SRU German Advisory Council on the Environment

Environmental Report 2012
Responsibility in a finite world

Chapter 2:

Metallic and mineral resources

June 2012

Forword

This is a chapter of the Environment Report 2012 on "Responsibility in a finite world" published by the German Advisory Council on the Environment in June 2012. Guiding principle of that report is that environmental limits should be taken seriously. Unlimited physical growth is not possible in a finite world. This means that the dramatic reduction of our resource and energy use and their environmental impacts are becoming a key question of the 21st century. The report has eleven focal themes[1], ranging from the new growth debate, the protection of important ecosystems such as peatlands, forests and oceans to a strengthening of integrated environmental protection.

With its Environmental Report 2012, the SRU extends the perspective beyond the energy transition towards other important future-oriented issues in German and European environmental policy. Using a "horizon scanning" approach, the seven council members of the SRU identify important unresolved problems and point towards specific options for political action. The starting point of the report is that serious impacts for economy and society have to be feared if safe planetary boundaries and environmental limits are being exceeded. Exploiting all potential for decoupling economic growth and environmental impact is therefore a matter of priority. Such an innovation strategy would offer at the same time considerable economic opportunities for German industry.

Analysing a number of intractable problems, the SRU highlights the potential for a reduction of environmental impacts, for example:

– The use of metallic and mineral raw materials can be reduced, for example through systematic introduction of closed-loop processes. The SRU proposes in this context mandatory deposit schemes for selected electronic devices. Raw material extraction – which tends to be very energy intensive – could become more climate-friendly if ambitious reduction targets are set for the European emissions trading system (the EU 30 % target for 2020) and if exemptions are cut back.

– Even the still growing goods transport could meet ambitious climate policy targets through a comprehensive electrification on the basis of renewable electricity. In addition to a shift from road to rail, the option of an overhead-cable system for electric-powered HGVs ("trolley trucks") should be seriously pursued. The technology has already been tested in demonstration projects.

– In the area of food, policy should also provide effective incentives for decoupling. Bringing down food losses by 50 % until 2025 could decrease the environmental impact of our food consumption. Moreover, the high meat consumption which has equally negative impacts on the environment and on health, should be significantly reduced. Abolishing the reduced rate of value-added tax on animal products and introducing a tax on saturated fatty acids are therefore options to be investigated.

Despite this large untapped potential, a sufficient degree of decoupling may not be achievable. As part of a precautionary strategy, policy and society should therefore also reflect on conditions of social and political stability under conditions of low economic growth.

Ecosystems such as forests, oceans and peatlands do not only supply important resources, energy and food, but they also make important contributions to climate protection and provide other ecosystem services, including habitats for many species. These services, which are not rewarded by the market, are under threat unless economic pressures are reduced. German forests, for example, may soon reach a point where they release more greenhouse gases than they store. For this reason the SRU recommends introducing limits on forest biomass use to secure the long-term status of forests as carbon sinks. In addition, a comprehensive and integrated monitoring should be established as an early warning and evaluation system.

Environmental limits can only be observed if the remit and authority of environmental policy vis-a-vis other policy areas are considerably strengthened. As a basis for this, the SRU recommends the establishment of an encompassing national environment programme with ambitious targets which would give a new impetus to other policy areas.

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[1] The Environmental Report covers eleven topics: the new growth debate, decoupling prosperity from resource use: metallic and mineral resources, food consumption as a policy issue, freight transport and climate protection, mobility and quality of life in urban agglomerations; appreciating the value of ecosystem services: environmentally sound use of forests; peatlands as carbon sinks, cross-sectoral marine protection; reinforcing integrative approaches: Integrated environmental protection: the example of industrial permitting, integrated monitoring, environmental and sustainability strategies.

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2.1 Problem

99. Natural resources are the basis of life and the foundation for economic activity. Resources in this sense means not only water, soil and air, but also biotic (e.g. wood) and abiotic resources (e.g. metals, minerals, fossil fuels). In view of the widely differing properties and uses of the various resources, it makes sense to adopt a differentiated approach. This chapter will undertake a critical analysis of the current situation with regard to the management of abiotic, non-fossil resources (i.e. metals and minerals). Serious environmental impacts can arise from the production and use of these resources. The situation is exacerbated by the fact that demand for metals and mineral resources is increasingly rapidly at both national and international level (cf. para. 104). In the case of certain resources, the boom in demand is causing at least temporary shortages and price rises. This makes it economic to penetrate into strata at ever increasing depths and to develop mines with much lower ore concentrations than in the past. At the same time it is increasing the pressure to explore ecologically sensitive regions. The aim of this chapter is to take a closer look at the environmental impacts of such developments and to examine suitable measures that permit environmentally sounder use of abiotic, non-fossil resources.

100. At European level the resources issue is certainly regarded as a pressing concern: this is documented by the flagship initiative "Resource-efficient Europe" (European Commission 2011f), the Commission's communication "Tackling the challenges in commodity markets and on raw materials" (European Commission 2011d), the EU raw materials initiative (European Commission 2008b), the "Roadmap for a resource-efficient Europe" (European Commission 2011c) and the European Parliament's latest report on an effective raw materials strategy for Europe (European Parliament – Committee on Industry, Research and Energy 2011). However, the prime concern of these documents is security of supply based on unimpeded access to raw materials, whereas they do not pay sufficient attention to the environmental and social consequences of resource management. The European Parliament's report is the only one to address issues such as reducing consumption, recycling, instruments, and responsibility for environmental impacts in the source countries. Even the German government's resource strategy focuses largely on an adequate supply of raw materials for industry, and largely ignores environmental aspects (BMWi 2010). The German Resource Efficiency Programme (ProgRess), lead-managed by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), supplements this strategy and now addresses the environmental dimension of resource policy as well (BMU 2011a). The main focus of the programme is on approaches to more efficient use of resources. While this is essential for environmentally sounder resource management, it is not sufficient in itself.

This chapter will demonstrate the need to pay greater attention in particular to the environmental dimension in the extraction phase (cf. Chapter 2.2) and the potential for better coordination of resource and waste policy. The expansion of closed-cycle management of resources offers an economy great opportunities for ensuring security of supply (RNE 2011). The requirements of the Waste Directive (2008/98/EC) are currently being transposed into German law. However, the revision of the Waste Electrical and Electronic Equipment Directive (WEEE Directive, 2002/96/EC) is the subject of highly controversial discussion (European Commission – DG Environment 2012). Moreover, another focus of current attention is the low recycling rates of many raw materials (MOSS et al. 2011) (UNEP 2011).

101. Giving a greener face to German resource policy is a particular challenge in view of the fact that Germany imports a large proportion of the raw materials used in industry. Whereas mineral resources such as sand and gravel are largely extracted and processed in Germany (BGR 2010), virtually all metallic resources have to be imported from abroad. This means that while direct monitoring and regulation is possible with regard to the environmental impacts of mineral resources extraction within Germany, the environmental impacts arising from the extraction of metallic resources are largely beyond Germany's direct control. In many source countries the social and environmental standards fall far short of the requirements in force in Germany. The problems of appropriate working and social conditions cannot be dealt with in this report, but the German government should pursue them with the same intensity as the task of minimising environmental impacts.

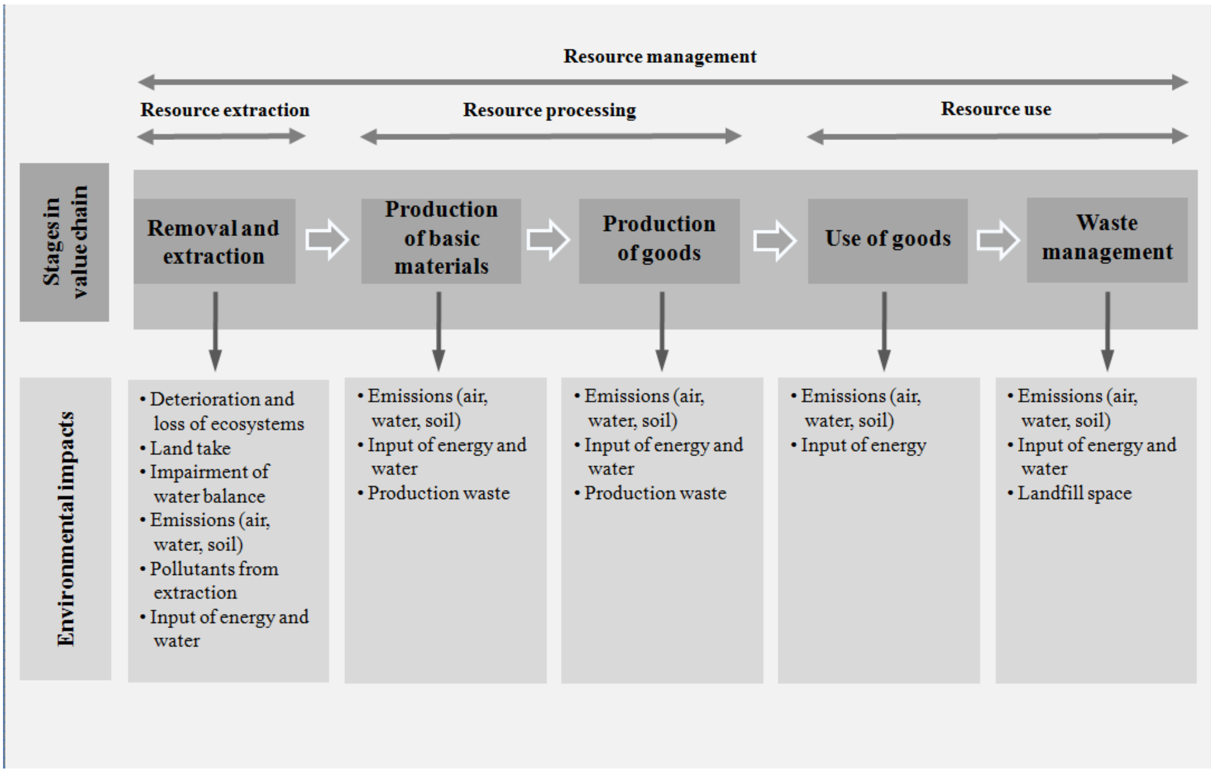
102. A change of direction in resource policy leading to a reduction in the environmental impacts of resource management has numerous environmental benefits: it reduces the pressures on biological diversity, the toxic consequences for man and the environment, and the consumption of energy and water. At the same time, greener resource management also offers economic opportunities. Resource efficiency lowers demand for finite and increasingly expensive raw materials and reduces the country's dependence on imports from unreliable sources of supply. More resource-efficient production and the associated cost savings will not only improve the competitive position of German industry, but also generate worldwide sales opportunities for exporting technologies for the future. Reinforcing closed-cycle management can also create new jobs in Germany.

2.2 Environmental impacts of resource management

103. This section summarises all stages in the value chain under the heading of resource management (see Fig. 2-1). Resource production comprises mining and dressing (extraction). Resource processing covers the production of basic materials and goods, while resource use describes the phase of consumption and waste management. Resource consumption is the measurable quantity of resources used in national production.

Figure 2-1

Environmental impacts along the value chain



SRU/UG 2012/Fig. 2-1

The increasing extraction and use of resources leads to environmental pressures arising along the entire value chain (Fig. 2-1). The most serious impacts occur in the first three stages of the value chain. Resource extraction gives rise to consumption of land and nature. It also results in releases of the resources themselves (e.g. lead dust), accompanying (possibly radioactive) substances and auxiliary substances used in extraction (e.g. cyanide and mercury in the production of gold). Production of basic materials and goods frequently involves high energy and water consumption and leads to emissions of pollutants with adverse effects on man and nature. Finally, the flows of materials give rise to waste. Not only is this not completely recycled, but it can also harm the environment if not disposed of properly (SANDER and SCHILLING 2011).

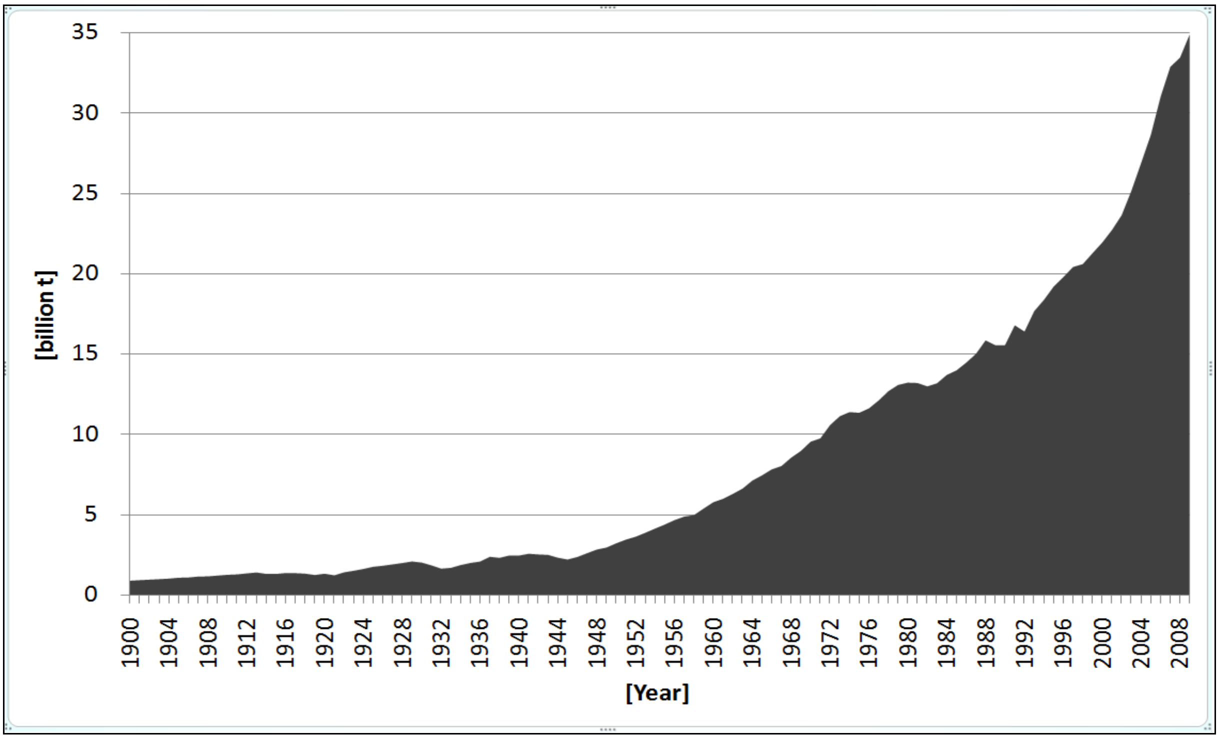
Initially, the impacts of resource use are locally and regionally limited – with the exception of the greenhouse gas emissions caused by the high energy consumption during extraction and processing. Developing and newly industrialising economies with inadequate environmental standards are particularly affected by the adverse impacts arising from resource extraction. Even in Germany, the extraction of resources such as sand and gravel is not without adverse impacts on the environment (MESSNER and SCHOLZ 2000). In view of the accumulation of adverse local impacts, worldwide resource extraction means that we are faced with a ubiquitous problem that initially produces local pressures only, but adds up to a problem of global dimensions.

