



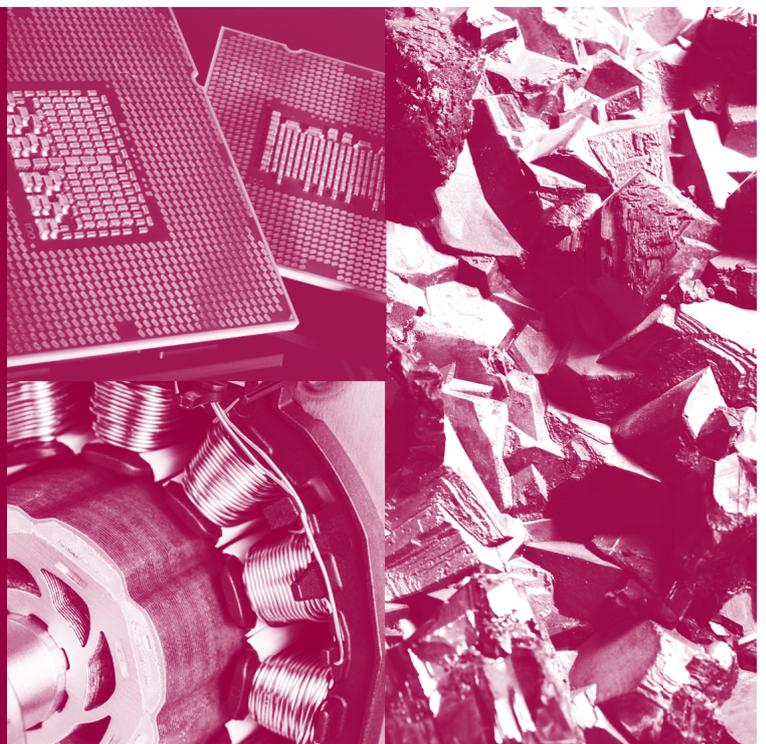
OFFICE OF TECHNOLOGY ASSESSMENT
AT THE GERMAN BUNDESTAG

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Supply of raw materials for High-tech german industries – specifying and further developing germany's raw materials strategy

Summary

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SUMMARY

The stability of the supply of raw materials is an important political objective for Germany as it needs to import a great number of raw materials. Due to structural changes of the global markets for raw materials and the steep rise in raw material prices, raw materials policies have gained political significance in the past few years. This applies in particular to non-energetic, mineral raw materials which are the subject of this innovation report. One of the causes of the rise in the price for raw materials is the growth in the demand for raw materials in the emerging countries. In view of the rising global competition for access to raw materials and the high concentration on the extraction of some raw materials in a few, partly politically unstable countries, the stability of the supply of raw materials can be regarded as being at risk. Another important aspect of the current discussion regarding raw material policies is the vital importance of some raw materials for the production of high and cutting-edge technologies. The dynamics of technological change can lead to a high rise in the demand for these raw materials and could be hindered by bottle-necks in the supply of raw materials.

In Germany and on a European level numerous initiatives by politicians have reacted to the changed situation on the market for raw materials. These include the German federal government's resources strategy, the raw materials strategy of the EU Commission, the EU parliament's raw materials strategy and party political programs on raw materials policies. Beyond the strict political sphere this development also gives institutions from industry, science, churches and civil society an opportunity to take a stand on topics of raw material policies.

The German federal government's resources strategy aims first of all to reduce trade barriers, increase diversification of raw material procurement and to fund raw material efficiency, recycling and substitution. NGOs criticize that this strategy does not take enough account of the social and ecological objectives of the raw materials policy and only inadequately meets Germany's responsibility towards emerging countries rich in raw materials. The debate about the German federal government's raw material strategy emphasises the broad spectrum of societal demands on a modern raw materials policy. Against the background of the current challenges on the raw material markets and the great number of objectives which a modern raw materials policy must meet this innovation report intends to highlight starting points for further developing German raw materials policies.



