Deliverable D5.1

Raw Materials Intelligence Tools and Methods

Project:	Mineral Intelligence Capacity Analysis
Acronym:	MICA
Grant Agreement:	689468
Funding Scheme:	Horizon 2020
Webpage:	www.mica-project.eu
Work Package:	Work Package 5
Work Package Leader:	MinPol GmbH
Deliverable Title:	Raw Materials Intelligence Tools and Methods
Deliverable Number:	D5.1
Deliverable Leader:	MinPol GmbH
Involved beneficiaries:	MinPol GmbH, GEUS, UCL
Dissemination level:	Public
Version:	Final
Status:	Submitted
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This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 689648.

Notice

TABLE OF CONTENTS

List of Figures

List of Tables

PURPOSE

Statement: to develop a coherent and comprehensive minerals policy-making framework, the right tools/methods/RMI context is needed.

This report maps key functions of Raw Material Intelligence (RMI) and their relevance for minerals policy development in particular future capacities needed at different levels – for industry, member states, regions, the EU and the role of the EU in international relations, considering primary and secondary minerals. Ideally, any minerals policy framework should consider equally primary and secondary minerals when framing the objectives/actions.

The scope and content of RMI will be a function of stakeholder needs of existing long-term scenarios with relevance to RMI (relation to Work Package 2, WP2).

The mapping will differentiate between operative tools (e.g. descriptive statistics) and strategic, long-term planning tools (e.g. scenario development and analysis).

A RMI-MATRIX will be developed in the next step, that allows the identification of best, medium and worst cases for RMI development.

The ultimate purpose of RMI is to inform policy making at the various levels of government. In order to be efficient and effective, both RMI and minerals policies have to tailored to each other. It is, therefore main purpose of this report, to assess to what extent actual RMI is and has been used in the formulation of minerals policies and which methods and tools can be used. Key aspects to investigate in the interplay between minerals policies and the supporting RMI would include:

(a) clear definition of scope (primary, secondary, etc. minerals);
(b) commitment to provide an appropriate minerals regulatory and knowledge framework;
(c) harmonisation between sectoral policies bearing on sustainable resource management;
(d) appropriate supply and demand scenarios, including the feedback from corresponding (mineral) policies (cf. WP4);
(e) Strengths-Weaknesses-Opportunities-Threats (SWOT) analyses of policy and regulatory options and their critical paths;
(f) monitoring the effectiveness and impact of regulations and policies; monitoring the status of minerals deposits of public importance.

Another important point is to show how this all feeds into the RMI-matrix (deliverable 5.2)

EXECUTIVE SUMMARY

Chapter 1 provides an introduction and lays out the methodological approach to Raw Materials Intelligence (RMI).

The scoping of RMI and its relevance for minerals policy development are laid out in Chapter 2. It discusses minerals policies as cross-cutting issues explores RMI as an instrument to develop such policies, taking consideration of market economy and supply security aspects.

Within the EU and elsewhere circular economy paradigms and resource efficiency scenarios are increasingly being promoted. The ensuing implications for (secondary) raw materials streams and thus for RMI and related policy decisions are discussed in Chapter 3.

Strategies and policies are based on models for future developments and these are discussed in Chapter 4. The interests and in consequence the policies of mainly importing and mainly exporting countries are rather different. Possible objectives are laid out and instruments to achieve these objectives are presented, from which proposals for action plans are derived.

Chapter 5 discussed more in depth the relevant tools and methods. In particular, fundamental aspects, such as mineral consumption patterns and data are investigated, from which supply and demand scenarios are derived.

Such scenarios are supported by foresight tools, which are succinctly summarised in Chapter 6, with more details on individual methods given in Appendix 1 (page 139).

A RMI-based policy framework requires a comprehensive and systemic modelling approach. Such approach is presented in form of a System Dynamics Model in Chapter 7, which discusses in detail the components of such a model.

EU policy making on mineral resources happens within a world-wide context, given that many important material streams are global. For this reason Chapter 8 examines minerals policies in other countries and regions have as part of the minerals policy effect assessment. This assessment is supported by summaries of international (Appendix 2, page 166) and EU (Appendix 3, page 185) regulatory instruments as well as foreign minerals policies for certain countries in Appendix 4 (page 218). The relevant findings are subject to a Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis from which conclusions for further EU policy options are drawn (Chapter 8).

The EU Raw Material Initiative provides a general framework for a minerals policy, but in fact it is not based on systematic EU RMI. Therefore, RMI requires to be strengthened.

DELIVERABLE REPORT

1. Introduction

1.1 Framing the Issue

Mineral raw materials are the starting point of a complex and comprehensive value-added chain. In times of increasing globalisation, they are a prerequisite for the functioning and the scope for development, prosperity and growth of any national economy. Evidently, minerals are of essential significance for the European Union's economy and its Gross Domestic Product (GDP). The per capita raw materials demand of EU citizens is expected to remain at a high level. Global raw materials demand as a whole will also continue to rise. At the same time, the problems of access to minerals within and outside of the EU countries are increasing. It is important to note that these limitations do not arise from a limited mineral potential. The problem is in the accessibility of the mineral potential outside and inside the EU; the latter particularly with respect to poor exploration, environmental and legal restrictions. This issue is to be faced in all EU countries.

As a consequence, securing the minerals supply by means of an effective minerals supply policy is of utmost relevance. Minerals policy on EU level on one hand and national minerals policies on the other hand have to be distinguished. The implementation of appropriate structures is essential for both levels. The particular importance of a coherent common European minerals policy is to be emphasized with respect to the legal structure of the European Union. A secure supply of raw materials is clearly a European priority that extends beyond country borders and national policies. In response to emerging needs the Council of Ministers requested the Commission on 21 May 2007 to "develop a coherent political approach with regard to raw materials supplies for industry" (Verheugen, 2007). The security of supply of minerals has now assumed a place high on the agenda of the industrialised economies: "raw materials are a key factor for sustainable growth in industrialized, emerging and developing countries" (Verheugen, 2007) and has received attention from the European Commission as well: "as a result of rising global demand, prices for many metals have reached record levels and Europe's capacity to provide raw materials is limited" (Verheugen, 2007)

The supply of minerals is explicitly recognised by the declaration that a "new strategy on raw materials will be presented to create the right framework conditions for sustainable supply and management of domestic primary raw materials" (G8, 2007). Consequently, the Commission launched the Raw Materials Initiative in November 2008 followed by a detailed analysis of the demand and potential scarcity of defined critical raw materials to the EU in June 2010 (EC, 2008). These initiatives have pioneered the development of an EU strategy on raw materials emphasizing the concept of the "added value chain", which continues to pursue the three pillar strategy to: (1) Ensuring the fair and sustainable supply of raw materials from international markets, promoting international cooperation with developed and developing countries; (2) foster sustainable supply of raw materials from European sources, and (3) reduce consumption of primary raw materials by increasing resource efficiency and promoting recycling (EC, 2010).

Nevertheless, it has to be emphasized that these activities of the EU decision makers have started rather late, given the relevance of the topic. Not only a number of problems were caused, but also additional new problems are arising. Public awareness of the significance of raw materials has been insufficient as yet; adequate structures have been lacking (Tiess, 2011). Establishing such a policy seems the more necessary, as the European Union becomes increasingly dependent on mineral-rich countries at low stages of economic development and is confronted with offensive economic policies of developing countries (Tiess, 2011).

A coherent European Union minerals policy should provide a framework for the Member States within which to create their own national minerals policies. The implementation of an EU minerals strategy needs a comprehensive Raw Materials Intelligence (RMI) concept. It must be highly efficient to yield results that can be implemented within a determined period of time, provided the political power is granted for this purpose (Tiess, 2011).

The complex matter of European Union raw materials issues covers a wide range of technical, scientific and legal aspects and needs consolidated political structures. Accordingly, effective consultation processes between stakeholders at EU-level as well as between EU and national levels should take place.

The overall objective of MICA is the development of a Raw Materials Intelligence (RMI) platform that serves the end users' needs for such intelligence. RMI is the basis for informed minerals policy development. To this end in WP2 the potential stakeholders and their needs have been identified (Erdmann et al., 2017). RMI is developed in the context of a complex web of sectoral mineral (and related) policies (economy, environment, water, fiscal, social, land-use, supply security, etc.) at both, national and international level. A policy is a course of action defined to reach such desired ends; therefore, policies are intrinsically of a normative nature. For instance, reducing CO_2 emissions in Europe (as a way to fight possible climate change) is the desired end by multiple stakeholders and there are various policies in place which seek to achieve such objective (e.g. based on IPCC guidance, goals of the EU steel technology platform). At the international level for instance development goals are the guiding principles (e.g. African Mining Vision, the Chinese Five Year Plans, etc.).

Policies are often codified or translated into different instruments such as laws, rules, regulations, directives, codes, etc., all of which direct/guide action. At EU and international level policies (public and private) and policy frameworks include:

- UN conventions and treaties
- EU policy framework (Raw Materials Initiative, EIP-RM, etc.)
- EU legislation (Directives, Regulations, etc.)
- Development plans (Chinese plan, Africa Mining Vision, BRICS policies, etc.)
- Corporate policies

All such policies, if focused on minerals, are called mineral (and related) policies, require the coordination of governmental and market processes to be effective[1]. An essential aspect of any document reflecting a minerals policy are the foresight of factors that will affect the expected future supply/demand of minerals at the local/regional/country/EU/international level. Therefore, foresight tools and methods are a crucial component for the design of any minerals policy. Such tools and methods inform policy makers of the challenges ahead expected and which courses of action could or should be taken today to reach desired ends. Therefore, the minimum set of tools/methods that are needed to develop a coherent and comprehensive minerals policy-making framework providing a fast response is investigated.

RMI is supported by information (i.e. interpreted data) and analytical tools. One can differentiate between operative tools (e.g. descriptive statistics, life cycle assessment (LCA), materials flows analysis (MFA), which are the subject of WP4, and strategic, long-term planning tools (e.g. back-casting, scenario development and analysis) that try to frame future developments.

The ultimate purpose of RMI is to inform policy making at the various levels of government. In order to be efficient and effective, both RMI and minerals policies have to tailored to each other. It is, therefore of interest, to assess to what extent actual RMI is and has been used in the formulation of minerals policies and which methods and tools can be used. Key aspects to investigate in the interplay between minerals policies and the supporting RMI would include:

- clear definition of scope (primary, secondary, etc. minerals);
- commitment to provide an appropriate minerals regulatory and knowledge framework;
- harmonisation between sectoral policies bearing on sustainable resource management;
- appropriate supply and demand scenarios, including the feedback from corresponding (mineral) policies (cf. WP4);
- SWOT analyses of policy and regulatory options and their critical paths;
- monitoring the effectiveness and impact of regulations and policies;
- monitoring the status of mineral deposits of public importance.

The above aspects will vary considerably from Member State to Member State. Compromising factors could be the lack of concrete minerals policy scenarios, the absence of reliable production statistics, import and export, or the absence of reliable (historical/future) mineral consumption analyses.

RMI is built from a multitude of different components. The challenge is to collect sufficient information for the envisaged needs and to support policy-making at national and EU level. While collating a database of the past with sufficient resolution is already a challenge in itself, making RMI a forward looking tool is even more daunting. The various components, or aspects, of RMI relate to each other and will interact with each other in a wide variety of ways. For the efficient collation of RMI, it will be important to have an understanding of worst and best case scenarios for combinations of the different elements. This would also allow developing minimum requirements for having a functioning RMI in place.

[1] To be noted: Mineral policies related to metallic minerals, industrial minerals, construction minerals are different; e.g. metallic versus construction minerals.

The various dimensions of RMI perhaps can be best arranged in a multi-dimensional matrix in order to better understand their interdependencies and cross-linkages. A RMI-Matrix will provide an overview of the respective situation in the Member States. The main dimensions identified include *inter alia*:

- minerals policy frame-work and its governing principles at national, European, and global level;
- stakeholder needs and expectations;
- methods and strategies to predict future development in use, demand, and supply of minerals.

The following chapters will provide an overview over the various elements that help to populate this RMI Matrix. While this Deliverable 5.1 will assess the different factors for the matrix, the actual RMI-matrix is subject of Deliverable 5.2. The RMI-Matrix developed will allow the identification of best, medium and worst cases for RMI development.

MICA, by definition focuses on minerals, thus excluding organic minerals from its scope. There is a multitude of nomenclatures and definitions for the different types and sources of minerals. In order to be consistent with other deliverables of MICA, the 'ontology', or catalogue of terms and definitions, developed under WP6 for the MICA online platform was adopted.

Different stakeholders will have different perspectives and needs (cf. Erdmann et al., 2017). We will here look at four dimensions:

- **political**: local, national, EU, global; various bodies
- **economic**: stocks and metabolism of RMs through the economy from deposit to landfill, + economic infrastructure (e.g. finance)
- **research & innovation**: education and training, research-performing organisations, intermediaries / networks / hybrids
- **socio-cultural**: political, socio-cultural and social NGOs, civic funding, society at large
- Thus, Raw Materials Intelligence and the associated tools and methods will cover the following categories, i.e. metallic minerals, industrial minerals, construction minerals
- **Primary metals** – *metal ores*
- **Primary minerals** – *non-metal (industrial) minerals, aggregates, cement, refractory material, ...*
- **Secondary metals –** *recycled manufactured goods, industrial scrap, mine and milling wastes, ...*
- **Secondary minerals** – *mine and milling wastes, building rubble, ...*

By definition energy minerals, such as coal, lignite, oil & gas, uranium, and thorium are not in the scope of this project. However, in many cases the production and availability of these are closely intertwined with those of the non-energy mineral resources. Metals and industrial minerals may arise as by-products from coal or lignite mining and uranium can be an important by-product from e.g. copper mining. In some cases the relative prices of the commodities determine, which is considered the main product and which the by-product of a given mine. Therefore, RMI has to take a broad view.

As noted in the introduction, RMI has two major components, namely databases containing information on demand and supply across the various societal domains, and tools that help to understand the current situation and to anticipate future changes.

1.2 Methodology

This report addresses the question of which RMI tools and methods have been used in the formulation of minerals policies. To this end a review of the objectives, instruments and action plans that constitute minerals policies and on tools and methods in the context of such policies has been conducted based on secondary sources. Likewise, examples of international minerals policy frameworks, frameworks based on system dynamics and on the circular economy have been summarised based on published sources. The analysis is based on dedicated, stand-alone documents describing different aspects of minerals policies. It should be noted that some countries do not have stand-alone documents, but the minerals policy can be derived from the legal framework, government administrative practices, or announcements by leading government officials. Where possible, various documents were assessed to reflect this situation.

Based on such findings, an assessment of policy effects and a SWOT analysis of identified documents describing minerals policies or strategies were carried out.

1.3 Report Structure

Chapter 1 this introduction.

Chapter 2 scopes RMI and its relevance for minerals policy development. A working definition for minerals policy (within MICA) is suggested; minerals policy being a cross cutting topic. Before any discussion of tools / methods related to minerals policy can be undertaken, the basics of a minerals policy framework need to be considered.

Chapter 3 demonstrates a model for the development of minerals policy frameworks, including objectives / strategies / instruments.

Chapter 4 discusses tools and methods in the context of minerals policies (linking back to Chapter 3). Of fundamental importance is the aspect of mineral consumption (behaviour), necessary for the indication and development of any minerals policy strategy. Chapter 4 includes models of mineral consumption versus policies, supply and demand scenarios (demand forecasting versus foresight tools for RMI) and tools/methods for identifying / preservation of mineral resources.

Chapter 5 introduces a RMI policy framework based on the System Dynamics model.

Chapter 6 discusses the issues of resource efficiency, taking into account appropriate scenarios. It highlights the implications and limitations of the circular economy paradigm and also the mine life-cycle in the context of the 'circular economy' paradigm.

Chapter 7 contains a comprehensive description of international minerals policy frameworks (including EU-minerals policy), but most of the details are given in the appendices (from page 139), with a view to arrive at an understanding of the relation between RMI and policy / international dimension.

Chapter 8 provides a systemic minerals policy effect assessment, making reference to the level of minerals policy, geopolitics and minerals. The assessment is based on SWOT analyses for both, the international and the EU level.

Chapter 9 offers conclusions.

More detailed information on tools, methods and various policy instruments are given in a series of appendices (from page 139).

