, should lead towards the gradual substitution of hydrocarbons as our main source of energy, and towards a more efficient and sustainable use of our resources, which will become increasingly scarce.

The Commission's Europe 2020 strategy sets out a vision of how we can turn the European Union in the coming years into a smart, sustainable and inclusive economy with strong growth rates delivering employment, productivity and social cohesion. Sustainable growth is one of the three priorities of Europe 2020; promoting a more resource-efficient, greener and more competitive economy.

Many companies are already acting and investing to improve their resource efficiency. It is an important strategy for cost reduction and productivity improvement and therefore many low-hanging fruits have already been harvested.

Additional investments will be needed to go further, but they will benefit Europe's long-term competitiveness. This is essential, considering the increasing competition and resource demand from emerging economies.

Finding new ways to reduce inputs, to improve management of resource stocks, to optimise production processes and to make the best usage of waste are just some examples showing how increasing resource efficiency can also bring economic opportunities for companies. This will help stimulate technological innovation, boost employment in the fast developing 'green technology' sector and open up new markets.

There is therefore a need for a more ambitious industrial policy improving framework conditions for developing and implementing new technologies, goods, services and business models, including a stable regulatory environment, an earlier provision of regulation and standards needed to create an internal market with a high demand for new innovative products and services, as well as increased use of innovative public procurement. We must also improve the available skills base and the financing of innovation and risk capital especially for young innovative SMEs.

Resource efficiency in products will be an important element in this context. Products need resources for their fabrication; they may consume resources in their use phase and may be disposed of, reused or recycled afterwards.

The challenge is to create a virtuous circle: improving the overall environmental performance of products throughout their life-cycle, promoting and stimulating the demand of better products and production technologies and helping consumers to make better choices through a more coherent and simplified labelling.

In support of a clear move of the market in this direction, the Commission is working on a sustainable product policy, looking both at the competitiveness and innovation dimension and at the resource implications.

Current sustainable product policy in Europe

A range of policies of a voluntary or regulatory nature are in place to improve the energy and environmental performance of products. The Ecodesign Directive establishes a legal framework for the placing on the market of energy-related products. The labelling schemes set by the Energy Labelling Directive, the Ecolabel Regulation and other schemes developed by Member States or the private sector provide consumers with information on the energy and environmental performance of products. Incentives and new public procurement rules are being implemented by Member States to stimulate the better performance of products.

The policy instruments are gradually being streamlined and aligned, focussing only on key resources where most significant improvements can be made. For instance, ecodesign and labelling requirements for washing machines and dish-

washers cover energy efficiency and water consumption. For electric motors, trade-offs between more energy-efficient motors and less use of rare earth resources were considered.

These instruments ensure the free circulation of goods throughout the single market and trigger innovation. They have also started yielding concrete results: in the field of energy efficiency, the first twelve measures under the Ecodesign and Energy Labelling Directives are expected to reduce annual energy consumption by some 340 TWh by 2020. This is equivalent of 12 % of the total electricity consumption in the European Union or the electricity consumption of Italy in 2007.

Initiatives like Ecodesign and Energy Labelling provide an opportunity to create new standards in European industry and ensure the quality of European products in terms of resource efficiency and sustainability. Setting this trend and getting a head start today will provide an important first-mover advantage for European companies in international markets. And since resource depletion is a global issue and regulatory convergence is important in international trading, we are also addressing sustainable product policy with our major trade partners, like the USA.

An improved sustainable product policy for Europe

Still, much remains to be done. Overall, the existing instruments are effective but not sufficiently connected and potential synergies between the different instruments are not exploited. Implementation could be more dynamic and forward-looking to drive the performance of products upwards.

First of all, companies are often confronted with barriers to investment in more efficient products and services: the issue is not only a question of cost. In particular small and medium-size enterprises (SMEs) still lack information and advice regarding the opportunities offered by efficient products and services in terms of a reduced energy bill and greater effectiveness. For example, the acquisition cost of a motor is only 3 % of its total cost. 97 % of the total cost is represented by the electricity cost during use. A highly efficient motor therefore has a rapid return on investment. It is a question of eliminating the existing barriers and of helping SMEs so that they can be the fastest to move and to innovate. In February 2011 the Commission re-examined the comprehensive European SME policy framework, the so-called "Small Business Act". New measures give priority to SMEs to take up the challenge of a resource-efficient economy. The Commission will continue activities in the "Enterprise Europe Network" to inform and advise SMEs on energy and environmental aspects.

Another issue is the accelerated implementation of industry standards promoting more energy efficiency, use of renewable energy and resource efficiency. The large energy-

saving potential of about 15 further ecodesign and labelling measures (at least another 340 TWh by 2020) should be tapped rapidly.

By driving the development of European or international standards for newly emerging tradable products and technologies, Europe can create a competitive advantage for its companies and facilitate trade. The industrial policy reflects the Commission's political will to enhance the role of standards as an enabler of innovation.

For example, the electrical and electronic industry is today an essential sector for the production of effective environmental technologies and can clearly contribute to the development of energy infrastructure, electric cars, intelligent cities, and many other products and services. The policies and standards promoted by the ELECTRA initiative will make it possible to increase the competitiveness of electrical and electronic industry.

There is also scope for coordinated incentives for efficient products. The success of European industry along the value chain of resource efficiency and renewable energy depends in a critical way on innovation. This is connected to the development of innovative products and services in the area of renewable energy and energy efficiency. Public procurement, incentives and funding of R&D along the value chain have the potential to boost resource efficiency and support the development of green business models.

Through its Innovation Union initiative, the Commission intends to improve framework conditions and access to finance for research and innovation so as to ensure that innovative ideas can be turned into products and services that create growth and jobs.

But resource efficiency in products can also be fostered at local and national levels: at the national level industrial platforms are sharing best practices for efficient products and offering general business support. At the regional level, networks are in place to coordinate incentives and public procurement for efficient products and services.

The Commission will continue putting the priority on sustainable growth and a more resource-efficient, greener and more competitive economy. The implementation of the various Commission initiatives, such as the Roadmap on resource efficiency or the industrial policy Communication, will give us the occasion to further deepen and develop our actions. I call on the Forum for Sustainable Development of German Business and other European industry networks to contribute to the ongoing policy dialogue on sustainable growth in Europe. It is our common challenge to define and implement the appropriate strategies for the future of Europe and of our strong, diversified and competitive industrial manufacturing and service industry.



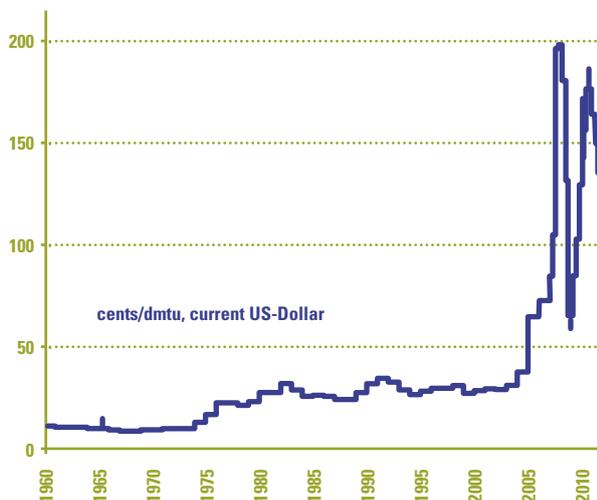
Dr. Hubertus Bardt

Risks in the Supply of Raw Materials

Numerous raw materials are required for modern industrial production. This applies in particular to modern technologies such as electronics applications and electric cars, but also solar cells and wind turbines. The supply is exposed to numerous risks. Enough raw materials are available from a geological perspective. Availability in nature is only a problem in a few cases. The earth has a sufficient supply of metals. But that is not enough to ensure a secure supply for industry. The risks have grown significantly in the past few years, and too little attention has been paid to this problem in Germany:

- In many cases only a few countries have raw material resources which can be mined economically. This applies, for example, to the rare earths. Up to 95 percent of these materials come from China. The deposits of other important raw materials are also concentrated in a few countries.
- Many raw materials are only offered by a few companies; this drives up prices. Two thirds of the publicly traded iron ore, for example, comes from the mines of just three suppliers.
- Many countries with important deposits of raw materials are politically unstable. Congo, for example, has deposits of the heavy metal tantalum which is required to manufacture capacitors for cell phones. Anyone who wants to settle in the politically unstable countries as an investor in order to advance the mining of raw materials should be concerned about the safety of their investments.

Contract prices for iron ore 1960 to 2012



Source: World Bank Commodity Price Data

- China in particular, but also many other countries hamper the export of raw materials through numerous protectionist measures. This protectionism extends from specific export duties and financial subsidies for domestic processors, to the introduction of export monopolies and refusal to refund VAT for raw material exports, and to the issuing of export licenses and bans on exports. The goal of these strategic industry policies is to move processing of the raw materials into the country, to the detriment of production in industrialized countries such as Germany.

These supply risks on the supply side are met by rising demand for raw materials. On the one hand, high-tech raw materials are becoming increasingly important for modern applications. Various rare earths are essential for the production of electronic components or powerful magnets. Miniaturization and the resulting sparing use of resources has resulted in higher demand for particular materials. New technologies require new amounts of raw materials. The switch to electric vehicles, for example, demands powerful batteries and therefore by today's standards considerable amounts of lithium.

The combination of increasing demand and higher supply risks results in considerable price increases. The price for iron ore has increased several times over, for example. Between 1976 and 2003, the price for iron ore moved within a range of 22 to 35 dollars. It had risen to almost 200 dollars by the summer of 2008. Therefore it fluctuated by a factor of 3 during the course of the crisis. Constant price increases for other raw materials such as oil, copper, and other metals is also an ongoing problem for the processing economy. But the strong price fluctuations also hamper corporate planning in a drastic fashion.

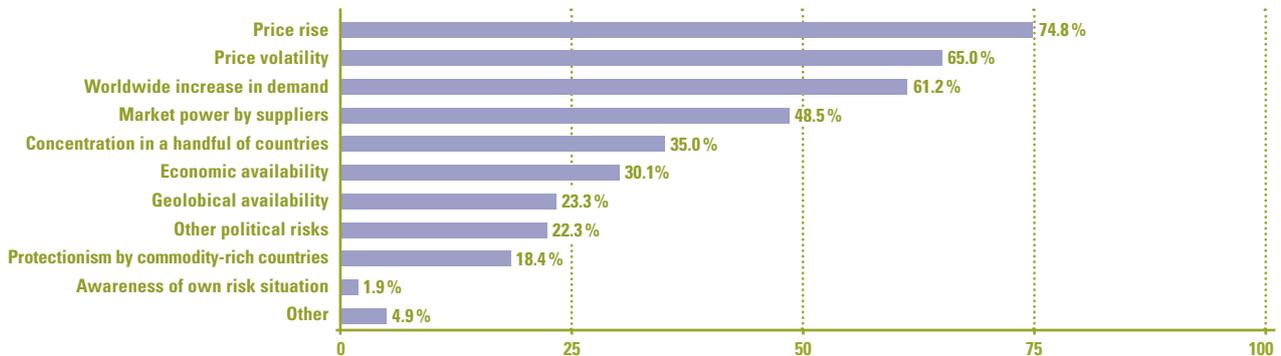
From the perspective of environmental experts in the economy, these developments – higher and more volatile prices – are the most important raw material supply problems. Supply risks are not perceived as strongly. This can primarily be explained by the fact that current price developments have a direct effect on the company profits, while supply risks don't have any acute effect on business operations yet.

Solution approaches for improved raw material security

Comprehensive measures at all levels are necessary in order to circumvent the raw material supply risks and to be able to secure the supply of industry. First of all, procuring the necessary raw materials is the responsibility of business. The state is not obligated to purchase raw materials for industry. But it has other duties, for example within the framework of diplomatic representation. Companies must also act in addition to government agencies. A joint effort is required, for example to improve the recycling opportunities. Securing the supply of raw materials is therefore not a challenge for individual companies, but rather demands the joint engagement of business and politics.

The major raw-material problems

A survey with business experts on environment



Source: IW Environmental Expert Panel 3/2010 (survey of 141 environmental experts from industry in June 2010), IW Köln

Duties of the companies

To begin with, it is essential for individual companies to analyse the respective risks of their own raw materials supply in order to respond with corresponding planning measures. To this end, the value-added chains which contain critical raw materials must be identified. Precursor products can also involve substances for which the supply situation is critical. Scenarios for a shortfall of individual substances can indicate a need to act. Raw material risks are on par with other business risks. They can be handled – but one has to know about them.

At least the financial risks can be reduced through appropriate hedging. However, this doesn't result in decoupling from the longer-term price developments. In addition, corresponding risk management competencies must be developed in the financial markets. Uncertainties with regard to supply and the prices can be reduced through long-term supply agreements. Long-term mutual obligations are a key element of a secure supply.

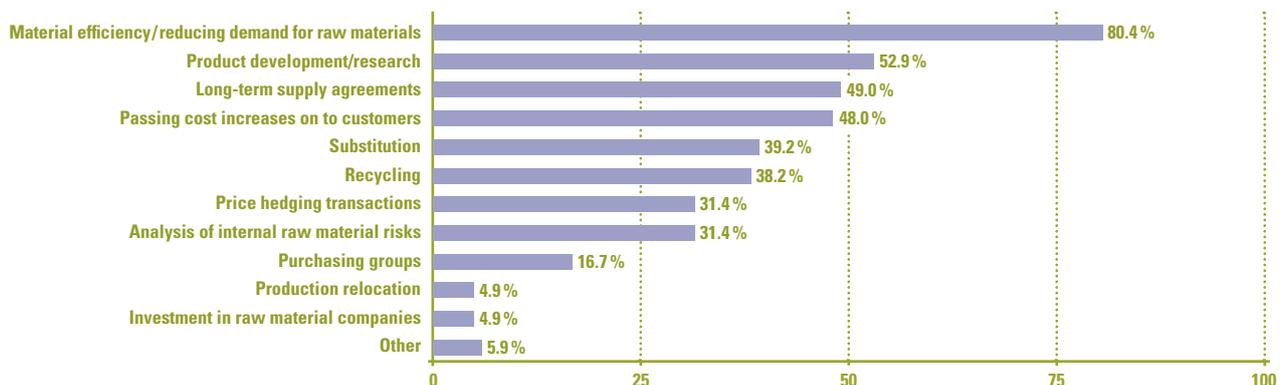
Raw material efficiency must form an important component of an appropriate raw materials strategy. Companies can

also try to reduce their use of raw materials by using critical substances more efficiently. Reducing unnecessary consumption is one of the economically most expedient measures. This approach is based on entrepreneurial self-interest, since the reduction of costs can be combined with an improved raw materials base. Risk reduction can also be achieved through the use of less critical raw materials. However, both measures can reach technical limits. Therefore the strengthening of research and development at the business level is one of the most important solution approaches. If you ask experts within the economy, increasing resource efficiency is the most important measure for companies. Self-interest is very pronounced in this regard, and detailed political guidelines are not required.

So-called vertical integration is another measure to secure the supply of raw materials. The company buys or invests in suppliers who have direct access to an extraction source. Thus the company's raw material supply is secured. Of course this approach is only feasible for individual companies if they are sufficiently large and consume relatively large amounts of the respective raw material. However, this approach is also tainted with a number of problems: It is expensive; it comes

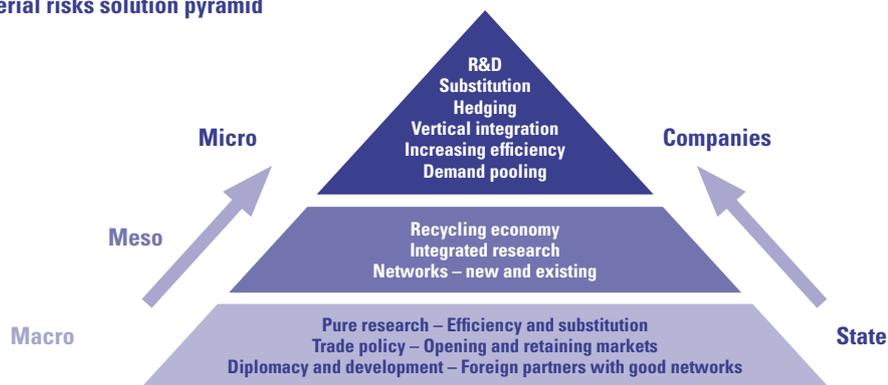
The most important reactions to raw material risks

Survey of environmental experts in the economy



Quelle: IW-Umweltexpertenpanel 3/2010 (Befragung von 141 Umweltexperten der Wirtschaft im Juni 2010), IW Köln

The raw material risks solution pyramid



Source: based on IW Consult/vbw, 2009

with market risks which industry is not familiar with; it can only be used for individual raw materials. Overall, this is at best an option for a few large companies who mostly process ore directly.