FUNDAMENTAL CHARACTERISTICS AND PROBLEMS OF RAW MATERIAL MARKETS

The current challenges regarding the supply of raw materials have to be considered against the background of fundamental characteristics of raw material markets. Knowing these markets is an important basis for understanding current challenges and assessing political solutions. The most important aspects are:

- > Producing and refining raw materials usually has *negative external effects*. Hence companies' production costs include only part of the overall costs. The height of the environmental and social standards will have an impact on the extent of these external effects.
- > Many markets for raw materials are characterized by a *high concentration of supply* by a few companies with large market shares. For one thing this is caused by the high barriers to market entry in the raw material sector. They can be mainly traced back to high capital requirements and the risks connected with financing new mining projects.
- > The substantial price fluctuations on the raw material markets are caused by an *adjustment failure* which results from the fact that a not anticipated change in demand cannot be offset by adapting the production capacities at short notice. It takes ten to fifteen years to start up a new mine, major projects can take up to twenty years, therefore supply only adapts very slowly to a rise in demand.

The existence of these fundamental problems does not, however, explain why the supply of raw materials, particularly in the past few years, has been regarded as precarious. Instead, the interaction between fundamental problems of the raw material markets and the current economic, technological and societal developments has to be considered. Such a consideration takes place in the context of the current discussion about critical raw materials.

CAUSES FOR THE CRITICALITY OF RAW MATERIALS

In the current discussion about raw material policies the term criticality plays a key role. In the fundamental approach to assessing the criticality not much has changed compared to the debates in the past, for example after the First World War or in the 1980s against the background of the East-West conflict. Back then, as today, criticality is linked to the economic importance of a raw material or its applications and to the risk of a disruption of raw material supply. However, it can be noted that the number of influencing factors which are presently considered when determining criticality has increased and has become more diverse.



The most important developments why some raw materials are currently considered critical are as follows:

- > The global demand for raw materials is growing and has led to increased competition for access to raw materials. An important driver for this development is the strong economic growth of the emerging countries.
- > For some raw materials the control of the production and trade focuses on a few actors who are partly state-controlled or influenced by governmental regulations.
- > The importance of raw materials as a production factor is increasingly recognized particularly when they cannot be substituted in economic relevant fields of application, for example certain high technologies. Fast diffusion of high technologies can lead to a sharp rise in the demand for raw materials to which the supply of raw materials can only react with a considerable time lag.
- > The raw materials sector is also increasingly influenced by societal developments, for example the increasing stringency of environmental laws in the mining countries, the increasing influence of the capital markets on the raw material markets (speculative trading) and the debate about social problems of the raw materials sector (e.g. child labor, the role of raw materials in financing regional conflicts).

When the scarcity of raw materials, the concentration of the control over raw materials and the importance of raw materials are high, this can lead to conflict-laden relations between actors in the raw materials markets as can currently be observed in the case of the so-called rare earths. At the same time, conflicts over access to rare materials can add to the insecurity of the future raw materials supply as it is uncertain how the conflicting parties will react if the conflict escalates. Certain societal developments have increased this insecurity. For example due to the increasing importance of the capital markets and the growing interdependencies between raw material markets and capital markets, it is not possible to clarify to what extent the rising raw materials prices can be attributed to real economic or fiscal developments.

THE SUPPLY SITUATION OF THE HIGH TECHNOLOGY SECTOR

Case studies pertaining to the supply situation for neodymium (one of the rare earths) and tungsten investigated the supply risk for critical raw materials from the point of view of individual high technology companies. For neodymium the focus is on permanent magnets which are used in particularly technologically and economic efficient wind turbines. Tungsten is used in carbide tools, energy



saving bulbs and electric contacts. The comparison of both value-added chains shows certain parallels regarding risk perception and the strategies for risk reduction. Companies on the beginning of the value chain perceive higher prices for raw materials as a more urgent problem than their Chinese competitors because this impedes their competitiveness. In view of the restrictive Chinese export policy the fact that mines for both raw materials are highly concentrated in China is perceived as problematic; it is presumed that in future Chinese exports of raw materials will be restricted even further.

Companies on end of the value chain are faced with the problem that products based on rare earths – such as neodymium – tend to have price and supply risks. Different strategies are put in place to avoid this problem. One of these companies has established a joint venture with a Chinese firm and so avoids the high Chinese export duties for rare earths. Another company's turbine concept pursues a strategy of flexibilization which makes it possible to leave the decision open to use a certain type of generator in its wind turbines – which requires the use of neodymium – until newly opened mines outside China have started their production and can thus contribute to easing the supply situation.