104. In view of the lack of central documentation (of quantities, sources, extraction methods etc.), awareness of the impacts of resource extraction is not very well developed. Whereas in a European context the risks may be regarded as manageable because of existing regulations, systematic quantification of the environmental impacts in developing and newly industrialising countries is not possible. However, there is no denying that the pressures will increase as demand rises. Since the beginning of the 1990s, worldwide extraction of metallic and mineral resources has doubled to 35 billion tonnes (Fig. 2-2). About 40 percent must be added to this figure to take account of the unused material extracted at the same time (dead rock etc.) (SERI 2009). If the present trend is maintained, worldwide extraction and use of metallic and mineral resources can be expected to reach about 50 billion tonnes by 2030 (SERI 2009). This growth is driven in particular by the growing demand in newly industrialising countries such as China, India or Brazil.

Extraction of deposits with increasingly low concentrations (Fig. 2-3) also increases the environmental impacts as a result of the greater energy consumption needed for extraction, the more complex processing of the raw materials, and the growing quantities of spoil and rubble.

Figure 2-2

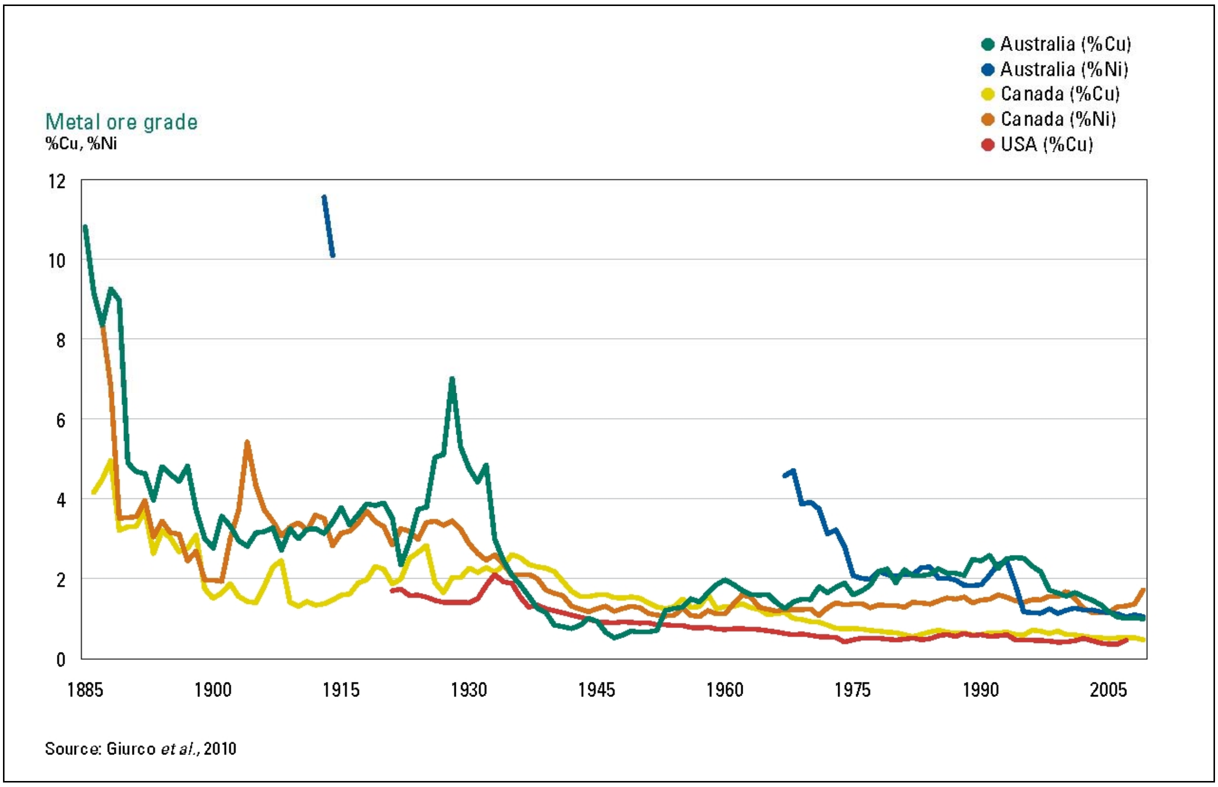
Worldwide extraction of metallic and mineral resources 1900–2009



SRU/UG 2012/Fig. 2-2; data source: KRAUSMANN et al. 2009

Figure 2-3

Ore content in nickel and copper mines 1885–2010



Source: FISCHER-KOWALSKI et al. 2011, p. 24

Growing worldwide demand for resources increases the pressure on regions that are very sensitive to anthropogenic influences (e.g. the Arctic), and at local level on protected areas and their immediate surroundings.

The next section provides a qualitative description of the adverse environmental effects of the resource industries on biological diversity, the toxic consequences for man and nature, and energy consumption by the resource industry. The impacts of resource extraction in marine and hitherto largely unexplored regions such as the deep seas are beyond the scope of this report.

2.2.1 Impacts on biological diversity

105. Resource extraction always means interference with the relevant ecosystem, accompanied by impacts on local biodiversity. It not only results in the removal of valuable raw materials, but also involves the movement of large amounts of other – unused – substances which have to be extracted to get at the substances sought. In Canada, for example, producing 1 t of copper gives rise to 99 t of spoil, which also has to be extracted (SDWF 2011). The land consumptionassociated with resource extraction can produce marked changes in the ecosystems affected and can lead to loss of local biological diversity. In addition to the destruction of habitats, pressures may arise as a result of emissions such as noise, particulates and pollutants, and also drastic changes in the water balance and the landscape. The seriousness of the impacts depends not only on the nature and scale of the encroachment, but also on its duration and intensity and the time it occurs. Other decisive factors are the resilience of the individual ecosystem and how close it is to a natural condition (European Commission 2011b). Depending on the type of encroachment, the impact may not be restricted to the land used for extraction, but may also extend to the infrastructure needed for extraction, such as roads or storage areas, and to adjacent areas, for example as a result of emissions or lowering of the water table.

106. As resource prices rise, the exploitation of new extraction regions becomes increasingly lucrative. For example, a satellite-based study has revealed that felling of the Peruvian rainforest – a global “biodiversity hotspot” – increases in parallel with the rise in gold prices. Both the price of gold and the annual deforested area quadrupled between 2003 and 2009. This was accompanied by an increase in imports of mercury, which is used for gold production in small-scale mining and is largely released into the environment (SWENSON et al. 2011).

The resources extracted in Germany are mainly mineral building materials (sand, gravel, quarry stone) and fossil fuels (coal, natural gas). This is already governed by high environmental standards for both extraction and subsequent use. As virgin soil land, these extraction sites may be of importance for rare pioneer species (NABU 2004). Here too, however, impacts may occur due to the destruction of (natural) ecosystems, pollution by emissions such as noise and particulates, and also changes in the water balance and the landscape. Wet extraction of gravel has considerable impacts on the water balance. Here removal of the overburden exposes the groundwater, and this can easily result in inputs of pollutants and deterioration of groundwater quality (MESSNER and SCHOLZ 2000). Economically attractive gravel deposits are often situated in the water meadows of major rivers, which dry out as water levels fall in response to gravel extraction and may thus be destroyed. As a result of intensive use, 90 percent of these – from a nature conservation point of view – valuable habitats already display changes ranging from marked to very severe (BMU and BfN 2009). Where gravel is extracted by dry methods, the open-cast excavations can be refilled after the end of extraction operations or – as in most cases in Germany – flooded. Although this creates secondary habitats (e.g. gravel pit lakes), these are frequently used as recreational areas in view of their attractiveness. The resulting visitor pressure places limits on their importance for nature conservation (NABU 2004).

Careful selection of extraction areas and subsequent restoration or recultivation can reduce environmental pressures and safeguard habitats or permit their targeted development as valuable secondary habitats for nature conservation (NABU 2004). Nevertheless, encroachments on the balance of nature in areas of extreme ecological sensitivity such as rainforests and areas with a high protection status, or in largely unexplored regions such as the deep sea (van DOVER 2011), may lead to irreversible impacts and disproportionately serious damage.

2.2.2 Toxic impacts on man and the environment

107. The acute toxic effects of the resource industry are mainly drawn to the public’s attention by spectacular events such as dam failures in facilities for sedimentation of metallurgical sludge (Baia-Mare/Romania, Aznalcóllar/Spain). The chronic effects, by contrast, are hardly noticed, because their occurrence is often delayed, they are hardly documented and, above all, they cannot be assigned clearly to an individual cause. Nevertheless, they can also cause serious harm to man and nature.

Occupational and environmental toxicity

108. Mining operations and ore dressing are some of the biggest sources of environmental pollutants worldwide (HARRIS et al. 2011). In the first instance, adverse impacts on health due to resource extraction affect mining personnel. Owing to inadequate safety standards they frequently suffer from illnesses such as pneumoconiosis, asthma or slow poisoning, or are exposed to accident risks (SERI 2009). Pollutant emissions and inputs may also occur during the processing of raw materials and the disposal of residual substances, especially where outdated technologies are used. For example, gold extraction in small-scale and artisanal mining operations makes use of techniques that result in substantial emissions of mercury. Estimates indicate that about one third (roughly 1,000 t/a) of worldwide mercury emissions arise from the extraction of gold in small-scale and artisanal mining operations, which account for 15 percent of annual worldwide gold production (TELMER and VEIGA 2009; Artisanal Gold Council 2011). The environmental impacts of mercury emissions are due to biogenic formation of the much more toxic organomercury, which contaminates waters and fish over large areas and for decades and thereby endangers human health. Rare earths are often associated with radioactive thorium, which is kept along with other toxic waste products in kilometre-long collecting ponds. The largest occurrence of rare earths outside china is in Australia (Mount Weld). The ores extracted there are transported to Malaysia (SCHÜLER et al. 2011), where the radioactively contaminated waste from ore dressing is also kept.

The adverse impacts affect not only the workers, but also local residents. Here the air and groundwater are heavily polluted. For example, the dust occurring during extraction and transport often contains high doses of arsenic, lead, other heavy metals or even radionuclides.

The occupational and environmental toxicity of resource extraction and processing is a problem that has not received sufficient international attention. Since the health risks of resource extraction are mostly far away from consumers in the industrialised countries, they are often unaware of them. Every year the Blacksmith Institute publishes, jointly with Green Cross, a report on the most heavily polluted places in the world, the worst producers of pollutant emissions or the most dangerous pollutants (GRANT et al. 2006; BLOCK et al. 2007; ERICSON et al. 2008; BLOCK and HANRAHAN 2009; McCARTOR and BECKER 2010). A large proportion of these pressures are directly or indirectly connected with resource extraction and processing. The studies indicate that more than one hundred million people are exposed to pollution that exceeds the internationally recommended health standards. This means that on an international comparison, the number of people affected by such health problems is roughly the same as for diseases such as tuberculosis, malaria and HIV/AIDS. The results are physical and mental disabilities, respiratory diseases, miscarriages and premature births, reduced intelligence, organ malfunctions, neurological dysfunctions, cancer and reduced life expectancy (McCARTOR and BECKER 2010).

Ecotoxicity

109. Contamination of the air, soil, groundwater and surface water with toxic substances presents a long-term and large-scale threat to nature. The wastewater from mine excavations or spoil tips can be extremely acid and contain large concentrations of dissolved heavy metals. It is possible to distinguish four main forms of water pollution due to mining (SDWF 2011): acid mine drainage (acid mine water containing heavy metals), contamination with heavy metals (e.g. arsenic, cobalt, copper, cadmium, lead, silver, zinc), chemical pollution (e.g. with cyanide, sulphuric acid), erosion of exposed soil and subsequent sedimentation. This may result in polluted drinking water, and water that cannot be used for irrigating farmland.

The main source of air pollution is the particulates occurring during the extraction and transport of resources (AEA Energy & Environment 2008). Ore dressing usually involves the use of fossil fuels, resulting in emissions of NO_x and SO_2 as well. Inputs of substances into the soil via air and water may also occur at considerable distances from the actual extraction sites. In China, for example, 10 percent of agricultural land is polluted with heavy metals. Pollution with lead plays a major role here, but there are also large areas where the limits for cadmium and zinc are exceeded (BUCKLEY 2011).

2.2.3 Impacts on groundwater and surface water

110. In underground mining operations to extract resources, it is often necessary to lower the water table. Depending on the individual hydrological and climatic conditions, this may have adverse effects on both surface water and groundwater. Changes in the groundwater can also have impacts at considerable distances from the mines (SDWF 2011). In the further dressing and processing of resources, water is used for separation and washing processes and for cooling (direct use) and indirectly for power generation (NORGATE 2010). Much like energy consumption (see Section 2.2.4), water consumption also increases as the ore content decreases.

In Chile, for example, 57 million m³ of water a year is used for copper processing (GLOKAL Change 2011), which inevitably results in changes in the water balance, especially in an extremely dry zone like the Atacama desert, where Chile’s biggest copper mine is situated. There are two problems here: one is the contamination of the water, the other is the loss of water through evaporation during sludge deposition. The water required for ore dressing in copper extraction is around 4 to 10 m³ per tonne of crude ore (WECOBIS 2011b) (world production 2010: 16.2 million t (USGS 2011)). The production of 1 tonne of aluminium (world production 2010: 41 million t (USGS 2011)) results in up to 57 m³ of wastewater (WECOBIS 2011a).