2. Scoping of RMI and its relevance for minerals policy development

2.1 Minerals policy – a cross-cutting topic

Minerals policy is the part of an economic policy, which is assigned to political economy in the scientific sense (Siebert, 1983). In other words: economic policy is the part of state politics which deals with the shaping of national economy (Tuchfeldt, 1984). It seems appropriate to refer to any *state activity* aiming directly at *influencing* extent, composition or distribution of the national product as economic policy (Molitor, 2006). Generally speaking, *economic policy* is a policy including all measures with which the state *intervenes* regulating and arranging the economy. Economic policy specifies the rules, within those the (to a large extent) privately organized economy can act. This leads to the following general definition of minerals policy:

A minerals policy can be defined as the *entirety of operations of a State for influencing supply of and demand for mineral resources on its territory and beyond that.*

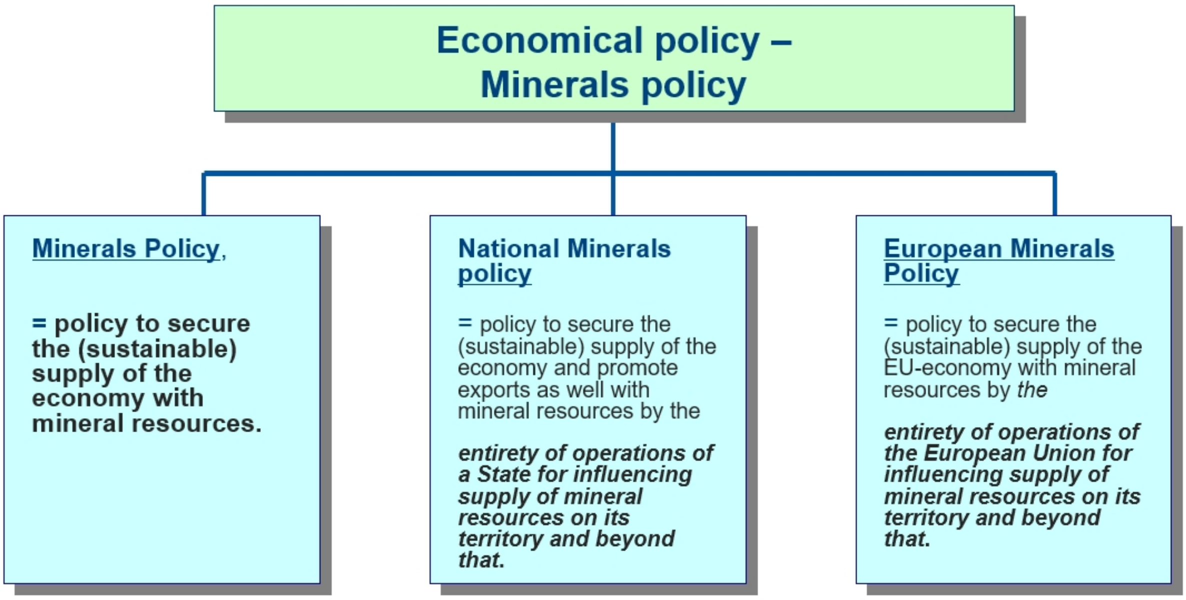


Figure 1: Minerals policy definitions.

That implies a conceptual definition of minerals policy with reference to 'Minerals policy in Europe'. It is evident that demand of minerals for the European economy is at a high level and even will grow in the future; however the security of minerals supply is affected by external (e.g. European high dependency on metallic mineral imports) and internal supply risks. So primarily a mineral supply policy or mineral security policy is discussed in the following. Securing an optimal supply with public (as well as private) goods (minerals as 'limited goods') and (connected with) increasing material prosperity over time are the main targets of every realistic economic policy (Klump, 2006). This lead to the following (working) definition:

Minerals policy is a policy that ensures that minerals demands an economy can be met by supplies.

Regarding the national and European level, the following can be said: a national minerals policy can be defined as a policy to secure the demand and supply of the economy with minerals by the entirety of operations of a State for influencing supply of minerals on its territory and beyond that. A European minerals policy can be defined as a policy to secure the demand and supply of the EU-economy with minerals by the entirety of operations of the European Union for influencing supply of minerals on its territory and beyond that (see Figure 1).

Thus, minerals policy is a cross-cutting topic and features many links to other branches of politics (sectoral policies). The concepts of minerals policy and other (related) policies involved need to be coherent for the reason that the former is part of these policies (and use their instruments). Examples of sectoral policies include (Figure 2):

- *Minerals planning policy*: encouraging exploration, identification and protection of deposits in context of land use planning
- *Research & Technology policy*: increasing efficiency of minerals and related products
- *Foreign policy*: diplomatic dialogue with non-member countries (of the European Union) setting objectives for trade and development policy
- *Trade policy*: securing access to minerals, for example through multilateral contracts
- *Development policy*: building capacities (e.g. cooperation of geological surveys) in non-member countries to support political stabilisation and access to minerals

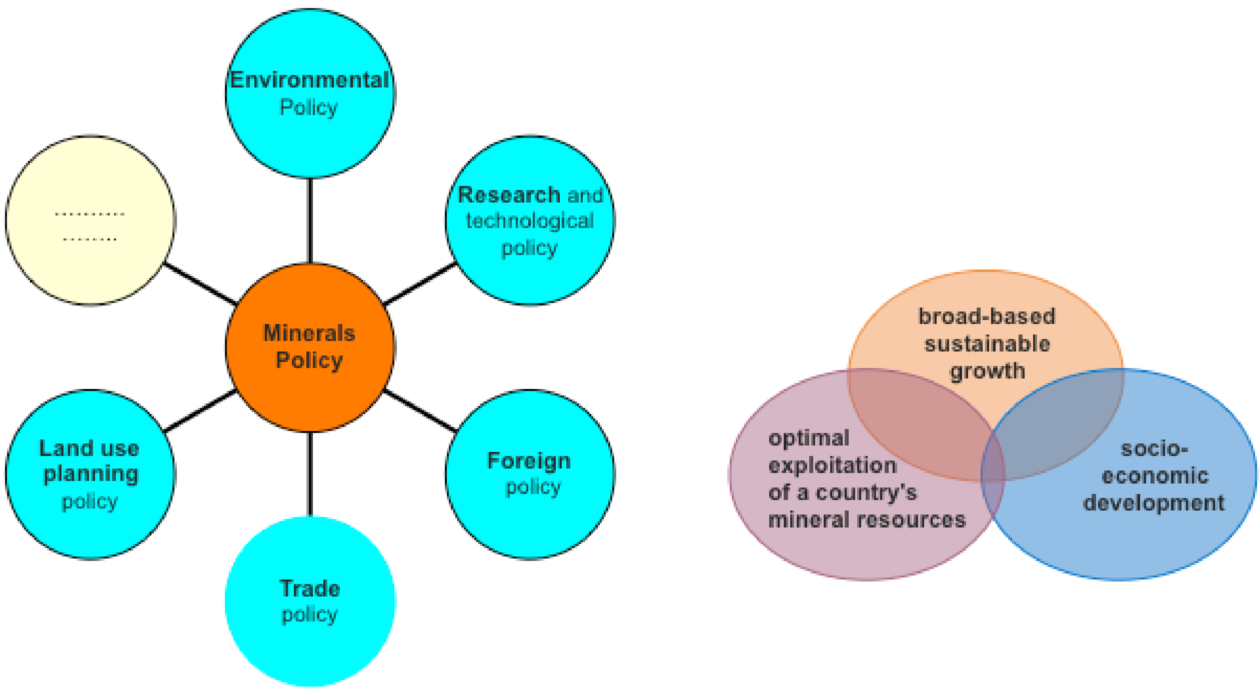


Figure 2: Minerals policy – a cross cutting subject.

Establishing a coherent minerals policy requires comprehensive and effective coordination and harmonisation between these separate policies. An isolated view of sectoral policies is counterproductive and will not result in a cost-effective contribution to the GDP of a state. This is the underlying reason for the creation of the RMI-MATRIX.

A minerals policy framework must be embedded in a general economic policy, so that individual aspects can be evaluated in a larger context (Enzer, 1981). An analysis of the mineral consumption to identify consumption behaviour is the starting point of any policy discussion (see Chapter 4).

A minerals policy needs to ensure that the domestic minerals economy (supply with minerals from domestic resources, internal supply) and the external minerals trade (external supply) contribute to the GDP of a state (or a confederation of states) at optimal cost. An active minerals policy implies encouraging an active mineral planning policy, i.e. exploration and protection of deposits in context of the land use planning. Clear regulations have to be established in order to secure access to minerals.

An active minerals policy also involves creating stable mineral rights and a favourable fiscal policy (for the entrepreneur). Thus both, access to minerals and investment protection for foreign and domestic investors are ensured. In summary, the state contributes to the creation of an appropriate minerals policy framework (Figure 3) for the protection and exploitation of its domestic mineral resources (*internal aspect*) and the access to mineral resources needed from countries outside the state (*external aspect*) – in the sense of a cost-effective input to the gross domestic product.

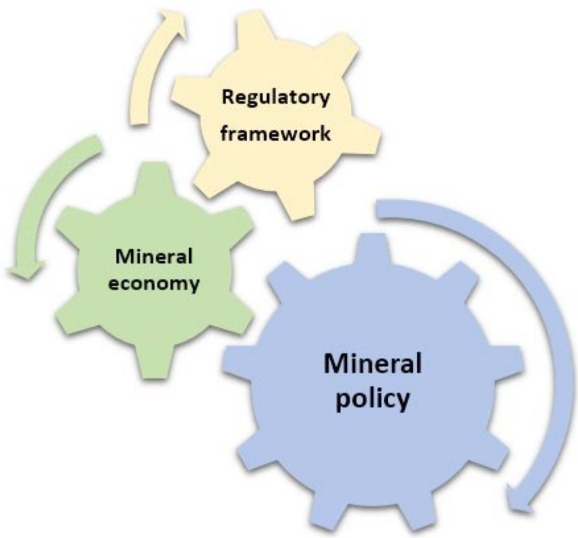


Figure 3: Close interlocking of minerals policy, mineral economy and regulatory framework (e.g. mining law).

2.2 Minerals policy versus market economy

Even though providing the economy with minerals (and base materials) is primarily the task of private business (Linden, 1997), there are essential reasons for the state to supervise it. Production and consumption of minerals yields serious external consequences, including environmental ones. Minerals are a product that is processed by many economic sectors, which influences all real assets. In other words: the real value of minerals in the value-added process of a national economy is crucial.

Enterprises can externalise the economic costs of supply disturbances (e.g. by reducing the number of staff employed), but for micro-economic reasons they may not be willing to finance preventive measures at the corresponding volume of economic costs.

The access to domestic and foreign mineral resources requires long-term planning. Because of the high research and capital expenditure involved and uncertain chances of success the readiness to assume risk is rather limited at some businesses. Due to the high costs of investigations and the, at the beginning, often hardly assessable chances of success they are on average afflicted with greater risks than investments in other economic sectors. Therefore, such investigations, if they are of public interest, should be supported by the state in order to give an incentive for the businesses to realise their projects. The measures of minerals policy should be set, above all, where the probability and extent of the risks would without public commitment result in unfavourable effects for the economy not only in quantitative, but also in price aspect.

2.3 Aspects of minerals supply security

The ‘classic initial position’ can roughly be characterised as interplay between three supply conceptions:

1) a mainly protectionist policy in line with the national interests;
2) a policy geared to a liberal world trade;
3) a policy influenced by companies (Wellmer & Hennig, 2003) concerned with minerals, international mining companies in particular (industrial policy) (Boettcher, 2003).

This means that the policy of a state can be opposed by the policy of an individual enterprise. The three fundamental objectives of an individual enterprise are:

1) maximisation of profit;
2) securing economic survival, and
3) expansion (Brandstätter, 1988).

Securing the supply with minerals is manifested in a comprehensive system of rules and complex interrelations (interactions) between different stakeholders (e.g. political instances) that are able to determine the situation and the behaviour of contractors and consumers. The entirety of these rules / measures can be structured into (Michaelis, 1976):

- decision-makers, i.e. governments, international organisations, as well as private enterprises;
- the **(RMI) tools** for implementation of these measures, namely as a branch of politics (e.g. trade policy) and definite instruments (e.g. custom duties);
- the products concerned and / or aimed at (i.e. here metallic, minerals, and construction minerals).

Furthermore, one has to distinguished between the internal and external (i.e. outside of state) economic context (cf. also the pillars of the EC Raw Materials Initiative).

Internal Policy Options – For mineral importing countries (such as the USA, Japan, or the EU) the main objective of a national minerals policy is to secure the supply of minerals. A published, clearly defined national policy is a very useful regulatory tool that serves two important functions (Figure 4):

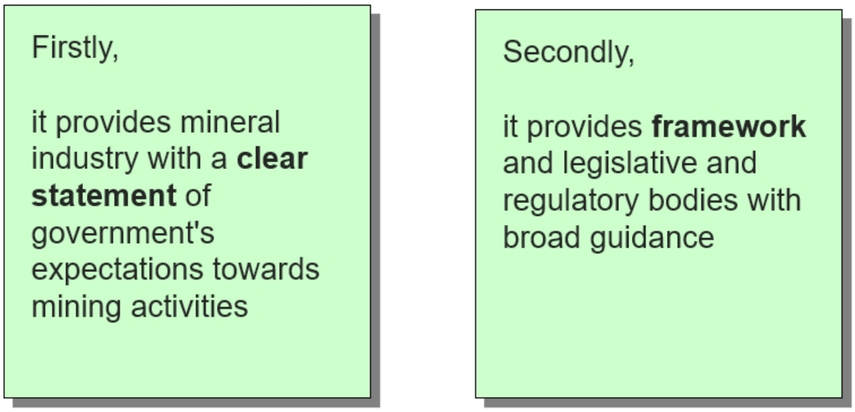


Figure 4: Internal policy options.

National minerals policies are supported by

- land-use planning policies that encourage a minerals planning policy, i.e. exploration and protection of deposits in context of the land-use planning
- research and technological policies that aim to increase the efficiency of minerals, products and minerals.

External Policy Options - include

- Foreign policies based on diplomatic dialogues with non-member countries setting objectives of trade and development policy, and
- Trade policies aimed at securing access to minerals from non-member countries, for example, through multi-lateral contracts.

A *realistic* minerals policy must take into account the basic geological and economic facts as well the internal / external conditions. The quantity of mineral resources currently accessible in the earth's crust is limited, minerals are non-renewable natural resources, and the regional distribution of the known mineral deposits is uneven. Many developed nations (e.g. Germany, Figure 5) need to source mineral raw materials from all over the world. Appropriate RMI tools are needed to identify and secure the supply of mineral resources.

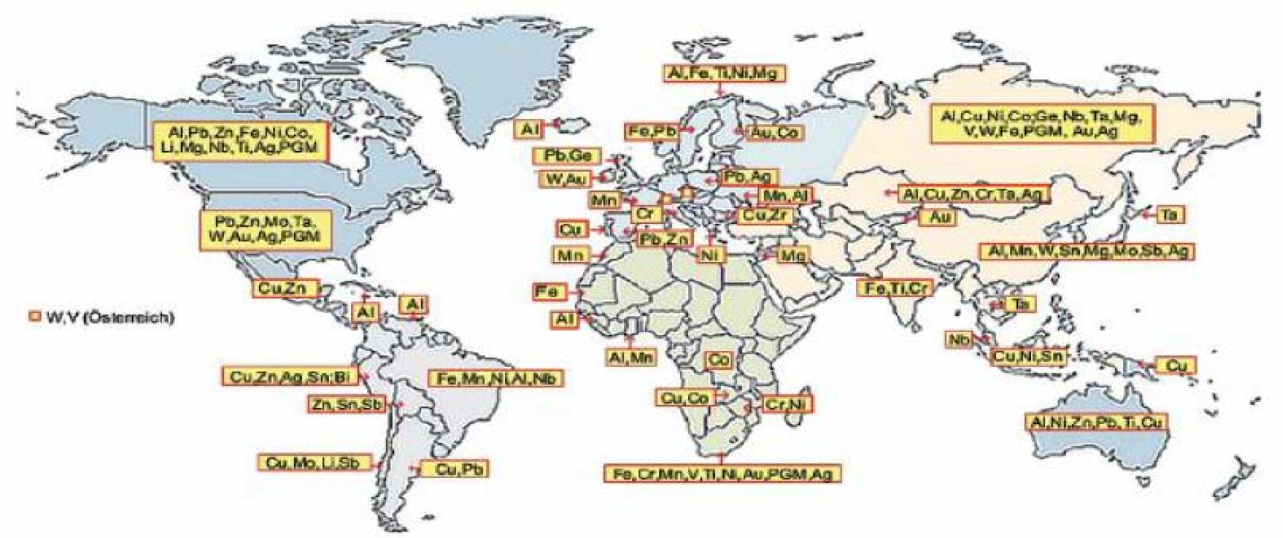


Figure 5: German metallic minerals import (source: BDI, 2007).