Entrepreneurial engagement is also necessary in order to initiate additional mining activities. By supporting such initiatives – for example through long-term purchase commitments – a contribution can be made to securing the supply of raw materials without necessitating direct involvement.

Cost reductions can also be asserted through demand pooling. In this manner the effective monopoly of individual raw material suppliers which dominate the market can be countered effectively by many companies which act as one purchaser. This results in lower purchase prices and a stronger bargaining position.

Collective tasks

Companies can often achieve more in alliances than if they only act on their own. Research to increase the efficiency of raw material use and to develop substitute raw materials should be performed together with other companies and research institutions. These associations would make sense from a cost perspective. Even smaller companies for whom separate research is not worthwhile could join and perform research towards a common goal. Such knowledge-based networks often have a positive effect on business success. At best, several birds can be killed with one stone: The costs to research efficiency potential and substitute materials would be lower, results could be achieved faster due to the exchange of information, and the company's outlook would be fundamentally improved. A common approach between companies and the government makes sense when it comes to promoting re-cycling. The use of raw material sources in the wastes from our cities – thus the term urban mining – reduces the demand for ores from insecure sources. The potential for recycling is significant. But technical and organizational innovations and the associated lower recycling costs are also necessary here in order to take advantage of the opportunities. Private

business initiatives and the development of governmental frameworks is necessary in order to develop and implement effective concepts. But there are also limits in this regard. Protectionism can often be observed when it comes to waste.

Political duties

Politics cannot be tasked with guaranteeing cheap imports to secure the supply of raw material, distorting prices, or promoting a de-coupling from world market relationships. A lopsided binding of individual raw material supplier countries to individual industrialized countries is also incompatible with a global economic system based on competition. Instead, politics must ensure free access to the raw material resources and the raw material economy companies, counter protectionist tendencies, and insist on the elimination of export taxes and similar instruments which are contrary to the market. Politics can also contribute to an international culture of trust on the basis of which raw materials are traded freely.

For market economy policy, there are a number of points of attack in order to secure the supply of raw materials:

- **Free trade:** Existing trade barriers and distortion of competition on the raw material markets must be eliminated within the framework of international free trade agreements, as has largely already happened for industrial goods. In this regard, only the government can act through bilateral and multilateral negotiations, especially at the World Trade Organization level. But securing markets against private restrictions to competition in the form of supply cartels or fusions is a key government task
- **Investment conditions:** Investing in raw material countries must be facilitated and secured. Establishing development aid can make an important contribution in this regard through the (continued) development of corresponding institutions. This also increases the chances of being able to buy the raw materials directly from the producers. The same also applies in reverse: If we want to convince other

countries of the open market concept, then we can't isolate our markets, not even against foreign investors. Sovereign wealth funds allow the resource countries to invest their profits and to build a strong foundation for their economic development. This has to be in our best interests as well.

- **Diplomacy:** Maintaining good local diplomatic relationships is essential to securing the supply of raw materials. This can help reduce the risk that raw materials are sold exclusively to other countries, that investments are jeopardized, or that protectionist measures are implemented. Personal contacts with the local decision makers are often necessary in order to increase the chances that the concerns of foreign companies are addressed. In general: Better local contacts make for smoother business operations for the companies involved in the supply of raw materials. Improved coordination of the foreign policy with regard to raw materials is also necessary at the European level in order to lend an appropriate amount of weight to international negotiations.
- **Research subsidies:** More research is essential in order to utilize sources of raw materials more efficiently. Thus politics can contribute to improving the security of supply of raw materials in Germany through technological developments. Goal-oriented basic research would create options for reducing raw material risks. This would also let companies know that the risks have been recognized and that greater efforts are under way to mitigate these risks, even if they cannot be fully eliminated.

The future supply situation for raw materials in the industrial nation of Germany is a challenge which is still underestimated. The only effective way to meet this challenge is through a differentiated approach by companies and political institutions. Everyone has to do their homework in order to be able to manage the risks. Ensuring the supply of raw materials on the open markets through business must continue to be the goal.



Olaf Tschimpke, Benjamin Bongardt, Ulrike Meinel

Efficiency is not enough – a NABU concept for a new resource protection policy

Earth's industrial societies are overtaxing the planet's natural resources several times over. This has catastrophic consequences not only for the world climate, because every use of a resource inevitably releases additional carbon and drives climate change. It also has dramatic effects on the lifestyle of following generations. Therefore resource protection policy must assign greater significance to truly sustainable development. After almost 25 years of sustainability policy with kid gloves on, the necessary measures will now also involve painful social and economic changes. A serious resource protection policy has to optimize and actually implement policy concepts which have so far failed, such as the "zero-carbon" concept and a comprehensive "recycling society". A successful resource protection policy must reduce the resource consumption of industrial societies by 90 percent within 40 years – this means that we have to achieve a true quantum leap on a global level.

The earth's natural resources are distributed unevenly. Up to now this hasn't been a problem for humanity and in particular not for the industrial societies. Apart from the discussion about the declining supplies of oil, the debate on natural resources which have to be protected rarely reached the public. But a change has been noticeable since a few years. In political debate as well as in civil society the topic is no longer approached solely from the perspective of the earth's carrying capacity. The focus is no longer on whether the ecosystems can cope with the consumption of resources, but rather whether enough of special and strategically important resources are available and therefore whether the existing economic structures can be maintained. It seems that the limits to growth with regard to humanity's supply of raw materials are finally being recognized. This scarcity doesn't always have to have a geological foundation, as it does for the raw materials copper (consumption increasing every year), oil (peak oil already occurred in 2006) or phosphorous (availability for approx. 100–240 more years) (IEA 2010, Morf 2007). Serious concerns of industrial and political actors are also being generated by specific countries who are securing exclusive access to raw material mines around the world (politically based scarcity). On the other hand, a few corporations already hold a monopoly on the mining of many raw materials. This makes for unpredictable price developments and results in risky dependencies of the processing companies and entire national economies (economically based scarcity).

Scarcities can also result due to ecological and social developments, for example if important ecosystems disappear from the globe due to the exploitation of raw material sources, or if social unrest makes it impossible to run secure mining operations. But such considerations don't play a decisive role for the circles which decide on the mining of raw materials. This must change in the future. A fragile ecosystem like the Arctic cannot be freely accessible for the mining of raw materials. It is also not acceptable for inhumane working and living conditions in the extraction of raw materials to form the basis for our consumer goods. In the future, business and politics have to create an intentional scarcity of the raw materials in such situations, for example by prohibiting the extraction of raw materials even though deposits exist.

So it turns out that there are different types of and causes for scarcities. But one thing is certain – any conservation of resources also benefits biological diversity and inter-generational fairness. The fact that sustainability aspects still hardly play a role in raw material policy is incomprehensible. But the fact that we currently have resource policy in the first place also means that there is an opportunity to establish a successful resource protection policy – no more, but also no less.

Why is a resource protection policy required?

Up to now, the demand in industrialized countries largely controlled the amount of energy and mineral raw materials which were extracted. But in the meantime, the rising consumption orientation and purchasing power in developing and emerging countries is also increasing the demand for products and thus for raw materials. This effect is reinforced by the constantly growing world population, for which ever more material must be extracted from the earth's crust. In addition, many technological developments are leading to an increased demand for rare elements. Modern information and communication technologies, for example, are now using 50 or more different chemical elements which are rare and which are only accessible in combination with the extraction of other raw materials. The „ecological burden“ of these materials is generally very high. These valuable materials are also generally lost forever at the end of their utilization phase because far too few devices are processed in a high-quality recycling process, due to the fact that this sort of process hasn't really been established yet (especially for electric devices).

In addition to the immense greenhouse gas emissions, resource utilization also damages ecosystems. The extraction of raw materials above or below ground always results in encroachment on habitats and results in the movement of material which is not required, such as unused extraction of soil in mining. If this consumption of resources by humanity is included in the calculation as an “ecological burden“ or in-

direct flow of material, then humanity's material consumption is even higher in comparison to prevailing indexes. At the same time the use of chemicals to extract specific substances – such as the use of cyanide in the extraction of gold – has extensive consequences for the entire environment.

Following all these examples and facts, there can only be one conclusion: A mindset and conduct which is aimed at expanding and improving the access to resources is the wrong approach. Such a mindset would mean that we are tolerating increased resource consumption year after year, even though it exacerbates the aforementioned problems and many others. In this manner we are leaving the following generations with a plundered planet.

What does resource protection policy mean?

A policy for the sustainable use of resources is indispensable. This has to take effect in the economy, infrastructure, research, environment, and farming just as much as in foreign and trade policy. At the same time Germany and Europe won't be able to solve the most pressing questions of such a resource policy on their own. However, in the future they must take the lead in working against the waste of resources, especially since they embody it themselves as a technically advanced and specialized consumer society. They must stop this waste and set a good example for lowering the consumption of resources.

The inevitable conclusion is the same as for climate policy: As the historical and current producer of this problem, an industrialized nation must pursue reduction goals so that the future stress on the environment is reduced to a sustainable level. The experts at the 2009 World Resources Forum agreed that this threshold is at approx. six tons of raw material consumption per year and person.

Disclosing resource consumption

Meaningful data is an essential starting point for a successful resource protection policy. Unlike cash flows, the resources flows can currently not be tracked completely because there is no obligation to document them. Resource protection policy must start here, with clear requirements for transparent recording and accountability of the material and substance flows.

Public material flow statistics would be helpful in this regard (environmental accounting). The first positive signals are noticeable in this regard. While it already exists in Germany, in December 2010 the European Parliament also supported the EU commission in introducing obligatory environmental accounting. Starting in 2012, it should then also be possible to publish the “Gross Ecological Product“ of the European Union in addition to the Gross Domestic Product.

Trade companies and processing industries are also facing challenges of resource protection that have been unknown up to now. Very concrete indicators on the material consumption of individual economic and social sectors are compiled everywhere – examples include the office paper consumption of a company or the potable water consumption of a city. But things get a bit more complicated for resource consumption in agriculture, in hightech industries and in long value-added chains with many stages of production. Neither the soil erosion on fields nor the use of rare earths in cell phones or computers and the associated ecological burdens are accounted for in detail by companies – so they don't know what their resource consumption is.

Therefore there are two extremes which must converge. On the one hand, it is possible to show global and therefore highly abstract indicators. On the other hand, very specific figures of resource consumption for some chosen aspects of our industry exist. Now it is necessary to work towards the consistent and transparent recording of resource flows in companies through corresponding accounting – including the indirect material flows of the entire value-added chain – which goes hand in hand with the environmental economics resource accounting (e.g. via the MIPS concept; see Schmidt-Bleek 1998).

In addition, it is also important to strengthen the influence of the "International Resource Panel" in order to increase worldwide awareness of resource protection and to expand the consulting capacities. This expert committee – currently affiliated with the United Nations environmental program – needs to carry a similar amount of consulting weight as the Intergovernmental Panel on Climate Change (IPCC) has when it comes to climate policy.

Enforcing a recycling economy

Areas of policy which deal with the use of raw material exist already. The relevance of a resource protection policy is roughly defined, here and there are a few tentative steps to strengthen the resource protection policy, for example in the recycling economy. Unfortunately the recycling economy policy in Germany is nevertheless not aimed at resource protection but at energy recovery, and there is a lack of a coordinated, targeted resource protection policy. The new German Circular Economy Law also fails to meet the need for high quality cycle management and doesn't implement the European five-level waste hierarchy properly. The cascade of products which would be continuously increased through reuse and recycling hasn't been realized. The market for secondary products and raw materials remains a niche market.

Thus corresponding quotas are set far below what is technically and also economically feasible, and producers have no incentive to change this. The burning of waste is subsidized by the government, because it is not subject to the energy tax. Furthermore it is not included in the trading of green-

house gas emission trading. High quality recycling of individual materials such as plastics or electronic devices doesn't take place because it isn't prescribed. The share of recycled content in building materials like concrete is minimal even though this would generate large savings in the amount of natural resources used. And there is still no biowaste framework directive in Europe which would at least close a cycle in this sub-segment of the waste economy. A closed circular economy cannot be achieved under these circumstances, even if this is the only sustainable way to secure a sustainable supply of raw materials for society.

Reasons for this failure can be identified already in the system of research funding in Germany. Large amounts of funding – e.g. for the federal government's high-tech strategy or biotechnology – currently primarily contribute to promoting the development of resource-wasting applications even more. Helpful research programs such as FONA (Research for Sustainable Developments) lead a shadowy existence.

Developing indicators

The indicator for reviewing the resource policy of the German sustainability strategy is the so-called raw material productivity. The Federal Statistical Office doesn't give Germany's performance an entirely negative grade in the annual indicators report. The raw material productivity describes the ratio of the German material consumption within a given year to the growth of the gross domestic product. The less material is required for a certain amount of economic performance, the more sustainable the development is. The raw material productivity has been increased by just over 40 percent within 14 years. At the same time, it is often noted that this indicator has limited informative value. Certainly the indirect material flows are at least shown graphically in the meantime. Unused material flows such as overburden are still not captured by the statistics. This shows that German policy for sustainable use and securing of natural resources is still in its infancy and that significantly more effort will be required in order to reduce the absolute consumption of natural resources.

Japan shows us that this can also be done differently. Since 2008, the country records all material flows generated by society, thereby also identifying the hidden (indirect) material flows outsourced to foreign production sites. The development of a sustainable raw materials policy was also supported by the European Union in 2010 with "Europe 2020 – A strategy for intelligent, sustainable, and integrative growth". Concrete resource policy measures and timetables are defined within the framework of the "roadmap for resource efficiency". The federal government has also taken initial important steps towards a resource protection policy within the framework of the German resource efficiency program (ProgRess).

Implementing effective political tools

The near future will show how concrete and serious the measures and intent of business and politics will be. The aforementioned programs are merely a first tentative attempt and step in the right direction. But the full range of political options must be addressed.

When it comes to resource protection, regulatory policy doesn't prevent economic activity or functioning markets, but supports them with a focus on sustainability. More guidelines will be required in the future in order to determine the eco-design of products and production methods – not only with regard to their effects on energy consumption, but their effects on the overall resource consumption.

Good policy approaches for the promotion of resource efficiency innovations exist already, but their effect is much too small. At the current financial volume they will merely create a sort of elite in the manufacturing industry. This includes programs to increase resource and material efficiency in companies, such as those initiated by the Federal Ministry of Economics and the Federal Ministry of the Environment.

Tax policy will have to play an important role. In the case of resource protection the financial burden for high resource consumption must be increased. At the same time resource efficient and conserving business should be relieved in the tax system. Tax burdens must be differentiated not only with regard to the material quantity but also the material quality, i.e. the rarity, ecological burden, or recycling factors must be included. The simplest form of tax-based resource protection policy is the elimination of subsidies which are damaging to the environment, such as tax reliefs for commuters. Taxes which have a steering effect are also required. A tax on beverage containers which depends on the type and amount of material would result in an increased market share for reusable bottles, and up to 400 000 tons of plastic consumption would be avoided.

