Deliverable report

D3.2 Critical Raw Materials Substitution Policies - Country Profiles

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D3.2 Policy profiles

Deliverable description
The report consists of 35 policy profiles describing national and local policies dealing with CRM substitution. In addition RTD programmes related to CRM substitution are examined. Finally, other institutional settings that focus on CRM substitution are presented.

The profiles are based on literature and web research as well as personal interviews with national experts.

Covered Countries
1. Austria
2. Belgium
3. Brazil
4. Bulgaria
5. China
6. Cyprus
7. Czech Republic
8. Denmark
9. Estonia
10. Finland
11. France
12. Germany
13. Greece
14. Hungary
15. Ireland
16. Italy
17. Japan
18. Latvia
19. Lithuania
20. Luxembourg
21. Malta
22. Mexico
23. NL
24. Norway
25. Poland
26. Portugal
27. Romania
28. Slovakia
29. Slovenia
30. Spain
31. Sweden
32. Switzerland
33. Turkey
34. UK
35. USA
1. Austria

Strategic instruments
Austria has two sustainable development strategies: one is an initiative by the Austrian federal government (NSTRAT); the second one is a joint initiative of the government and the Austrian states (ÖSTRAT). The sustainable development strategy by the Austrian federal government (Bundesregierung, 2002) is currently updated and no new version is available yet. While it makes a link to raw materials, CRM are not mentioned. The joint initiative of the federal government and the states, Austrian strategy of sustainable development (ÖSTRAT), was issued in 2010 (Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, 2010). It sets a general direction but it makes no direct link to raw materials or substitution.

The resource efficiency action plan (REAP), introduced in 2012 by the The Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management, aims mainly at securing supply and at resource efficiency (Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, 2012b). The Austrian industry was involved in the development of this action plan. Substitution is mentioned only in a very general way.

The Austrian raw materials strategy, passed 2012 by the federal ministry of science, research and economy (BMWF&W), has the goal to secure the supply of mineral raw materials for the Austrian economy. Interestingly, the strategy is much shorter than for example the German one (Bundesministerium für Wissenschaft, Forschung und Wirtschaft). This strategy does not mention substitution explicitly. The focus is on improving resource efficiency and recycling. Its implementation takes place in cooperation with the implementing states in Austria.

The Austrian raw materials plan („Rohstoffplan“) (Geologische Bundesanstalt, 2012) was implemented by the federal ministry of science, research and economy in 20121. The plan has a focus on describing the current situation in Austria and Europe. Moreover, it is focusing on mapping and evaluating different regions of raw material supply in Austria. The vision is to use as little as possible of the resources, to use them as efficient as possible, and – at least for the Austrian mining sector – to use existing mines and do not destroy intact landscapes.

The industry initiative Raw materials security 2020+ (“Rohstoffsicherheit 2020+”), published by the federation of Austrian industries, focuses primarily on securing the supply. It discusses various means (among others use efficiency, recycling and to a smaller degree also substitution) to achieve this aim in a sustainable way (Industriellenvereinigung, 2012).

Finally, the strategy for research, technology and innovation (Bundesregierung, 2011) as well as the Austrian land use planning („Raumordnungskonzept“) make no specific reference to CRM. The latter is more related to building materials (Geschäftsstelle der Österreichischen Raumordnungskonferenz, 2011).

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1 A large number of organizations, among others the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management, the Geological Survey of Austria, the states, researchers from different universities, and trade chambers contributed to this raw materials plan.
With respect to CRM, the REAP refers to the CRM list of the European commission and gives rare earths as an example. The Austrian raw materials plan introduces and refers to the European raw materials initiatives as well as to the list of CRM published by the European Commission.

**Comparison of the characteristics of the strategic instruments**

The Austrian raw materials initiative is largely explicative. At the points where it is normative, it stays very general. The raw materials plan is largely explicative. It gives a detailed analysis of the current raw material supply and use situation in Austria as well as other EU countries. The raw materials strategy and the raw materials plan have the objective to ensure a (sustainable) supply of raw materials to the industry.

In contrast to this, the political objective of the REAP objective is to ensure a sustainable resource supply, to increase innovativeness, and to support the creation of “green jobs”. This action plan identifies four action fields for increasing resource efficiency. It proposes specific actions for each of these action fields.

**Austria’s strategies in the context of the EU**

The REAP gives a detailed introduction to its political background and therefore introduces EU level initiatives, the German ProgRess as well as the Natural Resource Strategy for Finland. It makes references to the roadmap to a resource-efficient Europe and the Raw Materials Initiative. The raw materials plan refers to the European raw materials initiative.

Austria aims at being among the leaders in implementing the European strategy. The Austrian raw materials strategy is constructed analogous to its European counterpart (Bundesministerium für Wissenschaft, Forschung und Wirtschaft).

**Specific instruments**

**Research programs at the national level**

In Austria, the funding of research and technology development is organized centrally. The Austrian Research Promotion Agency (“Die Österreichische Forschungsförderungsgesellschaft”, FFG) is coordinating the research project calls at national level in Austria which are in the area of applied research and/or in close connection to company-based research (Unternehmensservice Portal der österreichischen Bundesregierung, 2014). The Austrian Science Found (FWF) is coordinating research projects targeted at basic research (Unternehmensservice Portal der österreichischen Bundesregierung, 2014). Finally, the Christian Doppler Research Association is positioning itself between the FFG and the FWF and it is focussing on research projects between academics and companies and also at the interface between basic research and applied research (Christian Doppler Forschungsgesellschaft, 2013). In this context some research projects exist that are focussing at resource-topics.

There are a few calls of the FFG which could be associated with CRM substitution:

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2 More information can be found for example through the chamber of commerce by the state of Niederösterreich (Wirtschaftskammer Niederösterreich).

3 In the support program to implement the law on natural mineral deposits (“Lagerstättengesetz”) research on CRM is supported, however this research focuses mainly on information with respect to geological questions.
Since 2011 the program “Production of the future” exists. It issues yearly calls with a total yearly volume of 22 Mio €. In topic 5 (out of 7), 2 of the 4 sub-topics address CRM-substitution directly ("5.4 – saving or substitution of CRM") and indirectly (5.2 – intelligent materials development and raw material use concepts), respectively.

The open call experimental development. This call is funded partly by the FFG and substitution in general is included in one of the three main goals that have to be addressed by the proposed research (Die Österreichische Forschungsförderungsgesellschaft 5/20/2014).

Programs by the FFG which focus on innovations and knowledge-transfer in general include:

- Open call “BRIDGE”. This program focuses on knowledge transfer. It is funded by the FFG & the Austrian Ministry of Transport, Innovation and Technology (Die Österreichische Forschungsförderungsgesellschaft 5/20/2014).
- A few programs are targeted in particular on innovative start-ups and SMES, but not related in particular to CRM or their substitution, however projects on CRM substitution could fall in these programs: the Eurostars program (co-founded by the EC) (Die Österreichische Forschungsförderungsgesellschaft) as well as other instruments, such as innovation-check, a feasibility check as well as support for the project start and its market introduction (Die Österreichische Forschungsförderungsgesellschaft).
- The COIN program (cooperation & innovation) aims at supporting joined projects of companies (in particular SMEs) and research institutes with the goal to generate knowledge resulting in marketable innovations (Die Österreichische Forschungsförderungsgesellschaft).

The FWF as well as special research programmes issue open topic calls aiming at non-profit research. (single projects: about 90.000 € per project / year (FWF)). Basic research on CRM substitution could be funded through such a programme.

Moreover, interviewees indicated that the federal ministry of Science, Research and Economy is developing a new research strategy that is focusing on basic research in the area of raw materials ("Rohstoffforschungskonzept") which should ultimately lead to a new raw materials research strategy. Moreover, currently an integration of the research on raw materials into the RDI-strategy of the federal government is prepared.

International research agreements
On an EU level, Austrian actors are active in H2020 research projects. In addition, the Montan University was successful in its consortium to establish a KIC on raw materials. Austrian institutions are active in the Eurostars programme as well as m-era.net activities. Moreover, there are a number of different research partnerships, in particular between the Montan University and other research institutes.

Other instruments and initiatives
The Austrian tax law permits tax exemptions for research activities (“Forschungsfreibetrag”), however this instrument aims at supporting research in general, no specific focus on CRM is set (Unternehmensservice

Within this program individual projects are eligible for funding of up to 200.000€ for a pilot study or 2 Mio € for a project with several partners ("Kooperationsprojekt"). One of the partners has to be company. The program is funded by the ministry of Austrian Ministry for Transport, Innovation and Technology (Die Österreichische Forschungsförderungsgesellschaft 20.05.2014).
Moreover, companies can apply for a research premium (“Forschungsprämie”) (Unternehmensservice Portal der österreichischen Bundesregierung), also this instrument supports research in general.

Austria developed an “Action plan for sustainable public procurement” which focuses on 16 groups of products. It has no direct link to CRMs or their substitution (Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, 2012a).

A number of Austrian institutions are working in the area of collecting and disseminating raw material related information:

- The federal agency of geology (“Geologische Bundesanstalt”, http://www.geologie.ac.at) provides an informational framework for basic research
- The BMWFW is responsible for the legal framework
- The Federation of Austrian Industries is representing the interests of the Austrian Industries
- The Forum raw materials (“Forum Rohstoffe”) is an industry association of mineral raw materials producers (Forum Rohstoffe)
- The Industry unions “Bergwerk & Stahl” and “Nichteisenmetalle”
- The raw materials alliance (“Rohstoffallianz”) is a network of primary and secondary producers, lobbyists, universities, and public authorities

Last, but not least, the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management issues the “sustainability award”, however this instrument is only targeted at rewarding sustainability projects at Austrian Universities (Bundesministerium für Wissenschaft, Forschung und Wirtschaft).

**Other relevant aspects**

The “AWS” (“Austria Wirtschaftsservice”) is providing credits for founding companies and subsidies, yet without a special focus on CRM / CRM-substitution (Unternehmensservice Portal der österreichischen Bundesregierung, 2014).

Ressource efficiency has been integrated into the law to support environmental development (“Umweltförderungsgesetz”) which is currently aiming at contributing to reaching Kyoto protocol goals. Here the primary focus is – again – not the CRM-substitution but efficiency (Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft).

**Publication bibliography**


Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (2012a): Aktionsplan für nachhaltige öffentliche Beschaffung (Teil I & II). Available online at


2. Belgium

The Belgian economy is comparable to the Dutch Economy in terms of size and composure of the manufacturing sector. Strong chemical and metal clusters are present in the country and exports comprise a relatively large share of re-exported goods.

Strategic instruments

There is no specific raw material policy in place in Belgium, but various related policy documents have been published.

None of the current Belgian strategies focuses on CRM. One strategy that is indirectly related is the New Industrial Policy (in Dutch “NIB”) network that was launched in 2010 by the Flemish government (Nieuw Industrieel Beleid). It does not specifically address threats and/or opportunities related to CRM, however.

The Region of Flanders has published its Sustainable Materials Management Strategy in 2012 (Happaerts, 2014). Its main focus is to achieve the maximisation of secondary raw material use in production processes, and the minimisation of environmental impacts resulting from raw material mining and processing (European Environmental Agency, 2011). Additionally, through its Environment and Energy Technology Innovation Platform (MIP, 2005) the Flemish Government supports companies and researchers to develop sustainable products and processes, where the used materials must be maximally re-usable or fit into a closed cycle. End-of-life targets are plentiful (quantifiable targets for household and industrial waste, building projects, end-of-life vehicles, tires, WEEE) but not quantified (MIP, 2005). An exception are the targets related to sustainable consumption, where use in retail and government sectors by 2015 should be on a level that is comparable to 2008 levels.

The 4th Environmental Policy Plan (MINA 4) 2011-2015 was published in 2010 by the Flemish government (Departement Leefmilieu, Natuur en Energie, 2010) The proposed MINA 4-plan actions are expected to stimulate environmental friendly production and consumption. The plan includes a series of objectives for 2015 on eco-efficiency, the consumption of materials, natural resources and energy, and the use of substitutes and renewable energy. There is a target set to “increase” (without quantification) the proportion of substitutes for near-surface minerals, as the demand is expected to rise in the period 2010-2015 (OECD, 2012).

Characteristics of the strategic instrument

The documents emphasise the reduction of environmental pressures, the promotion of bio-based materials and influencing consumer behaviour. The impact of policy may be either stimulated or thwarted by the fact that regional governments have the mandate to allocate research budgets.

Belgian strategies in the context of the EU

Belgium relies on the EU ad-hoc initiative (European Commission, 2010) to develop strategies to remediate raw material issues related to global supply.
Specific instruments

Research programs at the state level

In Belgium research funding is organized at the state level. For the Wallone region, a program called ERable exists (Département de l’énergie et du Bâtiment durable, 2011). It targets both at private and public sectors. This program, with a budget of 10 million Euros, aims to strengthen scientific and technical universities, colleges, research centres and enterprises and to promote the findings in the Walloon industrial sector by funding research projects. However, though resource efficiency is mentioned as one of the five major themes, no specific reference to substitution research is given (European Environmental Agency, 2011).

Other instruments and initiatives

The Strategic Initiative Materials (SIM) (SIM-Flanders) in Flanders is a non-profit organization. Its members consist of main research institutes and iconic industrial players like ArcelorMittal, Umicore, AGFA and many more. It has a focus on a limited number of research themes: innovative materials technology for applications in energy, in durable structural materials and recyclable materials. The initiative funds research either through strategic basic research projects (that are carried out at research institutes that are part of SIM and funded 100% by SIM) or numerous mixed-funding projects. The annual budget of SIM is subject to change and not clearly reported.

An example of an organisation that plays a role in involving the industries is the Federation of Enterprises in Belgium (Verbond van Belgische Ondernemingen).

Publication bibliography


3. Brazil

Brazil is hosting reserves of some CRMs. It is, for example, aware of the location of its deposits of rare earths minerals, and was a pioneer of their exploration and production until the 1950s. But the sector stagnated following the wave of nationalizations, and today Brazil lacks the necessary technological knowhow for a profitable production. In addition, potential sources of minerals, like for example the Amazonia region, is a home to an indigenous population and in addition known for its rich bio-diversity where protecting this poses a potential source of conflict with its use and occupation of land.

Strategic instruments

The National Mining Plan 2030 (Ministério de Minas e Energia, Brasil, 2011), issued in 2011 by the Brazilian Ministry of Mining and Energy, identifies “strategic minerals” that are “essential” or “critical” in at least one of the following categories: firstly, they are of importance to key industries (e.g. agriculture) and at the same time have a strong import-dependency (e.g. phosphate, diatomite and zinc), secondly they are expected to be of growing importance in the coming decade (e.g. niobium, graphite, chromium, and tungsten), and thirdly they constitute a competitive advantage of the Brazilian mining sector. In a policy to promote sustainable production of Mineral sector, one of the proposed actions is to encourage recycling, reuse and recycling of materials mineral resources.

With respect to the demand for strategic minerals for high-tech products, cobalt, lithium, rare earth minerals, and tantalum constitute “resources of future importance”. Strategic minerals in which Brazil has a competitive advantage in production and export include iron ore and niobium. Brazil accounts for more than 90% of global reserves and production of the latter.

The strategy makes explicit references to the following CRM: Niobium, phosphate, graphite, chromium, tungsten, manganese.

Characteristics of the strategic instrument

The Brazilian government seeks to promote exploration and production of its CRM resources. Moreover, it is initiating public-private cooperation (especially in research, development and innovation) to accelerate the development of value-added chains.

The strategic goals of the mining policy until 2030 are effective public governance, the management of strategic minerals, and to expanding the geological knowledge.

The National Mining Plan suggests in its fifth chapter possible actions among which to carry out a geological survey, to support research on mining and the productivity chains, to promote the opening of new mines in areas with phosphate and potassium-bearing minerals, and to establish working groups for strategic minerals.

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1 Agricultural fertilizers are essential to ensure productivity in the Brazilian agricultural sector. For example Brazil needs to import 90% of the domestically-consumed potassium, 70% of its nitrogen fertilizer and 50% of its phosphorus.
Brazilian strategies in an international context
The Brazilian strategy does not make references to other countries’ strategies.

Specific instruments

Research programs at the national level
Funding of research directed at CRM is included in the National Mining Plan 2030, but not in terms of substitution. Actions, which the ministry is promoting at the national level, are the encouragement and promotion of studies, research and technological processes, aiming at the mineral industry value aggregation and the densification of knowledge in the productive chains.

FINEP, the national funding agency, grants reimbursable and non-reimbursable financing. The support of FINEP covers all stages and dimensions of the scientific and technological development cycle: basic research, applied research, innovation and development of products, services and processes. FINEP supports, for example, the development of technology parks and the structuring and consolidation of research-, development- and innovation-processes in already established companies. In its operational policy 2013-2014 CRM are not mentioned (Finep), however FINEP funds a special program “CT-Mineral” which is focusing on the development and dissemination of intermediate technology in small and medium-sized enterprises and the stimulus to scientific-technical research of mineral export support (Finep). This program is funded by the financial contributions (2%) of the Mineral sector (CFEM) that holds mining rights to the Fundo Nacional de Desenvolvimento Científico e Tecnologico (FNDCT). FNDCT issues non-reimbursable funding, currently formed mainly by sectorial funds of CT. These funds are intended for non-profit institutions, programs and areas determined by committees of the funds.

Research programs at the state level

International research agreements
Brazil funds the IBEROEKA program which funds bilateral projects with Spain and Iberoamerican countries. The projects do not target a specific stage of the RTD process and they promote networking between public researchers. At the National Council of Scientific and Technological Development (Conselho Nacional de Desenvolvimento Científico e Tecnológico,CNPq), the bilateral cooperation agreements are concluded between this Council and, preferably, funding institutions or foreign research, of a similar nature in another country. The cooperation agreements support mainly the mobility of researchers within the framework of joint projects for research, development and innovation, in preferential areas, defined by mutual agreement with foreign funding institutions. The program targets at supporting short research stays at cooperating institutions. During the last years a number of calls have been issued, each of them in the context of bilateral agreements with a large number of international partners, some of them institutions such as the MIT but mainly countries or the respective national funding institution.
Other instruments and initiatives

Other relevant aspects
Since 1990, with the introduction of the law “8.010/90” investments into scientific and technological research can be exempted from taxes, a legal instrument to promote investment into R&D and to increase the resources available for research. To take advantage of this exemption, the researcher or accredited company has the burden of obtaining the license required for the tax exemption, as well as to fulfil other regulatory requirements. To minimize the associated bureaucracies, CNPq has sought to improve the process of imports for research carried out by entities and accredited researchers, with the increasing computerization of procedures and the recent implementation of the CNPq_Expresso system. In addition, the CNPq provides a Tutorial system “Import for research” (TIP_CNPq) interactive and online, which aims at supporting, among others, researchers and institutions and customs on import regulations. Since December 2011 the program is fully operational (TIP_CNPq).

Publication bibliography
4. Bulgaria

In Bulgaria no policy instruments regarding the substitution of critical raw materials are in place. In addition, personal interviews indicated that the general awareness of this issue among key policy-makers is still very low. Currently, Bulgaria is negotiating the design of its national development programme (The Republic of Bulgaria). In this draft resource efficiency is discussed as a sub-priority.