2.4 Scoping of RMI versus minerals policy

Within a minerals policy the following points should be made clear:

- the particular role of the state and the private sector
- the main focus of minerals policies
- the institutions (stakeholders) relevant for minerals policies ('sectoral policies')
- interconnectedness of sectoral policies (interactions).

The exploration, production, processing, and transport to the final consumer and furthermore the market-relevant operations, are subject to complex developments. Also, the numerous interferences of this topic with the interests of nature and environmental protection, as well as the land use conflicts are to be considered. First, it is important to map these interactions (Figure 6).

Securing supply with minerals for the European economy requires an interdisciplinary and/or interdepartmental approach. Such approach will take into account the complexity of the subject of 'minerals'. Thereby the following questions arise:

- Which *functions / tasks* (e.g. exploration and exploitation of deposits) are to be assigned to which stakeholders (e.g. geological surveys, ministries of economics)?
- Which *interactions* take place between the stakeholders?
- How can interactions result in *synergy effects*?
- Which RMI-tools are needed?
- How can a comprehensive minerals policy framework be established for the control and coordination of these interactions?

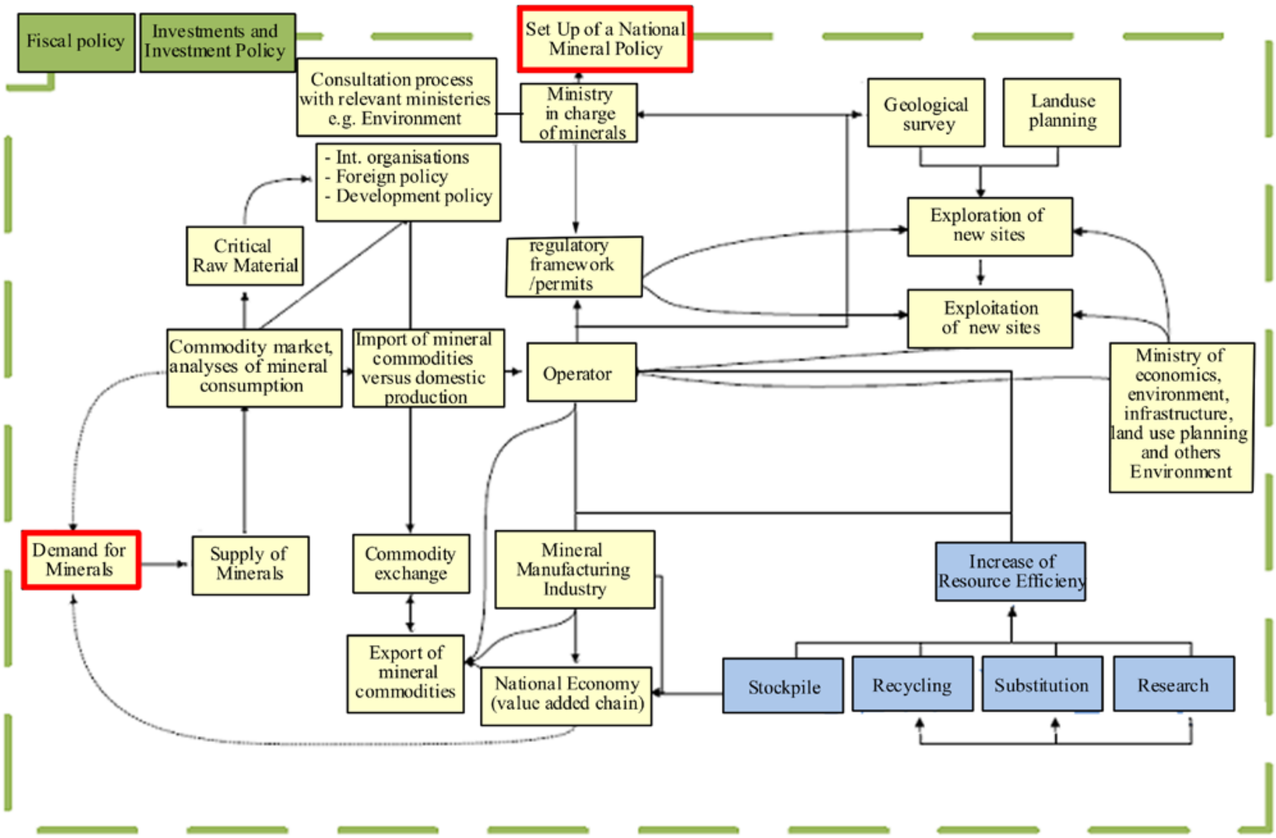


Figure 6: Mechanism of minerals policy framework (Tiess, 2011, adapted 2017).

With regard to the RMI-context it is important to consider the following:

- ***Mineral resources consumption*** (MC) – the need for minerals comes from the state / people. An important indicator is GDP, the grade of industrialisation and structuring of a state. (economy). > comprehensive analyses required, identification of historical, future MC trends;
- ***Detailed analysis of minerals needs (including value chain)*** – which would be supported by material flow analyses.
- ***Forecasts for a state's demand for minerals –*** forecasts can be made on the basis of the data collected and developments in recent years as well as international trends on the market.
- ***Minerals balance and market analyses*** – identification of domestic mining (resources / reserves) potential, production and imports; including global mineral market; to identify balances and options for securing mineral supply. Reliable statistical data sets are essential; collection of data may be carried out by the state/companies (controlled by law) or external institutions (e.g. BGS, USGS).
- ***Mineral imports*** – those minerals that cannot be produced in sufficient quantities to meet domestic demand of the state's economy have to be imported. To the contrary, semi-finished and/or finished products of the manufacturing industry including (imported) minerals can be exported. Minerals imports ought to be covered in statistics.
- ***Identification of critical minerals*** – criteria for criticality include:
  - o import difficulties (high price, not available in sufficient amounts)
  - o extraction of minerals limited to few countries, insecure or unstable political situation

- strategic minerals important for domestic (and export) industry available only in small amounts world-wide

The following stakeholders (Figure 7; see also Erdmann et al., 2016) can fulfil different tasks relevant for minerals policy and therefore have a share in securing minerals supply. Co-ordinating these interactions takes a precise strategy and coherent conception.

Figure 7: Stakeholders relevant for minerals policies for instance mining related stakeholders (Source: Christmann, 2008).

Internal (to the EU, a country) stakeholders can contribute to the following policy-building areas:

Analysis of Mineral Consumption (production, import, export of mineral commodities including the value chain) – Statistical offices, ministries of economy, etc.

Identification of mineral resource potential – Geological surveys play an important role within mineral planning policies. They issue mineral maps, information and in some countries they are directly involved in prospection and exploration. On the other hand, today it is common to bring-in exploration companies from abroad to explore domestic deposits, which then may be developed and exploited by domestic as well as international companies.

Land-use planning – **T**he competent authorities play a special role. Deposits are location-bound and exhaustible, which is particularly important when determining priorities in land-use planning, if several uses of a certain open space are up for discussion. Thus, spatial planning should not only guarantee a well-planned long-term reservation of mining areas, but also a comprehensive balancing of mining and other kinds of use. Relevant information about the deposit needs to be integrated into spatial structuring (cf. the project MINATURA2020, www.minatura2020.eu).

Mining industry (of a country) – Its interest is the production and/or import for supplying the economy (e.g. copper mining in a state, import of copper ore / concentrates to have sufficient copper for the (copper) economy). The minerals produced in a state may also be exported. Customs duties are collected equal to imports. The extraction of domestic deposits is carried out by one or several enterprises. Domestic minerals may not always find use on the domestic market and thus may also be exported. The mineral producers usually are the counterpart to the ministry or department responsible for minerals and may form a syndicate to collectively cooperate with governmental authorities and conduct an efficient and cost-effective as well as environmentally sustainable mineral production. The mined or imported minerals are sold to the domestic processing industry (e.g. steel and cement industry). The processing industry is an essential part of the national value-adding chain and considerably contributes to the GDP of a country. Securing the supply with minerals for the processing industry is elementary.

Mining and minerals governance – Checking and controlling the mining companies is an essential task of the ministry responsible for minerals; especially awarding and securing mineral rights for entrepreneurs (investment protection, access to minerals). The relevant legal basis provides for the granting procedures. Additionally, several aspects of environmental law are relevant for the businesses. Mineral producers are obliged to acquire a mining license, go through different (licensing) procedures and provide the authorities with various evidence and verification that concern the exploration of deposits, the technical feasibility of exploitation, the exploitation itself, closure of the operation and future use of the mine site.

Environmental policies – The extraction and processing of minerals in general is very energy-intensive and there is a high risk of pollution / harmful effects on the environment (ecosystems, biodiversity, climate change). Thus this is subject to energy and environmental law. For the exploration and extraction of minerals the ministry of the environment (or equivalent) is the competent authority. To minimize the effects of mining on the environment an in-depth review of mining projects by the regulator is needed. Although environmental restrictions might result in numerous problems for the mining industry (inefficient processes, mining prohibitions), environmental legislation is fundamental for sustainable development.

Research and innovation policies – They play an important role in assuring mineral supply security, especially for the reduction of mineral imports. Minerals imports are undesirable for a number of reasons including volatile prices, strategic distortion of markets by certain states, or due to exposure to political instability. R&I can contribute to an increase in domestic production in the following ways:

- Increasing resource efficiency through research for improved geological exploration and mining options (e.g. deeper deposits, maritime mining) as well as processing;
- Enhancement of energy and materials efficiency;
- Research in the field of minerals substitution;
- Research in the field of minerals recycling and re-use.

Relevant research can be undertaken by universities and academies as well as by private or public institutions. Adequate basic conditions for the training of specialists are of great significance.

Fiscal policies – They concern taxes and duties to which mineral producers are liable. These may apply to different stages of the exploitation and value chain, including the granting of mineral rights, sales of produced minerals, etc. Fiscal policies are one of the most critical elements in business decisions on investment. A 'smart' fiscal policy would take into account the whole value chain of minerals.

External (to the EU, to a country) stakeholders may influence decisions on a state's minerals policy in various ways, e.g. through:

International organisations – Various international organisations (e.g. WTO, World Bank, OECD, UN) and 'fora' (e.g. World Economic Forum, World Resources Forum, the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development) are concerned with mineral supply policies. Broadly, the role of these organisations is the building of international cooperation and networking structures, and in this sense also the consultation of businesses and nations concerning the development of a sustainable and efficient dimensioning of mineral imports. International organisations not only monitor the trade in mineral commodities, but may also support or implement development projects with a view to enhance the sustainable supply of minerals.

Foreign policy – Apart from foreign security policy and cultural policy the ministry of foreign affairs (unless a separate ministry of trade is responsible) plays an important role in foreign trade policy. Its task is the establishment of bi- or multilateral foreign trade relations, a common trade policy and the promotion of exports. The foreign ministry furthermore is important for development policy. It also has to be considered that the supply with minerals implies external activities (import of strategic minerals), which are carried out late or are badly coordinated without a foresighted minerals policy. The biggest part of the global mineral production comes from politically unstable countries, which is reason enough to study the problems of mineral supply within a national or European foreign and safety policy. Foreign policy can make use of various instruments to broach the issue of minerals and steer against a distortion of trade and competition: bilateral discussion of the foreign minister and state secretaries, bilateral and regional summit talks, bilateral mixed commissions and partnership and cooperation agreements.

Development policies – Since development policy contributes to economic and politic development of developing countries rich in minerals the stability of these countries might increase. This can lead to the extraction of minerals which then are available to the global market and whose revenues at the same time support the development of the producing country. Apart from this comprehensive task in development policy it should further contribute to the development of partnering countries and Europe's minerals security.

3. Circular Economy Paradigms and Resource Efficiency Scenarios

3.1 Implications and limitations of the Circular Economy Paradigm

Raw Materials Intelligence not only concerns virgin mineral raw materials, but also those that may be recovered from previous applications. Re-utilising materials that are already in the anthroposphere, rather than returning them as waste to the geosphere could be attractive for a number of reasons and also reduce the import dependency of the European economy. For this reason calls to make the European Union economy more ‘circular’ have been voiced.

The three basic tenets of the circular economy paradigm are utilising resources efficiently, limiting final (unrecoverable) waste disposal, and reducing losses of valuable material. These three tenets are imbedded into a wider socio-economic context at local, regional, national, and global level. While the three tenets at first sight appear obvious from an economic perspective, this context explains why we commonly deviate from them. Each stage in the life-cycle of a material has various costs associated with them. These costs can be monetary, social, or other, and can be internalised or not in the final product or service price. When for a given cost/price framework dropping, partially or wholly, one or more of the three tenets is cheaper than maintaining it, (short-term) economic wisdom would call for a less circular economy. While energy is a cost factor and, therefore, would be automatically included in this discussion, the associated carbon-footprint of the various energy conversion systems adds an additional dimension to the problem. Thus, one could add a fourth tenet that would call for a minimisation of life-cycle carbon emissions of the use of particular materials.

One has to keep in mind that for thermodynamic reasons no process, including recycling, can be 100% efficient. A considerable amount of our materials’ use is dissipative (EEA, 2016); resulting in losses to the environment or rendering the materials in a form that will require a considerable amount of energy to e.g. re-concentrate them. Figure 8 is a point in case, showing that in spite of a recycling efficiency in order of 90% over time an exponential loss of material in the anthroposphere occurs that will need to be replenished. Another example is corrosion losses of metals during normal use, e.g. in rusting cars that have to be made up by virgin iron, even, if all cars would be 100% recycled. Thus there will be always systemic losses that have to be replaced by mining of virgin materials. It is also logic, that an economic paradigm that is built on growth requires more materials being brought into the anthroposphere, including more minerals being mined. Visions for a circular economy try to overcome this development (EMAF, 2015; EEA, 2016).

As pointed out above, focusing on particular aspects of the life-cycle can be counterproductive, as it does not consider all risks and costs that may arise over the life-cycle and may overlook risk-displacement effects. Therefore, while a circular economy should be a guiding paradigm, costs and benefits need to be adequately balanced. For instance, from an environmental perspective, it would not make sense to travel by car for several kilometres to dispose of glass in a glass-bank. Such things, however, happen, when recycling is promoted without considering other environmental and economic costs within a relevant socio-economic setting. Full life-cycle cost-benefit analyses are required, when promoting changes in behaviour, such as recycling. In particular, energy costs have to be balanced against resources conservation interests. Often cost-benefit analyses for recycling options are based on micro-economic assessment, rather than on a macro-economic assessment that aims at a national or global scale optimisation. In fact, often recycling options are proposed that optimise only over single factors, such as GHG-emissions or minimisation of certain minerals uses, rather than taking a broader systemic view.

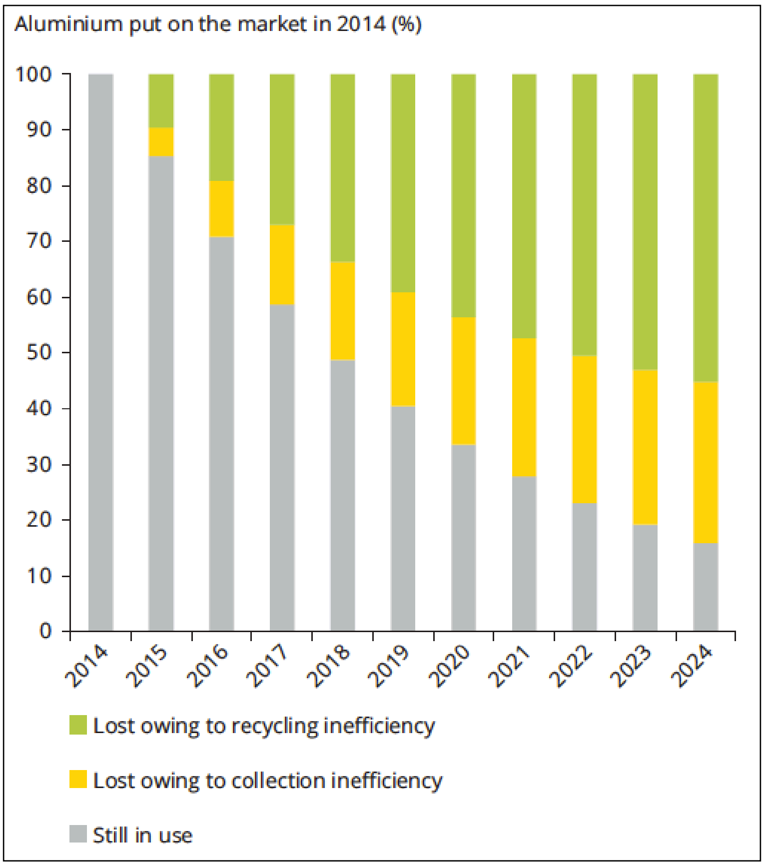


Figure 8: The cumulative loss of aluminium from the hard packaging cycle in Flanders over time (EEA, 2016).