The increasing scarcity of tungsten which in recent years has caused steep price increases seems also relevant mainly because it discriminates against international producers with regard to their Chinese counterparts. The supply situation which is already regarded as critical is reinforced for many applications as tungsten cannot be substituted due to its particular characteristics. This applies to some areas which are especially important in economic terms; for example the use of tungsten-based carbide tools plays an important role for the productivity of machinery construction and the metal working industry. China has a dominant market position for tungsten, but does not have a monopoly, and for tungsten the recycling of used products at 34 % plays an important role for the raw materials supply – as opposed to neodymium. This leaves a certain scope for commercial strategies to reduce the supply risk, it requires, however, a high degree of foresight and good knowledge of the situation on the raw material markets.

Even if it is generally expected that the supply situation for both tungsten and neodymium will ease in the coming years as mines outside China will be opened, operational strategic solutions will dominate until then. These aim to reduce the supply risk in the short to medium term by cooperations and/or acquisitions of more backward-integrated companies outside China in order to open up alternative supply channels. The focus here is on the cooperation with vertically integrated companies which are implementing the first processing steps and which



either purchase their raw materials from their own mines with the aid of long-term delivery contracts or in future even more through recycling.

AIMS AND PURPOSES OF RAW MATERIAL POLICIES

The analysis of the current discussion on raw material policies in Germany which is held by the political parties, trade associations and civil society has shown that there is a broad spectrum of objectives regarding raw material policies. These include the following objectives:

- > Security of supply
- > Price stability
- > Market transparency
- > Non-discrimination
- > Reduction of raw material use
- > Improving social mining conditions and reducing ecological impact of mining
- > Taking on responsibility towards emerging countries rich in raw materials

In view of this broad spectrum of objectives raw material policies must be based on a systematic perspective which does not consider the supply of raw materials independent of the sustainable use of raw materials. Currently two strategy papers which focus on raw materials supply and/or raw materials use have been produced. One is the German government's raw materials strategy which was drawn up by the Federal Ministry of Science (BMW) and the German resources efficiency program (ProgRess) submitted by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). In addition, a strategy paper by the Federal Ministry for Economic Cooperation and Development (BMZ) formulates the development policy goals and measures in the area of raw materials policies. Against the background of possible interactions between the different governance approaches regarding raw material policies it seems sensible to coordinate these strategy papers.

Due to the large number of the objectives regarding raw material policies it will be particularly necessary that on the one hand the future development of governance approaches and strategies regarding raw material policies is used for harmonious relationships – for example measures to increase resource efficiency can have a positive effect on the security of supply and the reduction of raw material consumption. On the other hand, however, conflicting relationships have to be taken into account. These could be for example between the objectives »security of supply« and »responsibility towards emerging countries rich in raw



materials«. In the light of the above, it seems important not to hide conflicting objectives within raw material policies but to address them openly in the political discussion and to offset them with governance regarding raw materials.

GOVERNANCE APPROACHES OF GERMAN RAW MATERIALS POLICIES

With reference to the objective of security of supply and the closely related economic goals (price stability, market transparency, non-discrimination) it can be noted that the German raw material policies draw on a broad spectrum of different governance approaches.

- > In the area of *public authority*, foreign trade policies focus primarily on the goals of security of supply and non-discrimination in the supply of raw materials. The development cooperation also focused more strongly on the resource sector's contribution on the state level to the modernization of the resource sector in emerging countries rich in natural resources. This means that development policy objectives can be pursued and the options for German companies to diversify the purchase of raw materials can be improved. In addition two new institutions were set up and their research contributes to an increase in the security of supply, the German Mineral Resources Agency (DERA) and the Helmholtz Institute Freiberg for Resource Technology (HIF). Their insights can influence companies' decisions regarding raw materials markets (DERA) or raw material related technologies (HIF).
- > In the area of *regulatory law* modifying the framework conditions for recycling could increase the emergence of secondary raw materials in Germany which could make a positive contribution to fulfilling the objective of security of supply. However, this would have to happen on the premise that regulatory control is oriented more consistently towards this objective than this has been done up to now within the context of a revision of the waste management law (KrWG). The discussion about changing the framework conditions for using domestic raw materials is still in an early phase of the political debate and the importance of the objective of security of supply, taking into account ecological and social goals, has not been clarified yet.
- > The EU Commission's proposals for *regulating the trade* with raw material derivatives can contribute positively towards the objectives of market transparency and price stability. This measure is particularly significant due to the elementary signaling and monitoring function of raw material prices for actors on the raw material markets.