One initiative that directly discusses CRM is a website run by a media company “GreenTech.bg” (GreenTech.bg). This company publishes information in Bulgarian about the “world of green technologies”

Publication bibliography


5. China

China dominates the global production of several materials that are considered to be CRM by the European Commission. In many cases China also dominates their further processing. This dominant position is the result of a focused policy program, which started in 1992 to develop China’s raw material production in order to become a key supplier of the world economy (Shi, H.N. et al., 2011).

Strategic instruments

Most of China’s raw material policy is described in the 2003 set of documents issued by the Office of the State Council of the People’s Republic of China (The Information Office of the State Council of the People’s Republic of China, 2003).

A massive body of research activities within China is dedicated to the circular economy and resource efficiency (President of the People’s Republic of China, 2008). Research efforts have largely been included in the ‘National High Technology Research and Development Program’ that started in the 1980s (Yuanyuan, 2011). Frequently stated aims are to offer job opportunities, to protect people’s livelihood as well as to promote industrial restructuring and sustainable development (Li et al., 2013). However, many policy documents remain to be opaque given the country’s centralized organization. The only references to substitution in these documents are to substitute economic activities related to raw materials, not material use.

Comparison of the characteristics of the strategic instruments

The main foci of the earlier introduced documents are on securing supply, on improving environmental conditions, on the creation of markets and on improving the cooperation with other countries. In detail, they propose increasing exploration efforts to find sources of raw materials that can be monopolized on the current world market, making the mining capacity more flexible to adapt to shifts in demand, to reduce environmental impacts of raw material production, to increase implementation of R&D, to strengthen international cooperation (not specified in terms of countries or organizations) and to improve the enforcement of existing legislation in mining and processing industry (Niemeläinen et al., 2010).

If research, development or technology is mentioned in any of the mentioned sources, it never relates to substitution of specific materials, merely substitution of specific sources of ore and coal for secondary materials or other geographical locations. The only reference in the 2003 documents (The Information Office of the State Council of the People’s Republic of China, 2003) is the statement that China will develop new alloys, new non-metals and substitutes for conventional mineral materials.

According to a report by the British department for Environment, Food and Rural Affairs (Department for Environment, Food and Rural Affairs, 2012), China is solely committed to securing supply, industry supply chain consolidation, reducing illegal trade and mitigating overproduction. Materials of interest are, besides the obvious REE’s, antimony, silicon, tungsten, iron, silver, zinc, vanadium, molybdenum and aluminium.

China’s strategies in an international context

China also executes a set of strict trade policies that evoked a global sense of discontent (called “China bashing”). In early 2012 the WTO issued a final ruling on export restrictions and duties imposed by China

\[1\] (Wübbeke, 2013)
on a group of raw materials. Although the WTO ruling declared almost all Chinese export duties and restrictions illegal and incompatible with the multilateral trading system, it's hard to judge on the legitimacy of these policies (Lackner, McEwen-Fial, 2011).

**Specific instruments**

**Research programs at the national level**

Apart from a reference that China is funding a national research lab (Yuanyuan, 2011) focusing on improving the yield of REEs, little information can be found on research programs. But there is a thin line between public and private R&D. Institutional reforms were started in the 1990s, many Public Research Institutes (PRIs) transformed themselves into private technology service enterprises or were affiliated with corporate groups as the means for their survival (Hu, 2008). Moreover, China’s foreign policy often relates to multinationals (Moran, 2010) where China takes an equity stake in “independent” producers like Rio Tinto, Sinopac, Ahalco, and Addax.

**Research programs at the state level**

No information was available on research programs at state level.

**International research agreements**

China is hardly involved in major international cooperation programs on critical raw materials. The country however does have ventures outside its borders through state companies. Along with the pragmatic character of the state policy on mineral resources, the focus seems to continue to be on the present: production, production methods and the societal (labour) and environmental effects of production (Hu, 2008). An iconic example would be Huawei that rose to become the fourth largest patent applicant in the world. It is leveraging external technology through its six overseas R&D centers (Hu, 2008).

**Publication bibliography**


Niemeläinen, Emma; Tuusjärvi, Mari; Niiranen, Tero; Vuori, Saku; Kananoja, Tapio (2010): Minerals strategies and policies around the world. Katsaus mineraalistrategioihin ja -politiikkoihin maailmalla. Edited


6. Cyprus

While Cyprus has some mineral deposits and mining sites, most of these are not profitable any more.

Strategic instruments

The Republic of Cyprus created the Committee for the Sustainable Development of Mineral Resources in Cyprus to issue recommendations on mineral resources. It is coordinated by the Geological Survey which carries out all administrative and geological work. In addition to this a proposal for Green Economy Program is under preparation to be submitted to the Council of Ministers for approval. Parts of this program involve mineral resources, addressing recycling and the recovery of resources. Here the focus is on Armourstone for marine construction works, on aggregates, on raw materials for the cement industry as well as on raw materials for the brick and tile industry.

Organizations that are involved in moving towards a more sustainable economy are the Ministry of Agriculture, Natural Resources and Environment, the Ministry of Interior, the Directorate General for European Programmes, Coordination and Development, the Department of Town Planning and Housing, the Department of Environment and the Department of Forests and Mines Services. Pursued policies are in part conflicting with each other especially with the strategies concerning land use planning and environmental policies. However the overarching goals are to achieve growth, employment and sustainability.

The basic aim of the general strategy, which includes the mandate given to the Committee for the Sustainable Development of Mineral Resources in Cyprus, is to plan a sustainable development of minerals resources securing supply, conservation, efficient use and recycling of mineral resources. It indicates the relevance of raw material criticality in the future and if possible to propose certain actions to counteract criticality. Substitution is part of the strategy and it is applied when it is necessary and possible. Currently the focus is, however, on the availability of raw materials and it not so much on their substitution.
7. Czech Republic

The Czech Republic has some reserves of CRM, mainly in the area of the Erzgebirge. A detailed overview is published by the Czech geological survey (Czech Geological Survey, 2013).

Strategic instruments

In 1999 the Czech ministry of Industry and Trade issued, together with the ministry of the Environment, “The Raw Material Policy of the Czech Republic in the Field of Mineral Materials and Their Resources” (Ministry of Industry and Trade of the Czech Republic and Ministry of Environment of the Czech Republic, 1999). This document focuses on a range of raw materials from both primary and secondary sources. Since it precedes the discussion around critical raw materials and consequently no specific reference to CRM can be found. A new mineral policy, which reflects CRM, is currently in preparation. Moreover, a new policy on secondary raw materials is declared. This policy also focuses on substitution, but not specifically for CRM.

In 2010 the Czech government adopted the Strategic framework for sustainable development which was prepared by the Ministry of the Environment.

Comparison of the characteristics of the strategic instruments

The raw material policy gives an overview about the raw material situation in the Czech Republic, with respect to domestic reserves, with respect to trade flows but also with respect to the institutional environment. Moreover, it defines goals for different time-spans and it develops tools for achieving the defined goals. The goals are macroeconomic ones.

Czech Republic’s strategies in the context of the EU

The Raw Material Policy makes reference to EU regulations, standards and targets, mainly with the focus on reaching or implementing these in the Czech Republic.

Specific instruments

Research programs at the national level

The Czech Science Foundation is a governmental agency which is, among other things, in charge of promoting and funding basic research in the Czech Republic. The Technology Agency of the Czech Republic (established in 2011) is, on the other hand, in charge of the funding programs for applied research, development and innovation. The scope of the targeted funding is stipulated in the National Policy of Research, Development and Innovation of the Czech Republic 2009 – 2015 (ERAWATCH, 2012). Even though this policy document does not target directly at the environment, material-related goals of the Materials Research priority target material intensity.

International research agreements

The Czech Republic participates in the European Innovations Partnership (EIP) on raw materials (European Commission).
Other instruments and initiatives
The Czech Geological Survey (CGS) collects and disseminates general information about geological resources and the environmental impact of mining in the Czech Republic. In addition they are involved in basic research on the "mineralogy and geochemistry of raw materials and the potential uses of mining waste". On their website the CGS point out their specific focus on CRM (Czech Geological Survey).

Publication bibliography


8. Denmark
In the Kingdom of Denmark Greenland has potential in critical raw materials. Greenland is known for geological settings carrying a high potential for hosting Rare Earth Element-deposits (REE), and a number of large deposits are being explored in an advanced stage. It is considered likely, that Greenland has the ability to become a mid-size supplier in a REE market which is currently dominated by larger players.

Strategic instruments
The “Kingdom of Denmark, Strategy for the Arctic 2011-2020“ is the strategy most obviously related to CRM, though mostly related to sustainable growth and social sustainability in the development of the Arctic region. The strategy was adopted by the Government of Denmark, the Government of the Faroe Islands and the Government of Greenland and launched by the Danish Ministry of Foreign Affairs in August 2011 (Ministry of Foreign Affairs, 2011). The strategy gives an overview of critical minerals (those that are already critical according to the EU Raw Materials Supply Group and those that might be critical in the long term) and the mining opportunities for these in Greenland. It does not consider the substitution of CRM.

The Danish strategy for sustainable development was published by the Danish Ministry of the Environment in 2009. The primary focus is on sustainable development in developing countries, green innovation in production and consumption through environment technology solutions, and the development of green markets in these regions. The strategy has no direct link to raw materials or substitution (The Danish Government, 2009).

In 2013 Denmark the Danish Ministry of the Environment published the strategy “Denmark without waste. Recycle more - incinerate less“ which focuses on recycling. The Government has a vision that Denmark will protect its resources and materials, and recycle more household waste, while incinerating less. This will entail more materials being sent back into the economic cycle with benefits for the environment. It refers to CRMs in the section of electronic waste, neodymium is mentioned as an example, however the focus is on recycling and it does not have a direct link to substitution (The Danish Government, 2013). Prior to this strategy in 2010, the same ministry issued the Action plan for promoting eco-efficient technology 2010-2011. It builds on a broad agreement with all the parties comprising the Folketing, Denmark’s parliament. Here the focus is on economic growth and social development without conflict with the environment. This action plan does not have a direct link to raw materials or substitution. CRM are not mentioned explicitly, but the action plan states that a number of raw materials are in limited supply (The Danish Government, 2010).

On a more detailed and applied level, the following acts can be seen as relevant laws: the Raw materials Act (Råstofloven), the Planning Act (Planloven) and the Nature Protection Act (naturbeskyttelsesloven). The Raw Materials Act has the purpose of making sure that supply and production of raw materials takes place in a natural and environmentally safe way. No specific CRMs are mentioned specifically. The political motivation behind the act is sustainability and environmental protection. The other two actions do not specifically mention CRM, either.

In Denmark there are no existing strategies regarding the substitution of CRMs.
Comparison of the characteristics of the strategic instruments

Looking at the characteristics of the four strategic instruments, all four have an explicative character. Moreover, the four instruments share sustainability, or sustainable development respectively, as their common goal. The action plan for promoting eco-efficient technology aims, in addition, at supporting innovativeness and competitiveness. Moreover, the Strategy for the Arctic contains a series of policy objectives, which broadly fall into two categories: first, supporting and strengthening Greenland’s path towards greater autonomy and self-government, and second, maintaining the Kingdom of Denmark’s position as a major player in the Arctic. The list of tasks in the strategies third chapter, “Self-sustaining growth and development”, includes exploiting mineral resources under the highest international standards and it mentions raw materials, critical metals and rare earth elements several times.

To address the aims, the four strategies propose different policy measures. The Strategy for the Arctic states that “Mineral sector activities must be conducted responsibly as regards environmental, health and safety concerns, and an appropriate supervisory body must ensure compliance hereof”. It also refers to the Mineral Strategy of Greenland but no detailed measures are proposed. The strategy for sustainable development refers to more concrete laws, such as the earlier introduced Environmental Protection Act, but no specific instruments relating to CRM are introduced.

The Recycling strategy mentions six measures, one of which directly relates to CRM: more recycling of materials from waste electronic equipment and shredder waste. Finally, the Action plan for promoting eco-efficiency mentions a large number of initiatives, but none of these targets CRM specifically.

Denmark’s strategies in the context of the EU

All four strategic instruments refer to EU-level initiatives: the strategy for the arctic refers to the Council’s conclusion on the Arctic (Council of the European Union, 2009) and the respective Parliament’s resolution (The European Parliament, 2011). The sustainable development strategy refers to similar international strategies that deal with sustainable development, directly and indirectly. The recycling strategy mentions, among others, specifically the EU target of separating 50% of “dry” household waste in 2020 and the WEEE directive on electronic waste (The European Parliament, 2003). Finally, the Action plan refers to the EU Environmental Technologies Action Plan (ETAP) (European Commission, 2004) and the former Eco-Innovation Action Plan.

Specific instruments

Research programs at the national level

We are not aware of any Danish RTD programs which are directed towards CRM substitution.

Other instruments and initiatives

The Geological Survey of Denmark and Greenland (GEUS) have established the Knowledge Centre for Mineral Resources and Materials (MIMA). The centre aims at identifying the problems associated with scarcity and vulnerability, but MIMA should also help to identify new opportunities for the exploitation of resources and materials. MIMA will carry out research and analysis of issues related to raw materials value chain from exploration to production (MiMa).
Publication bibliography


9. Estonia

Estonia has no deposits of metallic ores, but there are deposits of phosphate rocks in the country. The “Rakvere deposit” is the largest European deposit of phosphate.

Strategic instruments

Estonia has very general strategies: in 2005 the Estonian Ministry of the Environment issued the sustainable development strategy “Sustainable Estonia 21” (Estonian Ministry of the Environment, 2005) and in 2007 it issued the Estonian Environmental Strategy 2030 (Estonian Ministry of the Environment, 2007). Moreover, in 2012 the Estonian government issued its national reform programme “Estonia 2020”. However, all strategies make no specific reference to CRM and thus neither to CRM substitution.

While “Estonia 2020” targets at securing supply of raw material in general, the other two strategies aim at increasing sustainability.

Personal interviews indicated that Estonia plans to prepare the Mineral Strategy of Estonia in the near future (during 2015-2016). In this context Estonia views similar strategies of its neighbouring countries as examples, such as Sweden’s Minerals Strategy (Regeringskansliet, 2013) and Finland’s Minerals Strategy (Finnish Ministry of Employment and the Economy, Geological Survey of Finland, 2010).

Comparison of the characteristics of the strategic instruments

The Estonian strategies are explicative in character. While the national reform program has the objective to develop an accounting system of natural mineral resources in order to increase the Estonian security of supply of raw materials, the Environmental Strategy 2020 targets resource efficiency policies and the sustainable extraction of mineral resources. It builds upon the principles of “Sustainable Estonia 21” and serves as the basis for the preparation and revision of all sector-specific development plans within the sphere of the environment.

Estonia’s strategies in the context of the EU

The Estonian National Strategy refers to the EU-strategy “Europe 2020”.

Specific instruments

Research programs at the national level

In Estonia, according to personal interviews, the most important funding is the state budget. In addition, parts of the expenses for research and technology development are covered by private companies.
Research programs at the state level

International research agreements
According to personal interviews, the most important formations of partnerships between different countries are organizations of the European Commission (as DG Enterprise and Industry) and also the EuroGeoSurvey. The Geological Survey of Estonia is a member of EuroGeoSurvey (EuroGeoSurveys).

In the future (in 2016-2018), the interviewee expects activities launched by the European Institute of Innovation Community (KIC) as a good possibility to create partnerships between different countries concerning the exchange of ideas about CRM substitution.

The institute of Geology at Tallinn University Technology is involved in a number of international research projects.

Other instruments and initiatives
The Geological Survey of Estonia provides geological services, for example geological mapping, for the private sector and public sector and in addition it is organizing partnerships.

Other relevant aspects
The interviewee indicated that while the support from the government is not very strong today, but is expected to increase after establishing the Mineral Strategy of Estonia and then the support will be also more targeted in the direction of CRM.

Publication bibliography


10. Finland

The Finnish economy is characterized by on the one hand its traditional wood- and paper-industries and on the other hand by its export-oriented high-tech industry which is dependent on critical raw materials (CRM). In contrast to other European countries the mining industry is relatively important while still only accounting for about 0.3% of Finland’s GDP (Technische Universität Clausthal, Bundesanstalt für Geowissenschaften und Rohstoffe, 2013). In particular, Finnish bedrock contains significant known deposits of many critical metals and minerals (Finnish Ministry of Employment and the Economy, Geological Survey of Finland, 2010).

Strategic instruments

Finland has three main strategies related to raw materials (Minerals strategy, Natural Resource strategy, Arctic Region Strategy). While the Minerals strategy is most focused on inorganic materials, the Natural Resource Strategy includes also bio-based and renewable resources such as wood and water while the Arctic Region Strategy focuses in particular on the most northern geographical area of Finland considering a broad range of topics.

In 2009, Sitra, the Finnish Innovation Fund issued the Natural Resource Strategy of Finland. This strategy was submitted to the Finnish Prime Minister (Sitra, 2009). The strategy has been created through wide-ranging collaboration involving politicians, administrators, business representatives, researchers, organisations and the media. This strategy aims at drawing up a long term vision of well-being based on the sustainable use of natural resources. It sets goals that support this vision, it defines the measures and means that support the goals, and it aims at committing key actors to implementing development projects. Substitution is mentioned in the material cycle, one of the areas in which structural changes are required. However, the statement refers also to the objectives of the EU’s sustainable development strategy.

In 2010, the Finnish Ministry of Employment and the Economy and the Geological Survey of Finland published the Finnish Minerals Strategy. The Geological Survey coordinated the preparation process. The strategy was developed in a dialogue with politicians, scientists and representatives of different societal groups and associations. Some of the proposed measures are included in the Finnish Government Programme 2011 – 2015. The objectives of this strategy are to promote domestic growth and prosperity, to develop solutions for global mineral chain challenges and to mitigate environmental impacts. CRM substitution has a minor role in this strategy. It is listed mainly in the context of EU policy. In addition, substitution has been mentioned together with recycling and new materials as an area of focus in research. However, since Finland has historically a strong mining industry, including also mining technology design and manufacturing, the focus of the strategy is more on mining, exploration of ores, enrichment technology and innovative processes in the value chain of material (Finnish Ministry of Employment and the Economy, Geological Survey of Finland, 2010).

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1 The strategy includes among others the topics of the arctic marine, cleantech, transport, mining, tourism, renewable resources, and the energy industry.
2 Among others ministries, research organisations, universities, NGOs, industries, the Finnish funding agency, and environmental authorities have been integrated into the process.
3 The Finnish Ministry of Employment and Economy has the general responsibility for the Finnish minerals policy.
In 2013 the Finnish Prime Minister’s Office published Finland’s Strategy for the Arctic Region (Prime Minister’s Office Finland, 2013). Since significant amounts of metals are located in the northern part of Finland, the arctic strategy is included in this overview. CRM substitution is, however, not at the focus of this strategy. Instead, the objectives are to secure sufficient resources for the health and well-being of the arctic population, to improve the working conditions and to promote the well-being at work of all workers in the challenging Arctic environment. Finally, it aims at ensuring the availability of labour, particularly by promoting worker mobility.

None of the strategies mentioned above is about specific CRMs. Insofar as CRMs are explicitly mentioned, there is a reference to the list defined by the Ad-hoc Working Group on defining Critical Raw Materials (European Commission, 2010). The strategy which is most relevant with regard to CRM substitution is Finland’s Minerals Strategy.

**Comparison of the characteristics of the strategic instruments**

The Natural Resource Strategy is explicative in large parts. However, some normative issues are presented such as the start of preparing the Minerals Strategy. The underlying aims behind the natural resource strategy are to increase competitiveness and to create welfare in an innovative and sustainable way.