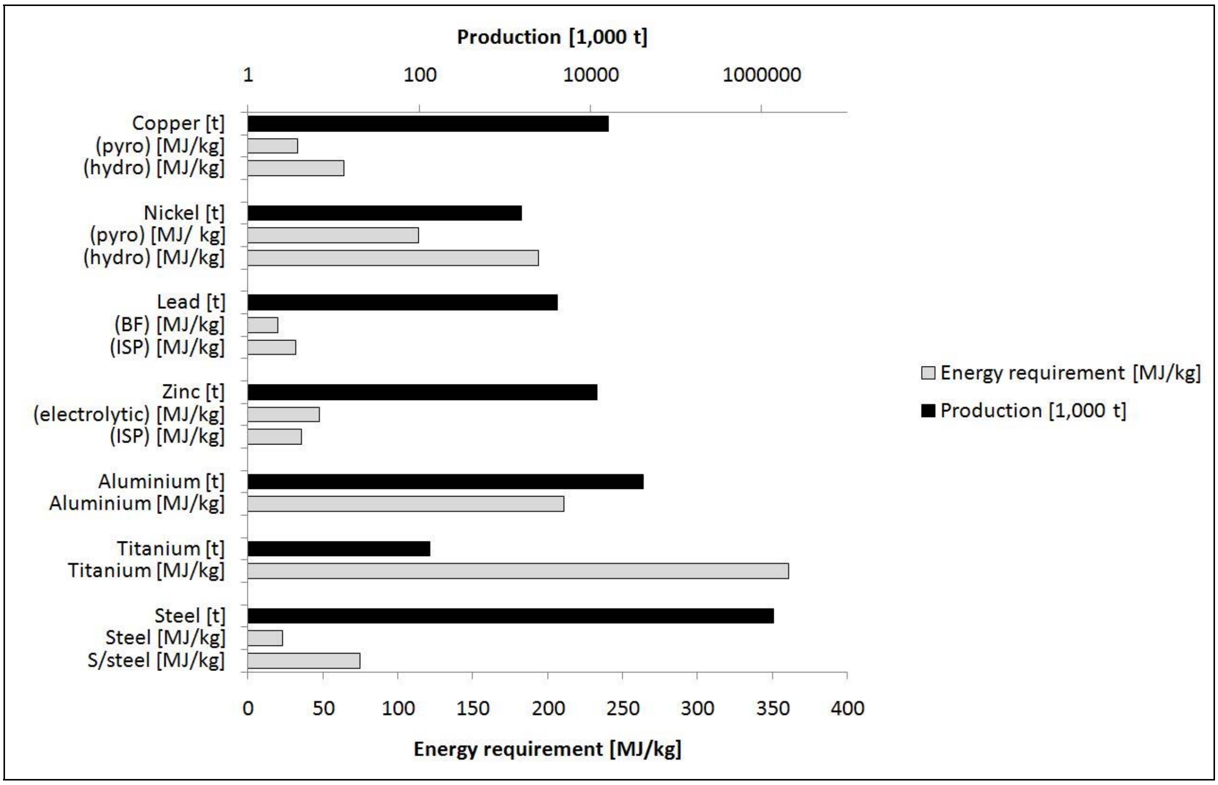
The extraction of lithium, which as a basic material for traction batteries plays a significant role in the expansion of electric mobility, may also lead to considerable pollution of the environment. Bolivia has the largest deposits worldwide – 6 to 9 million t on 10,000 km² of salt clay plain at an altitude of 3,600 m – and preparations are currently in progress for their extraction (HONOLD 2010). Here lithium-rich solution located beneath the plain is pumped to the surface and concentrated by evaporation. However, the plateau is also the region’s most important water catchment area, and the agricultural sector depends on it. There is already a shortage of water here and the water reserves are regarded as non-renewable, because groundwater recharge takes a long time. Apart from the destruction of ecosystems, other impacts of lithium extraction would be the high water consumption, wastewater and air pollution (e.g. lithium carbonate) (Global 2000 and SERI 2011; FEIL and RÜTTINGER 2010).

2.2.4 Impacts on energy consumption

111. Extraction and further processing of resources are very energy-intensive processes. Mining alone is responsible for about 7 percent of worldwide energy consumption (MACLEAN et al. 2010). This energy is usually obtained from fossil fuels. A further increase in energy consumption can be expected as ore concentrations in the mines decrease, especially in view of the larger quantities of residual material to be disposed of and the need to drill to ever-increasing depths (NORGATE 2010). This trend is already clearly visible in the case of gold, for example (FISCHER-KOWALSKI et al. 2011). In model scenarios, MACLEAN et al. (2010) therefore come to the conclusion that there is a risk of energy consumption in particular – alongside local water shortages and land take – becoming a limiting factor in metal production.

Figure 2-4

Worldwide production and energy consumption 2010 for the extraction of selected primary metals



SRU/UG 2012/Fig. 2-4; data source: USGS 2011; NORGATE 2010

Fig. 2-4 shows the energy requirements for the extraction and preparation of individual resources, and also the quantities extracted worldwide. The energy requirements for preparation of bulk metals such as copper or steel are relatively low, but these metals are extracted and produced in much larger quantities. In absolute terms, therefore, the energy consumption is greater.

Rising energy prices are already making recycling of bulk metals attractive (see para. 120 ff.). Worthwhile quantities of steel, copper and aluminium of adequate quality are available for recycling using existing technologies (WVM 2011). For instance, energy requirements for the production of secondary metals are only 5 percent of the primary production figure for aluminium and 29 percent for copper (FRISCHENSCHLAGER et al. 2010).

112. In the case of mineral resources, the extraction phase is less relevant despite the large quantities extracted. For example, the greenhouse gas emissions due to sand or gravel are much lower than for metal production. One factor of great importance, however, is the high energy consumption for the production of cement from mineral resources. This figure is increasing with the sharp worldwide rise in demand for housing and infrastructure (HORVATH 2004).

Replacing fossil fuels with renewable energy sources can reduce greenhouse gas emissions. Various analyses of potential have revealed that by 2050 between 80 and almost 100 percent of this could be met worldwide from renewable energy sources (WWF 2011; IPCC 2011). One major challenge will be to make renewable energy available where it is needed for resource extraction and processing, i.e. especially in developing and newly industrialising countries. However, the use of renewable energy sources could also – because of the associated technologies – lead to increasing demand for certain raw materials (MOSS et al. 2011).

2.2.5 Interim conclusions

113. Resource extraction always involves encroachments on the natural regime. It may result in deterioration or loss of ecosystems, adverse effects on the water balance, and emissions of pollutants and greenhouse gases. The severity of the impacts depends on the individual local framework conditions, such as how close the ecosystem is to a natural condition. Critical factors are the location of the extraction site, the quantity extracted, the concentration of the resources extracted, the accompanying (toxic) substances and the extraction technology used. The environmental impacts also vary depending on the nature of the resource extracted. The impacts of bulk metal extraction are due to the large quantities extracted and the high energy requirements for extraction and further processing. The extraction of technological raw materials in particular gives rise to toxic impacts on man and the environment. In view of the large quantities involved, the extraction of construction minerals is characterised by high land take and associated changes in and losses of ecosystems.

Owing to the lack of data and a suitable basis for evaluation, systematic quantification of the ecological impacts of the resource industry is not possible. However, the qualitative studies show that the impacts of the resource industry are great and that they will continue to increase in future because of the growing global demand and the exhaustion of easily accessible resource deposits. Special risks arise from the growing pressure to explore ecologically sensitive areas, where extraction should be dispensed with altogether.

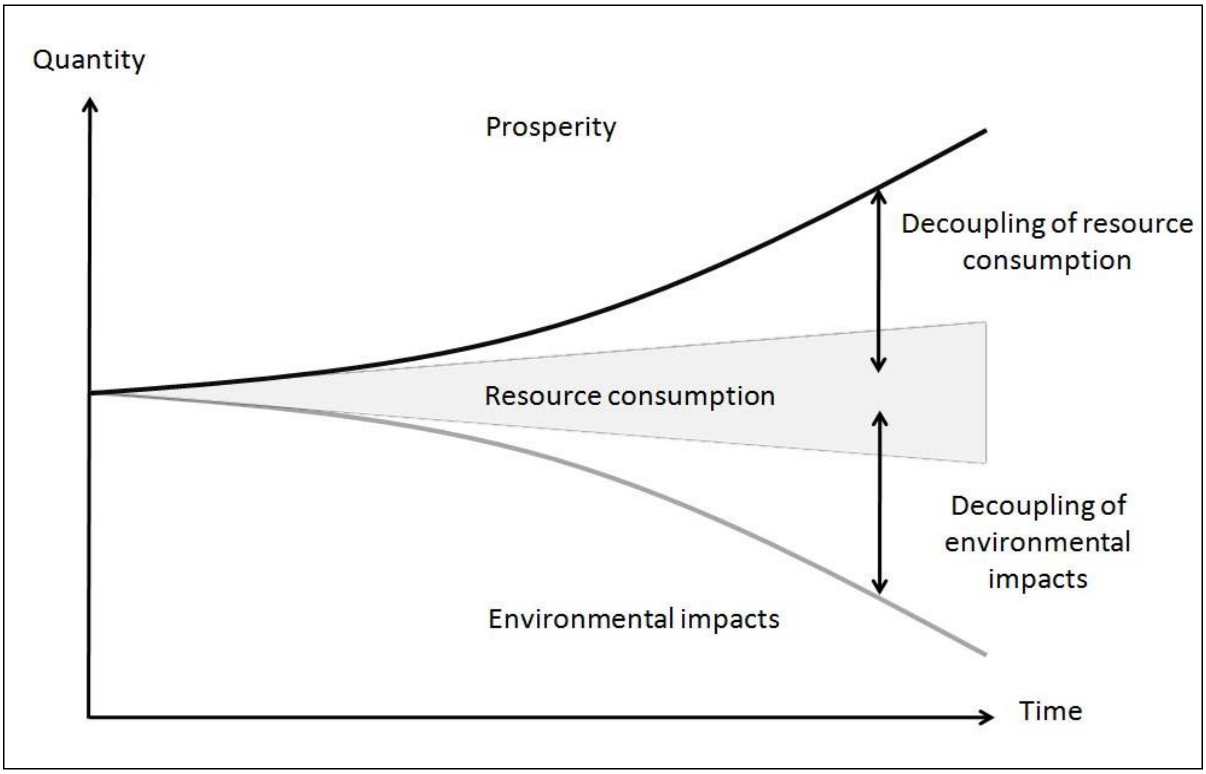
2.3 Objectives and approaches of green resource management

2.3.1 Plea for a dual decoupling concept

114. In 2001 the Organisation for Economic Cooperation and Development (OECD) defined decoupling as breaking the connection between adverse environmental impacts (environmental bads) and economic production (economic goods) (OECD 2001). The EU also gives prominence to the concept, for example in the European Commission’s communication of 21 December 2005 on a “Thematic strategy on the sustainable use of natural resources”. This states that sustainable use of natural resources (raw materials, air, water, soil, physical space, wind power, geothermal energy, tidal and solar energy) is to be ensured by reducing the adverse environmental impacts while maintaining economic growth. The International Resource Panel (IRP), under the aegis of the United Nations Environmental Programme (UNEP), makes a distinction between “resource decoupling” and “impact decoupling” (FISCHER-KOWALSKI et al. 2011, p. 5). Decoupling of resource consumption can be achieved above all by improving productivity, so that smaller quantities of resources are needed per economic unit produced. According to the IRP, impact decoupling calls for a reduction in environmental impacts in parallel with growing added value in an economic sense.

Figure 2-5

The two decoupling objectives of green resource management



SRU/UG 2012/Fig. 2-5

In line with these studies, the German Advisory Council on the Environment (SRU) applies the concept of decoupling in the following section to abiotic, non-energy raw materials. The SRU takes the view that a green resource policy should be based on both decoupling of resource consumption and decoupling of environmental impacts (cf. Fig. 2-5). The two objectives should be pursued in parallel. Unlike the IRP, the SRU defines impact decoupling as breaking the connection between environmental impacts and total resource consumption, and not between environmental impacts and economic output. This has the advantage that the two decoupling objectives can be considered on a cumulative basis, making it easier to see the connections between their interactions. For example, successes in one of the decoupling objectives may make it easier or more difficult to achieve the other objective: a reduction in material requirements reduces the need to exploit deposits that are highly sensitive from an environmental point of view. Strict environmental requirements make raw materials more expensive, thereby providing incentives to exploit efficiency potential. At the same time, however, the development of smaller devices may require the use of rare raw materials, and this increased demand may make it necessary to develop new mines, giving rise to additional adverse effects on the environment. Unlike bulk metals, the small amounts of these raw materials used in products mean that in most cases they are not recovered, and hence lost. Thus on balance, an improvement in efficiency need not necessarily result in positive environmental impacts.

Furthermore, the concept of prosperity provides a broader picture of quality of life than gross domestic product (GDP) (cf. Chapter 1). Prosperity is basically a theoretical concept which describes a parameter for measuring overall economic benefits, and which therefore goes beyond a one-dimensional focus on the mere quantity produced by an economy. At present it is still necessary to fall back on GDP for data collection purposes. Work should therefore continue on developing means of measuring prosperity.

It is necessary to distinguish between relative and absolute decoupling. Relative decoupling means that the rate of growth of raw materials consumption is less than that of prosperity (first decoupling step), or that the environmental impacts per tonne of raw material used are smaller (second decoupling step). Absolute decoupling, by contrast, requires a reduction in raw materials consumption regardless of growth in prosperity and a reduction in the environmental impacts of resource consumption as a whole. Whereas relative decoupling is not uncommon in industrialised countries, an absolute reduction in resource consumption is extremely rare (FISCHER-KOWALSKI et al. 2011).

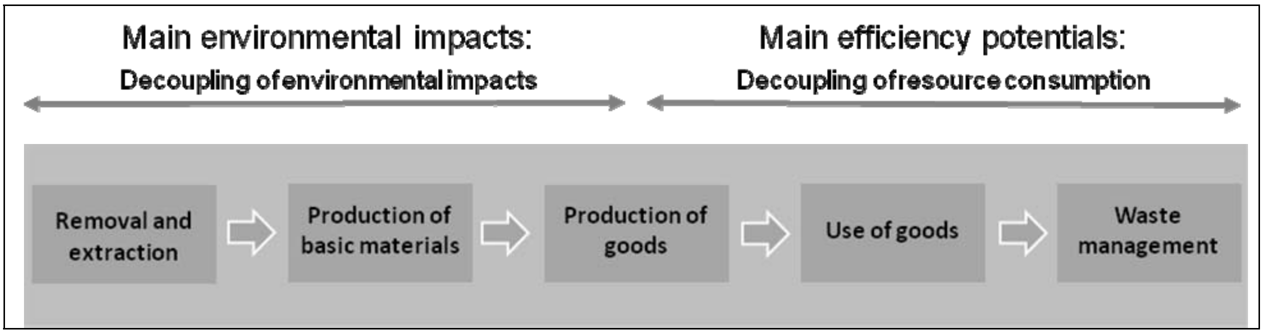
To date, decoupling of environmental impacts has been ignored by policy makers, but it needs to be given the same attention. However, the task of quantifying environmental impacts is extremely complex, as it is not possible to generalise biophysical limits for environmental pressures, and also because it is necessary to register environmental impacts over time and across national boundaries. This makes it all the more important to continue work on developing suitable indicators (cf. Section 2.3.5).

115. The greatest potential for reducing the environmental impacts of the resource industry is to be found in the first stages of the value chain. But the greatest unexploited potential for efficiency improvements exists in the field of product use and waste management (Fig. 2-6).

A crucial consideration is that improvements in resource efficiency in one area should not produce an increase in environmental impacts at another stage in the value chain. Particularly where miniaturisation is concerned, it is important to bear in mind that successes in material efficiency may be achieved at the expense of sacrifices in recycling of the raw materials used.