- > An approach to political governance through economic incentives is the *funding of research* into resource efficiency and recycling technology which addresses the objective of security of supply and the reduction of raw material consumption. In addition, financial incentives to implement new raw material projects in the context of public guarantee instruments and the proposed exploration program II are provided. The other measures, which aim to improve the availability of primary raw materials, result in a fundamental conflict with the objective to reduce raw material consumption as falling raw material prices question the profitability of measures to increase resource efficiency.
- > *Improving the social and ecological conditions* for the production of raw materials can be addressed on an institutional level primarily in the context of the development corporation with countries rich in natural resources. This aspect plays a major role in Germany itself within the context of the current debate on the revision of the Federal Mining Act (BBergG). Another governance approach which has to be seen in this context, is the development of technologies for a more sustainable raw materials production.

In order to achieve the objective of reducing the raw material consumption of the German economy, raw material policies draw on a combination of regulative approaches (framework conditions recycling), research funding and indirect governance approaches (information, conviction). The strong orientation of the governance regarding raw material policies towards soft, indirect approaches which are primarily characteristic of the German resource efficiency program are probably closely related to unclarified assessment issues in the area of resource efficiency. More direct governance approaches such as for example the extension of the Eco Design Directive to the use of materials or negative economic incentives (raw material taxes) were introduced into the political discussion in Germany by institutions on a European level and science but have so far not been met with a great response.

With exception of the development corporation, the regulative measure by the European Commission to disclose payments by raw material companies to the governments of countries rich in natural resources is only an approximation which explicitly aims at assuming Germany's responsibility towards emerging countries rich in natural resources. It should be noted that the objectives of the development corporation (e.g. developing local value added chains, tax revenues from raw material exports) are partially contrary to the measures which are currently pursued with the objectives of security of supply and non-discrimination in mind.



POLICY OPTIONS

Compared to other states which ensure their raw material supply partly through raw material associations which are state-controlled and/or influenced by the state (e.g. China, Japan) or strategic stocks (e.g. US, China), the German raw material policies restrict themselves to formulating the framework conditions for supplying German companies with raw materials. These are in line with regulatory principles which have been defined in the German government's raw material strategy. The following aspects listed below show what their further development and design could look like.

OBJECTIVE: SECURITY OF SUPPLY

Germany will continue to rely on the supply of primary raw materials from abroad and companies actively involved in mining abroad will continue to play a major role. Bilateral raw material partnerships, the proposed exploration funding program, the reform of untied financial loans (UFK) and the Defense Evaluation and Research Agency's consultancy services (DERA) are intended to strengthen the contribution of German international mining towards increasing the security of supply for German companies. In view of the small number of German companies which are currently actively involved in international mining and the high barriers to the entry into the raw material sector, the effectiveness of these governance approaches should be evaluated as soon as possible. A stronger orientation of these governance approaches towards European mining companies also seems sensible – while complying with certain criteria (e.g. long-term supply contracts with German companies, adherence to social and ecological standards).

Increased use of domestic primary raw materials can have positive effects on the security of supply for some industrial minerals and building materials. However, the debate about critical raw materials focuses on metallic minerals and not on these groups of raw materials. Compared to ecological and social issues the aspect of security of supply plays a minor role in the current political discussion about the revision of the BBergG. The question arises how the effects of a new raw materials project can be regarded holistically in all three dimensions in the approval process – independent of the respective political weighting of economic, social and ecological aspects. Regarding the security of supply methods for the dynamic assessment of the effects of an intended project on the security of supply can be an important element in such an assessment process (see chapter IV.3).