The Minerals Strategy contains both explicative and normative elements. It is more normative than the Natural Resource Strategy. It motivates the background behind minerals’ importance and, moreover, it introduces the EU mineral policy. The strategy defines 12 action proposals that are associated with four distinct topics: to strengthen minerals policy, to secure the supply of raw materials, to reduce the environmental impact of the minerals sector and increase its productivity and to, finally, strengthen R&D capabilities and expertise. The importance of this strategy is explained by the importance of the mining industry in Finland. While the focus is on primary materials production, the strategy targets the complete value chain. To be able to remain competitive, the importance of business development in this area, including innovativeness and sustainability, is emphasised. Finally, the importance of education relating to all stages of the value chain is highlighted. Finland is facing a lack of skilled labour as experts are retiring and new labour is difficult to recruit since in the 90s this field was predicted to run down.

The Arctic Strategy is addressing a wide range of topics, related in particular to this region. It contains both explicative as well as normative elements.

**Finnish strategies in the context of the EU**

The Natural Resource Strategy does not refer to other existing strategies. It refers, however, to a Dutch transition management model as well as the Japanese promotion of Resource Efficiency through “3R policies” (Reduce, Reuse and Recycle).

During the preparation of the minerals strategy, a review of numerous minerals strategies and politics had been carried out. Reviewed countries were: India, China, South-Africa, Brazil, Chile, Canada, the United States, Australia, Ireland, Sweden and Germany.

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4 The first version of the Artic Strategy was published in 2010 having a focus largely on external relations. The 2013 version has been updated and provides a more general view.
Over the past few years, all the countries in the Arctic region (Norway, Canada, Iceland, Sweden, Denmark, The United States, Russia) have prepared Arctic strategies or issued position papers outlining their policies for the region. The insights from these projects influenced the second edition of the Finnish Arctic Strategy.

All three strategies refer to the corresponding strategies on the EU level: the Natural Resources strategy refers to the raw materials initiative (Commission of the European Communities, 2008) and the biodiversity strategy (European Commission, 2011), the Minerals Strategy also refers to the raw materials initiative, and the Arctic Strategy refers to the report by the European Parliament on the direction of the EU’s Arctic policy (European Commission, 2012).

**Specific instruments**

**Research programs at the national level**

The Finnish research programs are centrally issued by the Academy of Finland which is a public funding agency for scientific research. The Academy is an agency within the administrative branch of the Ministry of Education, Science and Culture. Most of the issued programs are funding basic research. It monitors the impact of the research it funds. It issues reports in which it publishes the research results.

The Academy of Finland hosts a research program “Mineral resources and material substitution” (MISU), total funding volume 9-12 Mio € (Academy of Finland, 2014). The program targets universities and research institutes working on mining-, recycling- and substitution-related topics.

TEKES\(^5\), a Finnish funding agency for innovation, funded the Functional materials programme 2007 – 2013. There were a few projects on developing materials that can be used as substitutes for indium in solar cells, mobile phones (graphene) or other touch-enabled applications (carbon nanotubes developed by CANATU) (Tekes, 2014).

**International research agreements**

Finland is committed in two consortia in the context of European Innovation Partnership on Raw Materials. Finland is lead coordinator in the program “sustainable substitution in extreme conditions” (SUBST-EXTREME) (European Commission). The SUBST-EXTREME consortium will identify and develop substitutes for CRMs in energy, aerospace and mining industries. These industries currently use heat resistant alloys, stainless steels and hard materials. The focus in this project is on Tungsten, Cobalt, Tantalum, Niobium and to a smaller extent Chromium, Vanadium and Ruthenium.

Moreover, Finland also participates in the consortium “Raw Elements Substitution in Electronic and optoelectronic Technologies” (RESET) (European Commission). This commitment aims to create an efficient platform of all the private and public actors dedicated to a sustainable substitution of rare earth elements (ree) in photo devices. The focus is on Yttrium, Cerium (used, for example, in optoelectronic, LEDs, CFLs, LCDs and Plasma Screens) and Indium (used, for example, in the Panel display industry).

\(^5\) TEKES is a publicly funded expert organisation for financing research, development and innovation in Finland. TEKES funds both jointly financed research projects including companies, universities and research organisations as well as business development, R&D projects for companies.
photovoltaic, Transparent Conductive Oxide (TCO) Films for OLEDs). In addition, Finnish research institutes (e.g. VTT and Aalto University) are also involved in some European projects on substitution of CRM, for example the graphene flagship project.

Finland is participating in ERA-NET ERA-MIN and through TEKES it was contributing to the funding of both ERA-MIN Joint Calls, the second call also included CRM substitution (ERA-MIN, 2014).

In addition, the Academy of Finland has identified countries with which collaboration could be beneficial for Finnish research. It maintains bilateral agreements with some of these countries, such as with South Africa and Chile (Academy of Finland, 2014). Finally, Finland is engaged in collaborations with a large number of countries, even though these collaborations do often not target at CRM substitution.6

Other instruments and initiatives

The Academy of Finland (research program) is funded through the governmental budget. CRM substitution is one of the three focus areas (Academy of Finland, 2014).

Public procurement is not an instrument to support CRM substitution in Finland.

No institutes have been founded to address CRM substitution in Finland, however a few institutions are active in this field:

- The Ministry of Employment and the Economy (TEM) is responsible for the minerals and industry policies. There is ongoing research on substitution in several research institutes and universities, where research data is produced7. The sector reports of TEM are available on TEM’s web page. The reports are available mainly in Finnish. Some reports are available in English, too. (Ministry of Employment and the Economy) (Ministry of Employment and the Economy)
- The Geological Survey of Finland (GTK) produces data on raw material potential (including critical raw materials) of Finnish bedrock. It has the legal responsibility to collect and disseminate this geological data. GTK has to provide information on the mineral resources to industry as well as the society. One of their main interest groups is the mining sector. Part of the information is disseminated on GTK’s web pages to all interested Finnish and international parties. Additional data is available from GTK’s data service (Geological Survey of Finland).
- Research institutes (including VTT) and Universities are active in relevant fields and participate in national and European projects. In particular, there is an on-going mineral economy research programme at VTT focusing on primary and secondary resources and substitution8.

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6 For example Finland has written a Memorandum of understanding for bilateral cooperation in the mining sector between the Ministry of Employment and the Economy of Finland and the Ministry of Mining of Chile – MoU Academy of Finland, 2014.
7 While TEM funds some projects on its strategic focus areas directly, it mostly channels the funding through some funding agencies such as TEKES.
8 This information was provided directly by VTT. In the context of this program VTT organized a conference in November 2014 about which information is publicly available VTT.
Publication bibliography


11. France

Even though the importance of the French industrial production sector is declining, French companies in the pharmaceutical as well as the automotive and aerospace sectors belong to the leading companies in these sectors. These sectors face a high dependence on CRM (Technische Universität Clausthal, Bundesanstalt für Geowissenschaften und Rohstoffe 2013). The French government aims, however, at supporting the investments into key technologies and thereby at contributing to the French competitiveness in the long-run.

Strategic instruments

The French national sustainability strategy 2010-2013 has resource efficiency as its central topic (Ministère de l'Ecologie, du Développement Durable et de l'Énergie 2010). Its aim is being in a leading position in the field of „Green Economy“.

In 2010 France implemented a “Strategic metals plan” which highlights the importance of identifying how and where resource scarcity might be a weak spot of the French economy (European Environmental Agency 2011). As a consequence of this strategy, the operational initiative, the “committee for strategic metals” (COMité pour les MEtaux Stratégiques, called “COMES”), was initiated by the French ministry of industry (DGE: Direction Générale des Entreprises) in February 2011. The basic aim of this initiative is to secure the raw material supply and thereby contribute to promote the competitiveness of the French industry (Comité pour les métaux stratégiques (Comes) 2013). The initiative identifies substitution as one of the top five priorities to overcome the French dependency to import raw materials, among them CRM.

The initiative involves a large range of actors: professional and industry federations (car manufacturers, chemical industry, ferrous and non-ferrous metals federation) as well as key industrials (representatives of big companies: e.g. Air Liquide, Airbus, Peugeot, Solvay-Rhodia, Eramet), some research organizations (CNRS, CEA), the French standardization official body (AFNOR), the French Defence Procurement Agency (DGA), the Agency for the Environment and Energy Management (ADEME), and the Inter-ministerial delegation on economic and technological intelligence (D2IE).

The initiative focuses on the one hand on the list of 14 CRM provided by the Ad-hoc Working Group of the European Commission. In addition, it considers some other metals and materials of national specific importance which were identified by the respective industrial sectors (European Commission 2010, 2014).

In the context of the initiative specific software was developed in cooperation with the consultant company BIO Intelligence Service. This software is designed to assess companies’ vulnerability with respect to CRM. For companies with a high level of vulnerability towards CRM, this software can propose a potential substitution path. The software is available on the website of the DGE (Direction générale des entreprises 2012).

Characteristics of the strategic instrument

The initiative aims at helping industrials to be aware of the importance of the critical material issues in the operation of their companies. But the most important task is on educating SMEs on the topic of CRM.
The main objective of the initiative is to prevent a loss of competitiveness due to problems arising from a limited supply of CRM. The secondary objective is to possibly improve the competitiveness through the tools developed by being able to deal with the criticality of certain metals or materials.

**French strategies in the context of the EU**

The French policies were inspired by the German policies and strategies. The French strategy refers to the European Raw Materials Initiative to which it contributed as representatives of the BRGM were part of the Ad-hoc working group.

**Specific instruments**

**Research programs at the national level**

The research programs are centrally coordinated and funded by the National Research agency (ANR) (The French National Research Agency). There is no specific and targeted funding program on CRM substitution however the ANR integrates the general topic of CRM within the material development calls. The RTD calls address both companies and research institutes. Projects driven by companies, in particular also SMEs, are very welcome. The calls are application oriented with a strong importance of the industrial partnership, thus the proposals should include at least one industry partner.

**International research agreements**

France is collaborating with Germany in the applied “Eco-metals” program which focuses on strategic materials and metals. CRM substitution fits into this research program. For the single bi-national call in 2013 2 (out of 12 proposed) projects were funded with a total budget of 6 M€. The funding agencies were the French ANR and the German BMBF (L'Agence nationale de la recherche 2013).

France is participating in ERA-NET ERA-MIN and through ADEME and ANR it was contributing to the funding of the second ERA-MIN joint call which also included CRM substitution (ERA-MIN 2014).

**Other instruments and initiatives**

Tax rebates are granted to the industry which conducts RTD with selected Research and Technology Organizations (RTOs) (approved by the government) however there is no specific focus on CRM substitution since it is a general national incentive instrument to promote R&D activities. While public procurement does not focus on CRM substitutions, some industry federations take the procurement strategies of the companies into consideration for their procurement strategies.

In France no new institutions were founded in response to their national strategy. However an evolution is observable: within the research institutes some teams are now focusing on material efficiency, including substitution aspects.
The French geological survey (BRGM) issues information about raw material criticality. It produces, for example, monographs (www.mineralinfo.fr) on specific elements/substances¹. COMES, introduced above, is in charge of disseminating information on raw material criticality to the companies, either directly or through the respective sectoral federations.

**Other relevant aspects**

Securing the raw CRM supply can be done with the above mentioned strong direct support to the extent that the criticality is still manageable. If not, CRM substitution is mandatory. That is why companies (at least the large ones) are anticipating a future with a non-manageable criticality which is why they are investing internally into CRM substitution. As an example, though not in CRM, a car manufacturer is working both on securing the copper supply for electric cables and on the next cables generation which has, for example, a reduced copper content.

**Publication bibliography**


¹ Since 2010 the BRGM has published reports on gallium, germanium, niobium, beryllium, molybdenum, rhenium, selenium, tellurium, antimony, graphite, lithium, tantalum, tungsten, cobalt and the PGMs (platinum, palladium, rhodium, iridium, ruthenium).


12. Germany

The German economy is characterized by an advanced export-oriented high-tech industry which is dependent on critical raw materials (CRM) while at the same time being poor in primary sources of these metals and minerals. Germany is aware of this situation and consequently has a number of strategic as well as specific policy instruments concerning CRM, including their substitution.

Strategic instruments

In 2002, the German Federal Government issued the sustainability strategy “Perspectives for Germany”. This strategy is very general and considers raw materials at a very aggregated level (Bundesregierung, 2002). As this strategy precedes the discussion around CRM, these are not mentioned. However, the goal to double Germany’s resource productivity by 2020 was formulated, setting an ambitious international benchmark regarding resource efficiency.

In 2010, the Federal Ministry of Economics and Technology published a raw materials strategy to which the German industry, the federal government and the chancellor contributed (Bundesministerium für Wirtschaft und Technologie (BMWi), 2010). The key goal of this strategy – as highlighted by its subtitle – is to secure a sustainable supply of non-energetic mineral raw materials for the German economy. To achieve this, a number of diverse means and goals have been formulated; one of them being increased support for materials research. In this strategy, the ministry acknowledges the importance of substitution research to increase flexibility in manufacturing and as a means to tackle raw materials criticality.

Following from these two strategies as well as from the EU “Thematic Strategy on the sustainable use of natural resources” (Commission of the European Communities, 2005), the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety published the German Resource Efficiency Program “ProgRess” in 2012 (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU), 2012). The program was developed in a dialogue with scientists and representatives of different societal groups and associations. The strategy is mainly motivated by environmental concerns and aims to reach the ambitious target set in the general sustainability strategy from 2002 with respect to raw material productivity. The goal is to reshape the extraction and use of natural resources more sustainably and to reduce the associated environmental damages. Although CRM substitution is not at the core of this program, it is still a (small) component in three out of the 20 strategic approaches outlined in ProgRess.

The most focused existing policy document is a research strategy targeted directly at CRMs. The goal of the strategy “Raw materials of strategic economic importance for high-tech made in Germany”, in which the Federal Ministry of Education and Research took the lead, is to “expand research, development and education along the value chain of non-energy mineral raw materials over the next five to ten years” (Bundesministerium für Bildung und Forschung (BMBF), 2012). While necessarily not the main focus of the strategy, substitution was recognized as a relevant topic from a survey of the current research situation in Germany.

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1 Other goals are, for example, to remove trade barriers or competition distortions and to support the German private sector to diversify their sources of raw materials.
2 The broader public could participate in the discussion via internet consultations.
3 The program is targeted at universities, research institutes as well as also the industry.
None of the strategies mentioned above is about specific CRMs. Insofar as CRMs are explicitly mentioned, there is a reference to the list defined by the Ad-hoc Working Group on defining Critical Raw Materials (European Commission, 2010).  

**Comparison of the characteristics of the strategic instruments**

The raw materials strategy is explicative in large parts. It surveys the current situation, in particular also the different existing initiatives and identifies supporting measures to secure a sustainable resource supply and thereby contribute to the competitiveness of the German industry. Sustainability is addressed with the focus on inter-generational responsibilities.

In contrast, ProgRess is much more concrete and comprises three parts: evaluating the potential of resource efficiency in Germany and globally, developing specific measures, and giving very specific examples to illustrate some of the proposed strategic approaches. The discussion of the environmental impacts of resource use in this strategy is more extensive than in the raw materials strategy. In particular, potential harm in less regulated countries as well as greenhouse gas emissions that are associated with energy use for resource extraction are recognized. As this strategy is directly motivated from the resource strategy, it is not surprising that also the expected benefits of higher resource efficiency to the German industry are discussed.

The focus of the strategy “Raw materials of strategic economic importance” is on surveying parts of the specific current research landscape in Germany and, to a smaller degree, in Europe, and to identify demand for future research and development. On this basis, it outlines the funding priorities of the Federal Ministry of Education and Research in this field. The strategy is motivated by the observation that research on CRMs is needed to sustain economic performance, to be able to (further) develop new technologies and to reach Germany’s ambitious climate protection goals as well as to accelerate the pace of Germany’s move away from nuclear and fossil fuel based electricity supply (“Energiewende”).

While CRM substitution is not at the core of any of the existing strategies, still it is present to a greater or lesser degree in all three strategies discussed here.

The German federal government does not plan to be an active player on the CRM market because securing raw material supply is seen as the task of industry. Government activities focus on backing the private sector’s efforts to secure raw materials (Bundesministerium für Wirtschaft und Technologie (BMWi), 2010). The proposed policy measures vary between the three strategies but supporting research on CRMs and their substitution is included in all strategies with varying degrees of emphasis. The raw materials strategy proposes to advocate the topic also in the state governments and to design the foreign policy related to raw materials considering both economic- and developmental aims.

**German strategies in the context of the EU**

Germany took the lead in developing its raw materials strategy. ProgRess is a response to earlier set own targets as well as the environmental strategy of the European Union (Commission of the European Communities 2005). It explicitly introduces the different EU strategies as well as their historical developments. In this strategy Germany acknowledges that it is easier to target some topics on an EU level.

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4 By extension, the reference to the 2010 report also applies to the updated List of Critical Raw Materials for the EU, published in 2014 (European Commission, 2014).
5 Specific measures should follow the principle of sustainable development.
than at a national level. The high-tech strategy, which is research-oriented, gives an overview about the specific research programs at the EU level and it also gives a brief overview about existing research initiatives in Europe and worldwide.

Specific instruments

Research programs at the national level

Federal research programs targeted at applied research are all issued by the Federal Ministry of Education and Research (BMBF); the calls on state level are issued by the state governments. Project managing organizations (“Projekträger”) are often in charge of the individual calls. All calls are collected in central databases. Relevant programs and calls at the federal level are:

- The framework program “Research for sustainable development” („Forschung für Nachhaltige Entwicklung“, FONA) includes a number of initiatives/calls relevant to raw materials aiming at the development of “innovative technologies for resource efficiency”. Calls have been issued for:
  - Strategic metals and minerals (r³, www.r3-innovation.de), 2012-2016. Funding volume: approx. 30 Mio € plus the contributions by the participating companies. Next to recycling and “urban mining”, this call explicitly invited applications on the topic of substitution of CRM (Bundesministerium für Bildung und Forschung (BMBF)).
  - Provision of raw materials of strategic economic importance (r⁴), the second call for proposals to this program closes in January 2015.

All calls are targeted at collaborations of industry and research institutions, and the participation of small and medium size companies in consortia is encouraged. The research process must be interdisciplinary and considering the entire value chain.

- The program “KMU-innovativ: resource efficiency” (www.kmu-innovativ.de) is specifically targeted at SMEs as drivers of innovation (Bundesministerium für Bildung und Forschung (BMBF)). While CRM substitution is not a core focus, funding of technology development/adoption in the area of CRM substitution would fit into this program.
- CLIENT: this program supports international collaborations of research institutions and/or industry aiming to decrease environmental damage and restoring environmental functioning (Bundesministerium für Bildung und Forschung (BMBF)). Innovations in the area of raw material substitution are explicitly welcome. The planned funding volume is 60 Mio €.

The funding volumes have been taken from the presentation by Mennicken, 2012.
The framework program WING is targeted at “Material Innovations for Industry and Society” ("Werkstoffinnovationen für Industrie und Gesellschaft"). This program includes the call targeted at designing materials for a resource efficient industry and society “MatRessource” (calls in 2012 + 2014, funding volume about 54 Mio €) (Bundesministerium für Bildung und Forschung (BMBF) 2013) (Bundesministerium für Bildung und Forschung (BMBF) 2014b). The program is open to industry as well as research institutes and universities.