In addition, the efficiency potential in the area of public procurement should be utilized. The procurement of resource efficient products and services by public institutions is a crucial aspect for the development of green markets. This is possible through the Public Procurement Act which came into effect in April of 2009, but it is still far from being the standard. After all, orders by the federal government, states, and municipalities make up almost 25 percent of the demand side in Germany. Similar to Finland, a public procurement system which is based on a one hundred percent ecological approach has to be implemented in Germany by 2015.

Hold a discussion on values

Sustainable and therefore resource-conserving lifestyles are possible. One thing they have in common is that a radical change of habits in many areas will be required to imple-

ment them. A discussion of values in society is therefore unavoidable and must be supported both by politics and by business.

Already today it is possible for consumers to decide for sustainable consumption according to the motto "using instead of consuming" is already possible today. Resource-saving consumption starts by choosing to live near the centre of ones activities, extends to the decision against owning a motor vehicle, and even includes the choice of services provided by craftsmen instead of buying every specialized tool. In July 2008, the European Union published the Action Plan on "Sustainable Consumption and Production and Sustainable Industrial Policy". This is a good resource protection approach because it takes the responsibilities of both consumers and producers into account. Yet the ten EU rules for sustainable consumption are not particularly helpful and quite banal. Establishing the foundation for a more extensive resource awareness through increased educational measures is necessary. Resource conservation should also be part of the curriculum, training programs, and degree programs, just as it is for higher education standards.

The legislative competence of the federal government and the states also provides resource protection opportunities. The standardized sustainability review of planned legislation has been introduced recently at the federal level. It must be performed consequently, thereby supporting the legislative body in its efforts to actually only enact legislation which promotes resource protection and won't drive consumption up even more. The subsidy for scrapping used cars, for example, would never have passed a resource protection review.

Development policy as resource protection policy

In order to implement successful resource protection policies, the developing and emerging nations must be supported in their efforts to establish environmental and social standards. Furthermore a suitable monitoring must be performed. This starts with tying export credits, investment guarantees, and unallocated financial loans to the proof of human rights and to an environmental compatibility review performed by an independent body. This also includes the approach of using the resource wealth of developing countries for poverty reduction. It's not enough to ask the question, whether German development policy contributes to a secure supply of raw materials. We must rather have an answer to the question whether German foreign, economic, and financial policy is making a significant contribution to the sustainable development in the resource-producing countries. The Dodd-Frank-Act in the USA is a positive example for sustainable trade policy: it obligates companies to disclose their payment flows for raw material deliveries. Civil society organizations are vehemently advocating that Germany should stop its blockade for this law at the European Union level.

Until now, industry was poorly advised to fight this proposition. After all, the resulting transparency provides a means to fight corruption and can counter the financing of raw material conflicts by foreign companies.

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Material efficiency and resource conservation – selected results from the large-scale project MaRes¹⁹

A sufficient level of resource and climate protection demands that politics, business, and civil society take considerably more action than they have up until now, in order to limit possible catastrophic developments. If this challenge generates a dedicated response, this also opens up new opportunities to shape technical and social progress in a manner which helps to conserve nature, creates jobs, and is economically attractive: “A forced increase in resource efficiency improves Germany’s ability to compete and allows for absolute de-coupling from economic growth and resource consumption”. That is one of the key results of the large-scale project “Material Efficiency and Resource Conservation (MaRes)”.

There is no alternative to forcing increased resource efficiency:

- The increasing scarcity of resources (e.g. strategic metals) and the associated resource conflicts could trigger world-wide crises on a similar scale as climate change.
- Transferring the pattern of consumption and production of the north to a worldwide population of nine billion is impossible on account of the associated economic, environmental, and social problems. A resource revolution is unavoidable.
- International and intergenerational justice demands equal access rights to natural resources for every person.
- Not taking advantage of the economic opportunities of resource efficiency means becoming a loser in the global structural change.
- The material costs²⁰ generate over 45 % of the costs (incl. approx. 2 % energy costs) in the German processing industries. Green tech helps to lower costs and to secure leading markets.

¹⁹ We would like to thank all colleagues at the MaRes consortium for the excellent cooperation and for the building blocks of this summary. Thomas Götz (Wuppertal Institute) supported us in preparing this short results paper.

²⁰ According to official statistics, material costs are defined as: „Raw materials and other preliminary products obtained from third parties, auxiliary and operating materials incl. third-party components, energy, water, fuels, office and advertising material, and non-activated low-value commodities (DESTA-TIS, FS 4, line 4.3., Kostenstruktur im Produzierenden Gewerbe (cost structures in producing trades)). Therefore the material costs also include the advance services of upstream production stages. The stated cost fraction of 45 % is based on the production value of the processing industry, not on the significantly lower gross added value (without advance services).

- Falling material costs improve the competitive position, lower the dependence on imports and prices, improve raw material security, and reduce raw material conflicts.

In light of these problems and opportunities for ecological modernization policies, the German Federal Ministry of the Environment and the Federal Environmental Agency contracted 31 project partners under the direction of the Wuppertal Institute for Climate, Environment, and Energy for the research project “Material Efficiency and Resource Conservation” (MaRes, funding code: 370793300). The goal was to achieve substantial advances in knowledge required for material efficiency and resource conservation. Therefore, in the course of the MaRes project

- the potential approaches to increasing resource efficiency were determined,
- resource efficiency policies for specific target groups were developed,
- new understanding was gained on the effects of the policies on the overall and economic levels, and
- implementation activities were accompanied, agenda setting was performed, and the MaRes results were communicated according to specific target groups.

Of the over 120 project reports published under <http://ressourcen.wupperinst.org>, a few shining examples have been selected below:

Resource efficiency opportunities

In a broadly designed, multi-stage expert process, the technologies, products, and strategies relevant for increased resource efficiency were identified (“Top 250 topics”). Then more in-depth analyses of the opportunities were performed for around 20 selected topics (“Top 20 topics”) for which a particularly high resource efficiency potential can be expected. These opportunity analyses were compiled within the framework of an analysis process supported by experts, coupled with a graduate studies program. The quantitative and qualitative results of the “Top 20 topics” were analysed and evaluated individually and comprehensively in an intensive discourse process. This was used to derive topic-specific and overall recommendations on possible actions. Result: There is no ONE technology, industry, or resource which should be given priority. But the MaRes project did identify key fields for action:

- In Technology
 - Cross-industry and „enabling“ technologies (e.g. membrane technology or storage media) are door openers for resource efficient applications.
 - In comparison to conventional energy, regenerative energy also allows for considerable resource savings.
 - The information and communication technology (ICT) growth market demands careful resource management.

- At the product level
 - Foodstuffs: An integrated analysis of production and consumption is necessary (e.g. for fish, fruit, and vegetables).
 - Transportation: Resource-intensive infrastructure holds a higher efficiency potential than drive systems.
- In company strategies
 - Align product development with resource efficiency.
 - Base business models on resource efficiency: Product-service systems demand a new way of thinking.

Strategically important metals

In the course of the MaRes project, all metals and in particular those used in new technologies were subjected to a screening with regard to their environmental compatibility and recycling potential. The global material streams – from resource extraction to processing, utilization, recycling, and the garbage dump – were analysed in greater detail for the following ten metals in order to determine significant losses and environmental impacts: Silver (Ag), gold (Au), palladium (Pd), manganese (Mn), nickel (Ni), tin (Sn), zinc (Zn), gallium (Ga), indium (In) and titanium (Ti). A list of measures was suggested in order to reduce the material loss of metals. One focus was to increase the PGM²¹ recycling from car catalytic converters, mobile phones, and monitors.

Material inventory and material flows in infrastructure

The materials stored in Germany’s infrastructure were determined according to type and amount, along with the material flows associated with removal and maintenance (input of raw materials and output of waste). Transportation networks, potable water and sewage networks and treatment systems, telecommunication and IT communication networks, and the electricity, gas, and the district heating supplies were examined. The amount of mineral raw materials stored in the road infrastructure exceeds that in the other infrastructure systems several times over. In addition and unlike for the other infrastructure systems, the annual material flows for transportation infrastructure (100 million tons) is largely due to maintenance. Energy infrastructure – including that used for renewable energy – contains relevant amounts of metals.

Roadmapping of dynamic technology fields

With regard to material efficiency and resource conservation, recognizing opportunities for innovation and risks, new business areas, and markets early on is very important for successful innovation.

²¹ PGM (= platinum group metals): This group includes the metals ruthenium, rhodium, palladium, osmium, iridium and platinum, which are very important for many industrial processes and products such as e.g. vehicle catalytic converters and electrical/electronic devices..

“Green” technologies are often used to solve problems in applications, but the rapid pace with which their use is increasing and the ecological burden involved in producing them require careful consideration and foresighted planning.

“Roadmaps” were developed together with key stakeholders for two important resource-relevant topics – photovoltaics and workplace-related computer solutions.

- Long term perspective: e.g. of raw material shortages in photovoltaics or the opportunities of the “Green Office Computing” leading market.
- Potential assessment: The implementation of roadmap measures in the area of “green office” would result in savings of 29.4 terawatt hours of primary energy, electricity cost savings of 2.75 billion Euro, a reduction in CO₂ emissions of 5.5 million tons, and a reduction of 245,000 tons of computer material by 2020. With regard to photovoltaics, the costs could be reduced by half through exploiting the material efficiency opportunities identified in the roadmap.
- Accelerating and subsidising the distribution of available efficiency technology: Improved understanding of existing obstacles to the implementation of future resource efficient solutions (e.g. system changeover in IT) and clarifying the question of how to best develop the potentials for material efficiency and resource conservation – e.g. in the production of photovoltaic products – over the short, medium, and long term.
- Innovation timetable: Development of concrete measures to unlock material efficiency and resource conservation potential (e.g. “workplace-related computer solutions 2020” roadmap) with concrete targets, timetables, milestones, and areas of responsibility.
- The experience gained through roadmapping can be transferred to other areas of technology and utilized for innovation-oriented environmental policy.

Impact analysis

a. Macroeconomic perspective (top down modelling)

There is a large amount of overlap between a climate protection strategy and a forced resource conservation strategy. This applies both to the shared portfolio of applied technologies and to the synergies of the implementation strategies. This increases the demands on an integrated and goal-oriented economic, environmental, and research policy. The incentive to implement this sort of policy anyway is: The positive effects of such a dedicated climate protection policy on the national economy would be amplified through the integration of resource conservation to create a win-win strategy. MaRes modelling results on the combination of resource and climate protection policy show that even a limited use of resource policy tools already leads to positive economic and environmental effects. The simulation calculations with the Panta Rhei model (Meyer, GWS/Uni Osnabrück) for the

year 2030 resulted in the following effects – respectively in comparison to a reference approach with active climate protection which ensures a reduction in greenhouse gases of 54 % by 2030:

- a clear reduction in the absolute material consumption of around 20 %.
- an increase of the gross domestic product by around 14 %,
- an increase in employment levels of around 1.9 % (under consideration of demographic factors and productivity-oriented wage developments) and
- a reduction of 251 billion Euro for the funding allocation in the federal budget by the year 2030.

Overall, the simulation calculation came to the conclusion that a consistent resource efficiency policy strengthens Germany’s international competitive position. This would show for the first time for a high technology country that “the combination of a dedicated climate protection policy and a policy to increase material efficiency can be used to achieve the absolute de-coupling of economic growth and resource consumption (Distelkamp / Meyer / Meyer 2010)²². This simulation result is also interesting because it can provide a new understanding of the balancing of the structural effects of the “green” growth industries and shrinking risk industries in the national economy. In addition, the development of more sustainable consumption and production patterns and the limiting of “rebound” and comfort effects can now be quantified and examined in more detail with modelling tools. This is a new and highly promising field of research for transformation research.

b. Sector analysis using buildings as an example (bottom up analysis)

The interdependency of climate protection and resource conservation was examined with a simulation model using the building sector as an example. The focus was on the question of whether the reduction of CO₂ emissions through extensive building insulation is nullified if the additional resource consumption and emissions from the manufacturing of insulating materials are taken into consideration. The modelling results can be summarized as follows:

- In the high efficiency scenario “MaRes Leit-Plus”, a total of 48 million tons of the sample insulation material-XPS (extruded polystyrol) are used between 2005 and 2050. That equates to approximately twelve times the amount of insulation required for a reference progression if current trends are maintained.
- The forced insulation strategy in “MaRes Leit-Plus” results in final energy savings of approx. 1,700 petajoules per year or 70 % in total in the year 2050 compared to 2005 (energy used for space heating purposes).

²² Distelkamp, Martin / Meyer, Bernd / Meyer, Mark (2010): MaRes AP5 “Top-down analysis of the economic benefits of a forced resource efficiency strategy”, final report

- Applying the MIPS (material intensity per service unit) resource indicator set shows that the use of insulating material results in significant resource savings in comparison with the heating energy savings in the “MaRes Leit-Plus” scenario. Thus a cumulative amount of 6.5 billion tons of non-renewable raw materials and 1.4 billion tons of renewable raw materials can be saved by 2050.
- For the provisioning of „warm living space”, the majority of the life cycle assessment (LCA) categories under consideration (e.g. climate effects, acidification and over-fertilizing potential) can be reduced by 70–90 % through a high efficiency strategy by 2050 in comparison to the reference year. In comparison to the 204 million tons of CO₂ equivalent emitted in 2005, only 23 million tons are emitted in 2050 (-89 %).
- (Negative) tradeoff effects of insulating strategies at the expense of specific environmental impacts only show up in a few places in the life cycle analysis. Examples include the use of fluorocarbons (FCs) (which have a strong greenhouse effect) for foaming the insulating material XPS or the increase of biomass heating systems and their (indirect) effects on land use and odour emissions. But such effects are avoidable.

Policy areas

The numerous obstacles to efficient utilization of resources, such as a lack of information, external costs, or path-dependencies demand a targeted framework as well as stimuli and incentives which promote increased resource efficiency. Therefore there is no silver bullet for resource policy. The obstacles, target groups, and innovations are too varied. Therefore a sort of “toolbox” was developed in MaRes for the government framework conditions, for the business sector, and for the consumers, from which a prioritized and harmonized resource policy mix was selected for **six core strategies** (see below).

a) Framework conditions

Regulatory, fiscal, and contract-based tools can be used to trigger search processes as well as innovations, diffusion, and “green” investments in resource efficiency technology.

Regulatory approaches:

- Reporting requirements for manufacturers and importers: A lack of information on the use of material is a key problem when it comes to resource policy. This problem is in particular a result of globalized supply chains and product life cycles. Manufacturers should be obligated to provide information on the material groups and materials used in their products. This tool provides the knowledge base for further incentive tools (e.g. production input regulations, labelling).
- Product input regulations can be used in order to influence the design and composition of products. Up to now, approaches in the area of resource conservation were

primarily targeting the waste streams. Input regulations, however, apply to the product design phase. Requirements can also be tied to market access regulations.

- The EU ecodesign directive is suitable as the basis for regulatory approaches. It should be expanded to additional product groups and indicators which go beyond energy consumption.

Fiscal tools

- Taxation of primary building materials: The suggested amount is two Euro per ton, with the goal of increasing resource efficiency and reducing consumption.
- Differentiated VAT approaches can be used to reduce the tax burden on resource efficient products at the expense of inefficient products. One could also consider a tax advantage for secondary building materials or devices with contain a large percentage of recycled material.

International covenant

An agreement based on private law between public agencies and stakeholders along the product life cycle can serve to close metal material cycles which cross international boundaries (e.g. vehicles). In this case one would define concrete goals to increase resource efficiency, for example by ensuring that recycling is performed in other countries

b) Business level

Financing-based incentives: The goal is to establish resource efficiency as a key factor for the power to compete in the financial sector – as a cost reduction approach and for the dynamic growth of green technology.

- Performance: Resource-based key performance indicators (R-KPI) allow the financial sector to apply resource efficiency criteria in everyday business, for financial supervision, and in company reporting.
- Dialogue: Establishing an inquiry commission “Resource Efficiency and Sustainability in the Financial Sector” in order to support the debate on the role of the financial sector in the protection of resources; development of a political strategy with all stakeholders.
- Research: Implementation of a federal research program worth ten million Euro could relate the financial sector perspectives with the well-founded results of environment and sustainability research, so that the results can be used functionally by politics and the financial sector.