Improving the framework conditions for recycling is one of the few regulative approaches which are connected to the objective of security of supply as this could improve the availability of secondary raw materials in Germany. Within the context of the revision of the KrWG the quantity of secondary raw materials which have been recovered from the recycling process as well as their quality and use have so far just been considered selectively and have not been addressed systematically by fixed quotas or other policy approaches. In the case of the European Directive on Waste Electrical and Electronic Equipment (WEEE Directive) the discussion on quotas has become more differentiated. The implementation of the proposed material specific recycling quotas and target values for re-use will also depend on the extent German legislation will make use of the statutory instruments of the KrWG to prescribe the best recycling options or a series of exploitation stages. In addition to this regulative approach to increase the availability of secondary raw materials the funding for research and development into recycling was increased to expand the technical and economic efficiency of the respective processes and to create the conditions for increased technology diffusion. Establishing recycling facilities for raw materials, which play an important role for realizing high-technologies, at an early stage is an obvious option for further developing raw material policies. To some extent this is already being followed and should be more widely used in future.

Particularly for raw materials with a low production volume the supply situation can change significantly within short periods of time. This is why the existing information and consulting service by the DERA should be extended to reach more companies. The goal of the consulting services should be to raise companies' awareness of supply risks, which for example could result from the closing of a mine, an early stage and to show concrete approaches to reduce the supply risk. The consultancy service should not only approach enterprises in the raw material sector but also enterprises which are indirectly dependent on raw material markets. These are for example enterprises in the high-technology sector as they need information about raw materials for their product decisions but usually do not have an in-depth knowledge of how the raw material markets operate. Changes on the raw material markets can take place in long cycles particularly through the long lead times for the opening of new mines. However, particularly in the high-technology sector the innovation and product cycles are very short so that a long-term perspective for raw material purchase is not necessarily compatible and assumes awareness from enterprises.



The problems of the raw material markets when coordinating supply and demand are obvious. However, a government take-over of a coordinating role – for example as manager of raw material stocks which levels price development by targeted buying and selling – would be difficult to reconcile with the regulative focus defined by the German federal government’s resources strategy. In order to find a balance between the coordination by the market or the state a stronger network of the raw material dependent industrial enterprises in Germany and international mining companies would make sense to further the reciprocal exchange of trends in the development of supply and demand and to open up new policy options for German companies to purchase raw materials (e.g. strategic participation in raw material companies, joint ventures, long-term delivery contracts).

OBJECTIVES: PRICE STABILITY, MARKET TRANSPARENCY AND NON-DISCRIMINATION

The objective of price stability is closely related to the objective of security of supply. The analysis of the direct effects of rising raw material prices on enterprises in the high-technology sector has shown that these are less affected than the average for manufacturing. The neodymium case study is a concrete case which showed that the high price increases for neodymium significantly increased the risk for the introduction of gearless, separately excited wind turbines into the market. Due to the lack of transparency of the raw material markets it is difficult to assess the extent to which the increasing speculation with raw materials and raw material derivatives is responsible for price increases. In this context the proposals by the EU Commission to regulate the trade with derivatives can contribute to increasing market transparency and price stability as the speculative influence on pricing is recognized more easily when the trade with derivatives is made more transparent. As well as the obligation of transparency for the trade with derivatives the option of preventative market intervention by the supervisory authority is created in order to identify negative developments at an early stage. Against this background the proposals by the EU Commission should be supported by German stakeholders.

On the European level the non-discrimination of market entry is sought by different external trade approaches; the fight against infringements of existing trade agreements is so far receiving a lot of political attention. Another approach is the taking into account of the ban on export restrictions during negotiations on new bilateral and multilateral trade agreements. The case studies on tungsten and neodymium have shown that the Chinese export restrictions can cause an



uncertainty factor when developing technology and a competitive disadvantage over Chinese competitors and established technologies. The control which China exercises over the access to important raw materials and the political will of the Chinese government to employ this control to pursue industrial policy objectives presents enterprises from both value added chains with great challenges.