The framework program “Research for the production of tomorrow” (Bundesministerium für Bildung und Forschung (BMBF) 1999) is generally relevant to CRMs but makes no direct reference to them.

The German science foundation (www.dfg.de) funds basic research projects, usually evaluating project proposals without setting the research targets itself. Thus, basic research on CRM substitution could be funded by the DFG.7

Germany is collaborating with France in the “Eco-metals” program which focuses on raw materials of high economic importance (“Wirtschaftsstrategische Rohstoffe”) (Bundesministerium für Bildung und Forschung (BMBF) 12/7/2012).8

Germany is participating in the European Innovation Partnership on Raw Materials through the involvement of a few companies and public institutions (European Commission).

The Federal Institute for Geosciences and Natural Resources maintains a large number of international collaborations of various formats9, but CRM substitution is generally out of scope for these activities.

**Research programs at the state level**

- Bavaria had a research program on “new materials” (Bayrisches Staatsministerium für Wirtschaft, Infrastruktur, Verkehr und Technologie 10/10/2012) which is inherently relevant to substitution. The yearly funding volume was approx. 4 Mio. € (the program expired in December 2014, a new program will start in 2015).

- Northrhine-Westphalia has implemented a number of research and industry clusters with the possibility of funding specific projects emerging from the work of the clusters. Ressource.NRW is one such cluster with general relevance to raw materials but no specific focus on substitution (Ministerium für Klimaschutz, Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen, 2010). Although the original program expired in 2013, there is follow-up under the program of the European Regional Development Fund (EFRE.NRW) with a focus on environment-related industries but it is not clear yet what this includes in detail (Ministerium für Wirtschaft, Energie, Industrie, Mittelstand und Handwerk des Landes Nordrhein-Westfalen).

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7 Among the research projects in material engineering, a project considering the substitution of metals is currently being funded.

8 This program is open both to universities/research institutions and companies.

9 BGR is active in around 30 countries in which they are participating in technical cooperation (BGR).
Other instruments and initiatives
Tax rebates for RTD have been discussed but are not implemented in Germany (BDI/BDA-Arbeitskreis Steuerliche Forschungsförderung, 2009; Gillmann, 2007).

Public procurement is mentioned in the ProgRess strategy as a possible instrument with potential relevance to CRM. However, an explicit link to CRMs or to substitution is not made (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU), 2012).

In response to the raw materials strategy, a number of institutions and alliances have been founded in Germany:
- The German Raw Materials Agency “DERA” (Deutsche Rohstoffagentur, 2013) was founded in 2010. They conduct and publish research about raw materials supply and demand, including availability, prices and price volatility for a large number of raw materials. An extensive amount of information is available via the DERA-website or in print. In addition, it offers individual consulting services for industry10 and issues the German Resource Efficiency price (www.deutsche-rohstoffagentur.de).
- The Helmholtz-Institut Freiberg für Ressourcentecnologie (HIF, www.hzdr.de) was founded in 2011. The institute “pursues the objective of developing innovative technologies for the economy so that mineral and metalliferous raw materials can be made available and used more efficiently and recycled in an environmentally friendly manner” (Helmholtz Institute Freiberg for Resource Technology). The institute focuses in particular on technology related to CRMs.
- The raw materials alliance (Rohstoffallianz, www.rohstoffallianz.com) is an industry organization consisting of industry players that depend on raw materials in their production process. Its aim is to secure (critical) raw material supply for Germany by, among others, engaging in exploration projects or supporting recycling projects (Rohstoffallianz).

Other relevant aspects
The German parliament offers a number of different support mechanisms for companies investing abroad to secure a steady supply of raw materials (E.g. the exploration support program (Bundesministerium für Wirtschaft und Technologie (BMWi) 11/26/2012), the Untied Loan Guarantee Scheme (“UFK-Garantien”) (Bundesministerium für Wirtschaft und Energie), Investment Guarantees (“Investitionsgarantien”) (Bundesministerium für Wirtschaft und Energie) and Federal Export Credit Guarantees (“Exportkreditgarantien”) (Bundesministerium für Wirtschaft und Energie)) but without having substitution as a focus.

Publication bibliography

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10 For example the DERA offers consulting services regarding the market situation, judging price- and supply risks of material- and raw material imports. In addition they might outline potential evasion strategies. In addition they offer advice on the different federal funding programs.


13. Greece

The report “Greek extractive industry” (Ministry of Environment, Energy & Climate Change) outlines policies and strategies which are related to minerals supply in Greece. Policies related to mineral resources that are implemented to foster economic growth can be summarized under three main pillars, among other things sustainable development. In this overview-report the substitution of critical raw materials is mentioned, but only as a reference to the European initiatives, the definition of CRM as well as that some research focuses on the substitution of CRM. The National policy focuses mainly on developing the primary production of raw materials, including CRMs, and not on developing technologies for CRM substitution, as there is no corresponding industrial sector in Greece.

A general green growth strategy was implemented in 2010 by the Ministry of the Environment, Energy & Climate Change for the time-horizon 2010-2015. The aim is, among other things, to change production and consumption pattern. For example, it aims at a Green Public Procurement (European Environmental Agency, 2011).

Publication bibliography


14. Hungary

The Hungarian economy is medium-sized and shaped by a high importance of the service sector, which accounts for more than 60% of the GDP. In the industrial sector the most important industry is machinery, followed by the chemical industry. These two industries are probably the industries which are most related to the application of CRM (Embassy of Hungary in Beijing, China).

**Strategic instruments**

The Hungarian authorities are working on publishing the Action Plan on Mineral Resources Management and Utilization. This plan was prepared by the Geological and Geophysical Institute of Hungary and the Hungarian Office for Mining and Geology under the supervision of the Ministry for National Development in 2013. It is an implementing measure to the National Energy Strategy (Ministry of National Development, 2012). Currently, the Action Plan is under strategic environmental impact assessment, its approval and publication by the Government is expected in 2015.

The Action Plan provides a review of all major mineral commodity groups available in the country, sets a list of priorities, a future vision, and some details on the implementation. One chapter concentrates on rare earth elements, describing the potential primary resources as well as the excellent secondary source of the red mud residue of the alumina processing. Hungary is having bauxite reserves and thereby has a potential source of, for example, Gallium in its own country.

CRM appear in the chapter on Actions in the context of the raw materials inventory, stressing that the prognoses of the CRM reserves and market demand shall take into account the price volatility of CRM which has a direct impact on the economic value of a given reserve. CRM substitution is not targeted by the Hungarian Action Plan since key enabling technologies were out of the scope of the basis study. The Action plan explicitly mentions the rare earth elements neodymium, dysprosium, europium, terbium and scandium, which are also identified as being CRM by the ad-hoc working group on CRM (European Commission, 2014). In addition uranium, thorium, zirconium, and titanium are mentioned. However, gallium, the major constituent of the red mud tailings is not mentioned in the text.


**Characteristics of the strategic instrument**

The Action Plan is normative by proposing certain actions to counteract potential future deficiencies in CRM supply. Its aim is to promote sustainability, to support the national energy policy, to promote employment, and to enhance the extractive industry.

The Hungarian government proposes, among other things, to prepare a national minerals policy, to develop a broad raw materials inventory, and to support research, development and innovation (R&D&I) activities as well as demonstration- and pilot-projects. Moreover, it proposes to enhance the institutional- and economic framework, to maintain the professional capacities at all educational levels and to develop the relevant education, and to raise public awareness.
Hungarian strategies in the context of the EU

Hungary consulted the existing strategies of other EU member states when developing the Action Plan. The Action Plan makes explicit references to the raw materials initiative of the EU (Commission of the European Communities, 2008a, 2008b) and to the communication from the commission “Tackling the challenges in commodity markets and on raw materials” (European Commission, 2011).

Specific instruments

Research programs at the national level

In Hungary the National Development Agency (NFÜ), the National Innovation Office (NIH), and the National Fund for Scientific Research (OTKA) are in charge of funding applied industrial innovation as well as the basic research projects. Substitution of CRM is not an explicit priority in their programmes but such projects are eligible for support, in general. Theoretically, all potential actors are addressed by these research agencies.

The University of Miskolc (Faculty of Earth Science and Engineering) has hosted a research program on “the exploitation of the economic development potentials of critical raw materials in international co-operation” (CriticEl, 11.2012-10.2014, 1.6 Mio €). The aim was to contribute to the economic and social modernization of Hungary. Underlying goals are macroeconomic ones: investment in the high-tech and green-tech industry can result in job creation (University of Miskolc).

International research agreements

Some Hungarian research and industry entities are active and successful partners in Horizion2020 calls.

Hungary is participating in ERA-NET ERA-MIN and OTKA has contributed to the funding of the second ERA-MIN Joint Call which also included CRM substitution (ERA-NET ERA-MIN).

Other instruments and initiatives

We are not aware of public procurement strategies to support CRM substitution.

No institutes have been founded to address CRM substitution in Hungary; however the Hungarian Office for Mining and Geology (MBFH) is the national competent authority which collects primary resources data. It also has delegated an expert to the ad hoc working group on defining CRM of the EC. MBFH is supported by its satellite, the Geological and Geophysical Institute (MFGI), which provides research data and exclusive reports on CRM as well. The information are disseminated to the MBFH and the Ministry for National Development.

Publication bibliography

ERA-NET ERA-MIN. Available online at https://www.nks-werkstoffe.de/era-min, checked on 9/16/2014.

1 Germany also supports international industry collaborations in the CLIENT program which was introduced above.


15. Ireland
Ireland has a significant mining and ore processing activity, as well as an important industrial base and innovative capacity.

Strategic instruments
The Irish Department of the Environment, Community and Local Government issued “Our Sustainable Future: A Framework for Sustainable Development in Ireland” in 2012 (Department of the Environment, Community and Local Government, 2012). The objectives of this framework are “to identify and prioritise policy areas and mechanisms where a sustainable development approach will add value and enable continuous improvement of quality of life for current and future generations and set out clear measures, responsibilities and timelines in an implementation plan” (Department of the Environment, Community and Local Government, 2012). As a consequence from this plan, the report “Sustainable Development Indicators Ireland” (Government of Ireland, Central Statistics Office, 2013) was issued in 2013 by the Irish central office of statistics.

The Irish Environmental Protection Agency (EPA), together with the Department of Environment, Community and Local Government, led Ireland’s National Waste Prevention Programme (NWPP) in 2004 (Environmental Protection Agency, 2004) which focuses, as its name indicates, on waste prevention and thus does not consider CRM substitution. Metals are mentioned in relation to the WEEE directive. The fourth iteration of this programme is called “Towards a Resource Efficient Ireland” (Environmental Protection Agency, 2014), which sets out priorities for preventing wastage and unnecessary consumption of materials (metals and minerals), energy & water.

Following from this strategy, the fifth chapter of Ireland’s Environment 2012 report (Environmental Protection Agency) makes an assessment of the current situation in terms of sustainable resource use, consumption and waste. It mentions that 3.7 million tonnes of the 6.4 million tonnes of industrial waste is of mineral nature.

Ireland does not have any strategy which explicitly mentions CRMs.

Comparison of the characteristics of the strategic instruments
Some of the challenges of “Our Sustainable Future: A Framework for Sustainable Development in Ireland” are categorised into sustainable consumption and production, conservation and management of natural resources, and innovation, research and development.

The overall objective of the NWPP is to establish an ambitious programme that delivers substantive results on waste prevention & minimisation across both hazardous & non-hazardous waste arising. “Towards a Resource Efficient Ireland” presents the next phase of the evolution of the programme, which runs to 2020.

Ireland’s strategies in the context of the EU
Specific instruments

Research programs at the national level
In Ireland the “Science Foundation Ireland” (SFI) (Science Foundation Ireland) is issuing, centrally organized, research funds. It invests into academic researchers and research teams who are most likely to generate new knowledge, leading to edge technologies and competitive enterprises in the fields of science, technology, engineering and maths (STEM).

The foundation also promotes and supports the study of, education in, and engagement with STEM and promotes an awareness and understanding of the value of STEM to society and, in particular, to the growth of the economy. It makes grants based upon the merit review of distinguished scientists and also advances co-operative efforts among education, government, and industry that support its fields of emphasis and promotes Ireland’s ensuing achievements around the world.

In addition the SFI is funding two research centres that are indirectly related to CRM. The Centre for Advanced Materials and Bio-Engineering Research (AMBER) (AMBER Centre) consists of Irish Universities and research institutes and aims at delivering outputs which will result in new devices in ICT, medical devices and industrial technology sectors. The Irish Photonic Integration Research Centre (I-PIC) (Irish Photonic Integration Centre) comprises researchers at four institutes and targets the ICT and medical devices sectors. It is cooperating with 18 industry partners to develop highly-compact and miniaturised photonic technologies.

The EPA issues calls related to environment-related topics. For example, in 2013, they issued a green enterprise funding call (Environmental Protection Agency, 2013a) and a research call (Environmental Protection Agency, 2013b). Both of these initiatives are, however, neither linked to CRM nor to material substitution.

International research agreements
Irish institutions and researchers are involved in a number of European research projects (European Commission). Among others they are involved in a FP7 projects on “Nanosciences, Nanotechnologies, Materials and new Production Processes“ (NMP) (Seventh EU Framework Programme Ireland) as well as in FP7-Environment (Seventh EU Framework Programme Ireland) projects.

The call for a KIC in Raw Materials in 2014 (European Institute of Innovation & Technology), with the final announcement on the successful application due in December 2014, could be another interesting initiative for Ireland.

Other instruments and initiatives
Enterprise Ireland (Enterprise Ireland) is the Irish state agency responsible for supporting the development of manufacturing and internationally traded services companies. Enterprise Ireland provides funding and support for companies, both SMEs (Enterprise Ireland) and large companies, to support activities such as, for example, improving efficiency.

The Department of Communications, Energy and Natural Resources (The Department of Communications, Energy and Natural Resources) has responsibility for the Telecommunications, Broadcasting and Energy sectors. It regulates, protects and develops the Natural Resources of Ireland. Within the department there
is an Exploration and Mining Division (EMD) (Minerals Ireland) which has the responsibility of regulating and permitting of exploration for and extraction of minerals.

The Geological Survey of Ireland (GSI) (Geological Survey of Ireland) founded in 1845, is the National Earth Science Agency. It is responsible for providing geological advice and information, and for the acquisition of data for this purpose. GSI produces a range of products including maps, reports and databases and acts as a knowledge centre and project partner in all aspects of Irish geology.

There are no specific instruments concerning CRMs.

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AMBER Centre: Jointly hosted in the Trinity College Dublin (TCD) by CRANN and the Trinity Centre for Bioengineering (TCBE), in collaboration with the University College Cork and the Royal College of Surgeons in Ireland (RCSI). Available online at http://ambercentre.ie/.


Geological Survey of Ireland (Ed.): About the GSI. Available online at http://www.gsi.ie/About+Us/, checked on 1/7/2015.


Irish Photonic Integration Centre: Official Website. Available online at http://www.ipic.ie/, checked on 1/7/2015.

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The Department of Communications, Energy and Natural Resources (Ed.): Official Website. Available online at http://www.dcenr.gov.ie, checked on 1/7/2015.
16. Italy
In Italy classic mining of ores has been abandoned to a large extent and it is now only relevant for the cement industry, as well as for the production of ceramic goods. At the same time some of the Italian industrial sectors depend on the availability of CRM.

Strategic instruments
In 2002, the Ministry of the Environment issued a national sustainability strategy for Italy. It contained, among other things, concepts for increasing resource efficiency.

In Italy currently no specific strategies relating to CRM, or their substitution, are in place. Italy is currently discussing how to implement the raw materials strategy of the EU (Ministry of Economic Development, 2014).

The Ministry of Economic development is discussing to adopt a strategy based on the recommendations provided by the EU and the Raw Material Working Group. In this strategy it is discussed, among others, how to improve the recycling of rare earths and other CRM. In addition, it is discussed how policies at the European level might support the European production of CRM. One of the actions could be “to envisage incentives for research and studies at European level for the introduction of alternative elements and technologies”.

The Directorate-General for mineral and energetic resources (DGRME) of the Ministry of Economic Development (MISE) published a report on rare earths (REE) (The Directorate-General for mineral and energetic resources (DGRME) of the Ministry of Economic Development (MISE)). This report summarizes the supply, research collaboration as well as industrial exploitation situation in Italy. There is neither a production of REE in Italy nor are Italian companies are engaged in mining activities of REE abroad.

Other instruments and initiatives
In Italy the Directorate-General for mineral and energetic resources is responsible for collecting and disseminating information on CRM.

Other relevant aspects
The Italian national agency for new technologies, energy and sustainable economic development (ENEA) has been active in the study of REE. Until 2008, ENEA has collaborated with China on the development of a pilot plant to extract REE from merchant concrete. The report on REE suggests that ENEA gets active in research collaborations to recover REE from electronic waste.

1 Due to the high investment costs combined with only medium firm size and a lack of support programs, it is unlikely that Italian companies will become active in mining activities of REE abroad soon.
There is a memorandum of understanding between a number of industry associations, the University of Milan-Bicocca, and the DGRME aiming at a cooperation in a “Forum - Raw materials Laboratory” for sustainable development in the mining sector, to create a community between industry professionals, institutions and associations, to contribute to the cultural development (e.g. education) of the sector, and to facilitate communication and dissemination. This laboratory was established in 2010 and one of the goals is to define CRM (Technische Universität Clausthal, Bundesanstalt für Geowissenschaften und Rohstoffe, 2013).

**Publication bibliography**


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2 Partners in this agreement are: the National Association of Mining Engineers (ANIM), the Concrete Techno-Economic Italia Association (AITEC), the Georesources and Environment Association (GEAM), and the Italian Petroleum and Mining Industry Association (Assomineraria).
17. Japan

The Japanese government is undoubtedly the global leader in awareness of raw material dependency. Reduce, Reuse and Recycle are concepts that have been around for decades and that are materialised in many policy documents. Substitution is part of “Reduce”, but using less is deemed a more useful strategy than using something else. Japan’s external trade balance depends largely on manufacturing fields such as materials production, machineries and electronics manufacturing industries.

Strategic instruments

A notable document laying down a national CRM strategy is ironically material oriented: the “rare metal substitution material development project” from the Ministry of Economy, Trade, and Industry (METI) in 2009 (Hono). The strategy is implemented through at least two national programmes which aim to support on the one hand basic research on materials technology to substitute CRM completely and on the other hand corporate R&D activities related to specific potential new products. The four pillars are securing overseas resources, recycling, development of alternative materials, and stockpiling. Compared to the classic 3R approach, the emphasis on overseas resources and stockpiling seem to highlight an increased sense of urgency, as these can be regarded as more short-term measures compared to reduce, reuse and recycling.

In addition to this strategy, Japan also published a set of guidelines for its government to follow when securing natural resources, including critical metals (Ministry of Economy, Trade and Industry, 2010). Substitution is explicitly named as one of the now five (opposed to four in the 2009 METI document), pillars of material security, next to warehousing, recycling, off-shore exploration, and bilateral cooperation with raw material producing countries. It is recognised that often Japanese companies wishing to acquire exploration or development interests overseas are faced with the need to negotiate with the target country’s government or state-run companies (TNO, The Hague Centre for Strategic Studies, 2012). According to the Japanese guidelines, this will require the direct participation of the Japanese government to ensure that the government of the target country is acting in accordance with international contract rules.