Public Efficiency Awareness & Performance: Increasing the willingness to change behaviours and beneficial external offers and framework conditions.

- Supporting small and medium-sized enterprises (SME) locally: Expansion of the consultant pool and regional structures in order to improve understanding of the topic of resource efficiency and to communicate it locally.

- Qualification of expert and process consultants to support the targeted integration of their specific know-how with the targeted consulting of companies.
- Concerted resource efficiency action: Initiated by politics, such an action can set positive signals at the central organization level to increase awareness of the topic.

Innovation and market introduction: The focus is on political tools which stimulate a resource efficient approach within companies and throughout the value added chain.

- Expansion and focussing of existing subsidy options: Resource efficiency innovation and market introduction program.
- Innovation drivers: Cooperation of innovation consultation within companies (innovation coaches) and private venture capital (business angels).
- Innovation laboratories: Establishing of organization possibilities with flexible scheduling and organizational structures to promote inter-company innovation processes and for the equipment, know-how, and personnel resources required for complex projects.

Supporting, comprehensive measures: Information, communication and evaluation.

- Promoting communication and information: Establishing a “resource efficiency agency” (see below) which coordinates

measures and activities and promotes development of the consultant pool and the regional structures. It should be networked well on an international level, yet be streamlined and active everywhere and “market” the topic.

- Reviewing systems and ensuring quality: An independent evaluation authority serves to perform regular evaluation of all measures as well as the system to promote research including financing aspects. An interministerial panel of the secretaries of state and the resource efficiency agency use these results.

c) Consumer level

In order for consumers to consume with greater resource efficiency and more conservatively, they must be familiar with their options and also need to be motivated to act accordingly. When it comes to energy, there are lots of guidelines, brochures, and internet offerings which provide many tips on saving energy. At the beginning of the MaRes project, there was no comparable knowledge and decision-making base for the entire resource efficiency topic at the consumer level. Therefore the goal was to identify ways to increase resource efficiency options in the everyday lives of consumers. Important strategies are summarized below.

Phase	Consumption phase	Basic strategies to improve resource efficiency
Consumer decisions	Question needs	Reflect on ones own needs Searching for and obtaining information, and evaluating it Discussion on consumption in social circles
Buying	Buying with awareness	Products with a smaller resource footprint (i.e. products with a smaller ecological burden and with minimized material, energy, water, and land usage throughout all stages of production) Small and/or lightweight products Products which are multifunctional and / or can be used in a modular fashion (can be adapted to technical progress or changing needs) Durable products (timeless design, robust, capable of being repaired) Re- or ongoing use of products and recycling products Minimizing packaging
Using	Frugal consumption	Saving resources in the usage phase (i.e. reducing the immediate resource consumption during use) Avoiding waste (e.g. avoiding disposable cutlery)
	Using without owning	Renting (e.g. tool rental or leasing of copiers), sharing (e.g. car sharing) or pooling (e.g. laundromat) Private lending, sharing, and exchanging (e.g. tools, carpooling) Virtualization (e.g. electronic data instead of products such as music CDs, books)
	Longer usage times	Reusing products Maintaining products oneself (e.g. servicing or cleaning) and repairing Using maintenance and repair services
Disposal	Recycling	Returning products which can be recycled and passing products which can still be used on to others

Source: Kristof / Süßbauer (2011)

A discussion of resource efficiency

Core strategies	Political tools ²⁵
Activating institutions – Key to successful diffusion	Resource efficiency agency (including evaluation for optimization of the support structures) Resource efficiency incentive and consultation program Expansion of the consultant pool and regional structures
Directing innovation – Sustainable future markets for resource efficiency solutions	Resource efficiency innovation and market introduction program Innovation agents Innovation labs oriented towards resource efficiency Venture Capital for resource efficiency solutions
Resource efficient products and services	Dynamic standards and labelling requirements (expanded EU ecodesign directive) Promoting product design based on resource efficiency Hybrid governance to increase the use of secondary material instead of rare metals in new products Primary building material tax
Incentives for resource efficient solutions via business finance	“Resource efficiency and sustainability in the financial sector” inquiry commission Resource-based key performance indicators (R-KPI)
Government as the demand generator and provider of infrastructure	Purchasing according to life cycle costs as a mandatory procurement criterion Demand pooling to minimize risks for innovation processes Infrastructure systems optimized for resource efficiency
Changing ways of thinking	Resource efficiency network Resource efficiency campaign: Target group – (future) decision makers Concerted resource efficiency action Qualification of consultants Establishing a “Virtual resource university” Developing educational/learning material for schools

Source: Kristof / Süßbauer (2011)

Bundling resource policy through core strategies

The applicability, practicability, and efficiency of resource policy demands a selection from the described “toolbox” and an estimate of the costs and the financial effectiveness. On behalf of the German Federal Ministry of the Environment and the Federal Environmental Agency, the MaRes project presented **six core strategies** in detail, suggested priorities, and determined target groups. This was the first time anyone had attempted to formulate a bundled and focused program for the new inter-departmental “resource efficiency” field.

Based on expert estimates from the MaRes consortium and a brief expertise for the BMU (Hennicke et al. 2008)²⁴, the total effective budgetary financial volume for this program is estimated at approx. 1.3 billion Euro per year. This total volume could be covered by the suggested primary building material’s tax or through self-financing instruments (e.g. cost savings in public procurement). The multiplication effect for the national economy is considerable and leads to additional public revenue, so that a significant self-financing effect can be expected.

²⁴ Hennicke, Peter et al. (2008): Entwurfsskizze für ein bundesweites Impulsprogramm Ressourceneffizienz: Die ökonomische Krise durch nachhaltige Innovationen und ökologische Modernisierung überwinden (Draft for a federal resource efficiency incentive program: overcoming the economic crisis through sustainable innovations and ecological modernization), Wuppertal/Osnabrück.

²⁵ For a comprehensive explanation and detailed description of these core strategies, see the Policy Paper 7.7 of the MaRes-Projekts (Kristof, Kora/Hennicke, Peter (2010): Mögliche Kernstrategien für eine zukunftsfähige Ressourcenpolitik der Bundesregierung: Ökologische Modernisierung vorantreiben und Naturschranken ernst nehmen (Possible core strategies for a future-oriented federal government resource policy: driving ecological modernization and taking natural limits seriously).



Verbund and combined heat and power

The chemical industry is one of the most energy and raw material intensive industries: In addition to highly refined products such as varnish, paint, and fine chemicals produced in multi-stage processes, base materials for other industries are also produced in very large quantities (plastics, base chemicals). Energy in the form of heat and power plays a big role in these processes. Plenty of reason for companies like BASF to use the energy and associated energy raw materials as efficiently as possible.

The primary energy demand of the BASF group (chemical business) in 2010 was around 5.2 million tons of oil equivalent. But the energy efficiency, meaning the amount of primary energy required per ton of sold product, is a more important indicator. Until 2010 the company was able to increase the energy efficiency by almost 24 % since 2002.

One of the approaches BASF took was in energy generation. Processes were designed to be more efficient and the integration of systems was increased. Nevertheless, energy carriers and raw materials continue to be important and irreplaceable raw materials for the chemical industry. Operating without power and steam is impossible:

Heat is needed for heating or melting processes, thermal separation processes, and distillation, electrical energy for drive systems or electrolysis systems. Thus designing the use of energy to be as efficient as possible is a key task and challenge from both an ecological and economic perspective.

BASF meets this challenge in two ways:

1. The Verbund

At the BASF Verbund sites in particular, it was possible to create an energy network which is unique in this form and is a major factor in promoting energy efficiency in production.

What does energy efficiency in the Verbund mean?

The networking of individual operations in the so-called Verbund system is the key to reducing the consumption of primary energy, and thus also of resources such as natural gas, oil, or coal: The principle: The heat (e.g. waste heat from exothermic processes) which is generated during production is supplied to other plants as energy in the form of steam, hot water, or other heat transfer mediums. Buildings can also be heated with this waste heat. The Verbund site in Ludwigshafen is the largest integrated chemical areal in the world which belongs solely to one company. The Verbund principle was developed here, continuously optimized, and then im-

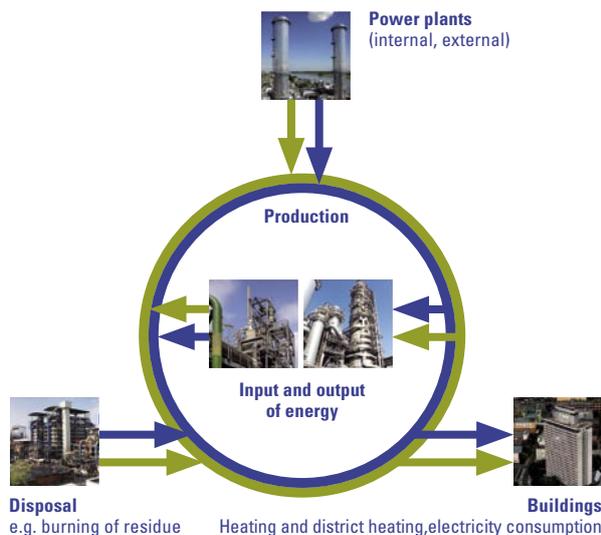
plemented at other sites: Antwerp (Belgium), Freeport and Geismar (USA), Kuantan (Malaysia) and Nanjing (China).

Around the world, around 25 million tons of steam from waste heat were used at BASF Verbund sites in 2010, approx. 44 % of the total steam consumption. Over 1.6 million tons oil equivalent of energy would be required if this amount of steam was generated in a natural gas fired steam boiler, for example. Thus BASF uses 1.6 million tons less of oil equivalent primary energy through the energy Verbund than without using waste heat in the Verbund. This corresponds to a reduction in CO₂ emissions of 3.8 million tons per year.

The Verbund also makes a major contribution to the efficient use of raw materials. Substances which are generated as an unavoidable by-product at one plant can be used as a raw material again at another.

Production residues can be used as secondary fuels in many cases. Using this fuel to generate energy avoids the use of valuable raw materials such as natural gas or oil. In this manner the secondary fuel used generates primary energy savings of around 0.4 million tons oil equivalent.

Illustration of the power & steam energy Verbund



2. Efficient generation of power and heat using co-generation

BASF covers over 70 % of its worldwide electricity consumption with power plants which operate on the combined heat and power (CHP) principle. The advantage of simultaneous generation of power and heat (steam) is that the fuel can be used with a very high overall efficiency: The combination of gas and steam turbines (combined cycle) in combined heat and power plant allows for an overall efficiency of nearly 90 % for the fuel - this is a peak level for industrial energy conversion. In comparison, separate generation results in an efficiency of 90 % for steam, but only about 45 % for power.

BASF operates large CHP power plants which use combined cycle technology in Nanjing and Ludwigshafen, but smaller systems such as those in Emlichheim or Limburgerhof also contribute to increased resource efficiency.

The BASF Group's largest combined cycle power plant is located in Ludwigshafen. It was put into operation in 2005. The system can generate approx. 440 megawatts of power and 650 tons of steam per hour, allowing the Ludwigshafen site to generate 100 % of its own total power requirements on average. The system also has a high co-generation index, meaning that it produces the highest possible power yield relative to the required amount of process steam.

The combined cycle system is composed of two natural gas fired gas turbines, each with a power output of 180 megawatts. The rotary motion of the turbines is used by two generators to produce power - similar to a bicycle dynamo. Then



CHP plant in Ludwigshafen.

the hot exhaust gases from the turbines are used by the heat recovery boiler to generate steam, which in turn drives a generator via a steam turbine (combined cycle technology). Then the process steam lines route the steam to the production plants where it is used as heat energy (combined heat and power).

Looking at all of the combined heat and power systems operated by BASF, the savings in fossil fuels and therefore CO₂ emissions are enormous:

BASF generated approx. ten million MWh of power and 26 million tons of steam in 2010 (internal generation in power plants, not considering waste heat utilization in the Verbund). This would require approx. 3.7 million tons oil equivalent of primary energy for separate generation in a steam boiler and without combined cycle (without CHP). But in reality, only 2.6 million tons oil equivalent of primary energy were used, primarily in the form of natural gas.

Summary:

Advantages of the heat Verbund: Eliminating the use of 1.6 million tons oil equivalent of primary energy / eliminating the production of 3.8 million tons CO₂ equivalent of greenhouse gases.

Advantages of combined heat and power and utilization of residues as secondary energy carriers: Eliminating the use of 1.1 million tons oil equivalent of primary energy / eliminating the production of 2.5 million tons CO₂ equivalent of greenhouse gases.

Through Verbund and combined heat and power, the BASF Group consumed 2.7 million tons oil equivalent less of primary energy within the BASF group in 2010 than it would have without utilizing waste heat and secondary fuels, and with separate generation of power and steam. 6.3 million tons CO₂ equivalent less were emitted in total. Less use of valuable energy raw materials such as natural gas and oil results in a clear benefit for the environment.

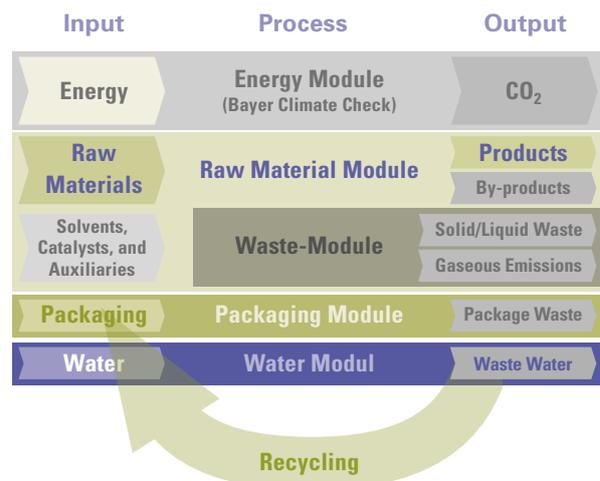


**Resource Efficiency Check:
Systematic identification of
improvement potentials**

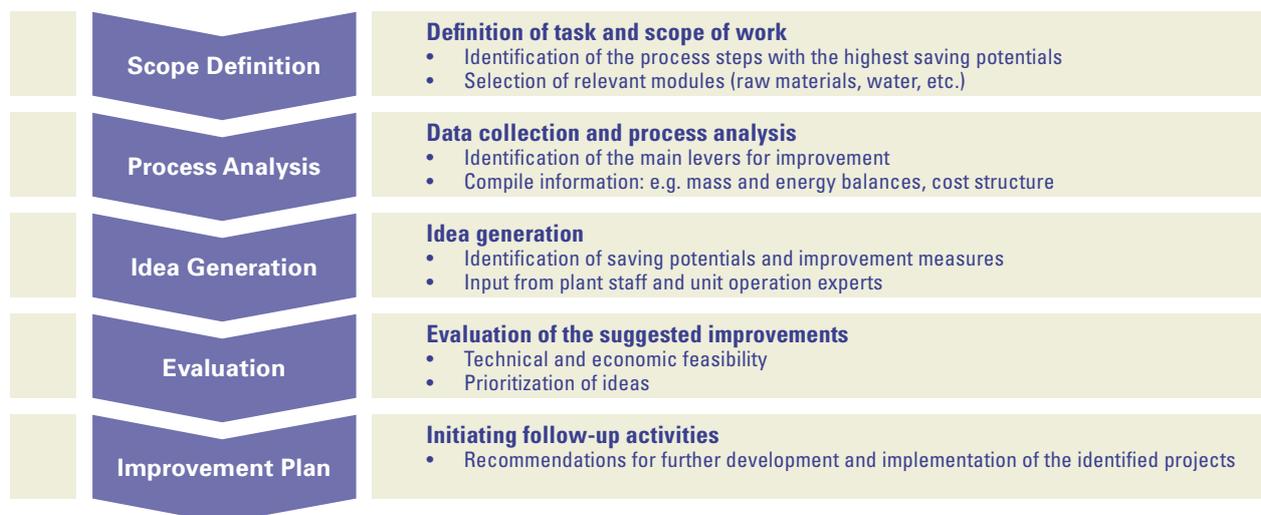
The Bayer Resource Efficiency Check identifies potentials which reduce resource consumption and minimize emissions and waste.