It also remains an open political, philosophical, and ethical question to what extent policies of circular economy could and should be enforced or fostered through economic incentives (tax rebates or subventions). By coercing industry and consumers towards certain behaviours, we slowly move towards planned economies. If planning was 100% efficient and could foresee all stakeholder behaviours, such economy could be very efficient in terms of resource use. However, historical examples have shown this to be rather hubristic and even counterproductive. A discussion of these issues is beyond the remit of this report.

Historically, recycling of certain materials has been part of everyday life and industrial practice before energy became so cheap and industrial processes so effective that it became cheaper to use virgin materials. Today, recycling of certain materials has become common practice again and is widely accepted in many EU Member States. Recycling has also become a global business, some of which however transcends legal boundaries. A variety of recycling industries in emerging and developing countries are built on illegal waste exports from the European Union. The EU has attempted to bar this in the area of waste electrical and electronic equipment (WEEE) by the amended Directive 2012/19/EU (CEU, 2012). Stocks of copper, silver, gold, and other materials are leaving the EU economy in this way and require (part) replenishment by mining.

However, some concepts of bringing unused stocks within society and industry into use again (e.g. EC, 2015; EMAF, 2015) will have a profound impact on our life-styles, attitudes to material assets, and in consequence on social relations and definition of status within a society. These concepts can be summarised as a call to move from owning assets to renting or buying their services. It is again beyond the scope and remit of this report to muse about ways to implement such concepts and the probability of them becoming implemented in a world-wide context. While in certain Western world countries there may be enough build-up of socio-cultural pressure to make e.g. the ownership of individual cars a taboo, it is unlikely that this will happen among the fast-growing urban middle-classes in Asia, that already outnumber their peers in Europe and Northern America. Moving from owning to renting and mobilising unused stocks could have indeed significant impact on the need for virgin minerals being extracted and would entail deep socio-economic changes. While such changes could be envisioned for Europe and certain other developed nations, whether this would have a significant global impact in the longer would be questionable considering the fact that resources use is shifting more and more to Asia in particular.

3.2 Mine life-cycle in the context of the 'circular economy' paradigm

The discussion on resources efficiency has to be also embedded into an understanding of the life-cycle of mines in a real-world economic context. Mines are opened, when their output can be marketed economically and closed (or put on stand-by or care/maintenance), when this cannot be done anymore. Thus, a considerable number of mines close before their resources have become exhausted physically. From a technical and mine-safety point of view re-opening of such mines, which are often closed without a proper mothballing procedure and simply abandoned due to the lack of funds, is costly and/or very dangerous. In consequence, valuable resources become inaccessible. This may need to be considered already at the planning and permitting stage of a mine in order to not render the resource inaccessible at some stage (Golev & Lebre, 2016).

The wastes from extractive industries may hold a considerable potential for further utilisation. Given the fact that mining wastes actually represent a considerable investment in terms of labour and energy as well as a cost in terms of providing for their management, industry does have an interest in utilising such wastes in a profitable way. Whether a waste can be sold off successfully depends on a number of technical and economic factors. It requires the availability of a beneficial use and of a related market, which depends on the respective quality requirements. The cost of supplying this market has to be lower than the alternative waste management costs. The resulting price has to be competitive with other suppliers of the same material, be it virgin or also waste or recycled.

Scott et al. (2005) have identified four possible scenarios that could turn mining wastes into viable industrial products:

1) the waste becomes a bulk product for a local market with little or no further processing;

2) the waste is a low unit-value product and a cost-effective alternative source of a mineral for a local industry;
3) the waste is the source for an industrial mineral commodity, traded nationally or internationally;
4) the waste contains a high unit-value, rare mineral for which there is a high demand internationally.

Distance to potential markets and the associated energy cost for transporting particularly low unit-value wastes prevent their utilisation in many cases from both, a business economy point of view and for sustainability considerations. Bulk wastes, such as overburden or gangue may find it difficult to find a market that can absorb the arising quantities, though the materials may be of suitable quantity. Unless a particular mine waste is covered by one of the four scenarios, the life-cycle environmental impact assessment will speak against utilisation.

However, economic viabilities are determined by current prices and cost, and not by long-term strategic and resources conservation considerations. Today, policy makers and regulators face the dilemma of how far they can and want to interfere with the prevailing paradigm of a 'market' economy. While a comprehensive extraction and utilisation of all (metal) value from an ore would make sense in terms of conservation of resources and minimisation of extracted volumes, it could make a given mine or mill uneconomic in a given price and cost regime. Costs in this discussion would also have to consider indirect environmental costs, such as the CO_2-footprint. Making 'comprehensive' extraction mandatory in a regulatory regime for this reason likely would be counterproductive. It could be, however, formulated as a policy objective.

While 'comprehensive' extraction and utilisation of mining and milling wastes may not commercially viable at a given time, it would seem important from a strategic supply and resources conservation point of view to manage such wastes in a way that renders them accessible in the future. The experience from the rapid scientific and technological development over the past hundred years shows that it is difficult to predict, which elements from the periodic table or which mineral might become of interest in the future. Therefore, it would be difficult to predict, which elemental or which minerals content would warrant the wastes to be managed in a way to render them accessible for future use. Geochemical abundances and other measures of frequency of occurrence or scarcity may serve as guidance.

In order to facilitate the use of such potential resources for future generations, it may be of interest to policy makers and regulators to demand appropriate (chemical, mineralogical) analyses of the waste materials to be undertaken by the operator and deposited with a competent authority, such as the geological surveys or the EC-sponsored minerals databases currently under development – very much like the results of geological investigations, such as drill-core logs would deposited with the geological surveys. At the same time a three-dimensional map of the deposited material would facilitate later extraction. While segregation of different types of materials during deposition may be required in any case to avoid e.g. the generation of acid drainage, it would also facilitate later recovery and thus could be made mandatory (within operational constraints due to available storage space or potential environmental impacts).

Providing for the future accessibility of mining and milling wastes may entail the risk that less stable and long-term safe solutions have to be chosen. Thus, while back-filling in principle is the preferred option for such wastes, it generally makes them practically inaccessible for later extraction, due to the geotechnical risks of re-opening old mine works. Such risks have to be carefully balanced against resource conservation and re-use needs. It will have to be a case-by-case decision.

3.3 Towards more resource efficiency: POLFREE findings and scenarios

Overview

A recent EU Framework Programme 7 (FP7) project has explored policy mixes for the transition towards a more resource efficient and circular economy in Europe. POLFREE (Policy Options for a Resource Efficient Economy, www.polfree.eu) explored drivers and barriers for a resource-efficient economy in Europe. The project investigated why resources are being used inefficiently by different actors, proposed a policy mix for overcoming barriers and substantially increase resource efficiency and, through advanced modelling, draw different scenarios for a resource efficient Europe, based on different institutional settings.

Proposing new mixes for an ambitious resource policy requires a good understanding of the barriers and challenges faced by different actors when trying to behave more efficiently. Current patterns of resource use are complex and generally single factor explanations of inefficient resource use do not offer much mileage. Therefore, the first objective of POLFREE was to define a framework that could contribute to the understanding of the interactions of different dimensions, actors and system values underpinning resource use. The analysis showed that the concept of barrier may be misleading as it often implies that there is something that can be easily overcome and addressed by single policy instruments. Instead, the concept of resource use is depended on a variety of factors that act simultaneous and dynamically, in causal loops that provide stimuli but also barriers to more efficient behaviour. The concept of the 'web of constrains' (Dijk et al., 2013), developed in the project, helps to capture this complex and systemic interaction at different levels and draws the attention from specific barriers to systemic blocking.

This has implications from the point of view of policy making in the sense that policy instruments that do not address systemic interactions tend to have limited impact, therefore, rather than single policy instruments there is a need of policy mixes that are mindful to the web of constraints and aim to transform it into a 'web of drivers' or 'virtuous cycles'.

The analytical framework based on the web of constraints was applied to analyse barriers to resource efficiency from a number of different perspectives, including legislative and policy frameworks, business and organisations and consumers and citizens. The analysis suggested that although policies and instruments have been introduced to address some of impediments to efficient use of resources, such as the generation of waste, there has been a lack of consistency and integration between different areas and dimensions of policy making. The study also revealed that inconsistencies also happen within single policies. Following with the example for waste, policy priorities have shifted from incineration to recycling and, although in principle this change responds to resource efficiency considerations, it does not fully account for technological lock-ins across different treatment options. The analysis concluded that the multi-layer policy context is not an unequivocal push to increasing resource efficiency.

The review of the business barriers also pointed to complex dynamics between stimuli and impediments defining the framework conditions in which businesses operate. In general, businesses do not seem to see economic advantages of improving resource efficiency within their current product range (Diaz Lopez et al., 2014). Although there have been some success stories of companies that have made resource efficiency a core attribute of their business model, these tend to be the exemption rather than the rule, pointing to systemic blockings in the incentive system that drives business action. While many firms have adopted some form of corporate social responsibility (CSR), the links between this and improved resource efficiency are not always clear. The review of individual barriers to resource efficiency also shows a very complex picture, where consumers may have different motivations across different areas (transport, buildings, food) and may show inconsistent system of values and divergences between values and behaviour (Kammerlander et al., 2014).

The multiplicity of barriers and their complexity, given simultaneous interaction and dynamic behaviour, call for policy mixes that are coherent and consistent and reduce the number of trade-offs, while maximizing synergies across policies and instruments. Public intervention in this area derive its legitimacy from the existence of 'system failures' that explain inefficient use of resources by social and economic actors on the one hand and the increasing scientific evidence on the pressure put to ecosystem by human systems of production and consumption.

The need for policy mixes that tackle the multi-level and multi-aspect conditions of the resource efficiency challenge cannot be derived from just applying individual instruments but requires the careful selection and combination of several instruments or a 'policy mix', even more, considering the cross-cutting dimensions and wide variety of resources, as well as the often 'unintended consequences' of actions and policies in other fields. The policy mix needs to be mindful to the variety of resource types, actors, goals and structures as well as different stages of innovation to effectively address future challenges.

The policy mix proposed by POLFREE identified relevant policy fields where there is potential for untapped opportunities to increase resource efficiency. The proposed policy mix combined nine policy fields, represented by three innovative instruments that show greatest potential and which combined could induce a radical increase in resource efficiency (as shown in Table 1).

The analysis, however, also revealed that crosscutting approaches may tend to increase the role played by veto players. Resource efficiency, although generally framed as win-win, has been targeted by veto players and actors that generate income from the wasteful patterns of resource consumption. Therefore, the policy mix needed to rely on flanking instruments to re-allocate some of the cost savings and benefits from new business models to those who may be negatively affected.

Table 1: Policy mixes proposed by the POLFREE-project (Source: www.polfree.eu).

Phasing out environmental harmful subsidies	A comprehensive inventory of EHS in the EU
	Environmental Subsidy Controlling: The 'Environmental Check' for Subsidies
	Systematic phasing out of EHS
Internalisation of external costs	European-wide harmonisation and introduction of construction minerals taxes (incl. border tax adjustment) – Construction Minerals Directive
	TMR-based material input taxes
	LCA-based Value Added Taxes
Resource-efficient electricity production and distribution	Smart grids
	Effective levels of carbon taxation through changes in the ETS and carbon border adjustments
	Integrated micro-generating systems and through incentives and subsidies in industries and households accompanied with energy efficiency audits
Resource-efficient mobility	Strict CO_2 emission standards
	Vehicle and road tax
	Prioritising urban non-car infrastructure
Resource efficiency in the building sector	Landfill bans and landfill targets on C&D waste
	End of life of buildings and building passports
	Promoting 'co-housing alternatives' and living together through economic and planning instruments
Minimisation of food losses and waste	Resource efficiency across the supply chain – Supporting cooperation, capacity building and innovation
	Green Public Procurement
	Courtauld commitment of food waste prevention
Resource efficiency by product service systems	Awareness raising campaign about existence and advantages of PSSs
From waste disposal towards a resource-efficient circular economy	Individual producer responsibility
	Mandatory eco-design standards for reuse and repair-ability
	Waste targets for resource efficiency
Resource efficiency by industrial symbiosis	Landfill taxes, bans and end of waste criteria
	Pan-European network of industrial symbiosis programmes/ coordinating bodies
	Incorporating IS requirements in regional planning and activity permits

An important element in POLFREE was to use modelling to try to quantify whether, if at all, achieving a resource efficient economy in Europe was feasible and what would be the impacts of the implementation of the proposed policy mix. This required building a vision for a resource efficient Europe, based on policy and inspirational targets towards 2050. The vision included headline targets for:

- *Materials* – global raw material consumption (RMC) reduced to 5 t RMC/cap and no net additions to stock for EU;
- *Land* – cropland reduced to 0.17-0.20 ha/person or by 34-44% compared to 2005 and no net loss of cropland for the EU;
- *Water* – mean water footprint per capita reduced by 30-50% below 2004 levels and Water Exploitation Index EEA (2003) below 20% in all European Countries, and
- *Carbon* – mean carbon footprint per capita reduced by 60-80% below 2004 levels and greenhouse gas (GHG) emissions reduced by 80 to 95%, compared to 1990.

Based on the vision, three distinct policy scenarios were produced that had different underlying institutional setting. For each of the policy scenario the policy mix (Table 1) was adapted to reflect the likely choices under the parameters defined by the scenarios. The modelling compared the three distinct resource efficient, circular, low-carbon scenarios against a business-as-usual scenario (Business-as-usual (BaU), Table 2).

Table 2: POLFREE Scenarios at a glance (Source: www.polfree.eu/policybriefs).

1 Global Cooperation All countries co-operate through international agreements and harmonised economic and regulatory policy instruments to pursue decarbonisation and a resource-efficient global economy.
2 EU Goes Ahead The EU pursues the development of a low-carbon, resource-efficient economy unilaterally, through strong EU-level economic and regulatory policy instruments instituted by Member States. The rest of the world fails to increase existing ambition.
3 Civil Society Leads Civil society, NGOs and businesses drive resource-efficiency and decarbonisation through voluntary changes in preferences and behaviour. Policies are introduced to facilitate such changes.
4 Business-as-Usual (BaU) An increasing focus or ambition surrounding decarbonisation of resource efficiency in both EU and non-EU countries fails to materialise. This allows a comparative case against which conclusions surrounding the above scenarios may be drawn.

The modelling exercise combined two economic-environmental models, GINFORS (Lutz et al., 2010; GWS, n.d.) and EXIOMOD (Tukker et al., 2009; Tukker & Dietzenbacher, 2013), based on Environmentally Extended Global Multi Regional Input-Output models (EE-GMRIO, cf. www.wiod.org), with the bio-physical model LPJml (Bondeau et al., 2007; PIK, n.d.).

The main conclusion from the modelling exercise is that the business-as-usual scenario provides a gloomy picture for the global environment, but also for prosperity. While CO_2 emissions will more than double by 2050 (compared to 1990s levels), water stress and consumption of resources are expected to increase dramatically. In this scenario, Europe would experience declining, but still positive GDP growth rates, but also a loss of more than 30 million jobs.

In contrast, a global cooperation scenario would not only contribute to environmental targets to be achieved, but also with raising GDP growth and employment. This is achieved through a combination of economic instruments and regulation (see Table 3). In this scenario, CO_2 emissions peak in 2020 and then decrease to 2050 (by 2050 they are 11% lower compared to 1990s levels). Resource consumption also declines significantly by 13 Gt by 2050 compared to 2010 levels, despite population increasing. Global GDP is also consistently higher than in the BaU scenario (by 2050: +5.2%) and even better for Europe (by 2050: +8.2%).

If global cooperation cannot be achieved, substantial benefits remain, if Europe acts unilaterally to increase resource efficiency and circularity. In this scenario, although Europe meets its environmental targets, global emissions remain on a trajectory of a 4°C warming as non-European countries only pursue moderate climate policy objectives. In this scenario Europe takes advantage of being a first-mover and GDP growth is even stronger compared to the BaU (12.5% higher by 2050 compared to BaU), whilst employment increases by 3.5 million jobs. The policy mix under this scenario is similar to that of Global co-operation, with some adjustment to the design of taxation instruments that avoid problems of international competitiveness.

The modelling also shows that resource efficiency can be achieved through a post-consumerism movement led by civil society. This scenario assumes a decentralised, civil society-led change that leads to structural changes in the economy. In this scenario environmental targets are met, though GDP growth is close to zero by 2050. The scenario embraces 'beyond GDP' values, where different measures of progress are used. The impact on jobs is positive (with 9% increase in the number of jobs by 2050).