Comparison of the characteristics of the strategic instruments

The policy of METI is a “classic” CRM policy with fundamental aims in extending the supply of CRM and reducing risk in supply risk disruption. The approach of the Ministry of Education, Culture, Sport, Science and Technology (MEXT) is more based in the culture of reduce, reuse and recycling, including all societal forces influencing them (Ministry of Education, Culture, Sport, Science and Technology, 2006). A classic measure example would be that Japan stockpiles 7 critical elements to cover 42 days of consumption, in addition to its own private stocks which cover 18 days of consumption (TNO, The Hague Centre for Strategic Studies, 2012).

Japan’s strategies in an international context

Japan, the US and Europe are engaged in regular trilateral exchanges of knowledge based on raw material use and policy (DG Research & Innovation, 2013). Similar to Chinese policies, the Japanese government is expected to support Japanese companies investing in projects abroad. The type of support that is expected
varies according to the type of project. The Japanese government is also expected to develop more cooperative relations with countries (Kawamoto, 2008).

**Specific instruments**

**Research programs at the national level**

An essential role of the raw material policy in Japan is taken by the Ministry of Economy, Trade and Industry and the Ministry of Education, Culture, Sport, Science and Technology. The METI has launched the continuous Development Project on Rare Metals Substitution in 2005 that obviously put some emphasis on substitution, approximately half of the research budget in the period 2005-2011 (METI, 2009). It resulted for instance in a launch of technology development towards substituting/ reducing usage of indium for transparent electrodes used in liquid crystal panels, dysprosium for rare-earth magnets, and tungsten for carbide tools (Ministry of the Environment, 2010).

The Japanese government traditionally also has close ties to the private sector and has significant influence through so-called Independent Administrative Institutions (IAIs). Examples of these organisations are the Japan Science and Technology Agency (JST), the Japan Oil, Gas and Metals National Corporation (JOGMEC), the Japanese Agency for Marine-Earth Science and Technology (JAMSTEC), and research institutes like the New Energy and Industrial Technology Development Organization (NEDO), the Japan Atomic Energy Agency (JAEA), the National Institute of Advanced Industrial Science and Technology (AIST), the Institute for Physical and Chemical research (RIKEN), and the National Institute of Science and Technology Policy (NISTEP). These organisations are a vital element in Japan’s “unified” approach in addressing main societal challenges. Arguably the most important organisation is the National Institute for Materials Science (NIMS), with a budget of around 210 mio Euro and more than 500 researchers.

There are strong top-down directed research programs on all comprehensible aspects of raw material use.

Being a forerunner in resource policy, some explicit substitution programs were presented by Kishi (2011) and Hosono (2012). The New Energy and Industrial Technology Development Organization (NEDO) hosted a research program (2008-2013, worth 16 mio. EUR) focusing on reducing the use of indium, dysprosium, PGM, cerium and phosphate. The focus was in particular on the product groups of screens, motors, cutting tools, catalysts, luminophores, and polishers. Substitution and reduction are part of the 4th Basic Environmental Plan from 2012, aiming at aluminum profiles, nanoparticles replacing PGM’s in catalysts, titanium based electrodes, energy convertors using less PGM and batteries in general made from non-critical materials.

Another national programme is the “basic research on drastic substitution and reduction of consumption amount”. It is an elemental strategy project from MEXT, focusing on neodymium, dysprosium, tungsten, platinum, terbium, europium and cerium. The aim is a whopping 30 to 80% reduction of these materials (Hosono 5/4/2012).

A predecessor of the 2009 strategy is the “Designing Material Functions through Fundamental Research on Elements Roles” project from MEXT (Kishi 11/21/2011). This project started in 2007 aiming at the establishment of fundamentals on roles of material’s elements responsible for the material properties and the development of alternative materials substituting rare metals and rare earth elements by ubiquitous and non-hazardous ones. It is aimed at supporting researchers which are “paving ways” for their practical
stages and expected to explore opportunities for further development by applied research funding programs “after their accomplishment” (MEXT, 2007).

A quantified target was mentioned in Lopes, Bego. The Hitachi group achieved, in the context of the 3Rs, the reduction of cerium consumption of critical metals through recycling, conservation and substitution of approximately 50 per cent in 2011 compared with 2010.

**International research agreements**

The cooperation between the EU and Japan resulted in a Japan - EU Workshop on Substitution of Critical Raw Materials in November 2011 (European Commission, 2011).

**Other relevant aspects**

Japan offers many internationally renowned researchers in the field of raw material research, possibly focused on substitution. Among those researchers are:

- Teruo Kishi and Komei Halada, National Institute for Materials Science
- Hideo Hosono, Tokyo Institute of Technology
- Sadamichi Maekawa, Japan Atomic Energy Agency
- Terunobu Miyazaki and Satoshi Sugimoto, Tohoku University
- Takashi Nakamura, IMRAM, Tohoku University
- Tetsuya Yamamoto, Kochi Inst. Tech.
- Keizou Kobayashi, Hideaki Hamada and Tomoko Akai, AIST
- Hayashi Koji AIST and Japan Fine Ceramics Center (JFCC)
- Seiiti Suda, Japan Fine Ceramics Center (JFCC)
- Sekiba Toru, Nissan Motor, Co., Ltd
- Yasuhiro Tani, Ritsumeikan University

**Publication bibliography**


18. Latvia
Latvia is not having reserves of CRM, thus they do not have a focus on extraction.

Strategic instruments
Latvia first introduced a National Environmental Policy Plan in 1995, it was approved by the Cabinet of Ministers and it was created under the lead of the ministry of environmental protection and regional development took the lead (The Ministry of Environmental Protection and Regional Development, 1995; European Environmental Agency, 2010). This Plan was replaced by a new version in 2004 which aimed at covering the time between 2004 and 2008. The focus was on recycling and – in a very general way - substitution\(^1\), and use efficiency and resource conservation, respectively. The successor of this plan is the environmental policy strategy 2009-2015, also issued by the Ministry of Environment (The Ministry of Environment, 2009).

In addition, the Environmental Protection Policy in Latvia which was issued in 1998 by the Ministry of Environmental protection was mainly focused on use efficiency and corresponds to the European environmental protection trend. Substitution is not mentioned in this policy (The Ministry of Environmental Protection and Regional Development).

All policy plans make no specific reference to CRM. This is probably partly due to the fact that some of them precede the discussion around CRM.

Comparison of the characteristics of the strategic instruments
All three plans are explicative in nature. While the first National Environmental Policy plan targeted in general at sustainability, its successor targets at supporting technologies that require less raw materials, replacing non-renewable resources or recycle materials. It suggests subsidies for technologies that require less raw materials, substitute for non-renewable resources or recycle materials. The Environmental Policy, on the other hand has a significant reduction in the consumption of raw materials as its main policy objective. The Environmental Policy Strategy 2009-2015 targeted at the sustainable use of natural resources.

Latvia’s strategies in the context of the EU
Environmental Protection Policy in Latvia (1998) corresponds to European environmental protection trends and Agenda 21 viewpoints.

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\(^1\) Substitution is mentioned as a principle: from the point of view of sustainable development, if the resources required for the manufacturing of environmentally-friendly products are limited, they should be taken out of circulation and substituted by something else.
Specific instruments

Research programs at the national level
Personal interviews with the Innovation Division of the Entrepreneurship, Competitiveness and Technology Department of the Ministry of Economics of the Republic of Latvia indicated that in Latvia no specific funding is dedicated for the R&D towards substitution of CRMs. At the same time Latvia has adopted a National Innovation and Research Strategy for Smart Specialization, which will be used for the management of the EU’s structural funds, and currently 5 fields of smart specialization have been identified:

1. Knowledge-intensive bio-economy;
2. Biomedicine, medical technologies and biotechnology;
3. Smart materials, technology, and engineering;
4. Smart Energy;
5. Advanced information and communication technologies.

Publication bibliography


19. Lithuania

Similar to the report by the ad-hoc working group on defining critical raw materials, a list of critical raw materials was defined for Lithuania in 2012 (Milda Knašytė, Irina Kliopova, Jurgis Kazimieras Stanisliskis, 2012). Interestingly, the identified materials represent very different materials compared to those identified on EU level, namely crude oil, natural gas, sulphur, caustic soda, and cast iron. This is partly due to the fact that the ad-hoc working group on EU level restricted itself to non-energy minerals and metals.

**Strategic instruments**

So far, no specific national strategy dealing with CRM or the substitution of CRM has been identified which is partly due to the fact that some of the Lithuanian strategies precede the beginning of the discussion of CRM. The underlying goal of the Lithuanian strategies might be summarized as getting more while using less.

Lithuania has at present different strategies which cover resource efficiency by sectors (European Environmental Agency, 2011). The National sustainable development strategy, for which the Ministry of the Environment is responsible, was introduced in 2003. It makes no reference to CRM or their substitution (European Sustainable Development Network, 2003; The Government of Lithuania 9/16/2009). An important priority is the reduction of the environmental impact from the main branches of economy (transport, industry, energy, agriculture, housing and tourism). This will mainly be done by increasing their eco-efficiency and inclusion of environmental concerns into their development strategies and re-use of raw materials. The document by the European Sustainable Development Network also outlines national quantitative targets for different areas. No target is set for CRM or material substitution specifically, but on the use of local renewable resources and recycling of secondary raw materials.

The Lithuanian strategy for the use of European Union structural assistance for 2007-2013 was introduced by the Ministry of Finance in 2006. It highlights the importance of raw material prices in general for Lithuania’s production. Increasing raw material prices are perceived as a threat in the conducted SWOT-analysis. No specific link to CRM is established.

The aim of the Lithuanian State Strategy of Use of Underground Resources (under preparation) (Department for Environment, Food and Rural Affairs, 2012) is to ensure the rational use of mineral resources and contribute to the country’s modern economic creation.

The Innovation Development Programme 2014–2020 (Agency for Science, Innovation and Technology) is the fundamental strategic document setting guidelines for innovation policy in Lithuania. Even though this strategy has no specific reference to CRM or substitutes for CRM, it relates some key economic areas to raw materials dependence. The Ministry of Economy and Ministry of Education and Science are the main institutions responsible for the formation and implementation of innovation policy in Lithuania: the Ministry

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1. Skirmantas Skrinskas, Vyda Elena Gasiuniene, Alfredas Laurinavicius, 2010
2. “Almost 80 per cent of the total Lithuanian exports of the goods and services originated in Lithuania are produced by manufacturing, where raw materials, fuel and energy account for nearly two thirds of the total costs” Ministry of Finance, 2006.
3. Information about this strategy were only found in this source, no Lithuanian information on this strategy could be found.
of Economy is responsible for the policy of the development of innovation environment and the Ministry of Education and Science is responsible for the policy of research and development.

The National Reform Programme 2014 was coordinated by the Minister of Economy and involved representatives of other ministries as well as of the Bank of Lithuania and Statistics Lithuania during its progress (Minister of Economy, 2014). It summarizes the main structural reforms that are being implemented, or that are planned to be implemented, in the effort to achieve quantitative targets of the Europe 2020 Strategy. The document also outlines national quantitative measurements for different areas. No measurements are set for CRM or material substitution specifically, but on resource efficiency.

**Comparison of the characteristics of the strategic instruments**

The Lithuanian strategies are, with two exceptions both explicative and normative in nature. The Innovation Development Programme is only explicative and since the Strategy of Use of Underground Resources is not published, we cannot evaluate its characteristics. The political objectives vary between the strategies and can sometimes already be inferred from their names and publishers. The goal of the National sustainable development strategy is to promote sustainability, growth and competitive markets. The strategy for the use of structural assistance as well as the National Reform Programme both target macroeconomic characteristics: to accelerate economic growth, and growth, competitiveness and stability, respectively.

**Lithuania’s strategies in the context of the EU**

Three of the earlier introduced strategies make references to EU-level initiatives and strategies: the sustainable development strategy refers to the Europe 2020 Strategy, the structural assistance strategy refers to the Lisbon Strategy and the national reform programme also refers to the Europe 2020 strategy and the Euro Plus Pact.

**Specific instruments**

**Research programs at the national level**

Founding in Lithuania is organized through the research council of Lithuania. In addition, the ministry of Economy of the Republic of Lithuania is allocating the respective funding.

Moreover, the Lithuanian National Biotechnology Platform (LNBP) distinguishes two main priority areas: industrial biotechnology and agro-biotechnology with the objective to reduce the dependence on the import of non-renewable raw materials, and pharmaceutical biotechnology which focuses on products for molecular biology and diagnostics (Bio-Economy.net).

In order to achieve better commercialisation of R&D results and to have a more effective innovation system, the Innovation Development Programme of Lithuania for 2014-2020, which we introduced above, was prepared and approved by Resolution of the Government of the Republic of Lithuania on 18 December 2013. The Programme embraces measures covering the entire innovation cycle, particular attention is devoted to experimental development and product preparation for the market. It also aims at strengthening innovation performance of the Lithuanian economy and increasing investments into R&D to 1.9 percent of GDP by 2020.
Moreover, separate research institutes have been grouped into larger, intellectually more capable science centres (The official gateway of Lithuania). The new centres – science, studies and knowledge economy clusters of international level – are housed by the valleys, where science will be able to interact directly with high-technology-generating business. Currently, Lithuania is developing five integrated science, studies and business valleys, two of which are – or can be - of relevance for present or future research on CRM and substitutes of CRM.

First, Vilnius “Santara” valley aims to develop biotechnology, innovative medical technologies, molecular medicine and biopharmaceuticals, ecosystems and sustainable development, IT and communications technologies⁴. Second, Kaunas “Santaka” valley will focus on the development of sustainable chemistry, mechatronics, and related electronic technologies, the future of energy, information and telecommunications technology⁵.

**Publication bibliography**


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⁴ The valley will house a Joint Centre for Life Sciences, a Joint Centre for Innovative Medicine, a Joint Nature Research Centre, and created an Information Technology Open Access Centre bringing together geographically remote computer resources.

⁵ The valley will house a National Open Access Research and Development Centre. A Centre for the Latest Health Technologies and Pharmaceuticals created by Kaunas Medical University will be located in the same valley.


20. Luxembourg

Luxembourg has, when looking at the GDP per capita, the strongest economy within the European Union, and the second strongest in the world. According to Eurostat, its GDP per capita was 264 in 2013 (reference EU 28=100) (STATEC).

Although there were some industrial as well as political activities related to the steel sector, these activities have been declining in favour of the financial sector and some ICT presence. No national strategy related to Critical Raw Materials has been defined.

Strategic instruments

No national strategy on metals and/or minerals has been published. Consequently, there is no specific focus on Critical Raw Materials substitution (Le Ministère de l’Économie et du Commerce).

Specific instruments

Funding is available, but there is no programme covering pre-defined topics. The candidate consortia present their proposals which, after assessment, can be selected for funding (Ministère de l'Enseignement supérieur et de la Recherche).

Research programs at the national level

The policy targets the public as well as the private sector and aims both at consolidating national activities and at encouraging Luxembourgian actors to get involved in European and international collaborations. The National Research Fund (“Fonds National de la Recherche”, FNR) has implemented several thematic and structural research programmes through which research projects in Luxembourg’s priority areas for are financed. Indirectly, through the thematic programmes, some of the selected projects could be linked to the critical raw materials challenge (Luxembourg Portal for Innovation and Research).

Luxinnovation’s services are structured around seven sectors and themes that correspond to Government priorities, as in the thematic programmes of the FNR, some indirect links to CRM can be found in projects granted in previous years (materials, energy, etc.) (Luxembourg Portal for Innovation and Research). There is no national funding program directly related to the substitution of CRM, however Horizon 2020 grants can present a funding opportunity.

Publication bibliography


¹ Le Gouvernement de grand-duché de Luxembourg


21. Malta
Due to the limited size of the Maltese Islands and the high population density, resource efficiency and the prevention of mineral depletion are key drivers for the economy of the country.

Strategic instruments
The Malta Environment and Planning Authority (MEPA) is the national agency responsible for land use planning and environmental regulation in Malta (Malta Environment & Planning Authority). It issued the Strategic Plan for Environment and Development (SPED) which is intended to replace the Maltese Structure Plan of 1990 and has a time horizon until 2020. The focus is on the Maltese environment as well as on its development. It is meant to inspire the Maltese policies for this period (MEPA & Parliamentary secretariat for Planning and Simplification of Administrative Processes, 2014, 2012).

According to the SPED, minerals are Malta’s only non-renewable resources, and limestone is the principal resource that has been exploited over the years. It considers the wastage of mineral resources at the extraction stage and lack of re-use/recycling of waste (depending heavily on landfills) the main drivers of mineral depletion. The thematic objective 7 of the SPED is to promote the efficient use of resources, including local stone and soil, by, among other things, safeguarding mineral resources from sterilisation and ensuring phased extraction of minerals and restoration of quarries.


Malta does not have any strategy which explicitly mentions CRMs.

Comparison of the characteristics of the strategic instruments
The target of the Strategic Plan for Environment and Development is to provide the spatial component for the implementation of sustainable development through a framework for a better organisation of the terrestrial and maritime space of the Maltese Islands.

The National Strategy for Sustainable Development serves as a guide in prioritising actions that are undertaken by all members of society to ensure the prudent use and management of resources in a way that meets the needs of the present without compromising the needs of future generations. The Strategy addresses social, economic and environmental concerns in a coherent manner and permits policy makers to assign relative priorities to these three pillars of sustainable development. It affords an opportunity for identifying specific initiatives and for committing authorities towards their implementation within defined time frames.
Specific instruments

Research programs at the national level
There is no national funding program directed to the substitution of CRMs.

The Malta Council for Science and Technology (MCST) (The Malta Council for Science & Technology) is a governmental organization which is centrally in charge of research-related topics: it is responsible for research policy, promoting scientific research, as well as the management of the local research funding programme. Moreover, it is the national contact point for the EU Research Framework Programmes. The MCST is also in charge of implementing the National Research and Investment Strategic Plans. It issues a number of specific research programs and services, for example the FUSION programme (The Malta Council for Science & Technology) which supports research and innovation and also pursues the idea of supporting the researchers to market their innovative ideas.

The FUSION programme prioritises the Smart Specialisation Areas as identified in the National R&I Strategy 2020 (The Malta Council for Science & Technology, 2014), though not exclusively. This business driven process aims at concentrating efforts on a few select areas chosen on the basis of unique selling points and indigenous strengths. The selected thematic areas, identified through a rigorous process involving a variety of inputs, are the focus on investments due to their potential for innovation, thus giving the country a competitive advantage over others. These areas are: maritime services, aviation and aerospace, health, resource efficient-buildings, high value-added manufacturing with a focus on processes and design, aquaculture and the role of ICT. The National R&I Strategic Plan identifies value added manufacturing as a priority research area for Malta, and recommends the preparation of a dedicated R&I strategy for this sector (The Malta Council for Science & Technology).

International research agreements
Malta has the possibility to participate in EU research projects, such as Horizon 2020.

The Malta Council for Science & Technology is the National Contact Point organisation offering information and free tailored consultation on Horizon 2020. The Council offers guidance on all funding opportunities and administrative stages of the application, submission and project implementation (The Malta Council for Science & Technology).

Publication bibliography


22. Mexico

Mexican is a country that has natural reserves of minerals and metals and a mining industry tradition. Moreover, the Mexican economy is not characterized as being a mainly high-tech economy. Consequently, the focus of Mexican policies is to strengthen their mining position and to attract FDI in the mining sector.