The decreasing availability of many raw materials, the growing environmental pollution and climate change emphasize the urgent need for sustainable development. Improved resource efficiency through process technology innovations and new products will be the key for the chemical industry to de-couple the consumption of non-renewable raw materials from economic development.

The Resource Efficiency Check systematically screens production processes as well as auxiliary processes, e.g. waste water and offgas treatment, for measures which reduce the consumption of resources and minimize emissions and waste. Examples for resource efficiency potentials include yield improvement, increased recycling, elimination of reactant and product losses or the utilization of by-products. In line with the experiences from the Bayer Climate Check improvements of the operating parameters as well as an optimization of the process design through innovative technology have to be considered.



A modular concept allows for each production plant to cover all relevant resources and to take the specific characteristics of the particular process into consideration. In addition to the energy and raw materials aspects, improvement measures with respect to water consumption and packaging waste are developed.



The result of the Resource Efficiency Check is a list of measures and optimization approaches within the production process, prioritized according to cost and benefits

Initial Situation

The Resource Efficiency Check concept was developed on the basis of the Bayer Climate Check. Within the framework of the Climate Check Rollout, it was found that the potential energy and CO₂ savings in the production processes are considerable. In addition, further savings potentials with respect to the consumption of raw materials, auxiliaries, water and for the reduction of emissions and waste have been identified. Besides the direct and indirect CO₂ emissions through energy consumption in production, a major (and usually by far the largest) share of the „carbon footprint“ of a product results from the use of non-renewable raw materials. In light of the constantly rising raw material prices, there is essentially the same relationship on the cost side. Due to the large amounts of chemical base and intermediate products and polymers as well as the typically very high product value for fine chemicals and pharmaceutical products, even small specific saving potentials result in a significant reduction in the annual CO₂ emissions and manufacturing costs.

Solution approaches

The goal of the Resource Efficiency Check is to identify all measures for improving resource efficiency and waste reduction in the core production processes as well as in auxiliary processes (e.g. waste water or offgas). The applied systematic workflow is based on a Six Sigma approach and is shown in the figure.

At the start of a Resource Efficiency Check existing or relatively easy to obtain performance figures (such as e.g. „Carbon Footprints“ from the Bayer Climate Check, consumption values for raw and auxiliary materials, emission and envi-

ronmental figures) are used to assess the resource intensity of a production process and select the relevant modules for the respective production process (see figure). In most cases during this exercise the process steps with the highest saving potentials can be already identified, which allows to ensure a clear focus for the subsequent project phases.

In the process analysis phase, a complete and detailed compilation of all process data is collected and used to prepare mass and energy balances on the basis of actual consumption data. This forms the quantitative basis for the identification and evaluation of the key levers and concrete measures for resource efficiency improvements during the idea generation and evaluation phases.

Based on the experience from the Bayer Climate Check, a close cooperation and strong involvement of plant staff and process experts is realized during the idea generation phase, which is considered to be a key success factor, especially with regard to implementation of the improvement measures later on. All ideas are worked out in the evaluation phase to a sufficient level of detail so that a reliable evaluation of the technical feasibility and a quantitative assessment of the potential savings and economic feasibility are possible. The detailed description and evaluation of the improvement measures are documented in a standardized project list, which is used after the Resource Efficiency Check as a tool to follow up on implementation of the measures. The project list will be updated on a regular basis, for example to track the effect of higher raw material or disposal costs on the economic feasibility of improvement projects and to adjust the rating and priority of the implementations accordingly if necessary. In addition to the technical details of the recommended measures and documentation of the savings potential and economic feasibility calculations, these project summaries also include a detailed description of the steps required for further follow-up and implementation of the measures. This

allows for a smooth transition to subsequent activities, especially for ideas which have to be further investigated to determine their feasibility (e.g. as part of a technology development project).

Finally all improvement measures which were identified and analysed within the course of the Resource Efficiency Check are prioritized according to their technical feasibility and economic benefit on the basis of these project evaluations. The prioritized measures can be entered directly into an Improvement Plan, which defines the implementation schedule for process optimization measures or the initiation of technical development projects.

Successes and Goals

The Resource Efficiency Check methodology is currently being tested in pilot projects. Initial results indicate significant improvement potentials such as increasing the yield and selectivity of the reaction, reduction of reactant and product losses in separation processes, improved solvent recovery, and water recycling. The modular approach has clearly proven to allow focussing on the respective key topics in a production system while at the same time offering a high level of flexibility. This facilitates the coordination with already concluded projects or parallel activities which are ongoing to optimize the resource efficiency in selected sections of a production process.

A systematic approach for identifying resource efficiency improvement potentials – such as the Bayer Resource Efficiency Check – ensures the sustainable use of ecological-economic synergies in the optimization of processes. This is particularly important within the context of company-wide Operational Excellence initiatives, which are currently intensively pursued in process technology industries.

The Bayer Sustainability Check: A comprehensive quantitative and qualitative balancing of the sustainability effects of products or product groups over their entire life cycle



With its Sustainability Check, Bayer AG has a tool that is capable of evaluating the economic, ecological and social effects of a product over its entire life cycle. The claim to fame of this innovative tool is that it not only evaluates the negative sustainability effects arising from the production processes, it also considers the positive effects that primarily occurring during use of the product. In designing the Sustainability Check concept, Bayer AG endeavored to apply an integrated approach in the light of increasing global challenges such as population growth, climate change and resource scarcity. Bayer developed the Sustainability Check in cooperation with Z_punkt The Foresight Company, a renowned consulting company for strategic future issues, and had it tested and certified by the internationally recognized Wuppertal Institute for Climate, Environment and Energy.

From megatrends to sustainability indicators

Depending on the defined analysis goal, the Sustainability Check makes use of a suitable selection of Key Sustainability Indicators or a broader set of up to 30 sustainability parameters. The entire set of indicators is updated on a regular basis. It is the result of a systematic future analysis based on megatrends. On the basis of a set of 20 megatrends recognized in the Foresight Community, 10 megatrends that are important for Bayer's global business on the one hand and for sustainability management on the other were initially selected. Then sustainability challenges were identified on the basis of these selected megatrends. Sustainability challenges

are understood to be potential restrictions on the economic, ecological or social opportunities of current and future generations. This understanding is based on the sustainability definition of the Brundtland Commission. The result of this analysis is composed of 12 overriding sustainability challenges, which include safeguarding the global food supply. This is one of the challenges resulting from the growing world population and the increasing impact on the climate and environment. Securing access to water is another challenge resulting from the aforementioned megatrends.

A total of 30 quantifiable sustainability indicators were developed to back the challenges. The goal of the Sustainability Check is to determine how a product or product group affects these indicators in positive and negative ways over its entire life cycle. For this purpose, a methodology was developed for each indicator to generate a qualitative and quantitative evaluation of how the parameter is affected by a product over its entire life cycle.

From products to sustainability effects

The process for evaluating individual products or product groups follows defined steps:

1. Definition of the balance timeframe and identification,
2. Definition of the reference scenario,
3. Internal and external data collection,
4. Analysis of the sustainability effects,
5. Determination of the overall effects.

1. Definition of the balance timeframe and identification of theoretical sustainability effects

To begin with, a balance timeframe is defined for the product being analyzed. It includes the various production steps, usage contexts and disposal. Based on the product properties, the manufacturing processes and searches of various stakeholder positions, a portfolio of theoretical sustainability effects is developed for the balance timeframe. Energy, water, and materials for manufacturing and/or transportation are consumed for every product, and air emissions, discharges into water and wastes are generated, at least in theory. The theoretical effects resulting from the use of the product are much more heterogeneous. A crop protection agent, for example, is diluted with water and applied using energy, leading to higher food production but potentially also to soil contamination. The portfolio of theoretical effects not only includes direct effects, but also indirect first or higher order effects. A pharmaceutical, for example, leads to faster recovery and indirectly to less lost time in the job market.

2. Definition of the reference scenario

The type and quality of these theoretical sustainability effects depends on the reference scenario with which the product is compared. Under some circumstances, defining

the product with just one reference scenario may be insufficient. A specific insulation material must, to make sense, be compared with an alternative insulation material and with no insulation at all under conditions involving additional heat requirements. No insulation with lower room temperatures and additional clothing may be an interesting scenario in theory, but is not a realistic comparison.

A sustainability balance is inevitably not meaningful with absolute values, but always only through comparison of its individual elements with competing products or functional substitutes.

3. Internal and external data collection

In order to verify if and to what degree the theoretical effects are realized, Bayer-internal knowledge of established systems and surveys are used to collect data, which are combined with data in public databases from the Federal Environmental Agency, World Bank, WHO, FAO and other institutions. Bayer is able to make use of internal systems with regard to the ecological effects of manufacturing. The energy and water consumption, emissions, waste and other parameters are measured for each site and operation and can be transcoded for the product amount and the respective balance timeframe. The biggest impact, however, is usually generated in the upstream supplier chain. In order to assess this, the formula for manufacturing a coating, for example, is used to calculate the required volume of all other supplied materials. Since they are mostly commodities, life cycle analyses for these materials are frequently often available in public databases already. These can be used to determine how much energy and water is required to produce a certain amount of this substance from the raw material source, and how many emissions are generated in the process.

4. Analysis of the sustainability effects

In order to quantify the usage effects, the relevant consumption system must be modeled on the basis of market and environment data. If, for example, a crop protection agent used in the United States leads to a higher local corn yield, then it can be assumed that the additionally produced corn is also available to people in Mexico and South America. The degree to which this applies can be estimated based on the exported fraction.

Location factors are also considered for evaluation of the individual effects, because water consumption in dry areas, emissions in the vicinity of biodiversity hotspots, and value creation in countries with a high risk of poverty have different effects than in Germany, for example. However, these indirect ecological and social effects can only be described qualitatively and cannot be quantified. Finally, it is also possible to reliably calculate how many people in which countries can rise above the poverty level due to a specific product.

5. Determination of the overall effects

In addition to considering qualitative and quantitative effects, parametrization is also one of the big strengths of the Sustainability Check. Thus individual effects at different points of the value creation chain can be aggregated to determine an overall effect. A specific coating that increases the durability of steel beams results in CO₂ emissions during manufacturing and transport, but also prevents CO₂ emissions because less steel has to be produced over the usage period. For pharmaceuticals, workplace accidents in production systems, side effects and the therapeutic effect in Disability-Adjusted Life Years are measured. These negative and positive effects on the same indicator can be aggregated or put in proportion and described with a leverage parameter.

The effects are not combined across the various sustainability indicators, however, since greenhouse gas emissions do not affect the same stakeholders as a reduction in waste or reduced health impacts. Thus the Sustainability Check shows how and to what degree a product contributes to solving which sustainability challenges, and where sometimes unavoidable conflicting objectives arise when it comes to solving different challenges. This applies in particular to products whose positive and negative effects apply to different indicators. Pharmaceuticals, for example, result in resource consumption and emissions during manufacturing, make direct contributions to health and indirect contributions to income during use, and may even lead to water pollution through their disposal. In order to enable at least a rough comparison of these effects, they are not only expressed

in their respective units but also in footprints of the average European citizen. The average income, average harmful health effects, and the emissions and resource consumptions per person are used as conversion factors.

From sustainability communication to strategic sustainability management

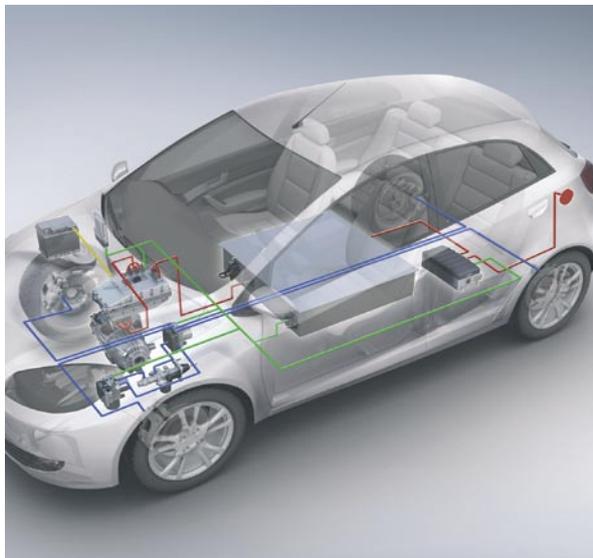
To begin with, the Sustainability Check was applied in all Bayer Group companies. These initial analyses are used to quantify the basic expected sustainability effects of established products more precisely and so that they are usable for dialogue with customers and stakeholders. In the meantime, the first innovation projects and investment alternatives have been evaluated with the Sustainability Check. The analysis of an investment project, for example, has shown how high the positive effects of the individual factors would have been but has also uncovered unexpected negative effects.

The first product groups have also been analyzed with the Sustainability Check in addition to individual products. This showed that certain products perform differently from a sustainability perspective in different countries. This is knowledge that can enter into the marketing strategy in the future. These examples show that the Sustainability Check has rapidly developed from a pure communications tool to a true management tool. It helps Bayer to continue working actively to improve the Group's sustainability performance in the future, therefore making a contribution to solving global challenges.



Acting strategically, adhering to principles

How will cars be powered 20 or 30 years from now? What raw materials will still be available to us? And what demands will people place on mobility and the energy supply? Anyone considering such questions has to keep a close watch on powerful trends such as globalization, changes in population growth and structure, climate change, and resource conservation. This is why Bosch performs regular analysis of such “megatrends.”



Each year, Bosch invests around 400 million euros in making drive systems electric.

Two megatrends in particular are in the spotlight. First, there is the growing global importance of environmental and resource conservation, and of climate protection in particular. Second, the development of the emerging markets, and above all Asia’s increasingly significant role in the global economy, are accelerating globalization and the depletion of natural resources.

We have taken these developments into consideration in our long-term business planning. Bosch generated 20 percent of its sales in Asia Pacific for the first time in 2009. By 2015, we want to record half our global business volume in Asia Pacific and the Americas. In order to counter the price and supply risks of raw materials, one of the goals of our product development process is to keep the use of particularly scarce materials to a minimum and to look for alternatives. Thanks to remanufacturing of used vehicle parts, we save raw materials and materials costs, and also pass these be-

nefits on to our customers. In light of rising energy prices, we are turning to energy-efficient products and processes in all our divisions. Moreover, we are promoting the use of renewable energy.

In early 2009, the Bosch board of management reached an agreement with the divisions relating to measures for more energy efficiency. Taking the 2007 levels as a baseline figure, the target is to reduce the carbon dioxide emissions of all manufacturing sites worldwide by at least 20 percent by 2020.

Our worldwide network of DfE coordinators is a permanent feature of the Bosch environmental management system. With environmentally friendly design, we ensure that energy efficiency, recycling requirements, and the limited availability of materials are observed in the product development process, and that Bosch products are eco-friendly and conserve resources.

We have introduced a maturity level model for all manufacturing and engineering sites. It serves as a basis for further improvements to our health and safety, fire protection, and environmental protection efforts. In addition, we also exchange best practice solutions, and this also promotes international cooperation.



Photovoltaics array for Stuttgart airport, supplied by Bosch Solar Energy.

Along with 20 other German companies, Bosch signed the “Code of Responsible Conduct for Business” in 2010, thus affirming its values-based and long-term corporate policy.

Bosch eXchange: the smart exchange system

By remanufacturing used products, the Bosch exchange program is an excellent combination of ecology and economy.

Remanufacturing plays a particularly important role in the automotive industry. Owners of older vehicles in particular want repair costs that are reasonable given the value

of their vehicles. The increasing scarcity of resources and the threat of global warming also demand that natural resources be used responsibly.

The international „Bosch eXchange“ program responds to this challenge by remanufacturing vehicle parts on an industrial scale. The program now includes 9,000 vehicle parts from 24 product groups, and in this way satisfies the demand for repairs that are in line with current value. It also helps drivers to comply with legal requirements, and plays a part in protecting the environment and conserving resources.