Table 3: The policy mix (main instruments).

Climate policy on the inputs of fossil fuels and has four pillars: • An upstream carbon tax for all industries, • A regulation of the share of renewables in electricity production, • A set of regulations and economic instruments favouring e-mobility and • Subsidies for investment in the energy efficiency of buildings.
Decoupling of economic development and the use of ores and non-metallic minerals is targeted by: • The regulation for recycling of ores and non-metallic minerals, • An upstream tax on ores and non-metallic minerals and • A public innovation fund for the material efficiency.
• Sustainable agricultural land and water use is targeted by: • A regulation for water abstraction of agriculture, • An information program to avoid food waste, • A tax on meat consumption and • An information program to reduce the yield gap in agriculture.
Additional tax revenues are used for a reduction of taxes on goods and services with low carbon and resource contents.

Key findings of POLFREE

Findings from POLFREE suggest that 'systemic blocking' explains current inefficient resource use patterns. Barriers to resource efficiency are multiple, happen across sectors and dimensions and are mutually interacting and dynamic. The concept of the 'web of constrains' can provide an analytical framing to the challenges of resource efficiency and underpin the development of consistent policy mix.

A policy mix in the area of resource efficiency needs to consider interaction between different types of resources, actors and dimensions of resource efficiency and also consider different levels of policy making. The policy mix proposed identifies a number of areas and instruments that show great potential to unveil opportunities to increase resource efficiency and help to achieve the targets outlined in the vision as well as flanking instruments that help in the transition. Without an ambitious and coherent policy mix, resource efficiency may only happen to a small scale or in niches and is unlikely to address current resource issues, even though it is generally considered as a win-win area.

The modelling of the policy scenarios provides three clear messages: 1) a business as usual scenario may have very negative implications for Europe not only in terms of environmental pressure but also of economic stagnation and loss of jobs; 2) any of the scenarios proposed, provides a substantial improvement to the BaU both, in terms of environmental goals, but also creation of wealth and jobs; 3) the scenarios provide different alternative options for Europe to become more resource efficient based on a very distinct institutional setting regarding European leadership, role of government and policy making and developing paradigms.

4. Model for development of minerals policy framework

4.1 Conceptual framework

In the following a basic model of a minerals policy framework is discussed that focuses on mineral supply security. A policy for securing the supply with minerals should establish a framework including objectives, strategies, action and monitoring plans. In general, the following minerals policy approach would be taken:

1 MAIN OBJECTIVE

- Sub-objectives / strategic objectives

2 MAIN STRATEGY

- Sub-strategies - In line with objectives

3 CONCEPTION + ACTION PLAN

- Implement objectives + strategies
    - Actions – In line with objectives and strategies

4 MONITORING PLAN

- Monitoring / assessment of policy implementation
- Review with respect to1+2

5 POLICY ADAPTION/REVISION

- Correction / revision of 1,2,3

4.2 Objectives and strategies of a minerals policy

The main responsibility of a minerals policy framework is guaranteeing an optimal, i.e. demand-oriented, cost-effective, timely and environment-friendly, supply of the economy with minerals as well as a fair intertemporal spreading of mineral reserves and in this sense a cost-optimal contribution to the GDP. In this respect the material consumption (MC) plays an important role (cf. Chapter 5).

A policy of supply with minerals has to pursue several competing, partly complementary and intersecting targets, and to decide priorities and emphases, whereby mid- and long-term supply perspectives are more important than short-term ones. Primarily relevant is a high security of supply to prevent endangering the economic growth of a state. The objective of ***security of supply*** refers to the demand for a timely, demand-oriented and qualitatively suitable allocation of minerals needed by the economy. This means that shortages in supply and long-term supply disruptions are to be minimised as far as possible.

A ***low-cost supply*** is relevant for increasing competitiveness. The objective of *economic effectiveness* serves the cost-effect supply with minerals including the creation and maintenance of fair competitive conditions for domestic producers. For this adequate rules and regulations are required. Importance is to be laid upon rational (i.e. resource efficient) use and consumption of minerals and in this sense protection of environment as far as possible.

Another significant topic is transparency in foreign policy. It should contribute to the improvement of trade relations with non-member countries of the European Union, also considering the needs of developing countries.

Objectives of national minerals policies vary widely reflecting the unique circumstances of each nation. Countries with few mineral resources, but requiring substantial mineral inputs – such as Japan, Korea, or Taiwan, will obviously emphasise objectives different from those of a mineral rich non-industrialised nation – such as Papua-New Guinea, New Caledonia, or the Democratic Republic of the Congo. Likewise, large mineral producers with substantial internal demand, such as Brazil, China, India, and the United States, have their own policy approaches (Otto, 1999).

Under consideration of the deposit potential and the mineral strategy of the state it has to be differentiated between mineral exporters and importers on macroeconomic level.[2]

4.3 Objectives of mineral exporting countries (African, Latin American countries)

The general economic policy and hence minerals policy objectives in mineral-rich developing countries are primarily geared towards economic growth (Daniel, 1990). The export of minerals is viewed as the basis for financing development, foreign exchange earnings help stabilise the national budget and contributing to investment programmes. Other objectives (Gocht, 1983) are:

- Diversification of mining production to reduce dependence on individual commodity markets (target: securing revenue).
- Securing of the domestic supply of minerals to avoid expenditures of foreign currency for imports (target: autarky).
- Use of the minerals sector for the development of rural areas by improving infrastructure and creating new jobs outside of urban areas (target: area development).
- Minimisation of environmental impacts in the production and processing of mineral resources (target: conservation of ecology).
- Protection of deposits from improper exploitation and premature abandonment (target: conservation of resources).
- Obtaining sovereign power of control over the natural resources (target: sovereignty) by state control of production and marketing (target: control), change of ownership structures (target: participation), or promotion of domestic cooperatives.

4.4 Objectives of mineral importing countries (such as EU, USA, Japan)

A principal goal of the importing industrialised countries is to ensure guaranteed supplies of minerals, whereas that of the importing developing countries, to obtain low prices.

- Domestic economic aspect: Independence from mineral suppliers. Maintaining and improving domestic mineral economy as far as economically justified. Optimizing intensity and kind of exploration and extraction of domestic minerals as well as the coordination of domestic

[2] Minerals exporters are Australia and Canada; increasingly emerging countries, such as Indonesia, Jamaica, but also developing countries, such as Tanzania and Uganda. Raw material importers are, e.g., the EU, Japan, but also China.

producers and consumers. Promoting domestic mineral production by supporting mineral exploration programs, subsidizing domestic mining companies and stimulating R&D in the field of substitution possibilities.

- Developing new technologies to enhance the rational and efficient utilisation of minerals. Enhancing the recycling and re-use, especially of scrap metal. Minimizing the environmental impact of the extraction and processing of minerals.
- Promoting international cooperation between industrial countries and mineral producing countries for the development of new deposits, the transfer of modern but adapted extraction technologies.
- Foreign trade aspect: Guaranteeing the supply of minerals through international mining investments, participation in mining projects abroad, concluding long-term supply contracts or cooperation agreements and diversifying supply sources. Aiming for cost-effective supply to maintain the industry's competitiveness.

Security of mineral supply implies (amongst others) minimising economic costs of mineral imports as well as maximising profit from domestic mineral extraction and processing. These two objectives need to be balanced in order to avoid shortages of supply and support competitiveness of domestic mining. Adequate strategies, measures / activities and a coherent conception are required.

4.5 Minerals policy strategy

A strategy is a planned long-term aspiration for an advantageous situation or goal. It aims at the appropriate use of certain means, generally referring to some subordinate objective. Strategy is the 'greater plan' or a 'basic pattern of actions'.

Once the objectives, i.e. securing for a state the minerals supply, are set and the starting point is clear, the basic conditions for programming measures which promise to achieve the objectives are given (Molitor, 2006). This is the central step in the economic political decision-making process. Basis of the pertinent analysis are the stringent procedural relations between the means and the objective, as derived from the general economic theory according to the principle of cause and effect. The highest level of success in achieving the objectives has to be determined by comparison of possible alternatives. Often the optimal measure is a 'programme' that uses various means chronologically graduated (economic political strategy) (Molitor, 2006).

The general economic political and therefore mineral political objectives of most minerals **exporters** are mainly growth-oriented. The strategies for achieving the objectives aim at activities for exploring new deposits through the promotion of prospection and exploration activities (Gocht, 2006). This affects development policy, Geological Surveys and international mining companies. Furthermore, the establishing of an attractive investment / fiscal policy (mainly for foreign investors) should be mentioned.

4.6 Strategies regarding mineral importers

Security of supply for mineral importers can be realized through: **Domestic economic strategies**, i.e. mineral *planning* strategies and strategies concerning the *acquisition and usage of* minerals, through diversification of sources, optimal use of domestic resources, development of cost-saving processing technology and the promotion of recycling and substitution. **Foreign economic strategies,** i.e. strategies for the legal and political coverage of the acquisition of minerals for the

- maintenance of a permissive international mineral trade and money transfer,
- attainment of cooperation structures between industrial countries poor in minerals and mineral exporting developing countries, for setting up international cooperation structures between geological surveys and research institutions (Gocht, 2006).

Mineral strategies worth mentioning are pursued by the USA, Russia, Japan and China (see below).

4.7 Instruments of minerals policy

The instruments for regulations and measures for securing supply with minerals are extensive. Instruments for the implementation of mineral political objectives of a state are as diverse as the objectives themselves, ranging from market observation to public enterprises (Gocht et a.l, 1988). According to the sort of instruments and the objectives set, the following categories of *interventions* can be distinguished (Michaelis, 1976):

a) ***Domestic economic interventions with intended primary effects on domestic production and processing***
Subsidiaries, tax relieves, cut-rate loans, loan guarantees, transport subsidies, absorption of deficits by the tax authorities etc., promotive valorisation, guarantees for domestic disposal, buying up or funding storage of surplus goods;

b) ***Domestic economic interventions with the intended primary effect of secured provision or rational use of minerals***
- Protection of deposits based on land use planning (mineral planning policy)
- Recycling of minerals
- Measures aiming at rational use of minerals in production
- Measures restricting consumption of minerals and goods produced thereof

c) ***Foreign economic interventions with intended primary effects on domestic production and processing***
Import restrictions – customs duties and import levies, import quotas, tariff quotas and other quantitative restrictions, other non-tariff barriers;
Measures promoting export – Export facilitation through subsidiaries, particularly export refunds, cut-rate loans, promotive exchange rates, etc.;
Building up of strategic reserves

d) ***Foreign-trade interventions of the consumer countries to ensure access to certain minerals.***
Interventions of mineral producing countries for encouragement of the domestic resource economy and the promotion of their products including:
- Royalties, export duties and similar,
- Production and export restrictions, 'buffer stocks' and similar,
- Measures for the promotion of vertical diversification,
- Indexing of price,
- Producers' alliances in terms of cartel agreements on prices or quantitative restrictions,

- Nationalisation of extraction licenses, minerals occurrences and extraction, processing and transport facilities;

e) ***Interventions by consuming countries to improve access to minerals and processed products in mineral producing countries*** *(both as a unilateral action of one or more consuming countries, and because of agreements):*
   - Measures for the liberalisation of global commodity markets,
   - Autonomous customs duty suspensions and import benefits (subventions, cut-rate loans, etc.),
   - Simplifying monetary transactions,
   - Creating multilateral financial plans,
   - Cooperation with Geological Surveys,
   - Promoting storage of minerals liable to supply problems,
   - Promoting initiatives for the development and the extraction of minerals in producing countries and for the transport of these minerals,
   - Long-term agreements on the supply with minerals,
   - Bilateral agreements on trade and cooperation with developing and state-trading countries,
   - 'Production sharing' with developing and state-trading countries, international minerals agreements involving both producing and consuming countries,
   - Pooling of co-businesses,
   - Possibly a global adjustment with developing countries on the distribution of activities concerning processing and transport of minerals.

4.8 Mineral (policy) action plans

For the implementation of goals, strategies (and measures) an adequate conception ('*action plan'*) is needed. A conception is a comprehensive compilation of objectives and subsequent strategies and measures for the realisation of a higher goal. It includes all the information needed as well as time, measures and resources plans. Conceptions are usually put into writing and should be checked for relevance and topicality regularly. The conception must be developed including all component policies relevant for the topic of minerals and the interactions between them. These interactions need to be reasonable, especially for decision-makers. Time and measure plans have to determine at which point which measures have to be taken. Due to the complexity of the topic and various correlations between the policies this is particularly important. The implementation of such conception requires an effective consultation process of the different function owners (e.g. geological survey), where basic conditions such as deposits potential, minerals criticality or the degree of industrialisation of a state are to be considered. Two international examples are given below, i.e. Philippines and Sierra Leone.

Philippines

After a 9-month engagement process, the 'National Policy Agenda on Revitalizing Mining in the Philippines' (Executive Order [EO] No. 270) was issued in 2004 (**Department of Environment and Natural Resources, 2004**) and amended (2012). It contained 12 guiding principles for responsible mining towards sustainable development. It also called for the formulation of a Minerals Action Plan (MAP) which **will detail the strategies and activities for the attainment of the goals** of EO No. 270. There are **12 Guiding principles of EO 270:**

Economic principles

1. Recognition of the critical role of investments in the minerals industry in support of national development and poverty alleviation goals;

2. Provision of clear, stable and predictable investment and regulatory policies to facilitate investments;
3. Development of downstream industries or value-adding of minerals;
4. Support to small-scale mining in order to rationalize their activities;
5. Adoption of efficient technologies to ensure judicious extraction and optimum utilisation of non-renewable mineral resources;

Environmental principles

6. Protection of the environment in every stage of mining operations;
7. Safeguarding the ecological integrity of areas affected by mining;
8. Pursuing mining within the framework of multiple land use;
9. Rehabilitation of abandoned mines;

Social principles

10. Ensuring the equitable of benefits among direct stakeholders;
11. Sustained information, education and communication ((IEC) programs and respect for the rights of the indigenous people and communities; and
12. Continuous and meaningful consultations with stakeholders.

Minerals Action Plan ***(MAP)***

The Minerals Action Plan was formulated by the **Department of Environment and Natural Resources** in *consultation with other government agencies and stakeholders* and approved by the President thru Memorandum Circular No. 67 of 2004. MAP contains 57 strategies and 126 activities to address the problems of mining. It is an *on-going implementation*, with regular review of status and accomplishments with various sectors of civil society.

Sierra Leone

The main objectives of the *Core Minerals policy* of Sierra Leone are (Ministry of Mineral Resources, 2003):

- Review and amend the Mining Law, Regulations and Associated Laws to make them as attractive as possible for investment here rather than in neighbouring countries with similar mineral potential.
- Strengthen the Institutions that administer, regulate and monitor the mineral industry in Sierra Leone to allow the mining industry, especially with respect to the diamond industry to be turned around to become a positive for Sierra Leone;
- Develop and Strengthen Human Resources in the Minerals Sector.
- Attract Private Investments into the Minerals Sector. Encourage private investment to use the implementation of the *Kimberley Process* as a positive at the forefront of selling diamonds for peace and development properly registered by the Kimberley Process;
- Ensure that Sierra Leone's Mineral Wealth supports National Economic and Social Development
- Improve the Regulation and Efficiency of Artisanal and Small-Scale Mines
- Minimise and Mitigate the Adverse Impact of Mining Operations on Health, Communities and the Environment.
- Promote Improved Employment Practices, Encourage Participation of Women in the Mineral Sector and Prevent the Employment of Children in Mines.
- Add Value to Mineral Products and Facilitate Trading Opportunities for Mined Products.
- Improve the Welfare and Benefits of the Individuals and Communities Participating in and Affected by Mining.

Actions

The implementation of the objectives and strategies considered under the Core Minerals policy requires *good partnership among* the Government, private sector, civil society and international organisations. The strategy and objectives outlined in the policy will determine the activities that will be integrated into a comprehensive programme for the development of the minerals sector in Sierra Leone. Implementation of the Core Minerals policy will ensure the exploitation of mineral resources in the national interest and will bring improved economic and social benefits for the people of Sierra Leone (Figure 9).