Figure 2-6

Main environmental pressures and efficiency potentials along the value chain



SRU/UG 2012/Fig. 2-6

2.3.2 Decoupling of resource consumption from prosperity

116. Decoupling of resource consumption means that the trends in resource consumption and prosperity take different courses. Whereas prosperity continues to grow, resource consumption should show a long-term fall. This means generating a greater economic benefit per unit of material input.

On a global scale, decoupling is only possible through joint action (cf. Section 2.4.4), as there is a risk that a decrease in demand in one country will be offset by increasing demand in other countries. Above all, there is a need for cooperation between the industrialised countries, because their resource consumption is many times higher than in the developing and newly industrialising countries (SERI 2009). If they succeed in setting an example by showing that a society can be both resource efficient and prosperous, this can also influence the development paths of countries that are currently less prosperous.

Production of goods

117. Improvements in material efficiency can primarily be achieved by optimising design and construction, and also production processes (reducing wastage, increasing in-plant recycling). Radical improvements can be expected from innovations which result in new product and process design and provide product functionality in ways that use fewer resources. One example of this is combining the functions “Print”, “Copy”, “Scan” and “Fax” in a single device.

Resources can also be saved by replacing a product with one that is less resource intensive (e.g. CDs instead of vinyl records, digital instead of analogue photography). This makes it possible to reduce resource requirements without any restrictions for consumers. However, product miniaturisation may also result in certain products or components ceasing to be recyclable because of their complexity and the small quantities involved. This is primarily a problem in the case of technological raw materials used in electrical and electronic equipment, and also in environmentally relevant technologies, e.g. platinum group metals (PGM) such as ruthenium, rhodium, palladium, indium, tellurium, cobalt etc. (HAGELÜKEN and MESKERS 2010).

Seen over the entire life cycle, more efficient resource use can also be achieved by extending the useful life of products and by increasing the intensity of their use (HAAKE 1996). A focus on durability in design and production is a basic requirement here. For example, manufacturers can make their products last longer by using more hard-wearing components or diverting wear and tear to inexpensive and easily replaced elements. At the construction stage, more attention should be paid to making products easier to dismantle later and ensuring that individual replacement and reprocessing of components is possible (modular design). This kind of design approach is essential for innovation-oriented durables in which material-intensive components that are hardly subject to innovation (e.g. cabinet, drum and weights of a washing machine) are used for as long as possible, while other components can be adapted quickly and easily to technical advances (e.g. motors, control systems, control panels). Another approach is an update function for operating programmes, as provided for washing machines, for example.

118. Many measures for improving resource efficiency in the production of goods are associated with cost savings for the producer and thus exploit economic potential as well. However some measures only become economic if resource prices continue to rise. Others may not initially be compatible with manufacturers’ short-term economic interests (e.g. increasing product life). Moreover, inadequate information of consumers may result in the resource-efficient products being pushed off the market.

The opportunities for improving in-plant material efficiency are estimated at between a few percent and up to 20 percent of gross production value (Arthur D. Little et al. 2005, p. 57). The German Materials Efficiency Agency also estimates that SMEs in the manufacturing sector in Germany could save at least 20 percent of material costs by improving their production workflow efficiency. For the economy as a whole this would correspond to a figure of around €100 billion per annum (DEMEA 2011).

The fact that not even the economic potential for efficiency improvements has yet been exploited is due to a number of obstacles, such as lack of incentives, lack of access to knowledge and technologies, or poor quality of recycled material (RADEMAEKERS et al. 2011, p. 27 ff.). A survey of SMEs revealed that only 16 percent had fully exploited their resource efficiency potential. Obstacles mentioned by the companies to participation in assistance programmes included disclosure of business secrets, use of external consultants, complicated applications, uncertainty about the success of the measures, and long lead times until the effects of the measures are felt (VDI Zentrum Ressourceneffizienz 2011).

Product use

119. At present, needs are largely satisfied by buying or consuming products (HINTERBERGER 2011). To ensure prosperity combined with reduced resource consumption, there is therefore a need for changes in demand patterns and the way goods are used (FAULSTICH and SCHENKEL 1993). In particular, it is a matter of reducing demand for resource-intensive goods or increasing the intensity of their use. For example, large items of reconditioned medical equipment are already being marketed successfully with a market share of around 10 percent (Handelsblatt: “Health from the recycling plant”, 5 September 2010). Another possibility is to replace products with services, so that the focus is no longer on the production and sale of products, but the provision of benefits for the consumer. Leasing systems could be a means to this end. Under leasing arrangements the manufacturer remains the owner of the product, and the customer merely acquires a right to use the product. If there is a change in the customer's needs, products are returned to the manufacturer during the use phase or at the end of their life, and it is the manufacturer's responsibility to market them again or see to their disposal. This gives manufacturers an incentive to produce products in a way that makes it easy to carry out updates and improvements.

Waste management

120. The waste management sector is increasingly being perceived as a source of raw materials (European Commission 2011f; BMU 2011b). We may be seeing the start of a fundamental change in waste management from a statutory obligation to an attractive business field. However, this depends to a large extent on the ratio of primary raw material costs to the costs of secondary raw materials of equivalent quality, which themselves depend on physico-chemical limits, the level of dissipative uses (diffuse distribution of raw materials in various areas of application) and the existence of technologies and infrastructures (BUCHERT et al. 2009).

After their use, all processed raw materials become potential secondary raw materials. To some extent they are removed from the domestic economy by exports of second-hand products and waste. Other items to be deducted from the theoretical total potential include diffuse losses (e.g. due to abrasion in platinum catalysts) (HAGELÜKEN et al. 2005) and polluted quantities that have to be removed from the system and stored safely. However, even these stored and to some extent polluted quantities can be regarded as raw materials reservoirs which could in the medium or long term become a useful source under changed economic and technical conditions (e.g. fly ash from flue-gas cleaning (FEHRENBACH et al. 2007)).

121. With a figure of 72 percent (percentage of waste channelled into all "material recycling" processes), Germany has one of the highest recycling rates in Europe (Statistisches Bundesamt 2011b). However, any assessment of Germany's recycling policy must also take account of various other factors:

What quantities of materials are available for recycling in Germany? In addition to the recycling rate, it is above all interesting to know what proportion of resource-significant material flows such as metal scrap or used products is in fact available in Germany (and Europe) for the recovery of raw materials. To this end it is necessary to compare the material flows that find their way into national waste management facilities with the quantities exported. Exports of used products are basically part of international trade. They become a problem, however, when electrical scrap declared as second-hand goods is exported (cf. para. 145). In many countries that import such goods, recycling of this hazardous but resource-rich waste does not meet either social or environmental standards. There is a need for a political decision on whether and how material flows (e.g. end-of-life vehicles or end-of-life electrical and electronic equipment) can be channelled into national recycling paths.

What quantities of secondary raw materials can be recovered? In view of the composition of the waste and technical and physical limits on recycling, the quantity of secondary raw materials output is considerably smaller than the quantity of waste input. Here there is need not only to support technical innovations, but also to improve collection with the aim of improving purity levels.

At what level are the resulting secondary raw materials used? The spectrum ranges from high-grade use at the same level as a primary raw material (e.g. metals), through diminishing qualities in the course of multiple recovery cycles (e.g. paper) to one-off use (e.g. construction rubble for landscaping on landfill sites). From an ecological point of view, efforts should always be made to ensure processing and use of a secondary raw material at the highest level possible. Cascade use systems are therefore recommended, because they guarantee that raw materials remain in the economic cycle for as long as possible. The German government should support measures that promote the use of secondary raw materials at a high level.

How great are the environmental benefits of recycling? The use of energy, water, air, land etc. for collection, transport and treatment processes has to be set against the environmental impacts of primary production, and also the finite nature of the reserves. In the past, this consideration has been subject to the proviso of economic reasonableness, as based on a comparison with the costs of alternative disposal methods (e.g. incineration or landfill). In future, substantial environmental impacts of primary production and shortages will have to play a much greater role in the assessment of recycling activities, even if they are not (yet) reflected in market prices.

122. Considerable potential still exists for recycling as material. Individual raw materials such as metals can be reintroduced directly into the value chain without any loss of quality (though certainly with some loss of quantity). More than half the aluminium, copper and zinc produced in Germany already comes from recycled input material (WVM 2011). However, only individual bulk metals achieve these high figures. By contrast, the worldwide recovery rate for technological raw materials such as indium, tantalum, lithium or neodymium is less than 1 percent (UNEP 2011). This is due to lack of recycling infrastructures and treatment technologies, and to the small quantities of each product. These minute quantities are insignificant when it comes to achieving recycling rates which require a minimum recovery of the total volume. Lack of information for manufacturers and consumers may also be a reason for the low recycling rates. Other raw materials (e.g. mixed plastics, construction rubble) cannot be reused for their original purpose because of their properties or combinations, but serve as substitutes for primary raw materials in other situations. This kind of cascade use also helps to reduce the quantities and impacts involved in resource consumption.

All in all, the aim is to achieve high quality in combination with high recovery rates. This calls for further developments in treatment technology, and also for changes in input materials, for example bans on the use of pollutants (e.g. see RoHS Directive 2011/65/EU, requirement for petroleum-free printing inks etc.) and more effective collection and reclamation.

123. In all these approaches to decoupling resource consumption from prosperity, it is important to remember that improvements in efficiency always involve a risk of rebound effects (cf. Chapter 1.3). There is therefore a need to watch out for rebound effects and take appropriate supporting measures to prevent them.

2.3.3 Decoupling of resource consumption from environmental impacts

124. To decouple resource consumption from environmental impacts it is necessary to minimise the environmental impacts per unit of material. In view of the problem of quantifying the impacts, it is difficult to lay down specific decoupling targets (cf. Chapter 2.2). Basically, however, priority should be given to nature conservation (protection of areas and species) and protection for human health at all stages in the value chain. As Chapter 2.2 shows, resource extraction and raw material production in particular involve substantial impacts on man and nature. Owing to the demand for fossil fuels, product manufacture in particular has impacts on climate change.

At national and EU level, decoupling resource consumption from environmental impacts with the aim of protecting nature, the environment and human health can be supported by a variety of measures, and especially by strict environmental legislation. By contrast, it is more difficult to influence the worldwide environmental pressures caused by the resource industry. To accept responsibility for Germany's resource consumption, the German government should seek to reduce the environmental impacts outside Germany as well. There are various ways of doing this. For example, it may make sense to replace one raw material with another – greener – raw material. Although such substitutions can for a short while relieve the pressure on the environment, there are limits to this strategy. In the long term even this strategy can awaken fresh desires for resource deposits involving more complicated extraction, and this may give rise to new shortages.

By means of international cooperation in the fields of foreign, development and economic policy, Germany and the EU should therefore make agreements to work together with developing and newly industrialising countries to minimise environmental problems associated with the resource industry (cf. Section 2.4.4). From an environmental point of view, reducing the impacts of resource extraction is of prime importance. Environmental, economic and social framework conditions should be developed jointly with the source countries, in order to achieve high acceptance levels there. To this end there is a need for a targeted transfer of technology and knowledge.

2.3.4 Defining the objective

125. The resource industry makes a considerable contribution to transgression of global, regional and local environmental limits. The short-term advantages of generous consumption of exhaustible resources have to be set against the serious impacts of a non-sustainable resource industry – impacts which are borne by the developing and newly industrialising countries in particular. Systematic global quantification of the large number of adverse environmental impacts, for example in the fields of climate change, loss of biodiversity and toxic effects on man and the environment, is not possible. However, a qualitative examination of the impacts shows that extensive environmental damage can be expected if the resource industry does not change its course (cf. Chapter 2.2). There is a clear need to slow down the ongoing worldwide growth of resource consumption. This raises the question of the standards that green resource management should be aiming for.

126. In neo-classical resource economics, the ideal rate of extraction of exhaustible resources is determined by the demand function and the discount rate, and possibly also by the availability of alternative materials (MEYER et al. 1998). By contrast, a strict interpretation of the principle of strong sustainability would mean that, as a matter of principle, non-renewable resources must not be used at all, as even the most sparing use gradually results in their exhaustion (SRU 2002, p. 66; KLEPPER 1999, p. 313). However, abstaining from extraction entirely would not help either present or future generations. Moreover, since it seems plausible to assume a certain substitutability in the field of material resources, it is justifiable here – by contrast with the functioning of ecological systems – to apply the principle of "weak sustainability". However, exhaustible resources should only be consumed to the extent that physically and functionally equivalent substitutes are created in the form of renewable resources (SRU 2002, para. 28 f.).

127. Another issue that arises in the case of globally traded resources is that of intra-generation equity, and above all global equity of resource use. The SRU is committed to the principle of fair and equal per capita claims to use of natural resources, which is also expressed in the National Sustainability Strategy (Federal Government 2008, p. 20). Partly to create scope for the legitimate development endeavours of poorer regions of the world, countries with a high per capita consumption should as a general principle reduce their consumption to a level that is capable of global generalisation (BRINGEZU and BLEISCHWITZ 2009; BRINGEZU 2009; SERI 2009). If one assumes that global material requirements are kept stable at the same worldwide per capita consumption until 2050, this results in a target of reducing average consumption in the EU from the present 16 t to around 6 t per head (measured as DMC (Domestic Material Consumption)) or 10 t per head (measured as TMC (Total Material Consumption)) (FISCHER-KOWALSKI et al. 2010, p. 11; Cambridge Econometrics et al. 2011, p. 8). Furthermore, Germany should assume greater responsibility for the environmental impacts of the first stage in the value chain – mining and extraction – in other countries. Even if the extraction of many raw materials takes place outside Germany, there are still ways and means of exerting influence (cf. Section 2.4.4).

In summary, therefore, the following objectives should be pursued in the interests of responsible and environmentally sound use of the Earth's limited reserves of raw materials:

– Decoupling resource consumption from prosperity with the aim of reducing per capita consumption to a level capable of global generalisation,

– Decoupling the environmental impacts from resource consumption, primarily by reducing the environmental impacts arising from the extraction of resources, and

– Extensive closed-cycle management of raw materials.