Alternator before and after remanufacturing.

When remanufacturing products, wear parts are generally replaced. After a thorough cleaning, reusable parts are machined and subjected to surface treatment as necessary. The individual parts are then reassembled and a final functional test of the product is carried out. Finally, the products are given an eXchange quality seal, with the same warranty as a new product, since their quality, performance, and service life are the same.

In 2009, Bosch remanufactured 2.5 million vehicle parts, thus saving 23,000 metric tons of CO₂ worldwide. Apart from the avoidance of waste, energy and materials are saved, and the customer enjoys cost savings of 30 to 40 percent.

At Bosch, the aim is to use forward-looking product development to expand the program each year, and in this way to achieve further ecological and economic benefits.



Ballast – a valuable raw material

The DB (Deutsche Bahn – German Railway) removes around three to four million tons of ballast from its rail system every year. This isn't due to line shutdowns, but rather is necessary so that all trains from light passenger rail cars to 5,000 ton ore transporters roll safely on the tracks. The old ballast which is removed is largely reprocessed and reused as a high strength and elastic substrate. Comprehensive testing ensures that hazardous materials are removed first.

The machine which stands on the dusty, football field sized lot in North Berlin looks a bit like a tank. While it gleams in petrol blue rather than disguising itself in dark green, the shape and size are very similar to that of vehicles used for military purposes. But this machine doesn't move. It's been sitting firmly in one place for two years. It is the centrepiece of a ballast reprocessing system at a DB Netz AG disposal partner, and recycles old ballast from the Deutsche Bahn. And this is certainly a job one cannot do with bare hands.

While the mountains of grey rock which are piled up all around the reprocessing system may look colourless and ordinary, the ballast is a valuable raw material for the Deutsche Bahn. It is the ideal substrate for 33,000 kilometres of the 33,500 kilometre long German railway network. This is because a track bed made from ballast is strong enough to support the trains safely, but also flexible enough to distribute the loads evenly and also to dampen the noise of the trains as they drive over the tracks.

Several million tons of the grey rock are currently lying under the German railway network for this purpose. But this does not meet the ballast demand forever. Just like the trains, tracks, and ties, the rail bed also has to be replaced and repaired on a regular basis. This is because even these robust stones wear down after a few years and lose their stabilizing effect. Therefore the Deutsche Bahn removes around three to four million tons of old ballast from the network every year, and installs almost the same amount. "Those are enormous quantities", says Dr. Jan Büge, environmental services manager at the Deutsche Bahn, which is why sustainable use of the ballast is particularly worthwhile. While waste is produced in a wide range of areas in the railway system, construction waste makes up the largest part by far at nearly 90 percent of the total. Here sustainable action means trying to avoid the production of waste, reusing waste that is generated, and thereby conserving resources.

And since sustainable action is at the top of the Deutsche Bahn agenda, it has among other things defined the sustainable use of ballast in the DB Netz AG through the ballast recycling guideline. Since 1999, this guideline stipulates that the

reuse of ballast categorically takes precedence over disposal and has top priority for reuse in the trackbed. The numbers show that this guideline is effective: Around 1.8 million tons can be reused in the railbed itself. Of the remaining tonnage, the majority is used in other places – for example as ballastgrit or crushed sand in road construction. The DB does not have exact numbers on the quantities involved, since the reprocessing and disposal companies take care of the sales themselves. But only a fraction ends up in the landfill at the end.

The fact that it is not possible to re-use 100 percent of the ballast for the trackbed is largely due to the size and shape of the rocks. This is because only angular rocks with a diameter between 32 and 63 millimetres can be reused, because only these rocks interlock strongly enough to form a stable track. Depending on the frequency and weight of the trains which drive over the tracks, the rocks will have cracked after a few years and gotten smaller and rounder. Then they have to be removed, sorted by size, and processed to have sharp edges added again in a reprocessing system. In some cases the small rocks are also contaminated with herbicides, diesel fuel, or lubricants, so that they cannot be reinstalled in the trackbed for these reasons.



Only sharp-edged rocks with a diameter between 32 and 63 millimetres can be reused.

Reuse is important to the Deutsche Bahn for both ecological and economic reasons. “We conserve a natural resource by having the ballast we remove reprocessed into recycled ballast”, says Thorsten Herold, who works at the environmental protection department at DB Netz AG.

But the reuse as track bed material is also advantageous for the DB for economic reasons. It is often more cost effective to use the reprocessed ballast, especially in areas with no natural resources. “One ton of recycled ballast currently often costs more than new ballast on average in Germany, says

Holger Jäger, disposal and transport team leader, but the DB often saves on transportation costs instead. Most of the quarries for basalt and granite – both rocks which formed from cooled magma – are located in the south-west and south-east of the republic. They sometimes have to be transported over long distances to their usage sites. Unlike recycled ballast, for which the DB ensures that it is reprocessed and reused as close as possible to where it was removed from the trackbed. “By recycling the ballast, we also minimize our transportation costs from the supplier to the construction site”, says Jäger. An additional resulting environmental effect is the energy consumption which is avoided through reduced transportation – especially in the case of transport by truck.

Unlike for the system in North Berlin. “Most of the ballast arrives here by train”, says the director of the operating company. He received a total of 20,000 tons of old ballast last year. The Deutsche Bahn checks to ensure that he recycles as much as possible. Every company contracted by the Deutsche Bahn is audited in depth by the DB AG quality assurance department. “Everyone who performs work for us in this segment must disclose their operating procedures, prove and document the qualifications of their personnel, and show that they have internal quality assurance”, Jäger says. The quality of the reprocessed ballast is also checked by a third party several times over the period of the contract. This is also stipulated in the ballast recycling guideline and the technical delivery terms and conditions of the DB Group. While the 28-page ballast recycling guideline is categorically produced by the DB Netz AG, it is based on publications and requirements of the Bund/Länder-Arbeitsgemeinschaft Abfall (LAGA – German federal/state working group on waste), which is intended to ensure that waste legislation is observed and implemented uniformly in all federal states across Germany. This guideline represents the generally recognized state of the art.

The most environmentally friendly and economically worthwhile approach is to have the ballast reprocessing performed directly on site, so that transportation to an external ballast reprocessing plant is not necessary in the first place. “Remove the track, ties, and replace the ballast”, this, says Dr. Büge from the Deutsche Bahn environmental services department, is only necessary about every twenty-five years when the rails and ties – which are also recycled just like the ballast – have to be replaced. “But the ballast has to be reconditioned and cleaned in the meantime”, he says. This regular reconditioning of the track bed can be performed by a mobile track bed cleaning machine in many cases. Such mobile machines are up to 150 meter long trains which slowly drive over the track to be cleaned. In the process, they take the ballast up, sift it according to size, remove unwanted components, sharpen the edges of the usable rocks, and set it back into the track bed immediately. The edges of the rocks are sharpened by a so-called rebound crusher. The ballast is whirled through the air and collides with the walls, creating new corners and edges.

Since the volume is reduced through this reprocessing, the machine automatically replaces the lost material with small amounts of new material. In a final process step, the train tamps the trackbed so that the loose rocks interlock again and ensure the stability of the track. "This is done with a sort of ice pick", says Dr. Jan Büge, "which is rammed time and again into the bed of ballast in order to compact the ballast."



The removed ballast is sorted by size before reprocessing.

The ballast is examined for contaminants before every cleaning or replacing of the track bed – whether it is removed completely or with the mobile machine. Only a small fraction of the ballast contains contaminants in practice, but these need to be identified. Up to one year before the first rock is

removed, the environmental technicians from the DB environmental service drive to the tracks with a special laboratory headquartered in Kirchmöser near Brandenburg and start with a visual inspection of the ballast. "The colour, fouling, and smell often provide an indication of whether the ballast is contaminated", says Dr. Büge. In addition, it is typically only certain track sections such as shunting points, track switch areas, stopping areas in railway stations, or parking areas for traction units which are affected by contamination. "All the places where the trains start up, brake, or are shunted", says the environmental technician.

The representative samples for the rebuilding project which Büge's team takes in a subsequent step provide final information on whether a location is actually contaminated. "We examine around 15,000 ballast samples for contaminants every year", says Büge, including the samples which the laboratory takes at regular intervals from longer-term construction sites.

Depending on the degree of pollution, experts at the environmental service assess the samples and develop recommendations for reprocessing/disposal. The installation categories according to LAGA, e.g. Z0 to Z5, are a key criterion. Z0 means uncontaminated and reusable with no restrictions, Z5 means severely contaminated. These categories determine how the ballast is handled. Since waste law is under the jurisdiction of the states and since the states have defined their own limit values, the old ballast may be categorized differently. "But most of the ballast removed by the Deutsche Bahn falls into the uncontaminated or lightly contaminated categories Z0-Z2 and can be reprocessed", says Büge. One might not want to put it in his or her mouth, but it is normally clean and a valuable natural product without which rail traffic would be virtually impossible.



Measures for improving energy efficiency

With its products and services, the Deutsche Telekom is already making a key contribution to solving key social questions today. In order to continue advancing the sustainable development of the environment, society, and economy, it takes advantage of the large potential provided by modern information and communications technology (ICT) and faces the current social challenges: These include global climate change, promoting equal opportunity for participation in the information society, and improved networking of the working and living environment.

Energy and resource intensive products and services are increasingly being replaced by more economical and intelligent information and communication technologies (ICT). At the same time, the volume of data is growing as a result of the increasing popularity of mobile multimedia applications. The infrastructure of the ICT industry within the European Union (EU) is already responsible for over eight percent of the power consumption and around four percent of the CO₂ emissions. These numbers could double by 2020.

In order to counter these negative developments, the research centre of the European Commission has created a platform within which the European telecommunications providers and manufacturers have agreed to increase their long-term energy efficiency through a jointly developed package of measures.

One of these measures is the „European Code of Conduct on Energy Consumption of Broadband Equipment“ (Code of Conduct BB), which describes guidelines for devices and requirements for system technology manufacturers. In detail, the Code of Conduct BB rules include:

- Determining the maximum consumption values for the entire infrastructure chain, from the operating company to the end customer's devices.
- Commitments by all participants to develop, select, and deploy devices according to energy efficiency criteria.
- Reporting on improvements to the energy efficiency of end user devices and the equipment used in the infrastructure chain.

In September 2010, the Deutsche Telekom signed this voluntary commitment along with other European telecommunications companies, thereby standing behind the optimization of energy requirements in the broadband industry. Deutsche Telekom AG has set itself the goal of reducing the energy demand of the broadband infrastructure.

In 2010, 15 percent of the energy used within the EU for ICT processes was due to broadband equipment – with a rising tendency.

Measures for improving the energy efficiency

In addition to technological and economic aspects, the role of energy efficiency and sustainability is gaining an increasingly important role when it comes to the introduction of new technologies. In order to implement these requirements, application of the Code of Conduct BB and further sustainability measures were included in an internal environment and sustainability program for future tenders of new broadband technology such as modems, switches, routers, and home gateways.

Using the Code of Conduct BB in the tender process emphasizes the position of the Deutsche Telekom as a leader in the area of sustainability for the technology manufacturers. Broadband technology manufacturers must rise to these challenges, and in the future also have to consider the higher energy efficiency requirements placed on their products in addition to the high performance requirements placed on the technology.

The measures negotiated in the internal environment and sustainability program will be reviewed through audits at various intervals in the future, and adapted and expanded annually.

Telekom as a leader in terms of sustainability

Deutsche Telekom has set itself measurable goals. In addition to increasing the energy efficiency of broadband equipment, greater consideration will also be given to emissions in the precursor product chain in the future, for example in the manufacturing, transport, and disposal of broadband technology. To this end, Deutsche Telekom is working on measures for higher transparency at manufacturers and suppliers. Recognizing improvement potentials and the sustainable improvement of the product's environmental compatibility are only possible through an integrated approach, extending from the production of raw materials to disposal.



A quantum leap in MMA manufacturing: Aveneer® conserves resources and protects the environment

Methacrylates are most varied and powerful building blocks of macromolecular chemistry. A modern process saves resources and allows for the use of renewable raw materials.

Methacrylates, such as Methyl Methacrylate (MMA) are used to manufacture high quality plastics such as PLEXIGLAS®, but also varnishes, paints, or adhesives are produced – Evonik is the second-largest manufacturer in the world. The company will continue to make the production of MMA more efficient over the medium and long term, and will also continue to offer its customers a high level of security of supply for the Methacrylate monomers sold under the VISIOMER® brand. To do so, Evonik is building on new technology: the AVENEER® process. With AVENEER®, Evonik has developed a much more resource conserving process for the production of MMA in comparison to the conventional Sulfo process. Just like in the traditional ACH sulfo process, AVENEER® is based on the raw materials ammonia, methane, acetone, and methanol – but doesn't require the use of sulphuric acid.



View of the AVENEER® pilot plant at Evonik Industries

The AVENEER® pilot plant which has been in operation since 2007 at the Worms (Germany) site illustrates the enormous

potential of the new process and its technical feasibility. AVENEER® also offers the option of using renewable raw materials as feedstock in the future, with intensive efforts underway in this area. The process already uses the resources intensively today – with an overall yield of 95 percent – which in the end is also better for the environment. An internal study showed that the CO₂ process emissions of AVENEER® are much lower in comparison to the conventional process.

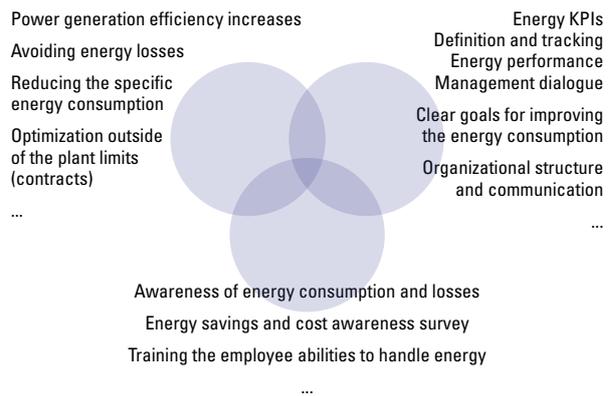
Selection of a site for the first world-scale-AVENEER® system is currently in progress.

EEM: Efficient Energy Management

The sustainable process to improve Evonik's energy efficiency in the area of Operational Excellence (OPEX)

Worldwide energy costs will continue to rise (Evonik 2009 approx. 0.7 billion Euro) and are already responsible for 15–30% of the manufacturing costs today. The resources are limited and energy efficiency is one of today's megatrends which no company can ignore.

By striving for Operational Excellence, Evonik plans to increase productivity, lower costs, and improve its own competitive position. EEM has been used for energy matters in order to develop an approach which identifies improvement potentials in the three dimensions – technical system, management infrastructure, attitude and behaviour of employees. EEM is a structured process which is performed by a team from operations, the OPEX energy experts, and process technology and engineering specialists.



By now over 50 EEM analyses were performed around the world, identifying savings potentials in the middle 2-digit millions. This is an important contribution to resource conservation and the reduction of CO₂ emissions.

HEIDELBERGCEMENT

When waste products become valuable raw materials

Both the cement and the aggregates industry are defined by characteristic distinctions: Firstly, both are very capital intensive. Secondly, they are tied to specific sites, meaning that they depend on raw material deposits in the immediate vicinity of the production site. Thirdly, both require a large amount of raw material, thereby making the conservation of finite resources an important activity. In addition, the high energy required in cement manufacturing is a significant factor which makes energy efficiency improvements essential for economic and ecological reasons.



Cement kiln at HeidelbergCement

Resource conservation is also climate protection

The fair distribution of natural resources among current and future generations is one of the fundamental goals of sustainable development. The increasing economic growth in many countries demands a more intelligent approach to utilization of our raw materials. In order to conserve them, we are increasingly making use of by-products or waste materials from other industries. These alternative materials are used either as a raw material, or they replace the fossil fuels in the burning process. Therefore resource efficiency also goes hand in hand with the reduction of CO₂ emissions at Heidelberg-Cement.