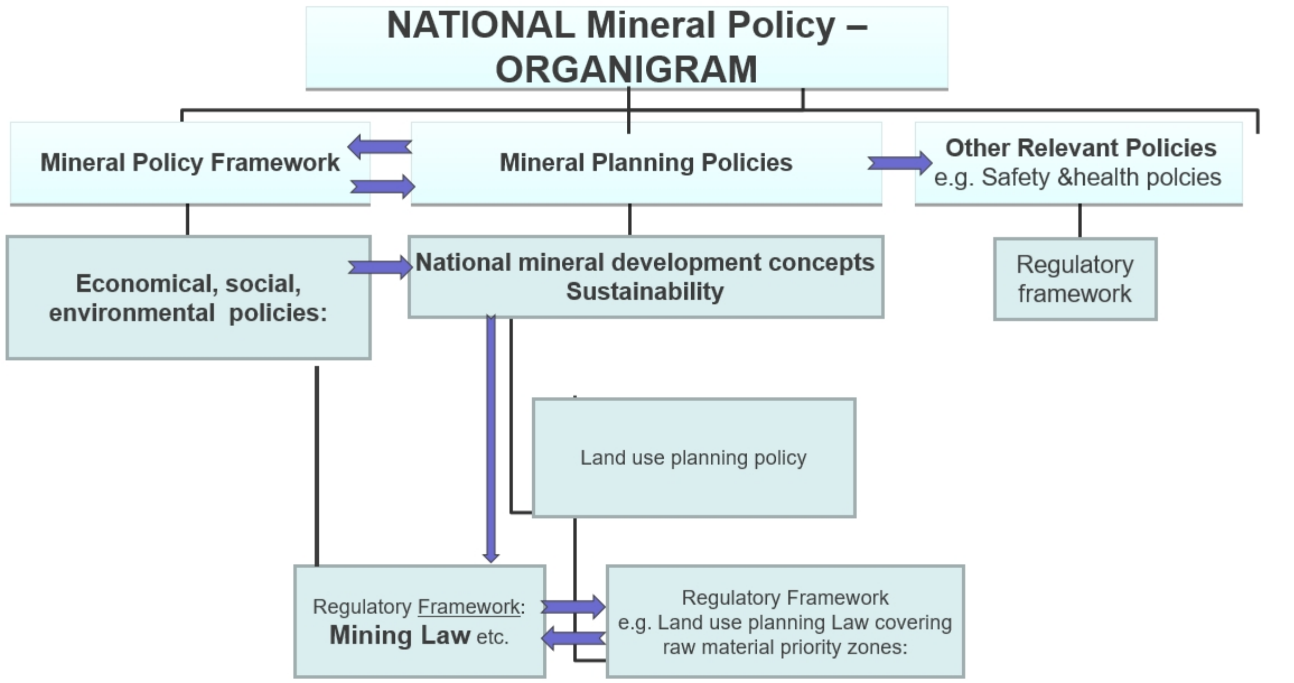


Figure 9: Sierra Leone's national minerals policy – organigram (original).

5. Tools and methods in the context of minerals policies

5.1 General

Mineral models of economy development are of special importance for the identification of the minerals policy strategy of a country's mineral consumption behaviour. Any minerals policy framework development must be based on a detailed analysis of minerals consumption including supply / demand scenarios (Figure 10).

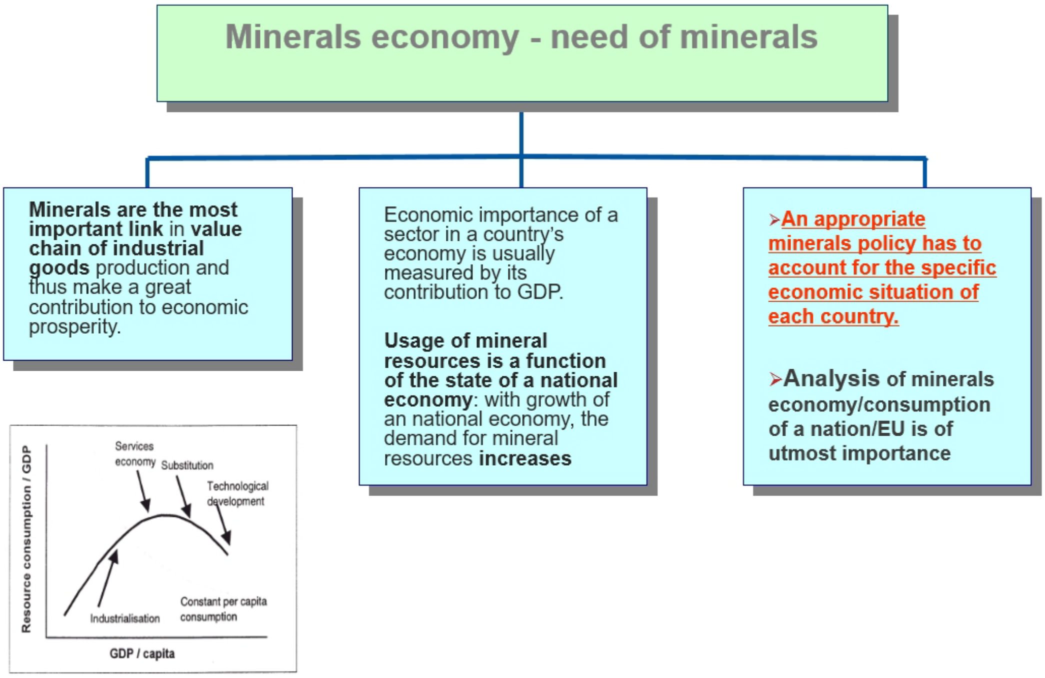
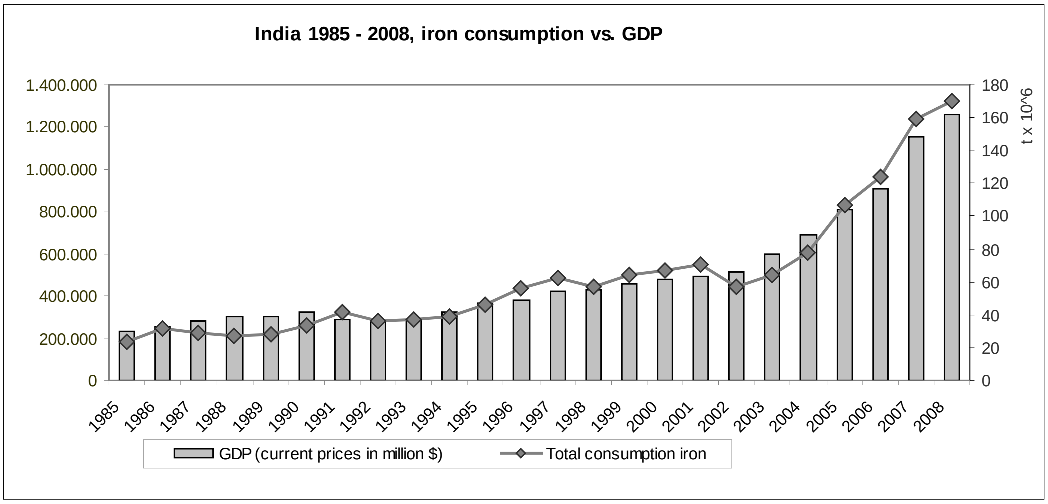


Figure 10: Mineral economy versus minerals policy.

The mineral consumption of a state is closely linked to its industrial goods production. This applies to construction, industrial, and metallic minerals. Since minerals serve goods production, economic performance forms an essential determining factor of mineral demand (Nötstaller, 2000). The demand for minerals is basically determined by global economic growth, changes of industrial structure, mineral price, and technological changes (Tilton, 1992).

As noted before, it is measured by the GDP or the gross national product (GNP). Simplified it can be said that, the better the economic performance of a country, the higher its demand for minerals. The extent of the GDP depends on the population size and their per-capita income (e.g. World Bank, 2016). At the same time, the per-capita income indicates a country's level of development, as well as the productivity and the level of prosperity of the population. Accordingly, there is a tight correlation between the per-capita income and the specific mineral demand (Nötstaller, 2003a).

This correlation is predominantly positive, making mineral demand dependent on the income (Nötstaller, 2003a). It also causes a high specific need for minerals and energy. This is why predictions (or forecasts) for future demand are based on several indicators, such as the ratio of energy and metal consumption to the extent of the GDP of a country (Gocht, 1983). Industrial countries with a high GDP tend to consume more than developing countries with a low GDP. Partially, a significant dependency can be observed (Figure 11).



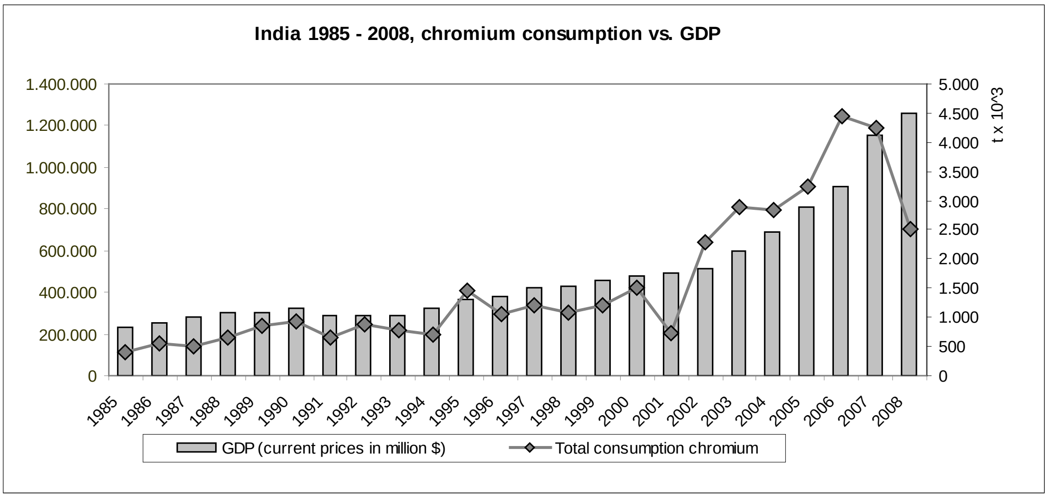


Figure 11: Iron and chromium consumption in India 1985 – 2008 versus GDP (data from BGS, 2010).

In advanced economies, the increasing service sector (tertiary sector) causes a *gradual decoupling* of economic growth and consumption of some minerals (Nötstaller & Wagner, 2007, p. 384). Figure 12 illustrates the (basic) relation of mineral consumption (metallic, industrial and construction minerals) to GDP, which was examined in several ways, especially by Van Vuuren et al. (1999). This relation is of fundamental importance for the RMI-policy discussion.

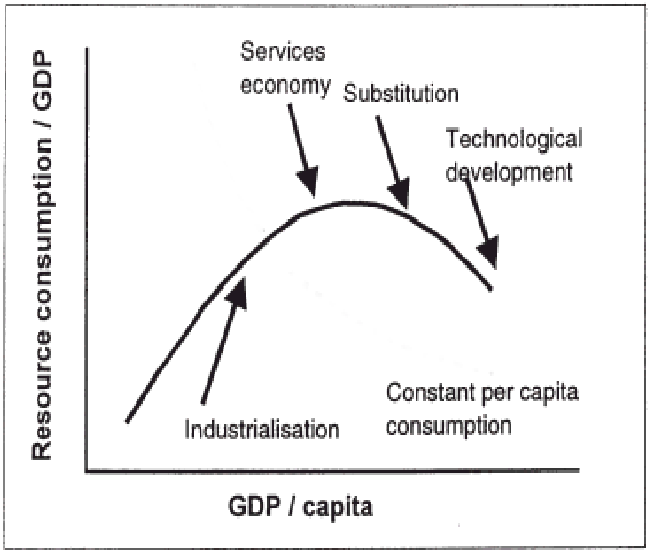


Figure 12: Relation of (mineral) resource consumption and GDP (Van Vuuren et al., 1999).

To further illustrate this, two EU-Member States, Germany and Bulgaria, are compared: Germany as an EU-founding Member in 2008 had a GDP of US$ 44.181 per capita, while Bulgaria, a former Comecon member country that joined the EU in 2007 in 2008 had a GDP of only US$ 6.825 per capita. The German economy requires substantial amounts of 'high-tech' metals, such as rare earths, lithium, titanium, PGMs, in contrast to Bulgaria. Germany also utilises a highly diversified metallic mineral mix, whereas the Bulgarian minerals mix is much less diversified (Tiess, 2011). Germany imports large quantities of basic metallic minerals that are mainly used for added-value products for export purposes. Germany in 2008 was the 7th world largest producer of iron and steel (USGS, 2010) and has several smelter and refinery facilities for copper, lead and zinc; also considerable amounts of steel, aluminium, nickel, copper, tin, and zinc scrap are imported, but there is no domestic mining anymore. Bulgaria has refineries for copper, lead and zinc, but unlike Germany it also mines some of these metals. Bulgaria imports steel, copper, aluminium, zinc, and PGMs scrap. Hence, Bulgaria, due to its GDP, would be in Phase I, while Germany has arrived in Phase III a long time ago (illustrated in Figure 19, page 56).

The relationship between economic development and aggregate demand is shown for France in Figure 13. Up to the year 2000 there was a good correlation between economic development and aggregate demand. From 2000 onwards economic development and aggregate demand was largely decoupled, perhaps because a certain saturation of infrastructure needs was reached. Similar trends have been found for other highly developed countries as well.

Mineral consumption determines (structures and establishes) mineral markets. The encounter of suppliers and consumers for the trading of goods is characteristic for a market. The relation between demand and supply is essential for the formation of prices; the amount of exchanged goods and the extent of profits are regulated by the market price (Klump, 2006, p. 46). Mineral markets are real assets markets. Strictly speaking, there are separate markets for many minerals depending on level of exploitation and quality.

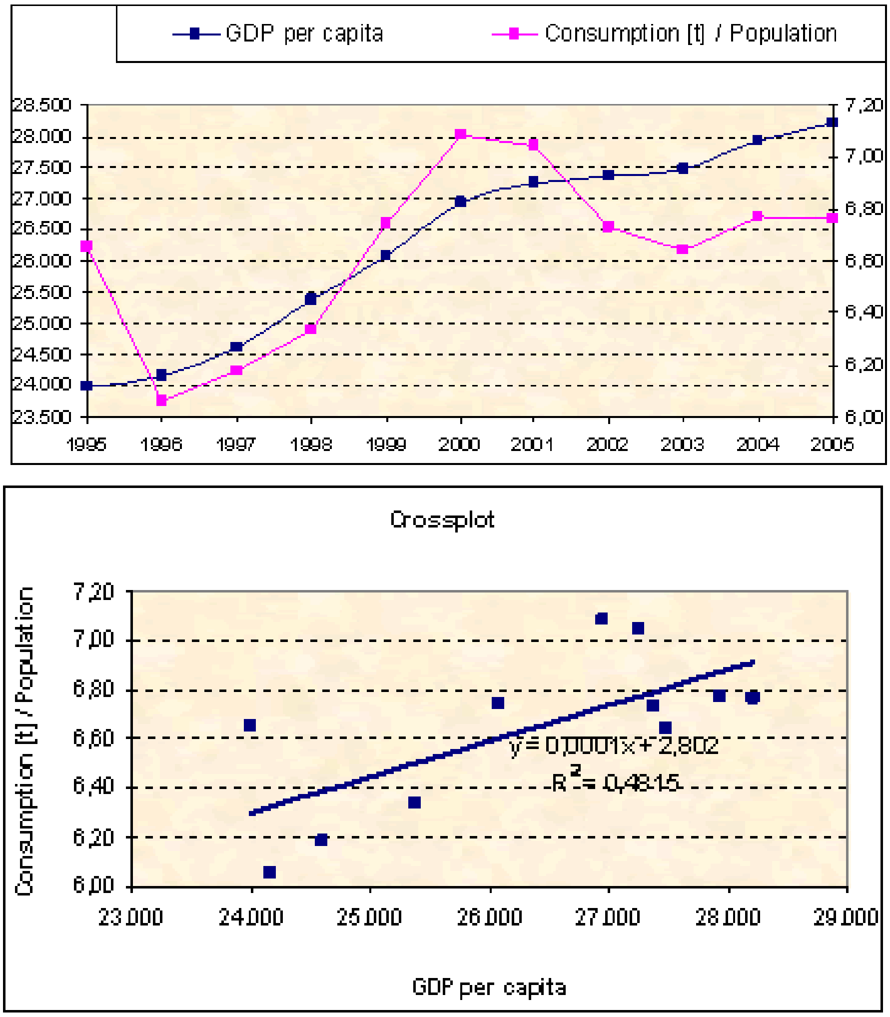


Figure 13: Aggregates consumption/GDP in France (Department of Mineral Resources and Petroleum Engineering, 2010).

Markets for metallic minerals are considered world markets because of their good merchantability. The structure of a market is mainly determined by the dispositions of the market participants. Regarding geological and mining conditions, these are limited for mineral producers.