Although environmental regulations have been tightened, mining policy still focuses one-sidedly on funding SME projects and attracting investment. The extremely dynamic developments of the past decade demonstrate that Mexico is already a very attractive mining location, while the expansion of exploration suggests that the mining’s future will not be without social and ecological problems. Already now miners’ working conditions are a political sensible topic.

Strategic instruments

Although mining is strongly routed in the Mexican history and identity, today an explicit, comprehensive strategy that could bring together the various dimensions in a concrete mining plan is lacking. The general coordination of mines is located rather low in the ministerial hierarchy\(^1\). The existing political and administrative structures are not suited to tackling the topic of CRM substitution. Promoting mining in a socially and environmentally acceptable manner, while preserving profitability and observing contracts, remains an important task for the government of the newly elected President Enrique Peña Nieto of the Institutional Revolutionary Party (Partido Revolucionario Institucional - PRI). But key actors in the mining sector are still expecting a meaningful change in the mining policy.

Mexico does have several de-central attempts to deal with CRM, however there is no main strategy.

The National Development Plan (Plan de desarrollo nacional - PND) for 2013-2018 (The Mexican Government) is a federal strategy issued by the Mexican Government. It includes in its strategy the promotion of higher levels of investment to improve the competitiveness in the mining sector. Three main actions are proposed to reach this aim: firstly to promote higher investments, secondly to ensure increased funding in the mining sector and its value chain, and thirdly to advice SMEs in the mining industry in the stages of exploration, exploitation, and trading. In addition, the goal is to modernize the institutional norms for the mining sector and to improve the processes of attention to procedures related to mining concessions (The Mexican Secretary of Economy). Within the PND there is a Program of Mine Development 2013-2018 (PMD), where substitution of CRM is not mentioned\(^2\). The previous National Development Plan (2007-2012) did not consider the minerals sector. As a consequence of an analysis of productivity, the expansion of the PND was driven by the mining industries of precious minerals, especially gold. A significant increase in the production of other non-precious minerals was observable, but the heterogeneity in the recent years’ growth poses the challenge of encouraging a more balanced development of the sector.

The Mexican Geological Survey, which is related to the PMD, aims at strengthening the mapping system. The infrastructure of laboratories and other public resources will be used to identify targets of exploration, contributing to the reduction of costs that are associated with these activities for the companies. In addition,

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1 The General Coordination of Mines (CGMineria) is situated on the third tier of the Ministry of Economy. It has two departments, the Directorate General of Mines, responsible for regulation and the Directorate General of Mining Promotion, which deals with investment matters.

2 When referring to critical materials the report refers to food supply.
the aim is to promote the best applications, to contribute to investment in the sustainable use of natural resources, and thereby contributing to national development (Servicio Geológico Mexicano). To this end they list an extensive portfolio of potential strategies. The link to CRM is through potential reserves of, for example Rare Earths.

In the Mexican RTDI system, each state has its Science and Technology Plan (even the period of time is differs between states). The contents of these plans depend on how good their research and technology institutes are. We have noticed that some of the states are aware of the importance of finding CRM alternatives and are researching in this field. Examples for these initiatives are, for example, the Universidad Nacional Autonomy de Mexico (UNAM) which sets its own research agenda, or the Laboratory for rare earths which is a project at the Autonomous University of Morelos State (UAEM) (Secretaría de Innovación, Ciencia y Tecnología).

In Mexico the Federal Government is responsible for the mining policy, including granting licences.

**Mexican strategies in an international context**

The Mexican strategy is inspired by the strategies of the USA and Canada. In practice we observe that in the RTDI the Universities usually follow the research topics of, for example, the European Union and Korea. In addition, Mexico committed to continue to finance institutions and researchers that participate in Horizon 2020 calls (The Republic of Mexico).

**Specific instruments**

**Research programs at the national level**

The Mexican National Council for Science and Technology (CONACYT) exists since 1970 as a public institution which is an, independent of the federal public administration, member of the education sector, with a legal personality and own patrimony. It is, among others, responsible for designing the Mexican policies of science and technology. The CONACYT developed an ambitious vision for 2025 aiming at increasing the importance of the Mexican economy and also at strengthening the international importance of the Mexican science and technology³. The identified strategic growth areas include communications and information technologies and advanced materials (CONACTYT).

In practice we will find also different strategies for science and technology in each state in Mexico. Some programs are organized at the local level, some programs are run by universities and other programs are issued by national RTDI institutes. Each institution has its own RTD agenda. The Federal Government issues funding through several institutes in the different sectors but it does not issue specific calls. The issued funds target SMES, large companies, research institutes and universities.

**International research agreements**

Mexico funds IBEROEA bilateral projects with Spain and Iberoamerican countries. The projects do not target a specific stage of the RTD process.

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³ The specific goals are to first, invest more than 2% of the GDP in R&D activities, second, that – as a result – the Mexican economy will be one of the ten most important in the world and finally, that Mexico will be positioned as one of the 20 most developed countries in science and technology.
Other instruments and initiatives

In Mexico RTD expenditures are not eligible for tax rebates. Moreover, public procurement does not target CRM substitution.

As a response to the growing attention to CRM, a program by the UNAM and Morelos University has been established. The funding volume is about 240 millions of pesos (approximately 14 Mio. Euro) (Notimex, 2014). The central authority that is overseeing the criticality of materials is the Mexican Geological Service. The Mexican mining Chamber (CAMIMEX) aims to group together, coordinate, represent and defend the interests of the mining industry to different instances of the Mexican Government and other agencies. In addition, the CAMIMEX provides information-, training-, management-, and support-services to promote the integral development of the industry (Camimex).

The Mining Development Trust Fund (FIFOMI) provides technical support and training to optimize mining and the value added chain.

Other relevant aspects

Mexico has now official policy documents identifying general objectives and strategies for the mining sector. Here they describe where they plan to expand domestic production of minerals and metals. In addition, Mexico has been actively promoting foreign direct investment for quite some time now.

Publication bibliography


CONACTYT. Available online at www.conacyt.mx.


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4 Information about all agents and their respective roles, can be found in the Guidance of Minery procedures Secretaría de Economía, 2013.

23. Netherlands
In the Dutch economy services constitute a large amount of the GDP. Consequently, industrial policies were only developed in the recent years. Service sectors like financial services and transport used to receive the highest attention in the policy making process. Increasingly, the role of manufacturing clusters in the Netherlands (mainly chemical industries, metal product industries, food products and to a lesser extent industrial machinery) receives appreciation, especially that they are considered to be R&D intensive.

Strategic instruments
The main Dutch policy related to CRM is laid down in the “Raw Material document” (“Grondstoffennotitie”) which was issued first in 2011 by the Dutch administration, led by the ministry of Foreign Affairs as an answer to the Millennium Development Goal no. 7 (The Dutch national government, 2011). It puts focus on the CRM list by the ad-hoc working group of 2010 (European Commission, 2010), but includes most of the other materials (around 40) that were on the longlist. It mentions CRM substitution explicitly. The international i.e. geopolitical element around 2010 was initially prominent in the CRM policy of the Netherlands. For instance, it was recognized that vulnerability to, and impacts of, resource scarcities can be reduced through substitution, including trade (PBL, 2011). In the Netherlands the federation of the metal- and electronics industry (“Federatie voor de Metaal- en Electrotechnische Industrie”, FME) and VNO-NCW (representing employers from mainly SME) are important intermediate organisations between the industries and the government. They were heavily involved in the making of the “Grondstoffennotitie” (The Hague Centre for Strategic Studies/TNO, 2011).

In the Netherlands the ministry of Infrastructure and Environment increasingly has a very prominent role in the Dutch resource efficiency policy. This is reflected in the progress report on European Environmental research (Ministerie van Infrastructuur en Milieu, 2014). This may seem to imply that policies related to resources and their use are, or have been, seen primarily as an environmental and sustainability issue, and to a lesser extent as an issue that should be addressed by R&D investments. However, the names of ministries may be misleading here. The ministry of Foreign Affairs and Economic Affairs is involved in the same way, balancing the focus on international trade, environmental aspects, labour markets and research. All ministries recognise that the public debate is often recognized as too “static”, emphasizing too much on a supposed finite character of raw material supply (The Hague Centre for Strategic Studies/TNO, 2010).

Characteristics of the strategic instrument
The primary policy goals of the Raw Material Document are to increase R&D expenditures, to preserve free trade and to support sustainable development. The character of the document is to allocate the annual research budgets of national department dedicated to economic affairs, foreign affairs, state affairs, infrastructure & environment and education. It is not intended to promote the size of the whole budget or to change the entities controlling it.

The raw material document used as the method the monetary value of the materials used in each industry, and the product use intensity to identify which materials showed the greatest occurrence of the critical materials. In 2013, the update of the national policy on raw material use specified this approach by focussing on the sectors that donated most to the domestic export: the goods that were produced within the
Netherlands and needed CRM's at some point in their value chain (Ministerie van Economische Zaken, 2013).

**Dutch strategies in the context of the EU**
The development of the raw material document happened in response to initiatives of the EU and Germany. Ongoing research on the relevance of specific raw materials for the Dutch economy suggests that more policies will be developed in the coming years (Bastein et al., 2014).

**Specific instruments**

**Research programs at the national level**
The Netherlands Organisation for Scientific Research (NWO) has dedicated one theme (out of six) on Materials in their latest multiyear program (2011-2014) (NWO, 2010). It is based on the aspects on substitution of fossil raw materials by bio-based materials, substitution by abundant materials, substitution of processes and substitution of consumption patterns. This theme offers an exceptionally broad scope, allowing for substitution in all possible ways. The budget related to the program is an annual 2,100 Full Time Equivalent, roughly resembling 2.3 bio Euro. Around 18% of the national research proposals are funded.

**Other instruments and initiatives**
The national government grants around 1.8 mio Euro of additional, competitive funds related to resource efficiency. As this includes a wide range of topics, none of it can directly be linked to CRM substitution. M2i is the network organisation in the field of functional and structural materials. Over 60 industries and universities work together on new materials with improved properties, new production processes, and in-depth knowledge of material behaviour from production to end of life. It is funded out of the NWO budget. The following institutes are worth mentioning:

- Debye Instituut, Universiteit Utrecht ‘Condensed Matter and Interfaces’ (Prof. A. Meijerink) substitution of luminescent REE
- Copernicus Institute, Universiteit Utrecht,
- TU Delft , Group Radiation Radionuclides & Reactors (Prof. Dr. P. Dorenbos) scintillating REO
- TU Eindhoven, Group Materials Science and Engineering (Dr B. Hintzen) photoluminescent LED’s
- Holst Center, open innovation platform TNO & IMEC, various substitution efforts
- Centrum Milieukunde Leiden (CML), specialist in MFA and SFA aiding substitution relevance assessments.

The Dutch government tries to keep strong liaisons with the European Commissions by participation in the Raw Materials Working Group led by DG Enterprise and through various persons within DG RTD (E. van de Weert).

**Publication bibliography**
Bastein, Ton; Rietveld, Elmer; van Zyl, Stephan (2014): Materialen in de Nederlandse Economie - een beoordeling van de kwetsbaarheid. Edited by Ministerie van Economische Zaken. Available online at


24. Norway

The Norwegian economy is one of the most important European raw materials producers.

Strategic instruments

The Norwegian strategy which is most relevant, is the Strategy for the Mineral Industry (Strategi for mineralnæringer) (Nærings- og Handelsdepartementet, 2013). It was issued 2013 by the Ministry of Trade, Industry and Fisheries. Its main goals are: firstly, to have a value-generative, profitable, and growing mineral industry with good growth. Secondly, that the Norwegian mineral industry is amongst the world’s most environmentally-friendly ones and should actively seek future-oriented solutions. Thirdly, predictable and efficient procedures should guide regulating activities at all levels. Finally, the industry growth should be strengthened through prioritizing mineral mapping, access to information about Norwegian mineral resources, better resource planning, continued development of the governmental mineral administration and investment into knowledge and access to skilled labour.

Graphite and Silicon are both produced in Norway and consequently these materials are targeted by the strategy.\(^1\)

Raw material substitution is not mentioned in this strategy.

Characteristics of the strategic instrument

The strategy has the goal to increase activity in the mining industry and thereby to increase the production of raw materials and to ultimately support employment and economic growth.

The strategy proposes a large number of policies to reach its aims. Among these measures are to increase the funding to geological survey\(^2\), to invest into education and competences as well as into research and development, to consider the environmental aspects of the production process, to put into place a predictable legal framework for the mineral industry\(^3\) and to improve the access to capital\(^4\).

Norwegian strategies in the context of the EU

The Swedish minerals strategy\(^5\) served probably as a model for the Norwegian strategy.

The Norwegian strategy refers to the European Raw Materials Initiative. It regards the EU’s dependency on imported raw materials as an opportunity for the Norwegian mining industry.

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\(^1\) Skaland Graphites in Troms is one of the two producers of natural graphite in Europe. Moreover, Norway is the world fourth biggest producer of silicon metal.

\(^2\) The objective is that 75% of Norway has been mapped by 2018.

\(^3\) A new law about the recovery licence to minerals has been adopted. (Lov om erverv og utvinning av mineralressurser (mineralloven) Nærings- og fiskeridepartementet, 2009)

\(^4\) The plan is to strengthen state-owned investment funds.

\(^5\) "Sveriges Mineralstrategi" Regeringskansliet, 2013
Specific instruments

Research programs at the national level
There is no national funding program directed to the substitution of CRM, however Horizon 2020 grants can present a funding opportunity. In general the Norwegian RTD programs are coordinated centrally and funded by the government.

Other instruments and initiatives
There is a tax rebate scheme for R&D. There is no special focus on the substitution of CRM in this scheme (Norges forskningsråd). Public procurement is not used as an instrument to support CRM substitution in Norway.

In Norway no new institutions were founded in response to their national strategy. Moreover, there is no central agency which collects and disseminates information on CRM.

Publication bibliography


Norges forskningsråd: SkatteFUNN. Available online at www.skattefunn.no, checked on 10/24/2014.

25. Poland

Poland does not yet have an officially adopted list of critical raw materials. There are, however, plans in the Ministry of Economy to conduct a study and present one next year.

Strategic instruments

In Poland two strategies exist that are related to CRM: the Operational Strategy of the polish geological survey for the period between 2010 and 2015 (Polish Geological Institute, 2010) and the National Environment Policy for 2009-2012, published by the Polish council of ministers (Council of Ministers, Republic of Poland, 2009). While the focus of the Operational Strategy is to ensure raw materials security in supply, the Environmental Policy targets at resource conservation and optimal supply. Both strategies do not make references to specific CRM or mention CRM substitution.

Comparison of the characteristics of the strategic instruments

While the operational strategy is mainly explicative, the environment policy has both explicative and normative characteristics; however the proposed actions are still very general. The operational strategy has the goal to provide a good foundation for the development of the Polish economy and for creating infrastructure, but it does not suggest specific instruments. The environmental policy, on the other hand, proposes specific actions until 2016 which include improving the regulatory framework for the protection of mineral resources and underground water reserves, limiting pressures on the environment from geological exploration and resource exploitation, and eliminating illegal resource exploitation. Its main goals are to ensure an optimal supply of mineral resources to the public and businesses, and to protect resources from qualitative and quantitative deterioration.

Poland’s strategies in the context of the EU

The Operational strategy makes a reference to the EU Natura 2000 program as well as to European websites about resource reserves (such as eEarth.EU and geomind.EU). The National Environment Policy also refers to the EU Natura 2000 program and, in addition, it references several EU directives, however none is related to CRM or their substitution¹.

Specific instruments

Research programs at the national level

The National Centre for Research and Development (NCBR) is the central Polish agency which is active in science, technology and innovation policies. It is funded by public sources and it is the implementing agency of the Minister of Science and Higher Education (The National Centre for Research and Development). Together with the National Fund for Environmental Protection and Water Management (NFOŚiGW) the NCBR it issues calls in the framework of the programme Generator of Ecological Concepts (GEKON). This call includes a part which is targeted at new technologies for material-recycling (The National Centre for Research and Development). In addition the NCBR has a programme which is targeted in particular on applied research.

¹ The strategy notes that the current EU legislation leaves the regulation to the geological prospecting to national law.
International research agreements

Sustainable Mining and Innovation for the Future (SMIFU), a cooperation between Swedish and Polish mining companies, identifies the most strategic issues that need to be addressed, and defined important areas for research, development and innovation within the mining sector (Rock Tech Centre).

Poland is participating in ERA-NET ERA-MIN through the National Centre for Research and Development, however it was not yet involved in contributing to the funding of specific ERA-MIN Joint Calls (ERA-MIN, 2014).

Other instruments and initiatives

In Poland the Polish geological institute (European Environmental Agency, 2011) and the Polish Ministry of the Environment are central institutions which collect and disseminate information on raw materials (Department for Environment, Food and Rural Affairs, 2012). The Polish geological institute collects and generates data about, among others, mineral raw materials and environmental geology. The information is disseminated to society (Polish Geological Institute).

No information was available with respect to public procurement as a strategy to support CRM substitution.

Publication bibliography


26. Portugal

Portugal is one of the European countries with a significant potential for the occurrence of a wide range of geological resources of economic interest, among those CRM. The mining sector, which consists of metal ores, ornamental stones, industrial minerals and industrial rocks, has shown a positive impact on the national economy reaching about 975 million Euro in 2010, driven mainly by metal ores (44%) and the industrial rocks (35%). Portugal has a range of metallic deposits: in the field of CRM it has deposits of: tungsten, antimony, indium, niobium, thallium, beryllium, germanium, and lithium. In addition, Portugal also has reserves of copper, zinc, uranium, tin, tungsten, gold, silver, and manganese.

The wolfram mine of Panasqueira and the base metals (copper and zinc) mines of Neves Corvo and Aljustrel, mine ornamental stones and some industrial minerals primarily supply foreign markets (Presidency of the Council of Ministers, 2012). Portugal has a supportive government and favourable mining laws that encourages mineral exploration and mine development.

Strategic instruments

As a result of the rising importance of mineral resources in Portugal, the Portuguese Government launched the National Strategy for Geological Resources – Mineral Resources (ENRG-RM) in August 2012 (Presidency of the Council of Ministers, 2012). ENRG-RM aims essentially at the time horizon until 2020 to increase the competitiveness of the mining industry and to ensure the supply of raw materials. The strategy takes a perspective of sustainability of Portugal as a whole, establishing the necessary balance between economic, social, environmental and territorial issues, given the direct and indirect impacts of the mining activities.

The ENRG-RM is focused on the mining industry, including CRM, and does not consider substitution. It aims at promoting a mining sector that is dynamic, sustainable at a multiplicity of levels, contributing to the GDP by on the one hand ensuring raw material supply and on the other hand generating revenues itself and that is able to promote regional development.

Due to its economic importance, the strategy focuses mainly on metallic minerals, some of which are CRM. The implementation of the ENRG-RM is operationalised by a Project Management Office (PMO) workgroup which consists of a representative of each public entity with expertise in the field of geological resources. In order to achieve the defined objectives, the ENRG-RM establishes an action plan with a time horizon until 2020, which includes a set of specific measures and actions in four areas of action among which the development of knowledge and appreciation of national potential as well as the dissemination and promotion of this.