This is essential especially because the cement industry releases approx. 5 % of the carbon dioxide emissions generated by mankind around the world. Half of these are due to decarbonization of the limestone during clinker manufacturing, 40 %

due to the fuels used for burning the cement clinker, and 5 % each are due to electrical energy and transportation.

In the period between 1990 and 2011, we reduced our specific net CO₂ emissions per ton of cement by 19.1 % to 621 kg CO₂. We have achieved this by:

- ongoing investment in energy efficient technologies,
- promoting the production of composite cements through the use of alternative raw materials,
- the significantly increased use of wastes – primarily biomass – as secondary fuels.

According to the current state of the art, the CO₂ reduction measures during the manufacturing of clinker are optimized to such a degree that further reduction to the degree we have achieved over the last 20 years is no longer possible in this cement manufacturing sub-process. HeidelbergCement is therefore concentrating on the development of cement types with lower clinker content, and on the increased use of alternative fuels and climate neutral biomass in particular.

Use of alternative raw materials

Alternative raw materials are used both in the manufacturing of clinker, the most important intermediate product in the manufacturing of cement, and in cement grinding as a grinding additive in order to conserve natural raw material resources and to reduce the clinker content of the final cement product. We use blast furnace slag from steel production or fly ash, a by-product of coal-fired power plants. We were able to reach our goal of continuously lowering the clinker content: The fraction has dropped to 75.5 % in the meantime.

Use of alternative fuels

An even more important goal for HeidelbergCement is to replace fossil fuels with alternative fuels whenever possible, especially with waste materials and by-products from other industries. By utilizing these materials, we make an active contribution to the conservation of natural resources and provide a solution for sustainable waste management. Which materials are used depends on their availability and their calorific value. We also pay attention to the chemical composition in order to avoid harmful emissions and adverse effects on the environmental compatibility of the product. When it comes to the selection and use of alternative materials, we utilize the guideline jointly developed in the World Business Council for Sustainable Development.

Our strategy for alternative raw materials and fuels is focused on three waste streams which are available worldwide:

- Sorted fractions of municipal waste with a high calorific value
- Dried sewage sludge
- Hazardous waste

Special waste requires special solutions

The increasing significance of high-energy wastes which require special processing before they can be used as a fuel should be highlighted here. The new Recyfuel system in Belgium is already setting the course in this direction: Recyfuel is a Joint Venture between the Belgian subsidiary of HeidelbergCement, CBR, and the company SITA, a subsidiary of the French company Suez Environment. The system processes hazardous waste into a high-energy secondary



Old tires are used as alternative fuel

fuel for the cement industry. The input materials include e.g. leftover paint, oil sludge, residue from the cosmetics or pharmaceutical industries, packaging, and other industrial waste streams for which recycling or other use is no longer possible.

Two fundamentally different products are produced in the system: Mixed with sawdust, liquid and sticky substances are processed into a fine, powdery fuel; the second stream primarily consists of processed plastic packaging. Both streams are used by the local cement plants in Belgium. In addition to a plant of this type which has been in operation in Norway for years, HeidelbergCement has also built systems in Romania and Indonesia using a similar concept, and will continue to advance this project around the world.

Quality, safety, and measurable success

Through the consistent application of internal guidelines, secondary fuels are utilized safely, transparently, and ecologically. With the strict implementation of this strategy in our production systems and the ongoing exchange of knowledge, we are constantly improving our performance. With a secondary fuel rate of 21.4 %, HeidelbergCement is a leader in the use of alternative fuels among the world's largest construction material manufacturers. But the company has even more extensive long term goals: By 2020, 30 % of the thermal energy required to manufacture the cement clinker should be obtained from secondary fuels. The associated reduction of greenhouse gas emissions – especially the climate-damaging carbon dioxide – would be correspondingly high.

VORWEG GEHEN

Saving energy is everyone's concern

RWE is giving energy efficiency a permanent place in the community with a programme worth 150 million euros

Energy efficiency is a key factor in creating a secure, economical and clean energy supply for the future. This is not simply about efficient conversion of primary energy carriers such as gas and oil into power and heat. Consumption by end users is also a key factor. The opportunities and challenges ahead lie in generating greater benefits with lower energy usage: for retail customers, public institutions and companies. The obvious potential savings are easy to achieve. They involve simple actions like turning off the lights when leaving a room or using intermittent ventilation instead of tilt windows. These changes in behaviour and energy-saving measures are familiar and can be implemented quickly.

But not everything works this easily. And many initiatives involve costs before savings can be generated. New technical systems, insulating materials and measurement equipment are investments which require a sophisticated approach to planning. What is technically possible? What is economically feasible? And how can I implement it in practice? Sometimes, energy users don't find adequate answers to these questions. Industry also lacks the experience to know what works best for users in their everyday lives. As an integrated supplier, our aim is to close this gap. The first step is to communicate the principles of energy efficiency to the community at large. Secondly, consumers need advice and thirdly new processes and products for practical applications have to be tested and developed.

In 2007, RWE launched the '150 million programme' for these three areas. RWE has adopted this approach to raising the profile of energy saving within the community. The RWE online portal www.energiwelt.de is the central platform providing information and a forum for dialogue. This website posts comprehensive information on energy-saving opportunities and the efficient use of power and heat. The topics covered range from buying a refrigerator to upgrading your house with the latest technology. The portal also provides advice on finance and gives an overview of the government subsidies available. The site operates like a marketplace and anybody interested can identify the right installers and suppliers for energy services.

The information provided on the website is directed towards the general public as well as being targeted at specific groups like school classes. The website also promotes a competition for schools: 'Lend a hand – we're smarter together'. This involves students developing projects with the goal of imple-

menting ideas relating to energy technology or raising public awareness for energy saving. The winning class receives a grant of 4000 euros together with equipment for implementing the project. The classes use thermal imaging cameras to analyse the rooms in their schools or organise awareness weeks at school on energy efficiency. Installers and technicians are a second target group. They have limited experience with the installation of heat pumps. Planners and architects are also on a steep learning curve even though electric heat pumps are a key element in developing an efficient energy supply. These pumps use ambient heat for heating purposes. RWE therefore holds training events on the latest technology. An important factor is that subsidies are frequently provided for installation. RWE has provided a subsidy of 400 euros for each pump to purchase more than 5000 heat pumps over the past three years. This results in an annual CO₂ reduction of 15,000 tons.



Energy efficiency - also an important issue for private households

However, energy efficiency also entails a social component. This is why RWE helps promote savings in low-income households. This is an area where targeted and efficient use of energy can play a major role. RWE established the 'Cleverer Kiez e.V.' or 'Smart Neighbourhood' project to raise awareness of this issue among Berlin residents. This project trained people who are long-term unemployed as energy-saving consultants. They then passed on their knowledge about energy-saving in the neighbourhood. More than 400 Berlin families have already benefited from this kind of advice. Annual cost savings vary between 50 and 100 euros for each household.

Projects like 'Smart Neighbourhood' and 'Lend a hand' also support the second approach being pursued by the programme: consulting and analysis. A detailed analysis is particularly effective for major consumers of energy like public buildings. RWE employees identify weak points in the energy systems of hospitals and town halls, and provide advice on how these

can be mitigated. The saving potentials lie between 20 and 50 percent. The results of the analysis are recorded in energy performance certificates. More than 10 million euros have been invested in analysis of energy consumption.

Intelligent control of energy consumption is important for leveraging efficiency and it complements direct savings. RWE seeks to achieve efficiencies by bringing this tool for controlling energy to mid-sized businesses. The goal is to identify machinery and other consumers with high power uptake. Options for optimising user behaviour are then identified. One example might be to adapt production processes and promote efficient use of energy to generate significant cost savings. RWE supplies software and trains employees in correct operation to achieve this aim. 400 companies have received the software free of charge, alongside a package of training and the input of specific data tailored to the company.

The programme's objectives are not limited to simply implementing practices with a proven track record. The aim is also to develop new ideas and take them to market at the same time. The third approach for the programme involves development and testing of innovative energy efficiency products and processes. A typical example of this approach is the 'Mülheim counts' pilot project. In this project, 100,000 households in the city of Mülheim have been fitted with smart meters which will read the monthly power consumption instead of taking annual readings. 'Mülheim counts' is the largest field trial in Germany carrying out research into retrofitting costs and options. At the same time, power customers are also able to gain experience with the new device. RWE customers can track the monthly trend for their power consumption online.

Intelligent networking is also the goal of the E-DeMa pilot project. RWE has joined forces with other project partners including Siemens, Miele, and the Technical University of Dortmund to carry out this project. E-DeMa stands for the development and demonstration of decentralised, networked energy systems. This project transforms consumers into power producers and dealers who trade the electricity produced in their own decentralised generation system on a virtual marketplace. The project links the different components in the system including smart meters, smart grids, as well as the information and communication technology required for the efficient energy systems of the future. The model region for this project is Mülheim and it has also been extended to Krefeld.

E-De-Ma overall principles for energy efficiency:

Energy efficiency must be developed in a cooperative effort between private consumers, companies, researchers and energy suppliers. The challenges cannot be overcome with a single technology. Many processes are required to promote energy efficiency on a technical, economic and indeed social level.

You can access additional information on energy efficiency by going to: www.energiewelt.de

SIEMENS

Energy efficiency in mining: how Siemens drive systems are audited for sustainability

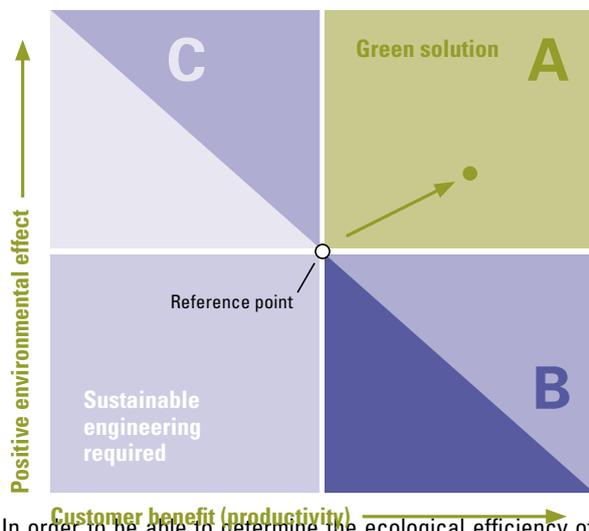
More and more companies are using ecological assessments to evaluate the environmental effects of their products and production processes. This makes it possible to determine and present environmental data along the entire product life cycle. But green products should be both environmentally friendly and economical. Therefore the so-called 'Eco-Care-Matrix' (ECM) has been in use at Siemens since 2009. It allows for the comparison of ecological assessments of industrial machinery, steel plant processes, or ship drive systems. The method was developed within the framework of a commissioned study at the Denmark Technical University in Copenhagen (DTU), together with Siemens experts, external environmental technicians, and physicists. Ecological assessments were also used in the mining department of the Siemens Division Industry Solutions for the first time.

Until the end of the 1990s, the question of a product's environmental effects over its entire life cycle was still a rather exotic topic at universities and research institutions. In light of the recent public and political debates on climate change and resource scarcity, calls for the development of ecological products and solutions are getting louder. In order to curtail global warming and counteract within the framework of what is possible, using energy in the most environmentally and climate friendly manner must succeed on a global scale. Technological innovations play a key role in this regard, because they increase the efficiency of energy generation, transmission, and utilization.

In the meantime, product life cycle management without ecological assessments or the so-called Life Cycle Assessment (LCA) is unthinkable. Since the turn of the century, internal company standards for new product development have developed into systematic analyses of the environmental effects of products over their entire life cycle. Unlike the „CO₂ footprint“ which primarily looks at greenhouse gas emissions, the ecological assessment is designed as a holistic approach. It captures and evaluates the ecological compatibility of all production steps – from the extraction and processing of raw materials all the way to disposal of the product. Nowadays ecological assessments are found in virtually all industries, from the raw material processing sectors to the consumer goods sector and waste disposal. It is also included in numerous EU guidelines, such as EC2002/96, the guideline for scrapping of electric and electronic devices.

Eco-Care-Matrix

The ‚Eco-Care-Matrix‘ developed by Siemens Industry Solutions (IS) is part of the Product-Lifecycle-Management process (PLM) and was developed as an addition to already existing ecological audits. The Eco-Care evaluation methodology reviews products and solutions before they are introduced on the market, not only for their environmental compatibility but also for their economic feasibility. With this standardized process, new developments in particular can be compared in a very targeted manner with existing references, and designed on the basis of sustainability, cost, and environmental protection.



In order to be able to determine the ecological efficiency of

The result of years of consistent development of the internal environment management system: the Siemens Eco-Care-Matrix. Section A: green solutions; section B: advantageous for productivity, but a detriment to environmental effects (design-to-cost); section C: advantageous to environmental effects, but a detriment to productivity (Eco Design).

a measure, economic productivity must be compared to the environmental impact. The ‚Eco-Care-Matrix‘ portrays the two dimensions, positive environmental effect (vertical axis) and specific customer benefit (horizontal axis). The centre of the ‚Eco-Care-Matrix‘ is an already existing technology, product, or reference solution. The ‚Green Solution‘ to be developed is only really green if productivity improvements are not gained at the detriment of the environmental effects, and vice versa. A green solution must be better than the reference along both Eco axes.

Open pit mining as an energy intensive process

Siemens has now applied the ‚Eco-Care-Matrix‘ in mining, in order to investigate the energy efficiency of intermittent conveying concepts. Large amounts of power and diesel are required to transport the enormous amounts of rock, ore, or coal. The environmental impact of energy-intensive open pit mining

with its high direct and indirect carbon dioxide emissions is enormous. Direct emissions, for example, are caused by exhaust gases from the combustion engine of the mining truck, whereas indirect emissions are not generated in the mine but result from consuming power generated in an off-site power plant. At the same time, reliable trucks which can operate under extreme conditions – +45 degrees Celsius in Central Africa to -40 degree Celsius in Canada – are required. Therefore cost reduction per ton of conveyed material is the main focus of attention – and over the entire life cycle at that.

For over 30 years, Siemens has been equipping mining vehicles with drive technology. A few years ago, it implemented a shared platform used for, among other things, power shovels, trucks, and draglines – the so-called SIMINE concept. An evaluation of specific drive solutions with the ‚Eco-Care-Matrix‘ has now shown that both the environmental effects and the specific customer benefits exceed the reference solution along both Eco axes.

The example of the 327t dump truck with diesel-electric AC motor clearly illustrated the specific advantages of the SIMINE TR solution. The drive concept ensures optimal control of the AC motors in the dump truck, providing powerful acceleration and high working speeds with low fuel consumption, thereby lowering greenhouse gas emissions. The drive system is based on the proven IGBT (Insulated Gate Bipolar Transistor) converter technology, which is distinguished by low line and switching losses as well as high reliability, robustness, and overload tolerance when supplying power to and controlling motors.

Under consideration of all operating and consumption data, an 11.6 % better environmental compatibility resulted on ac-



Trucks like the 860E-1K by Komatsu can transport a payload of 260 tons or more. Siemens drive systems ensure that the productivity in the mine can be increased and that the environmental impact is lowered.

count of the lower fuel consumption, when compared with the reference solution. Instead of the previous 400 l/h, the SIMINE TR drive solution only consumes 350 l/h. The specific customer benefit was increased by a similar amount through 6.8 % lower costs in comparison to a conventional drive system. Both the higher availability of the drive system as a result of longer operating times, and the increased transport capacity of 4 000 000 mt/a result in significant cost savings for the mine operators. This allows mining companies to further reduce the downtime of their systems and to optimize the productivity of their operations.