2.3.5 Indicators for decoupling objectives

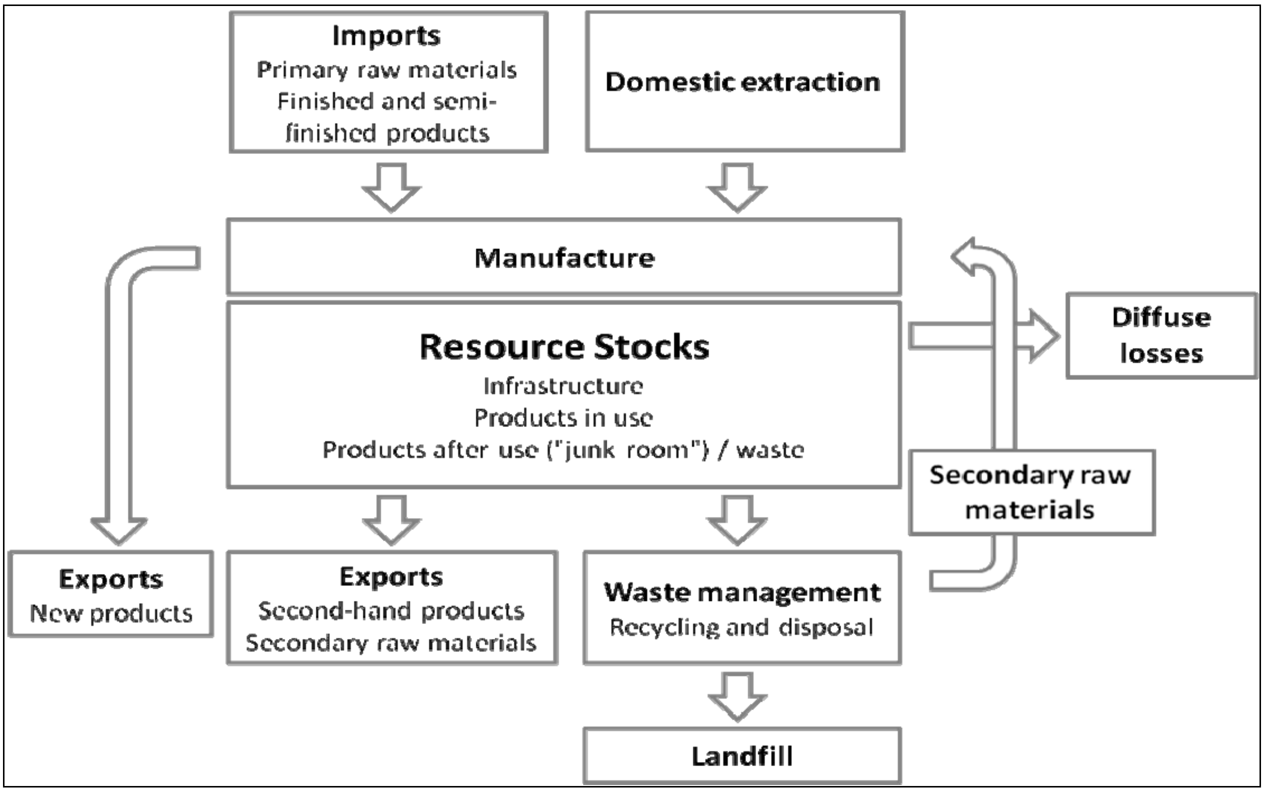
Knowledge about material flows

128. Measuring the effectiveness of a green resource management system calls for qualified objectives and a suitable basis of data. However, it is only in a few exceptional cases that the life cycle of the resources is documented from exploration through to disposal. At present, indicators of consumption, productivity or return to the production cycle are largely based on weight and not differentiated by individual raw materials.

In Germany and Europe there is currently a lack of important basic data for shaping effective political instruments (ERDMANN et al. 2011). There is an urgent need to document the life cycle (Fig. 2-7) of selected raw materials, either because they are needed in large quantities in industry or because their use has particularly critical consequences for man and the environment (e.g. technological raw materials, individual bulk metals).

Figure 2-7

Resource paths in the economic system



SRU/UG 2012/Fig.2-7

Ideally, it would also be possible to record not only the quantities of imported primary resources and finished and semi-finished goods broken down by individual raw materials, but also their main fields of use and exports of raw materials. Data from the Federal Statistical Office (foreign trade statistics) and the German Raw materials Agency (BGR 2010) can serve as an initial basis. Since the influences on resource use (economic situation, technological progress, imports/exports, reuse etc.) are many and various, the material flow model is correspondingly complex. A critical factor here is the time that elapses before a raw material is returned to the production cycle. Monitoring material flows makes it possible to provide information about the medium and long-term potential of quality-assured secondary raw materials. For example, a research project on the constituents, quantities and material flows of electrical and electronic equipment (EUWID 2011b) is currently analysing ways of implementing a differentiated material flow documentation system. The German government should make the collection and central documentation of such data compulsory for selected raw materials.

Indicators

129. As yet there are no indicators that provide a comprehensive picture of the environmental impacts of the resource industry. The development of indicators is therefore of central importance for resource policy. It should be actively supported by the German government and continue to be pushed ahead at European level. However, no single aggregated indicator will be able to give an adequate picture of the various facets of green resource management. To some extent it is possible to fall back on existing records. Here use can be made of "material flow indicators" that describe advances in productivity. These approaches are to be welcomed and should be developed further.

Table 2-1

Overview of relevant material flow indicators

Type	Acronym	Name and description
Input	DMI	Direct Material Input (DMI = Domestic extraction + Imports)
	DMI_{RE}	DMI in resource equivalents (instead of merely recording the weight of imports of finished and semi-finished goods, this also takes account of the weight of the raw materials consumed in their manufacture)
	TMR	Total Material Requirement (TMR = DMI + unused domestic extraction + unused extraction associated with imports)
	TMR_{RE}	TMR in resource equivalents (TMR_{RE} = DMI_{RE} + unused domestic extraction + unused extraction associated with imports)
Consumption	DMC	Domestic Material Consumption (DMC = DMI – Exports)
	DMC_{RE}	DMC in resource equivalents (instead of merely recording the weight of imports and exports of finished and semi-finished goods, this also takes account of the weight of the raw materials consumed in their manufacture)
	TMC	Total Material Consumption (TMC = TMR – Exports – Unused extraction associated with exports)
		SRU/UG 2012/Table 2-1

The indicators used for measuring material input are primarily DMI (Direct Material Input) or TMR (Total Material Requirement) (BRINGEZU and BLEISCHWITZ 2009, p. 23 ff.; see Table 2-1). These can be used to calculate the quantitative material input of an economy. The difference between the two indicators is that TMR also takes account of unused extraction such as spoil and dead rock. Since every quantity moved represents an encroachment on nature, TMR is more far-reaching from an environmental point of view. However, data acquisition – especially at international level – is difficult. If the material flow indicators are seen in relation to economic output, it is also possible to measure advances in productivity.

In 2002, as part of the National Sustainability Strategy, the target was set of doubling overall resource productivity (ratio of GDP to material input) by 2020 compared with 1994 (Bundesregierung 2002). To this end the Federal Statistical Office calculates the DMI for abiotic resource inputs as the sum of domestic resource extraction and imports of raw materials and finished and semi-finished goods (figures in tonnes). On this basis, resource productivity rose by 47.5 percent between 1994 and 2010 (Statistisches Bundesamt 2011c). To achieve the objective of the Sustainability Strategy, it will not be quite enough to maintain the present rate of productivity improvements (EGELER 2010).

The productivity improvement is due not only to a fall in resource extraction within Germany, but also to a rise in imports of finished and semi-finished goods in particular. Owing to the present method of calculation, which considers only the actual weight of imported finished and semi-finished goods, there is an apparent improvement in productivity if resources which have hitherto been extracted within Germany or imported are replaced by imports of products which have undergone further processing (EGELER 2010). The Federal Statistical Office and the Federal Environment Agency (UBA) have therefore run a project to examine further development of the DMI (BUYNY et al. 2009). The indicator is now to be supplemented by a material indicator in resource equivalents (DMI_{RE}), which instead of considering only the weight of the imported goods also takes account of the weight of all materials used in the entire production chain of the imported goods (BUYNY et al. 2009). It does not take account of unused extraction. Taking in this as well calls for a TMR_{RE}, but the data situation is not sufficient for this at the present time. The use of the DMI_{RE} is to be welcomed (SRU 2011a), since this presents a clearer picture of productivity and efficiency improvements that are not due to shifts in economic structure (e.g. relocation of early production stages from industrialised countries to newly industrialising economies).

If the calculation takes account of all materials used during the entire production chain of the imported goods, the increase in productivity between 2000 and 2008 works out at only around 6.9 percent, compared with 17.1 percent as calculated using the indicator in the Sustainability Strategy. The productivity improvement is based on rising GDP and slightly increasing material input (in accordance with DMI_{RE} plus 3 % change during the period 2000 to 2008) (Statistisches Bundesamt 2010). Although the present indicator suggests otherwise, absolute material input in Germany according to these calculations would not show a decline. On the basis of this method of calculation the figures fall far short of the target in the Sustainability Strategy.

It would also be an advantage to have more differentiated records for calculating resource productivity (SRU 2011a). Even today, a glance at the development of the various resource types on which the DMI is based (energy resources, construction minerals, metal ores) makes it possible to draw interesting conclusions. Whereas inputs of construction minerals, measured as DMI_{RE}, fell by 19.8 percent between 2000 and 2008, material input from ores rose by 14.3 percent over the same period (Statistisches Bundesamt 2010). Thus, so far productivity increases are due almost entirely to reduced use of construction minerals, although efficiency potential undoubtedly exists in the use of other raw materials. It would therefore be interesting to break down the trends in the ore sector by various metals, thereby making it possible to identify differences in progress.

130. In addition to the input of material into an economy, domestic material consumption (DMC) is also an important parameter. By subtracting all raw material exports from the material input by a country's economy, it is possible to draw conclusions about consumption patterns in that country. Consumption indicators are well suited to inter-country comparisons. As in the case of DMI, a calculation using resource equivalents is more informative for DMC as well (DMC_{RE}). For international comparisons it is advisable to use DMC_{RE} per capita. In Germany, domestic material consumption DMC_{RE} is falling, albeit from a high level. The main reasons for this decrease are a sharp rise in exports compared with imports, and the higher average resource intensity of the products exported. The period between 2000 and 2008 shows a drop of 18.5 percent in domestic material consumption (Statistisches Bundesamt 2010). The fall in domestic consumption of ores during this period comes to 25.8 percent, while construction minerals show a drop of 26.4 percent and industrial minerals a drop of 9.9 percent. Steps should be taken to safeguard this trend. In addition to the German government's existing productivity target, targets for a further gradual reduction in per capita consumption should also be laid down as a matter of policy.

131. The obligations and successes of closed-cycle management are documented by recycling quotas of widely differing information value (see para. 121 and UNEP 2011). In future, the criterion for assessing the success of closed-cycle management should be the substitution rate: the ratio of the quantity of secondary raw materials capable of being reused in production to total overall material input. First estimates by the Federal Statistical Office dating from 2006 indicate that the substitution rate is currently 4.1 percent for use as material (biotic, abiotic and waste for recycling) (Statistisches Bundesamt 2010). Here there is a need for a more detailed indicator permitting selective identification of a substitution rate for individual raw materials. This should be undertaken by the Federal Statistical Office.

The German government should also formulate objectives for increasing substitution rates. First, however, there is a need for further studies to ascertain the proportions of primary raw materials that can technologically be replaced with secondary raw materials.

Environmental impacts

132. The material flow indicators also provide indirect information about the global environmental impacts caused by an economy, since an increase in resource consumption is usually accompanied by an increase in destruction of the environment (BRINGEZU 2009). However, they cannot provide information about specific impacts, e.g. due to specific mines. The disadvantage of material flow indicators is that there is not necessarily a generalisable causal connection between the quantity extracted and the adverse environmental impacts. A quantitative indicator cannot differentiate between the widely differing impacts of different raw materials. Moreover, the adverse effects depend not only on the sheer weight of the extracted material, but also on other factors such as the technology used, the expertise of the workers, the specific characteristics of the country, the toxicity of the raw materials in contact with other substances, or the concentration of the raw material in the soil. There is thus a need for other indicators which can identify the adverse environmental impacts better than the material flow indicators.

AYRES (2001) criticises TMC and instead recommends that the energy used for extraction, conversion and processing be used as a more suitable measure. Cumulative (fossil) energy consumption as an indicator has the advantage that it provides a quantifiable figure for the inputs involved in extraction and further processing. This approach permits better comparisons of resource deposits worldwide. Cumulative energy consumption can document the contribution made by resource extraction to the anthropogenic greenhouse effect. However, it cannot show other environmental impacts such as adverse effects on human health or impacts on biodiversity, or at least not better than TMC.

However, data that are suitable for use as indicators of regional impacts on man and the environment can also be collected under programmes for monitoring internationally standardised limit values (which have yet to be fixed) (WHO 2007). This, however, presupposes that relevant studies are performed and publicly documented and bundled.

The SRU therefore concludes that a set of indicators needs to be compiled with a view to better documentation of environmental impacts caused by the resource industry. In addition to a mass indicator – preferably TMC – it would also make sense to have an indicator for cumulative energy consumption and regional data on environmental impacts.

2.4 Ways to a green resource industry: Instruments

133. There are basically a large number of mutually complementary instruments of a regulatory, economic and information character which are capable of increasing resource productivity and reducing environmental impacts (see overview, Table 2-2). Whereas environmental standards in Germany and Europe are high, there are a number of other countries where standards are considerably lower or existing environmental legislation is not enforced. The problem remains that national policy can only exert limited influence on the environmental standards applied to the extraction of resources in other countries. On the basis of an extensive analysis of possible fields of action, this section looks at a number of promising instruments that are of strategic importance for environmentally sound resource management. These include:

– National mining, nature conservation and water law, which is intended to ensure environmentally sound “domestic” resource extraction and prevent the pursuit of short-term economic interests at the expense of natural capital,

– Economic and waste management instruments aimed at resource and energy efficiency through closed material cycles and climate-friendly resource management,

– Environmental standards that are capable of incorporating the internationalised value chains of the resource industry.

– With regard to the approaches not discussed in detail below, especially in the field of decoupling resource consumption from prosperity, attention is drawn to the recommendations of the German Resource Efficiency Programme (ProgRess). The SRU emphatically supports the detailed development and implementation of this programme (BMU 2011a).