A critical question when morphologically analysing markets is which minimum market share is sufficient to achieve significant market influence (and therefore, price influence) or even market dominance (and, therefore, price setting). This share is market-specific and conforms to the competitive situation or to the feasibility of substituting the mineral. Since the supply elasticity as a function of market prices for minerals is almost always low, the threshold for a market dominating share is relatively low as well, often only around 30 or 40% of the total production. Thus, with the presence of only one bulk producer, monopolistic market structures may already exist.

5.2 Models of mineral consumption versus policies

The basic model, which is minerals consumption of a country equals production + imports – exports, is reflected in Equation 5.1.

Equation 5.1:

$$M_C = M_{PR} + M_I - M_E - M_W$$

Where M_C = minerals consumed; M_{PR} = production of primary and secondary minerals (recycling); M_{PR} = $M_{PR(PRIM)}$ + $M_{PR(SEC)}$; M_I = minerals imported; M_E = minerals exported; M_W = Minerals going to waste, i.e. non-recoverable.

The analysis of Equation 5.1 allows the following conclusions:

(1) M_C < M_{PR}, i.e. M_C is less than its output, then the country' economy is mainly oriented towards the development of mineral mining and exports and, as a rule it is characterised by the absence of significant mineral imports. Thus, the mineral model of mining and export oriented economy can be described by Equation 5.2:

Equation 5.2:

$$M_C = M_{PR} - M_E - M_W$$

This equation is also applicable at a local scale, as illustrated in Figure 14. In this respect, it is important to distinguish between consumption and production, as well as between internal and external aggregates supply (cf. Equation 5.1). Planning has to distinguish between internal (local /regional) and external (inter-regional, trans-regional) supply of aggregates. A minerals (planning) policy framework should take into account internal and external aggregates supply and provide the aggregates industry with the necessary support, e.g. access to land, and relevant information such as on transport logistics.

(2) M_C > M_{PR}, when domestic output M_{PR} is not sufficient to meet the demand M_C, which is the case for many of the consumption-oriented economies, including those of Europe, Japan, and USA, but increasingly so even for emerging economies such as China and India (at least for certain minerals). The latter have been previously primarily export oriented countries. This is characterised by the highest possible domestic output M_{PR}, substantial imports M_I (e.g. as illustrated by Figure 15), all possible reduction of waste M_W, and a broad-scale application of recycling technologies i.e. re-utilisation and maximising of $M_{PR(SEC)}$. The economic relation can be described by Equation 5.3:

Equation 5.3:

$$M_C = M_{PR} + M_R + M_I - M_W$$

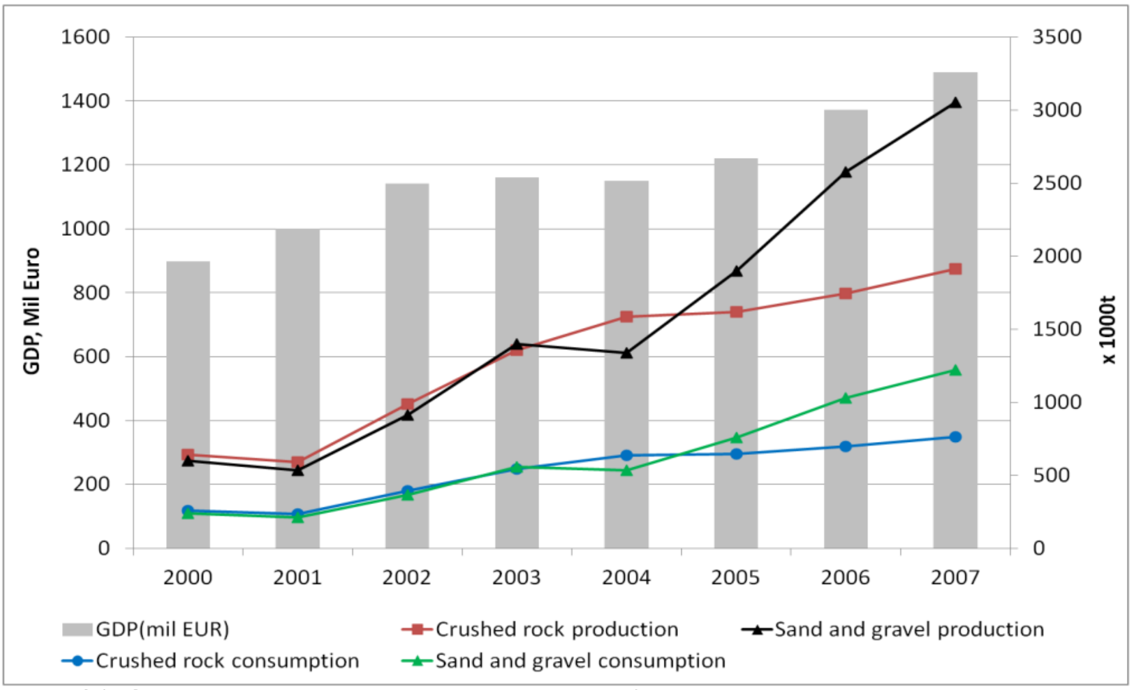


Figure 14: GDP per capita, production and consumption for the Varaždinska and Međimurska counties of Croatia between 2000 and 2007. Aggregates market analysis. Approx. 60% of the produced aggregates in the region Varaždin are exported to other, surrounding counties; the region supplies the capital of Croatia, Zagreb, with approx. 30% of the aggregates needed for the building sector (Source: Department of Mineral resources and Petroleum Engineering, 2011).

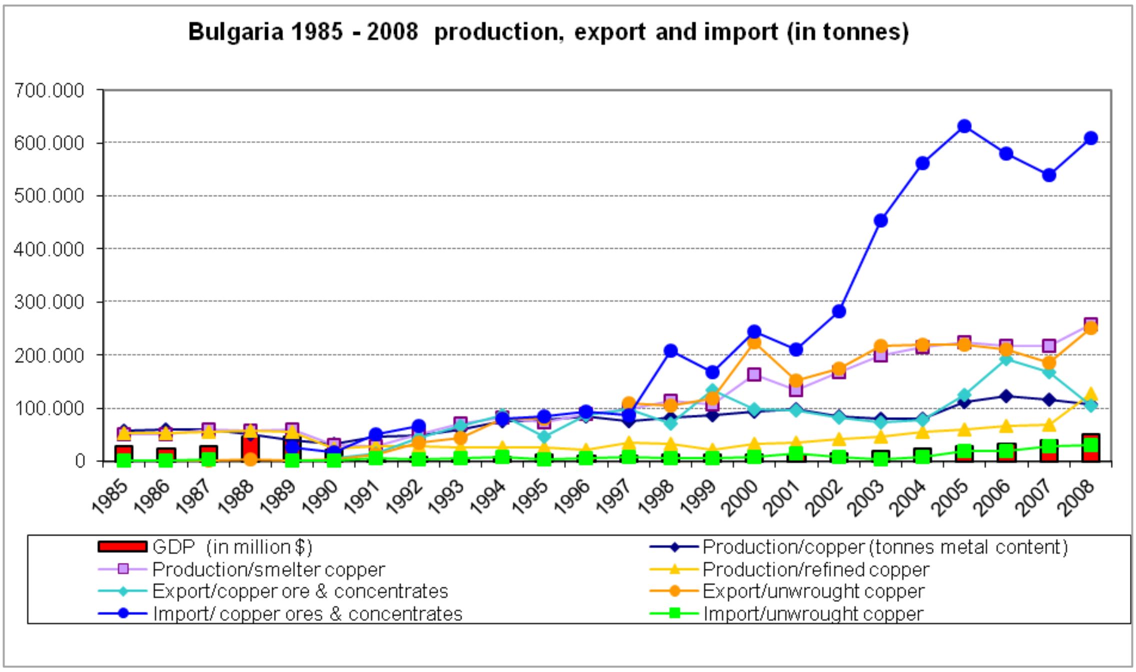


Figure 15: Copper production and consumption in Bulgaria (data from BGS, 2010); even being the second largest producer of EU-27, Bulgaria still requires a lot of imports.

(3) $M_{PR} \approx M_C$ is a model where material consumption (MC) is nearly balanced by domestic production M_{PR} consumption. This type of economy can be identified as one with an adequate mineral supply and demand ratio, in other words, as a well-balanced economy. Presumably, it can be viewed as an efficient economy of a country and can be described by the complete version of Equation 5.1, i.e. all components of the mineral economy work efficiently: the economy is characterised both by and adequate primary production $M_{PR(PRIM)}$ as well as efficient recycling ($M_{PR(SEC)}$) and little going to waste, i.e. minimisation of M_W. It can be shown that a move towards this ideal option would be a mineral- and resource-efficiency oriented way for the development of a country's economy possessing large mineral resources.

However, an economy with a balanced mineral supply and demand ratio is quite unrealistic in the near future for most Western World countries, because of the issue of existing resources/ reserves versus the actual mineral raw materials mix required. Table 4 illustrates this point by the raw material mix required by the Romanian economy.

In addition, the type of minerals consumed in a country ('mineral raw material mix') is changing during the economic development a country is undergoing. For infrastructure development, basic metallic minerals and aggregates are of primary importance. At later stages of development (shifting from industrialisation to services economy), other minerals are gaining more importance. Apart from a constant basic supply, countries promoting high-tech products, such as hybrid cars or electronic devices, are in need of a different range of minerals. Romania is not using high tech metals at this point (no imports / production of vanadium, lithium, platinum group metals) because the development of the industry has not reached that stage yet. With the increase in GDP and the development of the industry though, it is expected that the need for such high-tech metals would arise. It can be seen there is significant import dependence. Due to the restructuring phase and phasing out of mining, most of the metallic minerals production decreased significantly or even ceased entirely. Domestic production of iron ore ceased in 2007, which resulted in a total reliance on imported minerals. No active exploration was undertaken during this time period. In turn, the imports of metallic minerals (ores and concentrates) and related commodities increased (Marinescu et al., 2013).

(4) $M_C = M_{PR(SEC)}$ which is the final scenario envisaged by the paradigm of a 'circular economy'. The vision is that the intensive development of recycling technologies and efficiency in collecting wastes would result in gradual satisfying the mineral demands of the economy with mineral commodities. This would be the situation when in Equation 5.1 all other variables tend towards 0, or imports balance exports for the same commodity. However, theoretically no processes can be 100% efficient, some losses will always occur, i.e. M_W never can be 0. The collection of obsolete products will never be 100% efficient, recycling processes will always be associated with some losses, the separation of some metals in alloys may too energy intensive, etc. In addition, in a (world) economy that is constantly growing, obviously not all demands could be satisfied by recycling. The respective deficits in M_{PR} with respect to M_C have to be, therefore, made up by primary production $M_{PR(PRIM)}$.

Table 4: Metallic minerals: production/mining – import – export of commodities in Romania (Source: BGS, 2012 [European Mineral Statistics]).

Commodity	Production/mining	Import	Export
Metallic minerals/products			
Iron	pi, cr, fa	ore, pi, fa, s	pi, fa, s
Chromium		oc, m	
Cobalt			
Manganese	ore	oc	since 2006
Molybdenum			
Nickel		u	
Tantalum			
Titanium		tm, m, o	
Tungsten		m	
Vanadium			
Aluminium	a, pa	a, ah, u, s	a, o, ua,s
Antimony		m, o	
Arsenic			
Bauxite		x	x
Bismuth	mi		
Cadmium	mi		
Copper	mi, sm, ref	u, s	oc, mat, u, s
Gallium			
Lead	ref	oc, u	oc, u, s
Lithium			
Mercury		x	
Rare-earth		rec	
Tin		u	
Zinc	mi, sz	oc, u	oc, u, s
Gold	mi		
PMG			
Industrial minerals / products			
Barytes		x	
Bentonite	mi	x	x
Diatomite		x	
Diamond			
Feldspar	mi	x	x
Fluorspar		x	
Gypsum	mi	cr, ca	cr, ca
Graphite		x	
Kaoline	mi	x	
Magnesite		me, ma	ma
Perlite			
Potash		sul, chl	
Phosphate rock		x	
Salt	mi	x	
Sulfur	rec	x	x
Talc	mi	x	
Cement	cf	cc, pc	cc, pc

a = alumina, ah = alumina hydrate, cr = crude steel, fa = ferro alloys, m = metal, mat = matte and cement, o = oxide, oc = ores and concentrates, pa = primary aluminium, pi = pig iron, rec = rare earth compounds, ref = , refined s = scrap, sm = smelter, sz = slap zinc, tm = titanium minerals , u = unwrought, ua = unwrought alloys
ca = calcined, cc = cement clinker, chl = chloride, cr = crude, pc = portland cement
x = imports and exports

Concerning the issue of recycling industrial minerals there are still many knowledge gaps. For instance, with respect to the situation of metallic minerals, compare the data for metallic scrap in Table 4 (import-export of scrap of different metals by different countries and their production). The importance of recycling is not covered comprehensively in minerals policy frameworks (see Chapter 3.3). Apart from that any minerals policy framework would need to cover primary and secondary minerals equally (which means to treat both categories equally) which was underlined in Tiess & Kriz (2011a).

Nevertheless recycling is gaining more and more in importance (Prillhofer *et al*., 2008). Of the three sub-sectors i.e. metallic minerals, industrial minerals and construction minerals, metals provide the highest potential for recycling, i.e. scrap utilisation (Hagelücken, 2013). The degree of recycling for some materials amounts up to about 40-60% and thus is relevant for European countries. Recycled lead (e.g. from car batteries), for example, accounts for around 60% of lead consumption in the EU (Tiess, 2011). Some end-of-life products, such as aluminium beverage cans, achieve in some countries even recycling rates close to 100% (http://recycling.world-aluminium.org/review/quality-value.html). Direct recycling of industrial minerals often is not feasible since the mineral forms an intrinsic part of the end-use application. However, there may be exceptions, when economically beneficial, as may be the case for recycling of magnesite materials (Tiess, 2011). Prices for recycled minerals have developed similar to of primary minerals over the last few years. For both, ferrous and non-ferrous scrap metals there have been *de facto* shortages resulting in drastic price increases and market distortions, for instance for steel scrap. The worldwide trade in ferrous scrap metal has expanded considerably (cf. Table 4). Because of the durability of steel products, however, the supply of scrap metal cannot keep pace with demand, which means that the already tight market for scrap metal is set to expand continuously. The amount of materials available through recycling is also determined by the length of the life-cycle of the products they are use in. Metals contained within articles with a short life and high recovery rates (e.g. beverage cans) may be able to satisfy more of the demand, than those present in longer lived articles. A challenge will be the management of (access to) dormant reservoirs.

5.3 Correlation between GDP and minerals consumption

Higher economic productivity necessarily results in higher (mineral) resources consumption. It is interesting to observe, how primary ($M_{PR(PRIM)}$) and secondary ($M_{PR(SEC)}$) correlate with the GDP. It is further interesting to investigate how the consumption of different types of (mineral) raw materials correlate with the development of the GDP in different countries along their trajectory of economic development. This can be illustrated, for instance, by looking at the European aggregates consumption (Figure 16; Department of Mineral Resources and Petroleum Engineering, 2010). The regression analysis in Figure 17 indicates a logarithmic relationship between GDP and aggregates consumption.

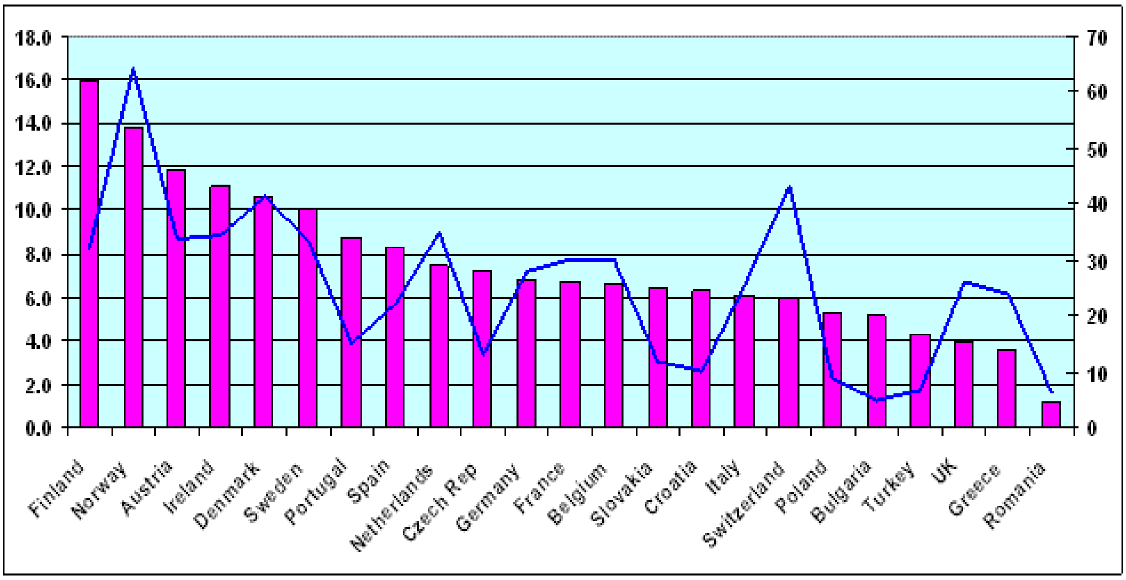


Figure 16: Aggregates production in 2008 in Europe. Blue line, left y-axis: tonnes/capita; magenta columns, right y-axis) GDP(€000)/capita (Source: Department of Mineral Resources and Petroleum Engineering, 2010).