Dragline excavator with direct drives

AC motor drive systems by Siemens are not only used in over 500 trucks, but also in around 140 power shovels, cable excavators, and dragline excavators. Direct-drive AC motors are particularly noteworthy in this regard – they are primarily used in dragline excavators, mostly in Canada, the USA, South America, Australia, and China. Unlike the trucks, the excavators are at the same place for a longer time. Therefore they don't require a diesel generator. The SIMINE DRAG drive concept for direct-drive AC motors eliminates the use of a transmission in dragline excavators, increasing the productivity and effectiveness. Direct drive systems have low speed motors whose speed is continuously adjustable via the frequency. Power is supplied by a cycloconverter. Eliminating the transmission significantly reduces the maintenance and material demand in comparison to conventional drive systems. Longer service intervals opti-

mize maintenance, thereby increasing the excavator's availability. Direct alternating current drive systems also have an up to 20 percent higher efficiency and consume less energy than conventional drive systems with transmissions. This reduces the operating costs. The systems can be retrofit on excavators which are already in use.

An 'Eco-Care-Matrix' evaluation for dragline excavators shows that direct drive AC motors in open pit mining applications are almost a quarter more energy efficient on both Eco scales than comparable conventional solutions. A 22 % higher environmental compatibility – and therefore savings potential per ton of excavated material of 1.01 kg CO₂ equivalent – resulted for dragline excavators. At the same time, the SIMINE DRAG solution offers advantages in terms of higher availability of the drives and, in comparison to the reference solution, a 25 % higher annual excavating capacity of over 47 million metric tons.

The examples show: intelligent systems that increase the energy efficiency in the industrial value-added chain are feasible. The Eco-Care-Matrix helps design engineers to meet the environmental standards required by legislation, while at the same time modelling the environmental effects of building a system or manufacturing a product ahead of time. In addition, ecological assessments lead to competition for the most environmentally compatible developments – even within the company. In the future, the Eco-Care-Matrix can and will also be used in other Siemens business units.



Recycling economy and zero waste strategies in steel manufacturing

ThyssenKrupp operates an integrated smelting works in Duisburg. Pig iron and steel production are combined here in one location. The company is investing in systems which reduce environmental impacts and conserve resources. For individual new construction projects, up to 30 percent of the entire budget is allocated to environmental protection measures. As for the new blast furnace 8 which was inaugurated in 2008, it amounted to 80 million Euro.

Protection of water, air pollution control measures, noise reduction, and an almost completely closed recycling system are an inherent part of the operational processes. The system configuration in Duisburg enables the reduction of energy and water demands during the production process to a minimum. Process gases generated during the production of iron and steel in the blast furnaces, steel mills and coke ovens play a key role in the energy network. They are used for generating power in power plants and as an energy source in the production systems.

The two power plants in Duisburg have a total electrical power output of over 800 megawatt. The energy management system is designed to completely cover the smelting works' demand. As a result, the amount of power and natural gas that has to be purchased additionally is kept to a minimum. Additionally, ThyssenKrupp Steel Europe feeds energy into the district heating and power grids.

The water cycles in the production of steel are almost completely closed: Large amounts of water at different quality levels are required for the fabrication process in the different manufacturing stages, especially for cooling purposes. The entire annual water requirement for ThyssenKrupp Steel Europe in Germany is at approximately 1.2 billion cubic meters. Only 5.5 % of this demand is actually covered by fresh water. The rest is reprocessed up to 40 times in closed systems according to the respective application. Fresh water is primarily drawn as bank filtrate from wells near bodies of water.

By-products as quality-assured resources

Resource conservation is also achieved by using the slag accrued in the melting processes of the blast furnaces and steel mills. Unusable by-products from the manufacturing of pig iron and steel are extracted in these oxidic masses. For many years ThyssenKrupp Steel Europe has been supplying blast furnace slag and granulated cinder to, among others, customers in the cement and building products industries. These products are subject to respective industrial standards.

Internal and external quality assurance processes guarantee that the product quality meets the high customer demands.

Up to 97 percent of the blast furnace slag generated as a by-product of pig iron production is processed directly into so-called granulated cinder. Granulated cinder is an important raw material for the manufacturing of cement. The usage of granulated cinder as raw material helps to conserve natural resources such as limestone and saves energy. In comparison to natural feedstock raw materials, the use of granulated cinder also allows for a reduction of CO₂ emissions. Blast furnace cement is considered to be particularly durable and resistant against frost, chemicals, and road salt. It is therefore preferred for use in buildings subjected to extreme external conditions. The TV towers in Düsseldorf and Dortmund or the Oosterschelde flood barrier in the Netherlands, for example, are built with blast furnace cement.



Blast furnace slag: Resource for building streets, raw material for the cement industry.

Blast furnace slag provides outstanding advantages for highway construction: Due to the self-hardening properties of the material, the load carrying capacity of streets built with this type of cinder increases for years. Steel plant slag is also used as a building material, for example to construct roadbeds or to stabilize the shores of rivers and oceans. Furthermore, finely ground, phosphoric steel mill slag is a much demanded fertilizer.

Blast furnace lump slag and granulated cinder from ThyssenKrupp Steel Europe are of such high quality, that they don't have to be declared as waste. Instead, these by-products of steel manufacturing are recognized as products with a specific purpose. This was the result of an agreement concluded in 2006 between the North-Rhine-Westphalian Minister of the Environment and ThyssenKrupp Steel Europe.

Zero Waste with Oxycup Technology

Since 2005, ThyssenKrupp Steel Europe has been operating a shaft furnace in Duisburg, used to convert steel manufacturing waste with a high iron and carbon content into high quality pig iron. The oven with a capacity of up to 170,000 tons per year is the only system of its kind in the world. With the Oxycup technology, ThyssenKrupp Steel Europe processes fine dust from the blast furnace airborne dust removal systems and from the sintering system.



ThyssenKrupp Steel Europe uses the Oxycup technology to obtain pig iron from production waste.

The dust is collected in the powerful dust extraction systems which the company has installed for the purpose of environmental protection. Blast furnace dust and dust from the oxygen steel mills is also used. Examples of other feedstock materials for the shaft furnace include washing tower sludge from washing of the blast furnace exhaust gases, roller scale sludge from the hot rolling mills, and sludge from the cold rolling mills and coating systems at ThyssenKrupp Steel Europe AG. The shaft oven also processes ferrous slag residue.

Just how valuable these materials can be is illustrated by the dust from the converter steel mills: Its iron content is comparable to that of the iron ore raw material. Therefore part of the dust and sludge generated at ThyssenKrupp Steel Europe was already reused directly in production before the shaft oven went into operation. But only coarse-grained materials can be processed in this manner. Fine-grained material sometimes requires expensive disposal. The shaft oven processes up to 200,000 tons of waste material every year, the majority of which was not recycled before.

In addition: When the oven converts waste materials into raw materials, this also generates material which has an economic benefit. The shaft oven produces washing tower sludge with

a high tin content, which can be further processed in tin mills. The slag produced in the oven is completely inert and as hard as granite. Extensive testing has shown that the slag is absolutely safe from an ecological perspective, so that the federal environmental agency has categorized it as a substance which is not hazardous to water. With this certification, the material can be used to construct dikes or for other water-related construction measures. The shaft oven is also integrated into the gas cycle of the Duisburg steel production site. The blast furnace gas with a calorific value of around 4,300 kilojoules per cubic meter is purified and then fed into the gas network, or is used directly as an energy source for the shaft oven.

Waste Management and recycling: Steel manufacturers such as ThyssenKrupp Steel Europe do not only help to avoid waste in their own production systems, their contribution continues with their products. Whether car body, washing machine housing, or bridge pier – once the life cycle of these products is at an end, the steel always ends up back where it came from. The steel mill turns steel back into steel, as often as you want and with no loss in quality.

Polysius develops resource efficient solutions

Cement-bound building materials are essential for modern, sustainable construction. Cement is produced on the basis of primary raw materials. Conversion and refinement of raw materials also consume fuel and power. The primary feedstock materials are limestone and clay, or a natural mixture of the two called lime marl. Conservation of these non-renewable resources should be achieved by increasing the resource productivity, increased recycling rate, and the use of substitution potentials (meaning the modernization of existing components).

The capital-intensive manufacturing of cement is defined by process technology innovations. Particular emphasis is placed on resource and energy efficiency. In the production of cement, water is used to cool the machines, to condition the exhaust gases, and in old wet ovens to treat the sludge. In the development of new processes, the ThyssenKrupp subsidiary Polysius is increasingly focusing on reducing the water consumption in the production processes.

150 years of the Art of Engineering

The Polysius research and development (R&D) centre is highly regarded around the world. Polysius is one of the leading engineering companies for cement and mineral industry equipment. The company's offering is marked by growth and ongoing development. Polysius machines and processes are used throughout the world in order to extract and process raw materials for highly demanded end products. Over 2000

employees around the world work in project development, construction, supply, installation, commissioning, and comprehensive service activities. Polysius constructs complete production lines and individual products, as well as modifying systems. The R&D centre secures sustainable and resource conserving products and processes for Polysius. In this way the company is reacting actively to global challenges and impulses. New markets set specific requirements for processes and products. Thanks to the R&D centre, Polysius is very well prepared for all demands. Through the use of tools which support the R&D process – such as finite element and computational fluid dynamics calculations – and the targeted scaling up of laboratory systems to pilot and industrial plants, the planned developments are well prepared for use in practice. The R&D centre incorporates various laboratories for research purposes: The chemical, physical, geological, and mineralogi-



A typical cement factory built by Polysius: This factory in Senegal produces approx. 3600 tons of clinker per day.

cal departments form the basis for the technical calculations, measurements, and process and design developments. The „pilot plant centre“, the so-called mini production line, contains mills, furnaces, and workshops in order to perform simulation under real-life conditions: milling tests, flammability and wear tests, testing of components, and environmental effects. The ideas for the R&D centre are generated by Polysius engineers, customers, or scientific institutions. This close communication and cooperation characterizes the relationship between Polysius and its partners. The main focus at the R&D centre is on the highest possible cost effectiveness, low investment costs, and resource efficiency. To this end, the scientists optimize the cement and mineral industry production processes for minimal energy requirements, minimal emission values, environmentally compatible system design, and maximum use of secondary raw materials and fuels.

Step by step process optimization

A total of 90 employees at the R&D centre maintain a focus on the continuous development and optimization of products and processes. The centre is divided into three sections – process technology, laboratory, and pilot plant – as well as design and technical calculations. This ensures that the solution – from the idea to the first prototype – passes through all stages within the R&D centre. Scale up to the industrial system is the last step in the R&D process, once final acceptance of the tested solutions at the laboratory scale is successful within the desired parameters. The division also performs the initiation of the first industrial system under its own responsibility.

Savings in practice

The manufacturing of construction material in the modern Polysius cement factories is a highly technological process which involves large impacts on the environment. The raw material for the cement, normally limestone, clay, and siliceous sand, are ground in the vertical roller mill and fired into the rotary furnace to produce so-called clinker. The final fired clinker has a temperature of approx. 1,400 to 1,500 degrees Celsius. A special product which is in high demand is white cement. Rapid cooling is necessary in order to preserve the white in the clinker. In general: The faster the cooling and the lower the fraction of coloured components in the starting material, the whiter the cement. One of the biggest milestones of more recent research projects is the development of an innovative cooling process. Traditionally, the white cement is cooled down to the temperature required for storage and transport using a water bath. The disadvantage of this approach is that another process step is required to dry the cement. Furthermore, the contact with water can result in a reaction with the clinker minerals, so that the cement quality no longer matches the theoretical assumptions. ThyssenKrupp subsidiary Polysius developed a twin-cooler within its R&D centre. It is a two-part system consisting of a cooling drum and grate cooler. The clinker which drops out of the oven is cooled down with water in a cooling drum from 1500 degrees Celsius to 600 degrees Celsius within two minutes, then transported to the grate cooler which uses air to continue cooling it down to 100 degrees Celsius. The residual heat in the clinker can be routed back to the oven as pre-heated air, thereby contributing to the energy efficiency of the overall process. In comparison, in the conventional process, the fired clinker drops out of the oven and directly into a container of water and is transported out wet, or sprayed with water in a cooling drum to cool it down to approx. 100 degrees Celsius directly.

With the new process, the use of water for cooling can be reduced by up to 40 percent in comparison to conventional processes. Re-using the residual heat also lowers the primary energy demand in the oven. This allows the system operator to save on direct costs and significantly reduces the environ-

mental impacts. The process is already in use in several cement factories built by Polysius: the fifth industrial plant went into operation in 2010. The new process results in a calculated reduction in water consumption of almost 600 cubic meters of water per day for all five plants together.

By modernizing cement factories, Polysius also provides options for reducing the water consumption significantly in existing plants, which produce normal cement using the old wet process. In the so-called wet oven, soft raw materials such as chalk and clay are mixed to form a slurry, then milled together wet with the dry and hard raw materials. Through this type of processing, the water consumption in cement factories with wet ovens is approximately 700 kilograms higher per ton of cement than with a modern dry oven operating on the dry process. Two practical examples for modernization of such old wet ovens through dry ovens are the cement factories La Robla in Spain and Kujawy in Poland. Modernization of the plant in Poland alone resulted in savings of over one million tons of water per year.



Resource efficiency in the tourist industry

Climate change is one of the biggest challenges for living together on Earth in the future. The use of fossil fuels such as kerosene or heating oil increases the greenhouse effect. As a result, more severe weather events will occur in the future. Thus global warming will have direct and indirect consequences for the tourism industry in the coming years.

We are consuming natural resources along the entire value-added chain through our tourism activities around the world. In order to increase the resource efficiency, TUI has been getting involved for many years with concrete measures which are continuously reducing the consumption of resources while at the same time saving energy, water, and waste disposal costs.

The efficient use of energy in our Group companies results in a continuous reduction of our impact on the environment and climate. The use of renewable energy sources like biomass or solar energy in particular make a big contribution to resource conservation.

Two examples which can be used to illustrate improved resource efficiency through the use of renewable energy sources within the TUI Group are the biomass heating plant at the ROBINSON Clubs Amadé in Austria and the solar heat system in the ROBINSON Club Agadir.

Biomass heating plant ROBINSON Club Amadé

The use of renewable energy to help with resource conservation and climate protection is an important element of the environmental efforts at TUI Hotels & Resorts. The ROBINSON Club Amadé in Kleinarl (Salzburger Land, Austria) obtains energy from a carbon neutral biomass heating plant with state of the art condensation technology.

Construction of the Club hotel in Kleinarl started in 2003. The original plan called for an oil heating system to supply heat. However, a more environmentally friendly solution was sought as part of the standardized ROBINSON sustainable philosophy approach. In cooperation with the investors in the club, farmers from Kleinarl, and the companies Nahwärme GmbH and AESG, a biomass heating plant was built in the spring of 2004 as an alternative to conventional energy sources.

By including local farmers, fuel can be supplied in form of chopped biomass from their forests and operations throughout Kleinarl. The modern system supplies 100 % of the

heating energy and warm water for the ROBINSON Club, and also supplies most of the village. With ROBINSON as a large customer, Nahwärme Kleinarl was able to build its district heating system for the entire downtown. Construction of the system resulted in savings of approx. 800,000 litres of heating oil per year.



The ROBINSON Club Amadé in Austria obtains energy from a carbon neutral biomass heating plant with state of the art condensation technology.

Already during the first year of operation, a cost benefit of approx. 30 % over the originally planned system was achieved. Another cost advantage is the elimination of installation and maintenance measures for conventional heating systems for the connected house and hotel owners.

Efficient use of solar heat at the ROBINSON Club Agadir

The ROBINSON Club Agadir in Morocco opened in April 2008. Great importance was already placed on the use of climate friendly technologies and renewable energy during the construction phase. As a result, the club operates the country's largest hotel solar power plant. A solar heat system with a total area of 900 m² is distributed over several of the club's roofs, covering all of the hotel's heating requirements and heating the pool. The German quality and market leader in the premium club vacation segment passes experience and knowledge on locally: The club has established its own hotel management school in Morocco in order to train new staff.

TUI has an ongoing commitment to the protection of the environment and nature. Through the efficient use of natural resources, we are reducing negative impacts on the environment and thereby securing the continued success of TUI.



Efficient use of solar heat at the ROBINSON Club Agadir, with Morocco's largest hotel solar powerplant.

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