Table 2-2

Decoupling: Approaches, instruments and examples

Objective	Approaches	Instruments	Examples
Decoupling resource consumption from prosperity (reducing resource quantity per economic output)	Reduce material input, miniaturisation	Material input tax	Bulk metals, rare earths
		Extraction tax	Mineral construction materials
		Emissions trading	Cement industry
		Ecodesign Directive 2005/32/EC	Electrical equipment, household appliances
		Promoting innovation and research, technology transfer, consulting	ReTech (Export initiative recycling and efficiency technology)
		Production standards	Electrical equipment, household appliances
	Increase in useful life	Product standards	Ease of repair, dismantling
		Promoting innovation and research, technology transfer, consulting	Assistance programme “Sustainable management: Possibilities and limits of new use strategies”
		Green public procurement	Re-use PC, furniture pool
	Closed-cycle management	Waste legislation	Waste hierarchy
		Minimum recycling rates	Concrete
		Product responsibility	End-of-life Vehicles Directive 2000/53/EC
		Deposit system	Mobile phones, electric/electronic equipment, car batteries
		Material flow register / acquisition of data on resource stocks in Germany	Rare earths
		Subsidies	Secondary raw materials
		Promoting innovation and research, technology transfer	Recovery of rare earths from electrical/electronic equipment, photovoltaic modules

	Product substitution	Product sharing, service instead of product purchase	Cars / bicycles / power tools
		Special eco levy on environmentally harmful raw materials	
	Changes in consumption	Awareness raising / information policy	“Raw materials angel”
		Value-added tax	Reduced rate for products with “Raw materials angel”
		Special eco levy on resource-intensive products	
		Subsidies for less resource-intensive products	
		Green public procurement	Green IT, construction sector
Decoupling of environmental impacts from resource use (reducing adverse environmental impacts per tonne of resources used)	Primary resource substitution	Promoting innovation and research, technology transfer, consulting	Solar cells
	National nature conservation	Extraction standards	Domestic building materials
		Nature conservation law (rules on encroachments and compensation, conservation of biotopes/species)	Domestic building materials
		Recultivation / restoration requirements	Opencast mining, gravel pits
		Special eco levy on environmentally harmful raw materials	
	International cooperation	Resource partnerships	Environmentally sound resource extraction in partner countries
		Certification	Bulk metals, rare earths
		International framework treaty on resources	
		Technology transfer	Recycling technology
		Development cooperation	Recultivation / restoration
	Climate policy	Emissions trading	Energy-saving cement production

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2.4.1 Mining law, nature conservation and water law

134. The extraction of raw materials and fossil fuels can involve considerable harmful effects on biological diversity. Examples include loss of habitats for species and communities, loss of established soil structures and adverse effects on groundwater (BMU 2007, p. 50). The extraction of raw materials is subject to a large number of regulations under federal and Land legislation. In particular, these include mining law, which represents a special regulation for the situations it covers.

The Federal Mining Act *(Bundesberggesetz – BBergG)* makes a distinction between mineral resources that are the property of the landowner and mineral resources that are not the property of the landowner (Section 3 subsection 2 Federal Mining Act). The Federal Mining Act governs all mineral resources that not the property of the land owner. These include coal and lignite, oil and gas, rock salt and potash, and ores (Section 3 subsection 3 Federal Mining Act). In the field of landowners' mineral resources, the Federal Mining Act applies only to certain non-metallic minerals and selected industrial minerals (Section 3 subsection 4 Federal Mining Act). The majority of landowners' mineral resources are not covered by the Act. Nevertheless, mining law applies to all cases of underground exploration and extraction of resources (Section 3 subsection 4 No. 2 Federal Mining Act).

The Federal Mining Act is concerned exclusively with safeguarding raw material supplies by extracting mineral resources (Section 1 no. 1 Federal Mining Act). This is clear from the "resource safeguarding clause" in Section 48 subsection 1 of the Federal Mining Act: this states that steps must be taken to minimise interference with exploration and extraction. As a consequence, the legal status of nature conservation issues is not very strong in the Federal Mining Act. No explicit provision is made for the examination of nature conservation issues. Moreover, authorisation of an operating plan, which is a precondition for the establishment, running and cessation of exploration and extraction operations, takes the form of a bound decision. In other words, authorisation must be given unless contra-indicated by the grounds listed in Section 55 of the Federal Mining Act, which do not include nature conservation. However, it follows from the case law of the Federal Administrative Court *(Bundes-verwaltungsgericht – BVerwG)* with regard to Section 48 subsection 2, first sentence, of the Federal Mining Act, that authorisation for an operating plan under mining law may only be given provided this does not conflict with any "overriding public interests" ("safety-net function") (Federal Administrative Court Judgement of 29 June 2006, BVerwG 7 C 11.05, established court practice). Where environmentally relevant regulations are not covered by the unspecific legal concepts of Section 55 of the Federal Mining Act, they may restrict a mining project or stand in the way of its authorisation as "overriding public interests" when weighing up interests under Section 48 subsection 2, first sentence, Federal Mining Act. Thus authorisation for a mining project may in certain circumstances be refused on the grounds of overriding nature conservation interests. The Federal Mining Act should nevertheless be revised. This should establish a primacy requirement to avoid conflicts and, depending on the severity of the mining encroachments on the environment, should couple the issuing of an authorisation with special requirements to demonstrate a need (TEßMER 2009, p. 13).

135. In addition to the Federal Mining Act, other authorisations may also be necessary, e.g. under the Federal Water Act *(Wasserhaushaltsgesetz – WHG)*. The extraction of resources can affect groundwater flows and levels. As a basic rule, an authorisation under water law is required if the extraction of resources involves using a body of water, which also includes using the groundwater.

136. The extraction of resources not covered by mining law (see above), such as gravel, most kinds of sand, anhydrite and calcium sulphate, limestone and quarry stone, is subject to a variety of regulations. These may include excavation law (Land legislation), the Federal Building Code, water law (Federal Water Act and Land water acts), nature conservation law, the Federal Immission Control Act *(Bundes-Immissionsschutzgesetz – BImSchG)*, the Federal Soil Protection Act and Land soil protection acts, planning law, the Environmental Impact Assessment Act *(Gesetz über die Umweltverträglichkeitsprüfung – UVPG)* and others. For example, permission to extract gravel usually requires a construction permit. If the extraction of gravel gives rise to a body of water, e.g. a flooded gravel pit, or if such a body of water is eliminated or significantly modified, an authorisation is required under water law, and this is issued in the form of a plan approval decision.

137. Resource extraction has impacts on existing ecosystems. Outside of nature conservation areas, encroachments on nature and landscape must regularly be assessed in the context of the impact mitigation rules. Furthermore, the European Commission has made a detailed study of resource extraction by the non-energy mineral industry in Natura 2000 areas and stresses the importance of examining the potential adverse impacts in advance and if possible avoiding them (European Commission 2011b). In its guide, it recommends seeking to identify and circumvent possible conflicts between Natura 2000 areas and resource-rich areas as early as the spatial planning stage (op. cit., p. 47–54). Moreover, the programme for resolving conflicting economic and nature conservation interests already exists in Article 6 paragraphs 3 and 4 of the Habitats Directive 92/43/EEC. The courts, especially the European Court of Justice and the Federal Administrative Court, are seeking to develop strict assessment and compensation requirements on the basis of the Habitats Directive and the Birds Directive 2009/147/EC (WEGENER 2010; with regard to Federal Administrative Court judgement of 17 January 2007 – 9 A 20.05 – (Halle western by-pass) and the subsequent, less strict case law of the Federal Administrative Court).

The Federal Office for Nature Conservation *(Bundesamt für Naturschutz – BfN)* takes the view that in many cases, given adequate knowledge of the protection needs of the locally occurring species covered by the Habitats Directive and Birds Directive and the operating requirements for extraction, it is possible to achieve a functioning cooperation between resource extraction and the management of Natura 2000 areas. However, this is only the case if no habitat type land (Annex I Habitats Directive) is excavated or permanently destroyed (BfN 2011).

There are however some resources which are relatively problematical to extract (e.g. the extraction of gypsum alters the pH of the adjacent soils) or where extraction represents a particularly serious encroachment (e.g. extraction of gravel in water meadows). In the opinion of the SRU, such cases are grounds for refraining from extraction. Furthermore, restoration measures and/or subsequent uses should be laid down when extraction permits are issued. Here the various nature conservation objectives of these measures always depend on the local framework conditions (e.g. surrounding landscape, potential occurrence of protected species) and must be investigated and laid down in the individual case.

The pressure on nature and landscape will increase with the further depletion of resources and the rise in their prices. Contrary to ongoing efforts by various Länder, e.g. Hesse, the SRU takes the view that nature conservation requirements should not be relaxed either at national (Land Hessen 2011) or at European level (Bundesrat 2007), not even for the benefit of resource extraction. Even if cooperation arrangements and subsequent uses are possible, there must be no extraction of resources that are unjustified on nature conservation or other environmental grounds.

In its guidelines the European Commission interprets the concept of “overriding public interest” in Article 6 paragraph 4 Habitats Directive to mean that it must be a case of a long-term interest. The Commission does not consider that short-term economic or other interests which only yield short-term benefits for society are sufficient to override the long-term conservation interests protected by the Directive (European Commission 2011b, p. 81). Moreover, the question of what is regarded as a potential overriding fundamental long-term public interest can be clarified in advance by the state in political measures and strategies (op. cit.). It should therefore be made clear at national level that, in the context of decisions weighing up interests relating to encroachments on nature conservation areas, resource extraction is not an overriding public interest that can be used to justify an encroachment.

2.4.2 Economic incentives

138. Economic or market instruments are often put forward in the environmental sector to create economic incentives for environmentally sounder behaviour. The aim is efficient allocation of production factors, especially through internalising external costs by means of taxes or charges, or through systems of tradable certificates such as the European emissions trading scheme. Market instruments are regarded as more cost-effective than traditional regulatory approaches (NEWELL and STAVINS 2003; BAUMOL and OATES 1988). However, as site-independent instruments they cannot provide adequate protection from harmful local impacts for sites with heavy environmental pollution. Market instruments may provide an incentive for the market as a whole to behave in an environmentally sounder way, but they still permit serious local impacts as long as there is a readiness to make monetary compensation. For this reason there is always a need to support economic instruments with site-specific environmental legal instruments.

Primary construction materials tax

139. Unlike countries such as the United Kingdom, Denmark, Sweden, Italy and the Netherlands, Germany does not yet levy a tax at national level on the extraction of abiotic non-energy raw materials. Since domestic resource extraction in Germany is mainly concerned with construction materials, it would be worth considering introducing – as in these countries – a tax on the extraction of primary construction materials. The project “Material Efficiency and Resource Conservation” (MaRess) recommended introducing such a tax on construction materials. The purpose of this tax is to improve resource efficiency, and also to increase recycling and substitution rates and the shares of secondary construction materials in the construction sector and to reduce specific environmental impacts (BAHN-WALKOWIAK et al. 2010). SÖDERHOLM (2006), by contrast, argues that such a tax merely tends to reduce the quantities extracted, but does not provide any incentive to reduce the environmental impacts of extraction. Environmental impacts should preferably be addressed by instruments that aim more directly at the polluter, such as a tax on pollutant emissions.

While SÖDERHOLM’s (2006) reservations are justified, the large number of different environmental impacts (cf. Chapter 2.2) could in itself be an argument for rough steering at the first stage in the value chain. Unlike instruments that focus entirely on avoiding emissions, such taxes are aimed at the input side of the economy. The aim is to reduce the quantity of resources input and thereby minimise the environmental impacts arising from use of the resources. This could reduce the exploration pressure, especially on gravel pits. In a second step, targeted reductions in specific environmental impacts due to pollutant and CO_2 emissions could then be made with the aid of further instruments, as is the case in Germany and Europe, e.g. through the emissions trading scheme or the Federal Immission Control Act. A primary construction materials tax would also have the advantage that it could increase the incentives to use secondary construction materials.

Since the level of imports in the construction materials sector is negligible, there is no risk of competitive disadvantages for German industry. For this reason, the introduction of such a tax can be recommended.

Material input tax

140. In addition to a tax on primary construction materials, a material input tax has been suggested in various quarters (STEWEN 1996; HINTERBERGER 1993; OMANN and SCHWERD 2003). Whereas the primary construction materials tax focuses on a specific sector of industry, the introduction of a material input tax would be a much more comprehensive measure in which the entire material input would serve as the assessment basis for a tax. Here all materials taken from the ecosphere and input into economic activities would be subject to a volume-based tax. However, the proposal for a primary raw materials tax (BEHRENS et al. 2005) has not yet received any political backing.

Although the material input tax is a volume-based tax, one could conceivably differentiate the tax rate for different substances on the basis of their hazard potential for man and the environment (BEHRENS et al. 2005). To provide an incentive to reuse materials that have already been used, secondary raw materials would have to be exempted from the tax.

The environmental accuracy of a material input tax is questionable. It would probably slow down the rate of extraction, but the fact that its effect was confined to the quantity extracted would not provide any direct protection for sensitive ecosystems. Its introduction would however be prevented by design problems. Only an internationally harmonised material taxation system, which in the best case would be applied worldwide to from start of the value chain, would not result in international distortion of competition. An independent German or European initiative would create the need for a border adjustment in the form of an import levy, to avoid creating incentives to shift the first stages of the value chain to other countries (BEHRENS et al. 2005). To this end it would also be necessary to determine the material input into finished and semi-finished products. Even minimum estimates or the determination of average figures would not seem to be a practicable solution in view of the large number of products on the market today. As well as generalisations, it would also be necessary to develop credible life-cycle analyses and certification systems in order to reward above-average environmental standards in extraction and processing. In this sense the ideas for a comprehensive material input tax cannot be implemented at present. The idea might make sense for individual materials such as selected metals, but this needs further scrutiny.

Emissions trading

141. Existing climate protection instruments, especially the European emissions trading scheme, could be used to reduce the contribution that resource-intensive goods make to the anthropogenic greenhouse effect. Many companies of relevance to the resource industry, such as those in the iron, steel and cement industry, take part in the emissions trading scheme. Emissions trading has a direct impact on these companies. The maximum limit on emissions restricts the level of greenhouse gas emissions for the sectors involved in the scheme.

However, the SRU sees a considerable need for improvements if emissions trading is to provide an incentive for the manufacturing sector to adopt efficiency measures. In the first two trading periods, large sections of industry, including especially resource-intensive heavy industry, received emission allowance allocations that were consistently too high (ELSWORTH and WORTHINGTON 2010; PEARSON and WORTHINGTON 2009; MORRIS and WORTHINGTON 2010; SRU 2011b; HERMANN et al. 2010). As well as the economic slump during the worldwide financial and economic crisis in 2008 and 2009, this over-allocation is responsible for a surplus of allowances that has constantly kept the emissions trading price well below the price of 32 EUR anticipated in the European Commission's impact assessment (European Commission 2008a). This considerably reduces the incentive created by emissions trading to invest in more climate-friendly production technologies. Although the banking rule which allows companies to carry over unused allowances into the third trading period prevents any further drop in prices, it also endangers the effectiveness of emissions trading in the third trading period that starts in 2013. The decision is to be welcomed that the allowances for allocation free of charge in the third trading period are no longer to be issued on the "grandfathering" principle, i.e. based on the historical emissions of an installation, but on the basis of sectoral benchmarks. However, even with strict benchmarks this will not initially be able to resolve the consequences of the present over-allocation. By accumulating allowances today, companies have the opportunity to put off investments in climate protection to a later date.

To enable emissions trading to provide more efficient incentives for more climate-friendly production by resource-intensive industry, the EU should first raise its greenhouse gas reductions target for the year 2020 from 20 percent to 30 percent of 1990 emissions. Moreover, it is crucial that in future the benchmarks for free allocation of allowances should genuinely be geared to technical potential and not to historical emissions. This will prevent unjustified sources of income developing in those industries where little has been done in the past.