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1 The following sources were used additionally to construct the profile: European Commission, 2010, 2014; UK trade & Investment, 2013; European Association of Mining Industries, Metal Ores & Industrial Minerals; Gamito, 2014; Caxaria; Labrincha; National Strategy for Geological Resources, 2012; Caxaria
2 In 2012 Portugal produced about 0.34% of the world production of Lithium (in that year) C. Reichl, M. Schatz, G. Zsak, 2014.
3 When considering sustainability, the Strategy explicitly considers economics, social, environmental and regional levels.
4 The members of this workgroup are the General Directorate for Energy and Geology, National Laboratory of Energy and Geology, the public Company for Development of Minerals EDM, a member of parliament responsible for the geological resources and for actions within the marine geology, and a representative of the General Directorate of Natural Resources, Security and Maritime Services and the Portuguese Institute for Ocean and Atmosphere.
Comparison of the characteristics of the strategic instruments

The ENRG-RM has a normative character. It establishes an action plan that includes a set of measures and specific actions having a time horizon until 2020 (Presidency of the Council of Ministers, 2012). Its political objectives are to improve sustainability in mining, to increase corporate social responsibility, to foster research as well as to create better conditions for investors by aiming to increase the societal acceptance of the mining sector.

Portugal’s strategies in the context of the EU

ENRG-GM is mainly based on the Raw Materials Initiative (Commission of the European Communities, 2008), the EC Guidance on undertaking new non-energy extractive activities (2010) (European Commission) as well as the Extractive Industries Transparency Initiative (EITI).

Specific instruments

With the implementation of the ENRG-RM in 2012, the Portuguese mining policy changed with respect to the royalties. Since then, up to 25% of the value of the royalties due to the Government may be used directly on sustainable projects to the benefit of local communities. These investments may be, among others, into social responsibility programs, environmental programs but also into R&D projects aiming at increasing mining efficiency.

Research programs at the national level

Portugal is participating in Horizon 2020 consortia focusing in Portuguese Mining sustainability:

- STAND 4 MINES (lead: Spain): Standardization of sustainable mining management systems
- ADMINE (lead: Germany): safeguarding the mineral wealth of Europe through a regulatory framework defining and protecting mineral deposits of public importance
- MINEINVEST (lead: Austria): European investors guide for primary raw materials as strengthening factor of mining to the European society
- RAWMATERIALS4EU (lead: Portugal): towards a new model of C&DW management for a circular supply chain integrating innovative solutions for a better recovery of Ram Materials.

International research agreements

The General direction of Energy and Geology (DGEG) has accompanied the building procedure of the European Innovation Partnership on Raw Materials (EIP), and has mobilised partners from several areas (academia, mineral associations, public entities and mining companies). This resulted in the launch of a Portuguese Partnership for Mineral Resources in 2012 (C. Neto 2014). A significant part of Portuguese entities and companies within the Portuguese Partnership for Mineral Resources are involved with EU partners in the responding to calls.

Within the EIP several strategic implementation plans have been developed. Currently Portugal participates as a coordinator in three EIP Commitments, one of them being Africa-EU-Latin America Raw Materials Platform Kandandu (EIP on Raw Materials, 2014-2018) to be implemented before 2018. In addition Portugal also coordinates the EIP on “Innovative bio-mining and bio-mineralization technologies applied to extraction of low-grade ores deposits, mine by-products and recycling of man-made products.” EIP on Raw Materials, 2015-2017 and on the EIP on Tools for Mining Small Complex Gold Deposits EIP on Raw Materials, 2014-2020.

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substitution of CRMs the University of Aveiro participates in Working Group 2 “Substitution of raw materials” of the European Innovation Partnership on raw materials (EIP on Raw Materials; EIP on Raw Materials).

Publication bibliography


Caxaria: Mineral Resources: Opportunities in Portugal.


27. Romania

Romania is one of the European countries with a rather weak economy. Its GDP per capita in 2013 was 54 (ref EU28=100), one of the lowest values within the European Union.

The Romanian production of mineral resources is very limited and focused to some carbon types and metals like copper, silver and gold. The Europe 2020 strategy and the Raw Materials Initiative, however, have been analysed by the Ministry. Still, there is no dedicated national strategy to “critical raw materials”.

Strategic instruments

The report “the strategy of the mining industry 2012-2035” (“Strategia Industriei Miniere 2012-2035”) describes the situation and objectives concerning the mineral resources in Romania. The report makes reference to the European Raw Materials Initiative and also to the list of the initially identified 14 Critical Raw Materials (Ministry of Economy, 2012). Some of the CRM listed by the European Commission – beryllium, graphite, magnesium, niobium, tantalum and tungsten – have been described as present in Romania, although no exploitation takes place.

Beyond the previous reference to the Raw Materials Initiative, no further action concerning the CRM has been defined. Critical Raw materials substitution is not mentioned in this strategy. The Ministry of Economy, Department of Industrial Policy and Competitiveness, has confirmed that there is no Romanian strategy for critical raw materials.

Characteristics of the strategic instrument

The strategy has the goal to boost the activity in the mining industry and thereby increasing the production of raw materials and ultimately support employment and economic growth.

Romanian strategies in the context of the EU

The Romanian strategy refers to the European Raw Materials Initiative. Progress has to be made in order to increase the mining activities in the country. There is neither a specific strategy for CRM nor for their substitution.

Specific instruments

Research programs at the national level

There is no national funding program directed to the substitution of CRM, however Horizon 2020 grants can present a funding opportunity.

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1 Ministry of Economy; Ministry of Economy, 2011
At national level, a number of projects granted, can be indirectly linked to address the challenge of the CRM, either by substitution of a particular raw material or by alternative technologies. No specific reference to substitution or critical raw materials has been made in the research & innovation programmes.

**International research agreements**

Romania is participating in ERA-NET ERA-MIN and through the Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI) it was contributing to the funding of the second ERA-MIN Joint Call which also included CRM substitution (ERA-MIN, 2014).

**Publication bibliography**


28. Slovakia

The Slovakian economy benefits from a long industrial tradition, dating back to the 1920’s. Major manufacturers like Houcon, ZVL and Eltek are active in the field of metal production and equipment for energy production. Moreover, Slovakia is the world’s largest producer of automotive products per capita. Six major car manufacturing groups have production facilities established in Slovakia. The mining industry is relatively speaking not dominant, although some mining activities are in place and the mountainous parts of the country regularly appear to contain attractive resources (Euromines, 2012).

Strategic instruments

Slovakia has a Raw Material Policy Proposal, created by the ministry of economy and ministry of environment, in place since 2004 (European Environmental Agency, 2011). The proposal has specific aims over different time-spans. Short-term aims relate to decrease the energetic demand of production processes, to increase the production quality, to decrease the impact of mining on the environment and to make sure the deposits are removed with the greatest possible efficiency during mining operations. Mid-term aims relate to increase the efficiency of materials processing and to increase utilisation of mining machines. Long-term aims relate to removal of the reserves in the time horizon to the years 2017-2018 without losses, providing the transition of the thermic operation of the mining and processing company to purchased materials processing. Slovakia is addressing raw material issues only focussing on to production of NEEI (Non Energy Extraction Industry) itself (this implies both a narrow scope, only production, as a broad one, the NEEI as a whole). It has no specific reference to criticality, let alone substitution.

Specific instruments

International research agreements

Slovakia is together participating in ERA-NET ERA-MIN through the State Geological Institute of Dionýz Štúr. Originally it intended to contributed to the funding of the second call, however it withdrew due to formal reasons (ERA-NET ERA-MIN).

Publication bibliography

ERA-NET ERA-MIN. Available online at https://www.nks-werkstoffe.de/era-min, checked on 9/16/2014.


29. Slovenia

Slovenia was a modest producer of mineral commodities in 2011, and its output was not significant on either a world or regional scale (USGS, 2011). Slovenia’s manufacturing is mostly focused on industries which are not dependent on CRM. However, an industry that produces motor vehicles, air transport equipment and electronics manufacturing are also present.

Strategic instruments

The National Mineral Resource Management Programme from 2009 (European Environmental Agency, 2011) addresses efficient mineral resource management and covers the entire mining cycle from exploration, mine development and extraction to closure and remediation. There is also a National Mining Strategy since 2011 that has an extensive focus on efficient mineral resource management. The general aims and objectives of the recourse management programme are the rational utilisation of natural (mineral) resources, to manage the provision of mineral resources and the preservation of access to natural resources for future generations according to the principles of sustainable development. Moreover, it targets at a provision of mineral resources from domestic sources and at reducing negative impacts on the environment and local communities.

Specific instruments

Research programs at the national level

The Slovenian Research Agency coordinates research programs, allocating an annual budget of around €145 mio. from competitive (for Slovenian nationals) and public research funds. This covers all scientific fields, and has no specific focus area.

Other instruments and initiatives

The Jožef Stefan Institute is the leading organisation in material science in Slovenia (The Jožef Stefan Institute). It participates frequently in European programs. Research at this institute covers a broad range of research and development of new technologies. In particular, professor Spomenka Kobe is an interesting person who is active in research in the field of substitution.

Moreover, the Institute of Metals and Technologies is an institute for basic and applied research in natural sciences (focus among others metal materials and composites), technical sciences (metallurgy) and environmental sciences (among others monitoring the management of secondary and waste materials of the steel and metal industry in Slovenia) (Institute of Metals and Technology).

Publication bibliography


30. Spain

Spain has non-energetic mineral reserves distributed over its territory. The South has reserves of copper, zinc, lead, gold, and silver; tin, tungsten, nickel, cobalt, germanium, uranium, and other strategic minerals. are found in the West. The North of Spain has gold reserves and the East of Spain potash. Moreover, industrial minerals, kaolin, ornamental rocks, industrial rocks, clays and aggregates can be found in Spain (Euromines; CONFEDEM). As a result of the strong increase in raw materials prices, companies have started in recent years to open new mines and to reopen some of those, which ceased to be profitable and were therefore abandoned in times when mineral prices were lower (Verity Ratcliffe, 2014).

Spain was a major producer at global level for some industrial and construction minerals and has a growing presence in the metallic subsector\(^1\). Most of the Spanish Mining companies, as in the rest of Europe, are SMEs\(^2\) (Spanish Ministry of Industry, Energy and Trade).

### Strategic instruments

At the moment, no strategy related to raw materials is implemented by the Spanish Government. Entrepreneurs have realized this lack and they recognize the potential that a Spanish Raw Material Strategy can lead to increasing the productive activity, to create employment and to contribute to social well-being. In this context, the National Confederation of Entrepreneurs of mining and metallurgy (CONFEDEM) demands a strategy in line with the European Initiative in Raw Materials (CONFEDEM).

In the case of mining, almost all the competencies have been transferred to the Communities. The Central Government only manages issues related to Mining security and the use of explosives. Therefore, the Spanish mining policy is the result of the sum of the policies from its 17 Autonomous Communities, and any action from the Central Government needs to take into account this distribution of competences.

### Specific instruments

While there are centrally funded R&D programmes, issued by the Centre for Technical and Industrial Development (CDTI), none of these programs is specific to CRM substitution (Centre for Technical and Industrial Development).

Within the European Innovation Partnership (EIP) on Raw Materials, Spanish entities participate as a coordinator in a number of EIP Commitments, among others in the “Innovation Network to increase the competitiveness of the European Magnesium/Magnesite sectors through Environmental and Social Sustainability” (European Commission, 2014-2017).

In addition, through the Centre for Technical and Industrial Development (Centro para el Desarrollo Técnico e Industrial, CDTI), the Spanish Ministry of Economy and Competitiveness (MINECO) participates in ERA-MIN, the network of European organizations owning and/or managing research programs on raw materials. It was co-funding the second joint call which, among others, focuses on CRM substitution. The prospective

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\(^1\) There are seven metallic mines in operation and around thirty projects that have gone further than the investigation phase Spanish Ministry of Industry, Energy and Trade.

\(^2\) According to the EUROSTAT-statistics of 2011 the majority of companies mining metal ores in Spain have up to 9 employees.
budget of MINECO is 300000 Euro in this call. Spanish partners are participating in three of the ERA-MIN working groups (ERA-MIN, 2014). FEIQUE is participating in working group 3 which focuses on substitution.

**Publication bibliography**


31. Sweden

Sweden has deposits of REE. In the area around Gränna the company Tasman Metals AB has a very promising deposit of REE. The company LKAB has a lot of REE in its tailings, but a potential exploitation is a complex and expensive process for which it is difficult to find financing possibilities.

Strategic instruments

The Swedish mineral strategy was introduced in 2013. The Swedish Ministry of Enterprise took the lead in this initiative. The Swedish mineral strategy has been developed with the support of the Geological Survey of Sweden (SGU). During the process, challenges, strengths and actions were identified in an open dialogue with industry players and others who contribute to, or are affected by, industry activity. The basic aim of this strategy is resource efficiency (Regeringskansliet, 2013). The focus of the strategy is on base metals, precious metals and rare earths. Substitution is not mentioned in this strategy.

In the same year the document “National actions for metallic materials” was published. It is a strategic research and innovation agenda which was created under the lead of the Swedish steel producers’ association. Companies as well as universities contributed to the document during the process. The focus of this agenda is on resource efficiency, it makes no specific reference to CRM (The Swedish metals-producing Industry’s associations, 2013).

Swedish companies, such as Stena Metall, Swerea Swecast, and Nordic Recycling issued the strategy “Resource Efficient use of materials - so do we renew Swedish areas of strength” (Resurssmart Materialanvändning). It sets a vision for 2030. Companies, universities and the Swedish environmental research institute contributed to this document. The basic aim of this strategy is recycling and increasing resource efficiency of, among others, rare earth metals. The document makes no specific reference to CRM. Moreover, substitution is mention in a very general way.

Finally, a very applied initiative, in the form of a network, is the European Rare Earth Competency network (ERECO) (European Commission) was established 2013 under the initiative of European Commission's initiative and by special request and funding from the European Parliament. The Swedish lead was with the Swedish Government together with the Swedish geological survey and the Swedish environmental protection agency “Naturvårdsverket”. The aim is to secure supply and the substitution of CRM.

Comparison of the characteristics of the strategic instruments

While all four strategies are characterised by explicative and, except for the national actions for metallic materials strategy, also normative elements, the policy objectives differ between the different strategies. The minerals strategy and the national actions for metallic materials share sustainable growth as a common objective. In addition, the minerals strategy aims at macroeconomic objectives such as innovation, growth and employment. Moreover, it aims at raising awareness to support the Swedish mining, industrial mineral and rock materials industry. Competitiveness of Swedish mining and mineral industry will be increased. The minerals strategy identifies five action fields where one specific field is related to resource efficiency, i.e. the mining and of mineral nutrients in harmony with the environment, culture and other sectors. For each of these action fields the action plan specifies specific actions. In the National action for metallic materials plan two of its seven strategies can be related to CRM.
The other two strategies are focused more on materials. The industry initiative focusing on increasing resource efficiency has the objective to be world-leading and internationally driving in resource-smart material use in 2030 through cross-disciplinary collaboration and a supportive social structure Sweden. Finally, ERECON aims at deepening the understanding about the opportunities to recycle and replace rare earth metals and to identify extractive and recycling potential of metals / minerals in Sweden. One of the seven strategies of the industry initiative on resource efficiency can be related to CRM.

Sweden’s strategies in the context of the EU
The materials strategy refers to the European Raw Materials Initiative and Europe 2020. The “National actions for metallic materials” references the Research Fund for Coal and Steel (RFCS).

Specific instruments

Research programs at the national level
The Swedish innovation agency Vinnova has been, in collaboration with Vetenskapsområdet, commissioned to conduct a topic overview of mining and minerals research area (LTU, 2013). This overview was issued by the Swedish Ministry of Enterprise. The project exists at national level in Sweden. In general research programs are coordinated decentralized in Sweden.

International research agreements
Sweden is involved in the European Innovation Partnerships (EIPs) together with other European partners. The target is to find substitutes for at least three applications of critical and scarce raw material. Moreover, it is involved in the European Rare Earths Competency Network (ERECON) (European Commission). ERECON aims to provide suggestions on which measures the EC can take to secure the raw material supply of REE for the EU. In addition, Sweden is, together with eleven European research agencies, geological surveys and ministries, participating in ERA-NET ERA-MIN through Vinnova and the Geological Survey of Sweden (SGU) (ERA-MIN, 2014). Sweden has contributed to both calls of ERA-MIN. The second call also involved CRM substitution. The goal of ERA-NET ERA-MIN is to define a roadmap for joint calls along the value chain of raw materials including primary resources, recycling, substitution, education and legal framework and international collaboration.

The “EURARE” research project focuses on increasing the knowledge of the rare earth elements (REE), which should ultimately lead to new materials research strategy (EURARE).

Together with Poland, Sweden cooperates on the project “Sustainable Mining and Innovation for the Future” (SMIFU) which aims at identifying the most strategic issues that need to be addressed, and defined important areas for research, development and innovation within the mining sector (Rock Tech Centre).

Other instruments and initiatives
The Swedish Ministry of Enterprise and the Geological Survey of Sweden are in charge of collecting and disseminating data on raw materials. The SGU has the task of providing geological information for the needs of the society in the short and long term. The collected information is disseminated to society. In addition, the SGU is active in research, it supports universities and colleges, and it is participating in networking and collaborative projects.
No policies with respect to public procurement of CRM substitution have been found.

Swedish institutes and researchers are involved in several international projects where the aim is to exchange knowledge and thus obtain a better knowledge base to find a substitute.

**Other relevant aspects**

We have not observed a strong direct industry support. Tasman Metals AB has made one of the world's most promising discoveries of HREE in the area of Grännna, but they still find it relatively difficult to get financing for mining. LKAB has a lot of REE in its tailings, but they also find it very difficult to get finance in the possible exploitation of the REE.

**Publication bibliography**


EURARE: About EURARE. Available online at http://www.eurare.eu/about.html.


32. Switzerland

Switzerland is one of the three most important trading places for resources which are mainly dealt with in a transit way. They recognize the strategic importance of raw materials. From this follows the importance of international relations, transparency etc. (Eidgenössisches Departement für auswärtige Angelegenheiten (DEA), 2013). In addition, Switzerland stresses that its private sector is mainly responsible for the raw material supply. In Switzerland CRM are sometimes referred to as “STM” (rare technical materials).

Strategic instruments

A number of Swiss strategies and initiatives are publicly available and are directly or indirectly relevant to CRM substitution.

Since 1997 the Swiss parliament (the “Bundesrat”) settled its political strategies in the area of sustainable development in the “Strategy of sustainable development”. Its fourth edition is published for the period between 2012 and 2015 (Schweizerischer Bundesrat). The current version follows from an evaluation of the previous version. The lead in the implementation was taken by the unit “sustainable development” of the federal office for spatial development „ARE“ (“Bundesamt für Raumentwicklung ARE”). The strategy makes a very general link to the substitution of rare materials (not necessarily CRM).

The federal office for the environment issued a report and action plan related to the green economy. One of the six fields of actions is “resource efficient ICT” where the authors stress that research on the substitution of CRMs should be supported (Bundesamt für Umwelt BAFU, 2013).

The Federal strategy: „Masterplan Cleantech – a strategy for ressource efficiency and renewable energies“ (Eidgenössisches Volkswirtschaftsdepartement EVD & Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation UVEK) focuses on the cleantech industry. CRMs are briefly described and substitution is identified in the context of clean tech innovations.