In this context, the WTO dispute settlement procedures against China pursued by the EU Commission should also contribute to overcoming fundamental challenges. The existing problems cannot be solved on this level alone but require closer coordination between the EU and China. In the face of the risks for the political relations between the EU and China which could involve an increase in the trade dispute in the field of raw materials and as Chinese raw material policies will also in future have a major influence on many raw material markets, an attempt should be made on the EU level to enter into a dialogue on raw materials with China to improve the mutual understanding of the challenges of raw material policies and to develop solutions for existing problems. A closer political agreement with China could for example make it easier for German companies to adapt to changes in Chinese raw material policies in good time (as for example the substantial reduction in the Chinese export quota for rare earths in 2010).

OBJECTIVE: LOWER CONSUMPTION OF RAW MATERIALS

Measures to consume fewer raw materials have been proposed by the German federal government's raw material strategy and the German resource efficiency program(ProgRess). Progress pursues a number of »soft«, indirect governance approaches which aim to increase resource efficiency of production and consumption by intensifying information and consultancy services.

The following can be said in favor of the comparatively high importance of soft political governance approaches which draw on positive incentives, information and networks; on the one hand far-reaching regulative approaches (expanding the ecodesign directive) would meet considerable resistance, on the other hand there is still no generally acceptable methodology, on which binding objectives could be based, to measure and assess the resource efficiency of products.

In the light of the great potentials to increase resource efficiency in the processing industry (the monetary value of potential resource savings was estimated at 48 billion euros in a study by the Fraunhofer ISI) and the positive experiences in the area of raw material and material efficiency consulting it appears promising



to reinforce these approaches. Due to the strong increase in raw material prices commercial incentives to increase resource efficiency and the awareness of the future relevance of resource efficiency in competition are currently very high which opens a »window of opportunity«. On the level of political management this can also result in positive interactions between approaches in the area of research funding which aims to develop resource efficient technologies and the improvement of information and consultancy services for enterprises.

There should also be a focus on the development of standards – which can be generally agreed upon – to assess resource efficiency of products to create the methodological prerequisites for a potentially stronger governance of resource efficiency on a commercial and governmental (regulative) level.

OBJECTIVE: RESPONSIBLE, SUSTAINABLE COOPERATION ON DEVELOPMENT POLICIES TO SECURE RAW MATERIALS

In the context of raw material extraction and security of supply it cannot be expected that the existing approaches to development cooperation, some of which are aimed at individual countries, suffice to overcome the, sometimes serious, social problems and ecological consequences of mining on site. This applies in particular when taking into account that it has so far not been possible to realize an international commodity agreement which defines binding standards for sustainable management of raw materials. In the context of development cooperation Germany aims explicitly to support the raw material sector's contribution for sustainable development in the countries concerned. Development corporations also support governments to improve their governance and to draw up a workable holistic overall concept for the development of their raw materials sector.

The EU-Commission's proposal to commit enterprises in the raw material sector to publish their payments to governments and to thus give the civil societies of countries rich in natural resources the opportunity to monitor the use of this income must be seen within a development policy context. In addition to consulting governments and administrations in countries rich in natural resources the development corporation should also strengthen the civil society of these countries. Precisely because many mining projects have negative social and ecological impacts on the communities concerned and the indigenous population it is highly relevant to involve the local population as early as possible and to develop suitable measures to limit the effects. Here a starting point could be the concept of »free, prior, informed consent« rooted in the ILO Convention no.



166. Another aspect is the certification of raw materials which are produced in compliance with social and ecological minimum standards.

Germany could make a special contribution by developing and supporting the implementation of such mining technologies which accommodate the needs of developing countries (e.g. adequate cost, transport, infra and training structures). Nevertheless, there is a certain tension between national research funding to develop technology and the desired relevance of technologies in emerging and developing countries. It does therefore not suffice to exclusively fund technology. Rather, this funding has to be supplemented with systemic approaches which consider the context of application in the technology development and also address the knowledge basis and capabilities of emerging and developing countries. In addition, in the technology development process the involvement of civil organizations can give additional weight to terms of use and can thus advance the acceptance of technology and possibly the necessary adjustments of institutions. These changes in the context require continuing development of the funding philosophy and development corporation.

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