2.4.3 Instruments for closed-cycle management of raw materials

142. The debate about resource security has considerably increased the status of approaches taken by European and German waste policy. This applies especially to the clear focus on resource conservation by means of the five-tier waste hierarchy, in which avoidance, reuse and material recycling are given priority over disposal and recovery as energy. The regulations for selected material flows such as end-of-life vehicles, batteries etc. have had a marked impact by laying down binding minimum requirements at least for the quantities collected (FAßBENDER 2011). In spite of these successes, neither the quality nor the quantity of the raw materials returned to the production cycle are satisfactory. Accordingly, instruments must aim on the one hand at improving the quality of the secondary raw materials by minimising pollutants and foreign matter, and on the other hand at raising the quantities collected, increasing the secondary raw material quantities produced, and consequently achieving more widespread use of the raw materials recovered. These instruments should address both manufacturers and consumers: While the manufacturers are responsible for design, treatment and reuse, the consumers influence demand through their purchase behaviour and it is they who ultimately influence the return of material to the production cycle.

Manufacturer-oriented instruments

143. The central principle for reinforcing incentives for recycling-friendly product design and high-grade recycling is that of producer responsibility, which applies to the entire life cycle from product planning and manufacture, through the use phase, to disposal of the product. Product planning is the factor of greatest significance for the useful life of products and their repair-friendliness and recyclability. The aim is to influence the choice of design, materials and combinations in the direction of a resource-conserving industry. At present the Ecodesign Directive caters almost entirely for energy aspects, so the inclusion of resource aspects would make sense in the long term (THOLEN et al. 2011). However, even from the point of view of energy consumption alone the transposition of this directive is very complex and time-consuming and nothing should be done to slow it down.

Restrictions on the use of pollutants promote recycling, because they encourage quality. One example is the RoHS Directive, which restricts or prohibits the use of selected elements (such as lead, mercury, and also a number of organic compounds). Although this directive focuses on human health, it also brings an improvement in the quality of the materials for recycling.

144. The instrument which was really intended to bring about a marked improvement in product planning is Section 22 of the Closed-Cycle Management Act. Under this, producers are basically required “as far as possible to design products so as to minimise the generation of waste in their production and use and to ensure environmentally sound recycling and disposal of the waste arising after their use”. The requirement to take back products under Section 24 was intended to encourage the producers’ own interest in recycling-friendly product design.

The take-back obligation for individual product flows is detailed in secondary legislation or separate acts. Flows of importance for resource issues (e.g. batteries, end-of-life vehicles, end-of-life electrical and electronic equipment) are regulated in this act. The existing regulations achieve the specified (weight-based) recycling rates by removing from the flow of waste especially the main constituents that account for a large proportion by weight and are most easily recoverable. Resources that are only present in small quantities and/or are not readily accessible in the product, are often of minor importance from the point of view of recyclers. But these consist in particular of technological metals such as rare earths, where extraction has serious environmental impacts, shortages are predicted and improvements in security of supply are being called for. It is evident that higher raw material prices alone are not sufficient to make recovery of technological metals economically viable: at present there are only five companies worldwide which engage in large-scale reprocessing of end-of-life electrical and electronic equipment and which recover individual technological metals as well as bulk metals (ERDMANN et al. 2011). The largest of these installations processes some 300,000 t a year (HAGELÜKEN 2010). Compared with the European volume of nearly 3.6 million tonnes of electrical and electronic equipment in 2008 (EuroStat 2012) this shows that there is a considerable need for more resource recovery facilities.

145. Expansion of high-grade technologies can be supported by developing and laying down minimum standards for all stages of the waste management chain (Öko-Institut and Eurometaux 2010). The quantity and quality of the available input flows are crucial, since the results of the treatment process always depend on the weakest link in the treatment chain (collection, dismantling, recovery). A considerable potential of recoverable raw materials remains unused because it does not find its way into the national recycling paths at all.

For example, batteries as a relatively short-lived product achieved a collection rate of 44 percent in 2010 (quantity collected as a percentage of quantity put on the market), which more than met the requirements of the Batteries Act *(Batteriegesetz – BattG)* (GRS Batterien 2011). At the same time, however, this means that 56 percent, or nearly 20,000 t, remained in circulation or were disposed of as municipal waste. The quantities of end-of-life vehicles and electrical and electronic equipment processed by the waste management sector also achieve high recovery rates. However, considerable quantities of vehicles and electrical/electronic equipment find their way into a second-hand market and are exported (UBA and BMU 2011; BUCHERT et al. 2007; UBA 2010). An unquantifiable proportion of the second-hand goods is not longer capable of use or repair, with the result that such exports constitute illegal movements of waste. This is due to lack of clarity in the distinctions between end-of-life and second-hand items, the complexity of legislation on movements of waste, and inadequate monitoring of export paths (JANZ et al. 2009). If the products then reach the end of their life in places where the manufacturers do not have to or are unable to discharge their responsibility, the result is that the raw materials are lost to the domestic economy. This also reduces the incentive to plan recycling-friendly products. At the same time, incorrect processing can give rise to serious adverse impacts on health and the environment (WONG et al. 2007). The situation can be improved by defining clear distinctions, providing adequate personnel for effective controls by and cooperation between authorities, giving legal status to the requirements for second-hand goods (contact centre guidelines on movements of end-of-life electrical and electronic equipment / contact centre guidelines on movements of end-of-life vehicles), and supported by transparent documentation of second-hand goods flows (SANDER and SCHILLING 2011; SRU 2008). The changes planned in the revised WEEE Directive with regard to recycling standards, the proposed increase in collection quantities and the framework conditions for exports are therefore to be expressly welcomed. However, these measures only have prospects of success if they are accompanied by documentation, monitoring and unmistakable punishment of offences.

Waste management quality can be improved by expanding the labelling and information requirements for particularly relevant products and ensuring that information about device-specific data, materials used, dismantling instructions etc. is available on the device in question (FÜHR et al. 2008).

146. There is also a need for optimisation within the functioning take-back system for electrical equipment in Germany. At present the disposal costs borne by the manufacturers are based on the figure for “number of items placed on the market”, which means the disposal costs are allocated among all manufacturers regardless of product design. In Sweden, by contrast, manufacturers of recycling-friendly appliances are charged lower disposal costs (LEONHARDT 2007), thereby creating greater incentive to ensure ecodesign of products. The transferability of this approach to Germany should be investigated as a matter of urgency, since it can be expected to have positive impacts on product design.

147. In parallel, work should go ahead on establishing waste management structures in newly industrialising and developing countries, as in the medium term they will be faced not only with faulty second-hand appliances from industrialised countries, but also with waste from increasing domestic quantities of electrical and electronic equipment. First projects initiated in cooperation with international producers, local companies and the informal sector are creating jobs in the countries concerned (EUWID 2011a). Separation into constituents that can be recycled locally and fractions that require more complex treatment can – given re-importation and processing of the latter quantities – help to avoid loss of raw materials and make an increasing contribution to supplies of technological metals.

Consumer-oriented instruments

148. Eco labels give consumers a chance to make a conscious choice of product. The impact of eco labels with ambitious, resource-relevant criteria should be examined (European Commission 2011a). The impact of existing eco labels like the Blue Angel, Nordic Swan or the Austrian eco label, which have already developed appropriate criteria, should also be reviewed (TEUFEL et al. 2009). Motivating consumers solely through information and appeals brings temporary successes which can only be maintained at a minimum level by means of regular repetition, as shown by experience with waste separation in households. Much greater success is achieved by economic incentives such as polluter-specific charges or deposit systems.

149. One special challenge for closed-cycle management is very low collection rates for electrical equipment. At present, about one third of the electrical and electronic equipment placed on the market is separately collected and processed (EuroStat 2012). By contrast, the figures for resource-relevant high-tech devices such as mobile phones and computers are critical. In spite of a wide variety of reuse and recycling programmes, the return rate for mobile phones recycled as a result of return to dealers, municipal collection centres or collections by charities is only about 28 percent (press release of 30 December 2011 (Bitkom): 83 million old mobiles).

Although free return of electrical appliances under the Electrical and Electronic Equipment Act succeeded in giving a slight boost to the recycling rate, there is still more that could be done to exploit the available potential. Whether the introduction of the recycling bin will be able to increase recycling of small electrical items, especially high-tech devices, remains an open question, since both legal (SCHINK and KARPENSTEIN 2011) and technical problems exist. Joint collection with other recyclables considerably reduces the opportunities for reuse and hence extension of useful life, since it can cause damage and pollution (BEIGL et al. 2010).

One effective system for high-quality collection could consist in deposit systems for electrical equipment, especially high-tech devices. The SRU takes the view that initially it would be worthwhile introducing such systems for mobile phones and computers. The last ten years have seen a rapid rise in the use of these two products. Statistics indicate that every 100 households in Germany own 57.8 laptops and 160.9 mobile phones (Statistisches Bundesamt 2011a). The system could be modelled on the deposit system for car batteries that has been in place since 1998. The model has proved successful: the present recovery rate is close on 100 percent (UBA 2011). A deposit on mobile phones or computers could be very similar: On purchase of a mobile phone, a deposit is charged which is refunded when the device is returned. Responsibility for running the deposit system would rest with mobile phone providers, computer dealers and electrical dealers. Instead of paying the deposit on a new mobile phone, the consumer could give back an old mobile phone.

Alternatively, consumers could be given positive incentives to encourage them to use their electrical equipment longer. Various mobile phone companies already offer their customers cheaper contracts if they do without a new mobile phone and merely purchase the SIM card instead. Various private companies that finance themselves largely via resale operations offer to buy used mobile phones via online portals. The first machines for returning mobile phones are currently being set up in the USA. These issue vouchers to the customer. Easily accessible collection systems with a large number of collection centres are a precondition for high collection rates (BEIGL et al. 2010). It would therefore make sense to ensure close cooperation with retail outlets.

In view of the limited effect of existing return programmes, the introduction of a deposit system for mobile phones and computers would seem to be the most appropriate solution and should therefore be recommended.

2.4.4 International approaches

Certification systems

150. Certification systems can help to set environmental standards for resource extraction worldwide. Certification confirms that the resource producer complies with defined requirements within the value chain. To date, certification systems have been successfully established where environmental and social pressures associated with the extraction of resources are the subject of public discussion (e.g. child labour in quarries, timber production). In all cases these are voluntary systems initiated either by the state or by non-governmental actors. Where certification systems (e.g. EU bio label) are developed by the EU or individual member states, there is also the possibility of linking certification with financial assistance (e.g. through the Renewable Energy Directive 2009/28/EC). Examples of successful non-governmental certification systems include the Forest Stewardship Council (FSC) for timber from sustainable use (see para. 366) and the Marine Stewardship Council (MSC) for fish from sustainable fisheries. The environmental impacts can also be substantially reduced by codices such as the codex for coffee (4C Association 2011).

In the field of metals and minerals there are only first initiatives, in particular for jewellery raw materials such as gold and diamonds. In Colombia the first gold complying with fair-trade standards was certified at the beginning of 2011: in addition to social and economic criteria, this also includes compliance with environmental standards (Fairtrade and Fairmined Gold 2011). Projects such as Fair Stone and XertifiX have developed environmental and social standards for the quarry stone industry (Fair Stone 2011; XertifiX 2011). Most certifications are undertaken by independent institutions (third-party certification) (WAGNER et al. 2007). Existing international initiatives can provide guidance on laying down standards:

– The Intergovernmental Forum on Mining, Minerals and Metals and Sustainable Development is an initiative by various governments, especially in developing countries, that pursue the aim of increasing the contribution of mining to sustainable development.

– The International Council on Mining and Metals (ICMM), an alliance of 20 companies and 31 national, regional and global associations, was founded in 2001. Among other things it has published, jointly with the International Union for Conservation of Nature (IUCN), a document entitled “Good Practice Guidance for Mining and Biodiversity” (ICMM 2006).

– The Extractive Industry Transparency Initiative seeks to increase the transparency of financial flows in the oil, gas and mining sector.

– In July 2010 the USA passed the Dodd-Frank Act, which requires oil, gas and mining companies listed on Wall Street to disclose their income and their tax payments. They also have to show that their products do not originate from regions of conflict in or around the Democratic Republic of the Congo. At the end of October 2011 the European Commission presented a proposal for a similar EU Directive against corruption and for more transparency (European Commission 2011g).

– The Equator Principles are a voluntary undertaking by banks to comply with certain environmental and social standards in the financing of projects. They are based on the standards of the World Bank and the International Finance Corporation (Equator Principles 2012).

– The Business and Biodiversity Offset Programme (BBOP) is an alliance of companies, banks, governments and civil organisations which aims to develop measures that compensate for the impacts of encroachments on the natural regime and thereby generate a net profit.

– The Global Mercury Project was initiated by the GEF, UNDP and UNIDO to reduce the contamination of water with mercury in small-scale gold mining. One objective here was the development of country-specific extraction standards.

– The core labour standards of the International Labour Organization (ILO) set out basic principles and rights at work.

In the field of mineral resources no generally accepted mechanism exists to date that permits product differentiation on the basis of compliance with sustainability and development standards in production. The establishment and supervision of such a system are made more difficult by various factors, including the wide variety of mineral resources, the regional characteristics of the extraction areas, differences in extraction methods and differences in the scale of operations (WAGNER et al. 2007). Certification approaches to date are concerned in particular with precious metals, gemstones for the jewellery industry, and quarry stone. One well-known example is the Kimberley Process Certification Scheme, which seeks to prevent the use of the diamond trade to finance civil wars (“blood diamonds”). Despite a number of successes, it has proved difficult to implement in fragile, undemocratic states. The establishment of certification systems could reduce opportunities for selling resources from extraction operations that are illegal and not environmentally sound or socially acceptable.

For this reason the BGR (2011b) is currently supporting the development and implementation of a certification system for cassiterite, coltan, wolframite and gold in the Democratic Republic of the Congo. In a pilot project assisted by the Federal Ministry of Economics (BMWi) and the Federal Ministry for Economic Cooperation and

Development (BMZ) in Rwanda (2008–2011), the extraction of the resources coltan, tin and tungsten is certified on a model basis in order to make resource quantities and paths transparent (BGR 2011c). This and other first successful initiatives aimed at increasing transparency in the supply chains of "conflict minerals" are now facing the challenge of sector-wide implementation (SCHÜTTE et al. 2011).

One important instrument for verifying the origin of resources could be a chemical and mineralogical "fingerprint" of the kind developed by the BGR for coltan, for example (BGR 2011a). At present, however, the complex analytical methods and high costs make the method more suitable for cases where a specific suspicion exists than for broad routine use (WAGNER et al. 2007). This could change in future as a result of technical developments and improvements.