The report “RessourceEFFicient Switzerland” (REFF) aims at using the natural resources more efficiently. It identifies a number of action fields and discusses how to approach resource efficiency in these different fields. CRMs are mentioned in a number of action fields, however they are not at the core focus. Moreover, substitution is only discussed for environmentally harmful metals (action field 6.11 – metal resources) (Ernst Basler + Partner AG, 2013). The BAFU (federal office for the environment) took the lead in this initiative.

On a local level the Canton of Zurich implemented an action plan for the waste and resource industry (Baudirektion des Kantons Zürich, AWL, 2011b), (Baudirektion des Kantons Zürich, AWL, 2011a). It is a local strategic instrument. The focus is clearly on the “treasures” hidden in the “Urban mine”. CRM are mentioned, however the main goal seems to be on “checking” recycling possibilities of the CRM from WEEE. There is no focus on substitution.

1 Interestingly, the previous strategies remain still valid. It seems that the new strategies just add on to earlier strategies.
Comparison of the characteristics of the strategic instruments
The majority of the Swiss strategies that are currently in place are motivated by the insight that sustainable development can only be possible in a green economy. Thus it intends to move towards such a green economy, a very prominent goal in the examined strategies is resource efficiency. The sustainability strategy, for example, identifies 6 different fields of activities 2 out of which concern resource efficiency. And also the report “RessourceEFFicient Switzerland (REFF)” promotes the more efficient use of natural resources. The Masterplan Cleantech, is motivated through the too big Swiss carbon footprint. The “REFF” is normative in nature; its aim is to increase resource efficiency.

Looking at the characteristics of the different strategies, the strategy for sustainable development and the action plan for a green economy are both explicative as well as normative. The Masterplan Cleantech is mainly explicative, with normative elements and the REFF is normative in nature.

Switzerland's strategies in the context of the EU
The sustainable development strategy makes references to the United Nations Conference on Environment and Development. The green economy action plan makes a number of references to EU-wide initiatives such as Europe 2020, to the OECD green growth strategy as well as to the resource efficiency strategies of Germany “ProgRess” (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU), 2012) and Austria (Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, 2012). The „REFF“ makes references to the EU-project EREP.

Specific instruments

Research programs at the national level
The Swiss National Found (SNF) is providing funds for basic research. The topics are defined bottom-up (Schweizerischer Nationalfonds). The SNF targets researchers at Universities.

The goal of the commission for technology and innovation (CTI) is to generate more innovative products and services. This agency is operating at national level and it is designed to foster collaborations between SMEs and universities. The focus is on applied research. They offer various programs to support in particular also the SMEs. Moreover, they provide R&D funding but the topics are defined bottom-up (Kommission für Technologie und Innovation KTI).

International research agreements
Researchers in Switzerland may apply to ERCs in the context of Horizon 2020. Due to the adoption of the initiative against mass immigration researchers in Switzerland have the status of researchers of a third country in the two other pillars of Horizon 2020. They may participate in collaborations but they are not eligible to receive direct funding through the Horizon 2020 program.

Switzerland is maintaining a number of bilateral research collaborations. Moreover it is participating in a number of multinational research programs. It seems to be involved in many projects. It is not clear how many of these research projects are about the substitution of CRMs.

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2 This initiative is accompanied by a website which allows access to the results.
Other instruments and initiatives

Tax rebates are currently not used as an instrument to support CRM substitution, however there are studies which analyze the expected effects of such a policy (not specific to CRM, but on research in general) (KPMG).

We are not aware of specific institutions that were founded to support CRM substitution. Most of the information and literature is issued and distributed by the federal office for the environment and the “EMPA” which is the material science research institute at the federal level.

There exists a recommendation about how sustainable procurement can be reached. This, however, does not focus on specific material groups. Thus, CRM are not mentioned explicitly (Eidgenössisches Finanzdepartement (EfD), 2014).

Other relevant aspects

Switzerland implemented a system to monitor sustainable development on a large number of indicators, among which resource use, resource intensity and also collection quotas (Bundesamt für Statistik (BFS)).

Publication bibliography


33. Turkey

There is no information on Turkish strategies on the substitution of critical raw materials publicly available. The only available information stems from a report by the Official Gazette (The Official Gazette, 2012). It is noted that mining of Boron containing ores (more than 70% of boron resources of the Planet is located in Turkey) is critical for the Turkish Economy. From this document we can conclude that the ministry targets to support developing technologies and installing new processes to produce more valuable boron containing products. In addition, personal interviews indicated that no national strategy or action plan considering CRM substitution exists yet.

Turkey is participating in ERA-NET ERA-MIN and through the scientific and technological research council (TUBITAK) it was contributing to the funding of the second ERA-MIN Joint Call which also included CRM substitution (ERA-MIN, 2014).

Publication bibliography


34. United Kingdom
The UK has access to a number of raw materials, and as the economics of extraction changed, mines have been opened.

**Strategic instruments**

In 2012 the Department for Environment, Food & Rural Affairs (Defra), together with the Department for Business, Innovation & Skills (BIS), issued the Resource Security Action Plan (Department for Environment, Food and Rural Affairs, 2012a). Substitution plays a role in this plan in that it constitutes an economic and environmental possibility to achieve a more sustainable management of resources. The analysis of CRMs forms a core part of the document, and a number of studies conducted both within the UK and internationally are compared. Moreover it highlights the different CRMs identified by the different studies.

Prior to this, in 2010, the Sustainable Consumption and Production team of the Defra published a Review of the Future Resource Risks Faced by Business and an Assessment of Future Viability (Department for Environment, Food and Rural Affairs, 2010). This study aimed at identifying those at-risk resources that are essential to UK businesses and determine actions that can be used to overcome these dependencies. The report identifies that substitution has a role to play in solving some of the supply chain issues (Department for Environment, Food and Rural Affairs, 2012c). This report provided key information to the analysis of CRMs produced in the Resource Security Action Plan.

The House of Commons Science and Technology Committee launched an inquiry into strategically important metals in late 2010 to collect opinions from a variety of experts with respect to the vulnerability of the UK economy to supply risks for these critical materials (The house of commons, 2011). In addition to arriving to a set of conclusions with regards to critical materials this House of Commons report also outlines a number of recommendations for future government action. The lack of substitutability is identified as one of the significant threats to the supply of strategic metals (Department for Environment, Food and Rural Affairs, 2012a).

**Comparison of the characteristics of the strategic instruments**

The Resource Security Action plan is both explicative and normative, but it does have clear activity in relation to the latter and responsibility for this is shared between both HMG (Her Majesty's Government) and other parties. The political goals are on the one hand innovativeness and competitiveness but on the other hand also sustainability and awareness among the SMEs.

The Review of the Future Resource Risks Faced by Business and an Assessment of Future Viability is an explicative review, its main political objective is sustainability. The report by the House of Commons is both explicative as well as normative. The political objectives are economic growth and sustainability.

**United Kingdom’s strategies in the context of the EU**

The Resource Security Action Plan includes an overview of illustrative and selected international approaches to resource security (including the four EU nations that have formulated strategies so far: Germany, France, Finland and the Netherlands).
In 2012 the Department for Environment, Food & Rural Affairs, issued the Review of National Resource Strategies. This report presents information on how other countries in Europe and around the world are dealing with resource security. It also presents information on their strategic directions for the future. The countries included in the report are: Germany (German Raw Materials Strategy, Raw Materials on German Energy Technologies and Raw Materials For the German Economy), France, Finland, The Netherlands (Dutch Raw Materials Strategy Critical Materials in Dutch Economy and Resource Scarcity in the EU and the Netherlands), US (Critical Materials Strategy 2010/2011), Canada, Japan, Korea and Taiwan. It also includes the European Resource Strategy and Supporting Reports.

**Specific instruments**

**Research programmes at the national level**

In the UK there is some coordination of funding programmes, but this was mainly on an ad-hoc basis and organised by general agreement. Much of this has been conducted through the Knowledge Transfer Network (KTN), and collaborations between the Technology Strategy Board, the Natural Environment Research Council (NERC), and the Engineering and Physical Sciences Research Council (EPSRC) to support cross-fertilisation of ideas by organising workshops.

The EPSRC issued a number of calls which can be related to CRM substitution, for example a large call, “Materials Substitution for Safety, Security and Sustainability”, issued in 2013 (total vol.: £10M) already contains substitution in the call-title. Other calls focused on developing Photovoltaic technologies that do not depend on CRM (EPSRC; EPSRC). In addition, the EPSRC Centre for Doctoral training also supports research on novel materials.

The NERC funds a programme on the “Security of Supply of Mineral Resources”. Here specific emphasis is also on strategic materials. The total funding volume is £7M (NERC). The Technology Strategy Board (TSB) funds a number of projects that try to substitute CRM, for example to develop touch-screens without Indium (Research Council UK; Research Council UK). However, the term strategic materials is used within the UK to allow potential to justify the substitution of materials not normally considered in the traditional list of CRMs. However, project proposals must identify the reason why materials are strategic to the market sector addressed.

**Research programmes adopted by the Devolved Administrations**

No research programmes in the area of critical raw materials are currently funded by devolved administrations. The most recent overview of materials critical to the Scottish economy was published in 2011 (AEA Technology, 2011).

**International research agreements**

No specific joint actions were identified specifically for critical raw materials, although joint calls are made in the area of sustainability, for example together with China (EPSRC). Another research programme is the G8 Research Councils Initiative on Multilateral Research Funding which, among others, funds an interdisciplinary programme on material efficiency. The grants funded under this initiative bring together international research teams. UK researchers have been successful in this call, participating in six of the ten consortia, including taking the lead in three ones (EPSRC).
Other instruments and initiatives

Commissioned by the Departments for Transport (DfT) and Business, Innovation and Skills (BIS), Oakdene Hollins prepared a study that tries to predict the growth of the hybrid and electric vehicle and wind turbine markets until 2014 and assess the implications of this growth on the demand for rare earths (substitution is taken into account in the assessment) (Oakdene Hollins, 2010). In another report, Oakdene Hollins published, in the context of the European pathway to Zero Waste, a study on the feasibility of protecting and recovering critical raw materials through infrastructure development in the south east of England (Oakdene Hollins 2011). The report identifies the primary uses of these materials, and describes opportunities to lower the demand for the primary production, which can be categorised as: growth opportunities for existing activities; implementation opportunities that require further infrastructure development for enablement; and applications which have good potential for critical materials recovery in the future. It identifies substitution as a necessary measure to reduce demand of critical materials in the future. The authors warn, however, that the replacement of many critical materials simply adds to the demand for different critical materials. Thus, a substitution strategy has to be applied with care. A working paper and reports series published by the UK Energy Research Centre (UKERC) investigates topics of materials availability, specifically examining metals critical to the development of low carbon technologies (UKERC).

The British Geological Survey publishes Risk Lists for critical materials, which are judged by their scarcity, production concentration, reserve base distribution, governance indicator, recycling rate and substitutability (BGS).

Between September 2011 and March 2014 a Materials Security Special Interest Group (SIG), created by the Technology Strategy Board, was active in activities to stimulate the progress towards a circular economy for high value materials (Materials Security Special Interest Group). The SIG issued, for example, a report on Innovation Opportunities and Material Security (Knowledge Transfer Network). The report has used the 14 materials highlighted by the European ad-hoc working group as a starting point for the discussion on which materials should be classified as critical based on their supply-side risks. A very early report on resource security was commissioned by the Resource Efficiency Knowledge Transfer Network, one of the organisations today operating as KTN (Knowledge Transfer Networks) (Morley, Eatherley, 2008).

In the UK there is not any single agency overseeing the criticality of raw materials and collecting and disseminating corresponding data. However, a number of organisations do have ad-hoc meetings and collaborate for specific actions. The Resource Security Action Plan also called for collaboration between organisations to develop a number of tools and to develop data for dissemination, particularly to SMEs.

Moreover, the UK public procurement has no action on substitution of CRMs specifically although there are requirements on sustainability and other issues (Department for Environment, Food and Rural Affairs, 2014, 2012b).

A number of business organisations and business led initiatives to gather information and provide input to government policy.

- EEF, the manufacturers’ association, have set up the Materials Security Working Group. The organisation have issued a number of documents and provided information to government organisations on the needs and importance of this area for their Members (EEF).
• Confederation of British Industry. This organisation has a number of working groups that address the issue of the security of supply of materials to their Members. The organisation produces a number of documents in the general area of resource efficiency (CBI).

• Other business led organisations address the issue of critical materials indirectly through the development of the circular economy. Examples of these organisations include the Green Alliance (Circular Economy Task Force (Green Alliance)) and the Ellen MacArthur Foundation (The Ellen MacArthur Foundation).

**Other relevant aspects**

There is no direct support for industries and their value chains relevant to critical raw materials, but more general the Department for Business, Innovation & Skills’ manufacturing activity (e.g. industrial strategies) addresses some of the mitigating activities such as resource efficiency, strong supply chains and development of innovative solutions. BIS also places importance to addressing trade barriers where they are shown to exist.

**Publication bibliography**


CBI (Ed.): Made to last. creating a resource efficient economy. Available online at http://www.cbi.org.uk/media/1218447/cbi_-_made_to_last_-_creating_a_resource_efficient_economy.pdf, checked on 12/8/2014.


35. USA

Being the biggest economy in the world, the United States of America have a long tradition in securing their interests, supply chains are not an exception here.

Strategic instruments

Strategic legislation in the US has been around for some time. The National Materials and Minerals Policy, Research and Development Act of (as early as) 1980 suggested “the Executive Office shall coordinate the responsible departments and agencies to identify material needs and assist in the pursuit of measures that would assure the availability of materials critical to commerce, the economy, and national security” (National Research Council, 2008).

Federal agencies (the Department of the Interior, including the USGS, the Department of Energy (DOE) and Department of Defense) are supposed to develop and fund activities related to both policy research and basic science to understand the dependency on critical raw materials and minerals. Apart from many military oriented documents, a civil example that demonstrates the awareness related to criticality of materials is the 2007 study by the national research council about critical materials in the US economy (National Research Council, 2008). A remarkable fact here is that substitution is already a main indicator in assessing criticality, being explicitly used as a variable on multiple criticality diagrams. The study was followed by an official CRM strategy document in 2010 (U.S: Department of Energy, 2010) and the study by the US DOE and a committee of the American Physical Society and the Materials Research Society, published in 2011 (APS, MRS, 2011). It identified several elements, including 10 rare earth elements, as potentially critical for energy-related technologies (U.S: Department of Energy, 2011b). The study of 2010 suggests eight main policies (related to R&D, stockpiling, diplomacy) that are in their turn aligned with the three pillars of DOE strategy: diversifying supply, developing substitutes and improving recycling. The 2011 document specified the strategy on important clean energy technologies that might contribute significantly to key material demand in the long term, namely grid storage batteries, fuel cells, nuclear power, magnetic refrigeration, catalytic converters, gas turbines and vehicle light weighting.

The following materials were analysed in the 2011 study by US DOE

- in electric vehicle batteries: lanthanum, cerium, praseodymium, neodymium, cobalt, lithium
- in magnets for electric vehicles and wind turbines: neodymium, praseodymium, dysprosium, (samarium)
- in phosphors for energy efficient lighting: lanthanum, cerium, europium, terbium,
- yttrium
- in solar cells: indium, gallium, tellurium

Comparison of the characteristics of the strategic instruments

It appears that the set of solutions proposed by the National Resources Committee (2012) to tackle CRM scarcity cover almost all possible fields, ranging from: stockpiling, specialized procurement, (“straw person buyer”) WTO agreements, R&D investment, increased efficiency etc. No special focus in the strategic instruments can be identified. Mining i.e. increased domestic production, as a possible policy approach is

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under debate, explicitly the plans of (re)opening several mines. An important stakeholder here is the Bureau of Land Management to keep oversight in corporate grants to develop mining facilities (U.S: Department of Energy, 2011b).

The report of the Department of Energy (U.S: Department of Energy, 2011b) also presents historical supply, demand and price data for the materials and carries out scenario testing to assess demand and supply in the short (2015) and medium term (2025) (Department for Environment, Food and Rural Affairs, 2012). This is consistent with the influence of the widely consulted USGS database (www.usgs.org).

**US American strategies in an international context**

One of the eight main policy points of the Critical Materials Strategy for the U.S is diplomacy. It is considered important to cooperate with partners facing the same challenges, for example with Japan and Europe, to address critical materials needs and reduce vulnerability to supply disruptions. The DOE will also continue to support the work of the U.S. Trade Representative in ensuring that global trading system rules are upheld and transparency in the market is encouraged (Department for Environment, Food and Rural Affairs, 2012; APS, MRS, 2011). The DOE also emphasises the importance of strong diplomatic relations with China to promote diverse, sustainable and economical supplies of materials.

**Specific instruments**

**Research programs at the national level**

The United States are, along with Japan, the biggest investor in public R&D, with an abundance of world leading research organisations to rely on (Graedel, 2009). The United States do not have an explicit Federal minerals strategy or policy. Dedicated policies for substitutability have not been developed, as it is felt that this aspect suffers from reliance on qualitative and/or semi-quantitative data, as there are no coherent or comprehensive quantitative data on the substitutability of raw materials (U.S: Department of Energy, 2011b).

The National Science Foundation (NSF) is the state’s second largest research funder (after the National Health Institute), overseeing a budget of around 7 bio USD annually (in 2010). Apart from the NSF, a plethora of interest groups and federally funded organisations is active in translating the needs of the manufacturers into policy initiatives, for example the American Enterprise Institute (AEI), the Office of Science and Technology Policy (OSTP), the Advanced Research Projects Agency (ARPA), or the National Defense Research Institute (NDRI).

Following the American Recovery and Reinvestment Act of 2009, the DOE has launched the Advanced Research Projects Agency-Energy (ARPA-E)\(^2\), which conducts out-of-the-box, high-risk, transformative research on energy technologies, including substitution of REE185 with a total budget of $400 mio to be spent over the period of two years to fund basic and applied research on energy technologies. The 2012 programme made twelve funding opportunity announcements which resulted in 122 awards valued at approximately $369 mio to advance battery technology, explore alternative fuels, and improve building efficiencies, among other areas (U.S: Department of Energy, 2011b). Explicitly mentioned in the Critical Materials Strategy of the DOE are non-crystalline Magnesium-Aluminium alloys, “Rare Earth free” electromotors, superconductors for wind energy, and hard metal based composite magnets (U.S: Department of

\(^2\) This agency is similar to the Defense Advanced Research Projects Agency (DARPA).
Energy, 2011b). The DOE is also working with the “Batteries for Electrical Energy Storage in Transportation” (BEEST) programme on a demonstration project on new batteries and storage chemistry, structure and technologies using earth-abundant resources (Department for Environment, Food and Rural Affairs, 2012).

**International research agreements**

Japan, the US and Europe are engaged in regularly trilateral exchanges of knowledge based on raw material use and policy (DG Research & Innovation, 2013)

**Other instruments and initiatives**

An example of the program announced in the DOE report (U.S: Department of Energy, 2011b) also supports research carried out at various national laboratories in Albany, Reno, Avondale, Salt Lake City and Rolla. These are mostly related to industrial equipment and certain specific alloys. The Ames National Laboratory in Ames, Iowa, specialises in materials technology, including research on substitution of REE.

On the website of governmental research grants (www.grants.gov), no explicit research grant was related to CRM substitution.

**Publication bibliography**

NAFTA Governments Statement on Raw Materials. OECD Steel Committee Workshop on Steel and Related Raw Materials (2008). Available online at http://otrans.3cdn.net/a8eb259c9a00f969f8_p5m6b5w9f.pdf.