The BGR cites the following standards for certification (WAGNER et al. 2007):

– Product standards (quality): Quality and performance, ethical criteria;

– Source standards (transparency): Source of raw materials and ability to track value chains;

– Process standards (environment, health, safety): Standardisation of environmental, health and safety requirements in production;

– Standards for trade chains (producer and consumer): Fair and/or transparent trade between producers and consumers.

In the opinion of the SRU, certification systems are an instrument that is well suited to raising sustainability standards and transparency in sectors that have hitherto not been adequately regulated. In the field of mineral resource use, small-scale mining in particular would be an important target for certification systems, as production here often fails to comply with sustainable conditions and certification could lead to a marked improvement in environmental and social conditions.

Resource partnerships

151. The German government's resource strategy from 2010 also pursues the aim of establishing bilateral resource partnerships in the form of international treaties. This new form of cooperation with resource-rich countries is a reaction to rising resource prices and export restrictions, and requires a coherent economic, foreign and development policy. Whereas from a German point of view such partnerships are above all intended to serve the purpose of securing resource supplies for German companies, they are also to support compliance with environmental and social standards (BMWi 2010). Raw materials can only be useful from an environmental point of view if they succeed in reducing environmental impacts. In other words they should not have the effect of encouraging extraction in sensitive ecosystems in third countries. Instead Germany and Europe should in their agreements insist on compliance with strict extraction and social standards. In return, Germany and the EU should promote the transfer of modern technologies.

Positive mention must be made here of the EU biodiversity strategy for 2020, which implements the objectives of the Convention on Biological Diversity (CBD). It seeks to "enhance the contribution of trade policy to conserving biodiversity and address potential negative impacts by systematically including it as part of trade negotiations and dialogues with third countries, by identifying and evaluating potential impacts on biodiversity resulting from the liberalisation of trade and investment through ex-ante Trade Sustainability Impact Assessments and ex-post evaluations, and seek to include in all new trade agreements a chapter on sustainable development providing for substantial environmental provisions of importance in the trade context including on biodiversity goals" (European Commission 2011e). Furthermore, resource extraction must not impede the CBD's strategic targets of increasing the proportion of protected areas on land to 17 percent and at sea to 10 percent (SCBD 2010).

152. The EU has signed an agreement with Chile on access to raw materials and is currently seeking to make similar agreements with Argentina and Brazil. Germany's first resource partnerships are with Mongolia and Kazakhstan (Federal Government and Government of Mongolia 2011; Federal Government and Government of the Republic of Kazakhstan 2012). Representatives of industry also advocate a resource partnership with Russia. For such agreements to be successful from an environmental point of view as well, they need to create a balance between environmental standards and resource security. While both these agreements include a focus on implementing environmental and social standards in the extraction and treatment of raw materials (Article 2 paragraph 3 d), these standards are not defined precisely, although the agreements could make reference to the core standards of the ILO. The wording of the resource partnership clauses on consultations with regard to environmentally sound and socially acceptable extraction and processing of raw materials is very weak. Unlike the agreement with Mongolia, the agreement with Kazakhstan does not include a clause on the nature and organisation of the planned consultation.

The second guiding principle in the draft of the German Resource Efficiency Programme (BMU 2011a) is "Viewing global responsibility as a key focus of our national resource policy". In this connection the draft states: "To this end the German government, in cooperation with its partner countries and in European and international bodies, is making intensive efforts to ensure the design of sustainable extraction methods and constant improvements in environmental standards in the extraction and processing of raw materials" (BMU 2011a). The existing resource partnerships evidently do not live up to this claim.

International framework treaty on resources

153. Certification of imports or bilateral resource agreements may be regarded as a first step on the way to international resource agreements. Nevertheless, they will not in themselves provide satisfactory solutions, because they leave scope for evasive reactions on the part of the economic actors.

For this reason the idea of international resource agreements should be actively pursued. Such agreements, however, only have a chance if they are not drafted on an isolated basis in terms of environmental policy alone, but also take account of the export countries' revenue objectives. They should also cater for development policy objectives, and in particular the use of revenue (resource rent) for poverty alleviation, social and physical infrastructure or economic diversification, especially to legitimate income transfers from North to South (UNCSD 2011; BLEISCHWITZ and BRINGEZU 2007; BRINGEZU and BLEISCHWITZ 2009; The Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development 2010)

In this connection, one could develop and environmentally upgrade approaches of a "New International Economic Order" of the kind that was the subject of controversial international discussion in the post-war years until the second oil price crisis of 1981 (SENGHAAS 1978; DONGES 1977; ELSENHANS 1980). The starting point for the earlier discussions was a deterioration in real exchange parity (terms of trade) between resource revenue and necessary imports of industrial products, and the considerable price volatility inherent in resource markets (THE WORLD BANK 2009). Price increases and price stabilisation necessarily presuppose control of supply quantities. One particularly effective but conflict-prone form is monopolisation of supply by means of raw materials cartels that lay down production quotas for their members and thereby improve the revenue situation. Attempts to form such cartels under resource agreements between producing and consuming countries for copper (ADAM 1980) and tin (HILLMAN 2010) failed in the 1970s and 1980s for political and economic reasons. Even the more moderate EU solutions for stabilising export revenue under the Lomé Conventions have been expiring since the year 2000 (WBGU 2005). Nevertheless, given appropriate political support from the industrialised countries, control of supply quantities need not be regarded as fundamentally impossible (ELSENHANS 1984; 1983). Rigorous enforcement of strict environmental requirements will ultimately have the effect of limiting supply and increasing revenue and will thus provide a lever for environmentally upgraded development of the old development policy idea.

In future, therefore, export restrictions will only be viable instruments in the long term, provided they are implemented under consensus-based resource agreements (e.g. Article XX (h) of the General Agreement on Tariffs and Trade (GATT)) and a credible environmental policy rationale based on Article XX (g) GATT and in compliance with international environmental conventions (WBGU 2000, p. 114 f.). By contrast, arbitrary unilateral export restrictions by exporting countries would not be compatible with the rules of the World Trade Organization (WTO), of which many resource-exporting countries are members (OECD 2010; STÜRMER 2008; WTO 2011).

In the 1980s and 1990s the prospects for resource agreements were slim, because the importing industrialised countries were interested in a liberal, non-discriminatory global market and were able to prevail in this thanks to their position of market power. This situation has undergone a crucial change with the economic shortage of important resources and the shift to a seller's market (STÜRMER 2008; THE WORLD BANK 2009). This gives rise to new constellations of interests: exporting countries have an interest in securing their level of revenue beyond the end of the current price cycle. Consumer regions that rely on a resource-efficient economy, such as the EU and Japan (BRINGEZU and BLEISCHWITZ 2009), will also seek to ensure lasting economic security for their import substitution efforts as well as enter into strategic partnerships with exporting countries. There has also been an increase in sensitivity with regard to imports from war zones (Dodd Frank Act). Reducing the environmental impacts of resource extraction has also acquired greater importance among producers and consumers (UNCSD 2011). In this constellation, integrated multilateral approaches should be preferred to a liberalisation of trade that is not supported by environmental and development policy considerations, or to privileged bilateral partnerships with protectionist or even neo-colonial tendencies (STÜRMER 2008, p. 137).

The conflict about the Chinese export restrictions on rare earths which has been argued before the WTO in recent years can be taken as an illustration of both the structural change from a buyer's to a seller's market and the potential of the new environmental dimension of resource trade conflicts. In January 2012 the Appellate Body of the WTO, on the basis of a panel report (WTO 2011), finally prohibited China from imposing export restrictions. It also regarded even environmentally motivated exceptions pursuant to Article XX GATT as incompatible with China's Protocol of Accession to the WTO (WTO 2012). At the same time doubts were cast on the credibility of the environmental and resource policy grounds, because the restrictions and conditions did not apply equally to resource extraction for the domestic market. In theory, however, China could use its monopoly situation to bring about indirectly a significant increase in the price and decrease in the supply of rare earths by means of stringent environmental requirements for resource extraction or non-discriminatory resource conservation measures (Ekardt, F.: Ressourcen, Umwelt und Welthandelsrecht, Legal Tribune online, 21 March 2012). Ressourcen, Umwelt und Welthandelsrecht, Legal Tribune online, 21 March 2012).

The German government and the European Union should therefore actively pursue the long-term perspective of an international framework convention on resources. This should receive technical support from an inter-governmental and scientific resource panel (International

Panel on Sustainable Resource Management IPSRM). The panel should be modelled on the Intergovernmental Panel on Climate Change (IPCC) and thus considerably enhance the status of the existing IRP. In parallel, an agency should collect and process basic information on deposits, extraction conditions and environmental impacts (BRINGEZU and BLEISCHWITZ 2009). Fundamental environmental requirements can be agreed under this resource convention: authorisation requirements, environmental impact assessment, strict conservation of water bodies, avoidance of encroachments on protected areas and minimisation of risks to biodiversity, use of best available technologies, financing of recultivation following mine closure, safe deposition of waste, and strict requirements regarding environmental liability.

2.5 Conclusions and recommendations

154. The current discussion about security of resource supplies ignores the environmental dimension of the resource industry. The German government's resource policy continues to rely above all on political support for safeguarding access to raw materials. It is to be welcomed that, for the first time, the draft of the German Resource Efficiency Programme (ProgRess) addresses an environmental dimension of resource policy and is committed to responsibility for the global impacts of the resource industry. The programme defines important approaches, in particular for improving resource efficiency, though these can only be part of the mix of measures for sustainably greener resource management.

The UNEP concept gives concrete shape to two-stage decoupling for abiotic, non-energy resources. The approaches and instruments are intended to pave the way for green resource management. This should be based partly on decoupling resource consumption from prosperity, and partly on decoupling resource consumption from environmental impacts. The two objectives should be pursued in parallel.

To decouple resource consumption from prosperity, it is necessary to improve efficiency in production and product use, and to achieve a marked increase in closed-cycle management of raw materials. It also makes sense to ask cautious questions about the advisability of a heavily consumption-oriented lifestyle.

To decouple resource consumption from environmental impacts, it is necessary to avoid environmental impacts along the entire length of the value chain. As well as extraction methods that are compatible with nature conservation and environmental protection, priority should also be given in particular to considering the climate impacts of resource extraction and processing, and to optimising closed-cycle management and ensuring safe disposal worldwide during the waste phase.

One precondition for a realistic resource policy is much improved acquisition of data on the resource flows at national, European and international level. Further studies should be made with a view to calculating resource productivity with the aid of material flow indicators. New calculation methods using resource equivalents are to be welcomed. In addition, the German government should develop a per capita resource consumption target. To date, however, there is no environmentally accurate resource indicator capable of presenting a differentiated picture of the various environmental impacts. Here there is a need for further studies, as is also the case in the field of material flows, where there is currently a lack of knowledge. Furthermore, the Federal Statistical Office should be commissioned to record a substitution rate.

The SRU has investigated a broad spectrum of instruments over the entire life cycle of resources to see whether they can make a contribution to greener resource management. The following approaches appear to the SRU to be particularly effective, efficient and practicable, and the German government should therefore give priority to following them up.

Reform of mining law and priority for nature conservation

155. The Federal Mining Act should basically be revised. At present it is geared exclusively to ensuring security of resource supplies by extracting mineral resources. The legal status of nature conservation issues in the Federal Mining Act is not very strong. It would be desirable for the Act to establish a primacy requirement to avoid conflicts and, depending on the severity of the mining encroachments on the environment, to couple the issuing of an authorisation with special requirements to demonstrate a need.

Where resource extraction is not compatible with nature conservation considerations, priority must be given to protecting nature. Especially in the context of decisions that weigh up interests relating to encroachments on areas protected under the Habitats Directive, the German government should, as envisaged by the European Commission, lay down that resource extraction is not in itself an overriding long-term public interest (cf. para. 137) that can be used to justify an encroachment under Article 6 paragraph 4 of the Habitats Directive. Contrary to existing efforts, including those by a number of federal Länder, the SRU also takes the view that nature conservation requirements should not be relaxed in favour of resource extraction, either at national or at European level.

Introduction of economic instruments

156. In principle, resource taxes can also provide effective incentives to make efficient use of resources. The SRU therefore recommends introducing a tax on primary construction materials in Germany. A tax of this kind already exists in other EU Member States and would not involve any competitive disadvantages, because primary construction materials are extracted locally. Moreover, it could reduce the pressure to continue extracting mineral resources in Germany and could provide an incentive to make increased use of secondary raw materials in the construction industry. Material input taxes, however, are not practicable at the present time because of design problems.

Existing instruments, such as the European emissions trading scheme, can also make effective improvements in the climate impacts of resource-intensive goods production and create incentives to use resources more efficiently. Resource refining in the basic industries involves high energy consumption and high carbon dioxide emissions. In view of fears of competitive disadvantages, these industries have so far enjoyed extensive special rules and, in particular, over-allocation of emission allowances. The benchmarks associated with the free allocation of emissions rights will result in real reductions from 2013 onwards. Greater incentives to improve energy efficiency and resource efficiency can be created if emission allowances up to 2020 are reduced as a result of the increase in the EU climate target to 30 percent, and if the benchmarks are clearly geared to the technical avoidance potential.

Reinforcing producer responsibility

157. Development from a waste management system to a close-cycle management system calls for constant optimisation of identifiable weaknesses, in order to raise the quantity and quality of the secondary raw materials returned to the production cycle. Flows of end-of-life electrical and electronic equipment, which contain large quantities of technological raw materials, are of great importance here.

The instrument of producer responsibility, which aims at incentives for environmentally sound design of the entire product life cycle, should be defined in greater detail by developing minimum standards for the entire electrical and electronic equipment disposal chain, increasing the required recovery rates and introducing an obligation to show that second-hand equipment for export is still functioning. These measures should be accompanied by documentation, regular monitoring and rigorous prosecution of offences.

The introduction of a deposit system for selected resource-intensive products such as mobile phones and computers is suggested with a view to increasing the return rate for raw materials lying dormant in the cycle.

A complex material flow documentation should be compiled for individual bulk and technological raw materials of great environmental relevance, to make it possible to assess potential and access. This can be used as a basis for working out binding substitution rates (secondary raw material as a percentage of total consumption of the individual raw material).

Suggested international social and environmental standards

158. In view of globalised value chains, an environmentally oriented resource policy quickly reaches its limits: National or European approaches may be circumvented by the economic players, or they may have no effect because the main environmental impacts occur outside the territorial influence of the EU. Voluntary certification systems and bilateral agreements – such as resource partnerships – offer partial transitional solutions for raising international environmental and social standards. It is however important that the German government and the European Union work towards international agreements that link high environmental and social standards for resource extraction with development and security objectives. The EU should become a significant driving force for an international framework convention on resources, supported by a scientific resource panel (IPSRM) and an agency providing basic information.

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