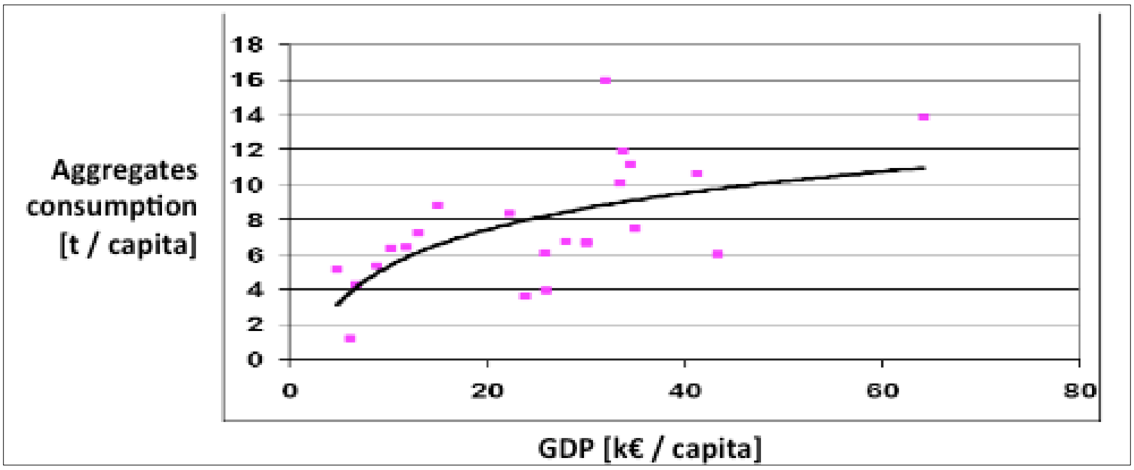


Figure 17: Regression analysis of the data presented in Figure 16.(Source: Department of Mineral Resources and Petroleum Engineering, 2010).

Usage of aggregates is a function of the state of an economy of a country. As an economy grows, i.e. the development of infrastructure is progressing, the demand for aggregates increases as well, as they are essential for infrastructural development and commercial and domestic building activities. In highly developed economies, the demand for aggregates stabilises at a high level. At a European level, the linkage between economic development and aggregate consumption is critically dependent on the large differences in the stage of economic development of the different countries. Since the rate of economic development of the new Member States of EU is considerably higher than that of the old Member States, aggregate consumption in Europe will grow substantially in the former over the medium term. This is further illustrated by the relationship between the economic development and aggregate consumption in three of the newer Member States of the EU, namely the Czech Republic, Slovakia and Slovenia. For all three there is a direct linkage between economic growth (GDP per capita) and aggregate demand (Figure 18).

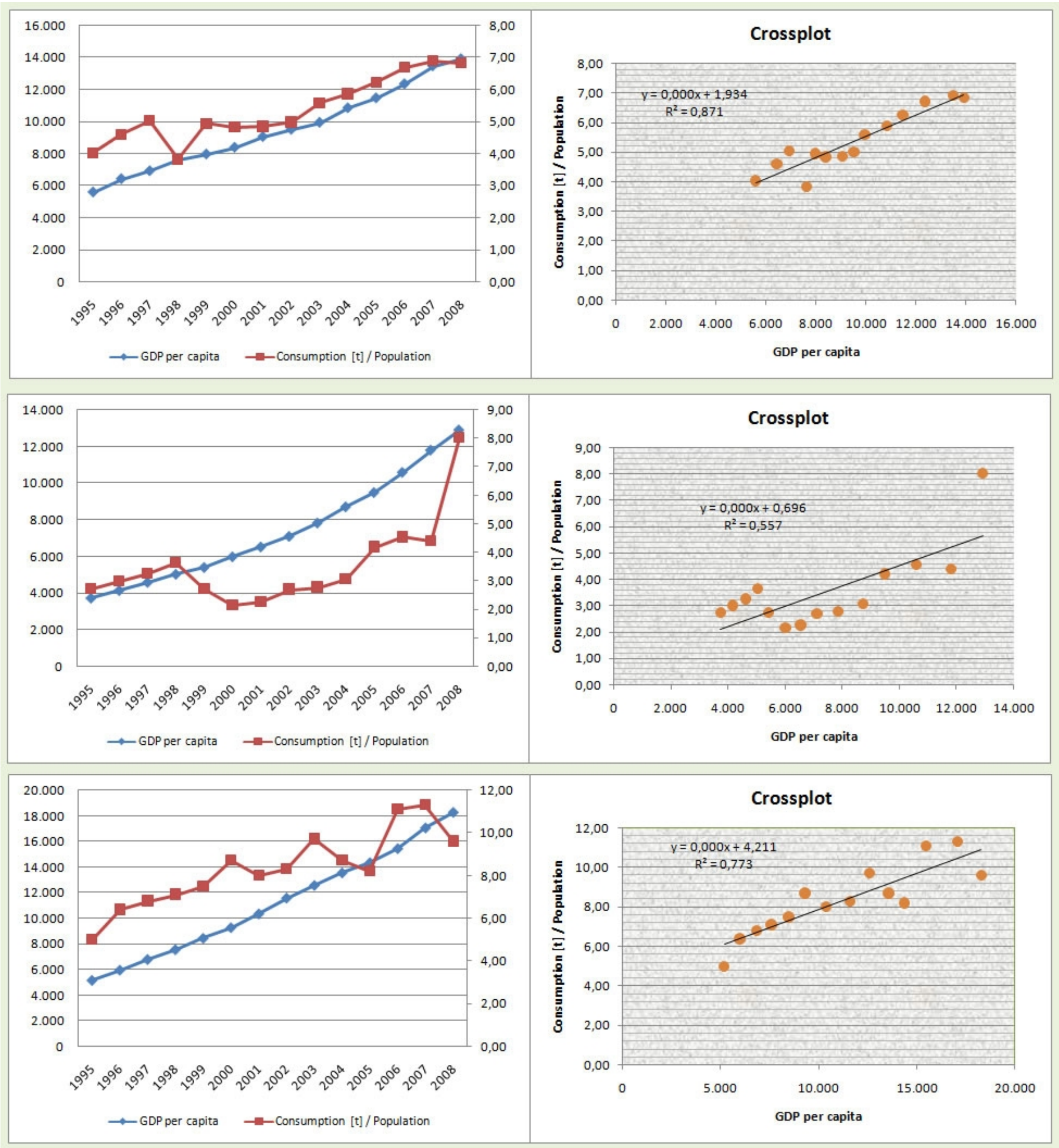


Figure 18: Aggregates consumption/GDP in Czech Republic (top), Slovakia (middle) and Slovenia (bottom) (Source: Department of Mineral Resources and Petroleum Engineering, 2010).

Figure 18 seems to indicate a logarithmic dependence between GDP and mineral consumption. This can be represented by Equation 5.4 (and Figure 19):

Equation 5.4:

$Y = a (\ln X)$

Where Y is the per capita mineral consumption for a country; X is the GDP per capita for the country and *a* is a coefficient that relates them.

The coefficient *a* depends on a set of influence factors. On the mineral market, there are several geological, exploitation and economic factors influencing the range of products. They have long-term effects on the development of mineral production. Apart from that, there are special determinants that can produce short-term effects and can account for market uncertainties and severe price fluctuations.

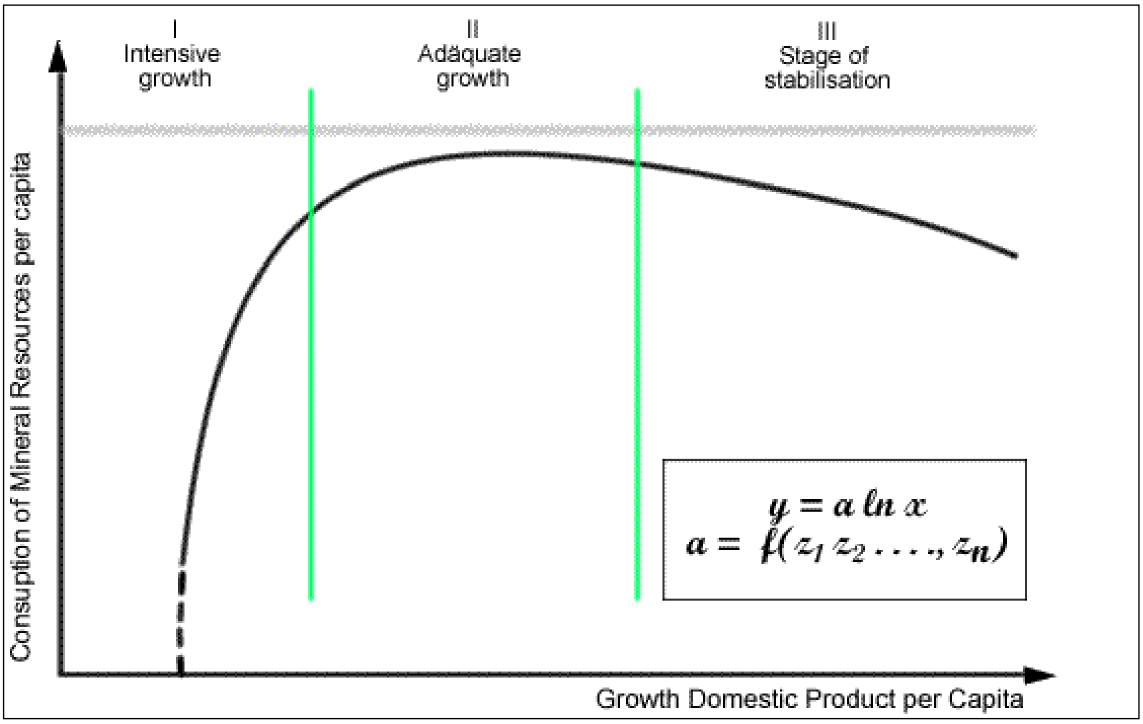


Figure 19: Relationship between GDP and mineral consumption at different stages / phases of economic development (Original Graphics).

The mineral commodities consumption as a function of GDP development is characterised by three broad phases. In phase I a rapid increase in consumption with GDP growth is observed. Growth in GDP is only possible with massive increases in mineral consumption. With further GDP growth mineral resources consumption begins to level off, particularly due to the demand for infrastructure investments beginning to be saturated. As a country becomes more affluent, consumption can actually drop off again, due to stocks-utilisation and the implementation of recycling. The problem for low-GDP countries, therefore, lies first of all in the difficulties to expand the mineral commodity production or import to further support GDP growth, e.g. for the building of infrastructure or manufacturing capacities.

Another example for a Phase I (intensive growth) country is Romania. In Romania, the GDP is industry-driven, particularly manufacturing industry-driven. This means that the consumption of minerals by the manufacturing industry (metallic minerals mostly) is likely to increase substantially in the future and a careful strategic mineral resource management in Romania will be required in order to maintain GDP growth. This need for resource management would mean the development of a proper mineral framework policy for Romania in the future. Figure 20 provides the consumption of all non-energetic minerals in Romania between 1994 and 2009, whereas Figure 21 illustrates the relationship between consumption of selected metallic commodities and industrial contribution of GDP.

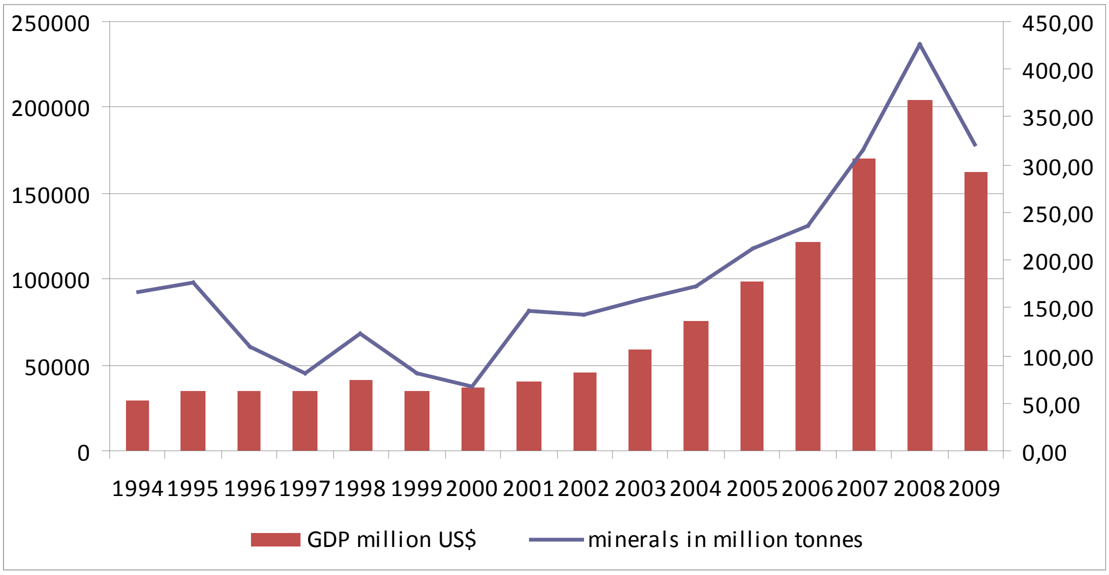


Figure 20: Development of minerals consumption in Romania, 1994-2009 (Marinescu et al., 2013, www.insse.ro/cms/files/Web_IDD_BD_en/index.htm).

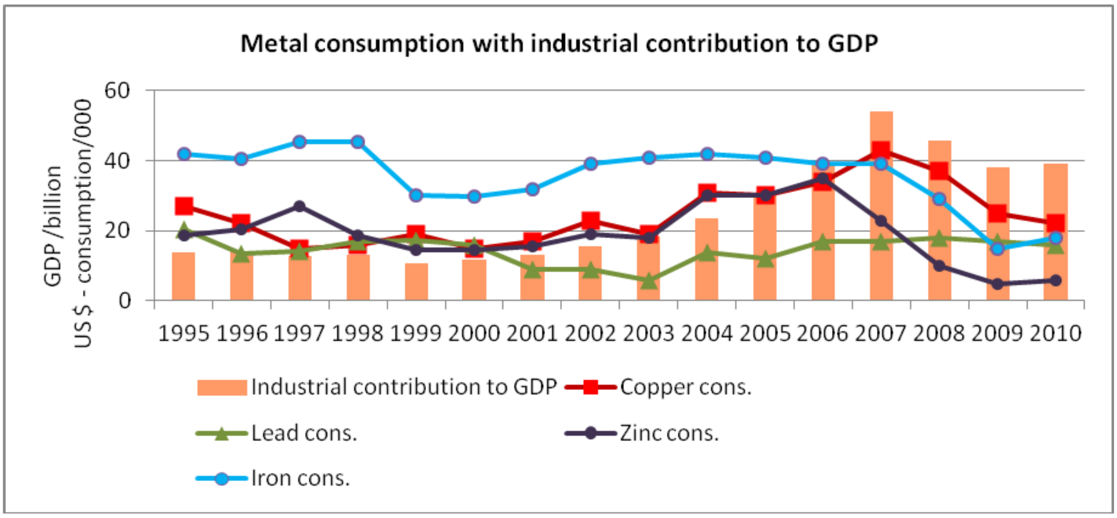


Figure 21: Metal consumption of selected commodities in Romania compared with the industrial contribution to GDP – consumption of primary copper, zinc, lead and iron (Source: Marinescu et al., 2013).

From Figure 22 it can be observed that the mineral consumption in Romania (copper, lead, zinc, iron) has been showing an increasing (past) trend in correlation with GDP per capita. Linear relationship for all the different commodities, i.e. copper, lead, zinc, and iron with GDP per capita has been noted in the graph. As can be seen all the linear relations have a positive slope and there has been an increasing trend in the past 10 years. An increasing future trend can be expected for the mineral consumption in the future also. From the given linear relationship it is evident that, consumption per capita has a positive relationship with GDP per capita and by knowing the forecasted value of GDP per capita, the consumption trend of the selected commodities can be predicted in the future.

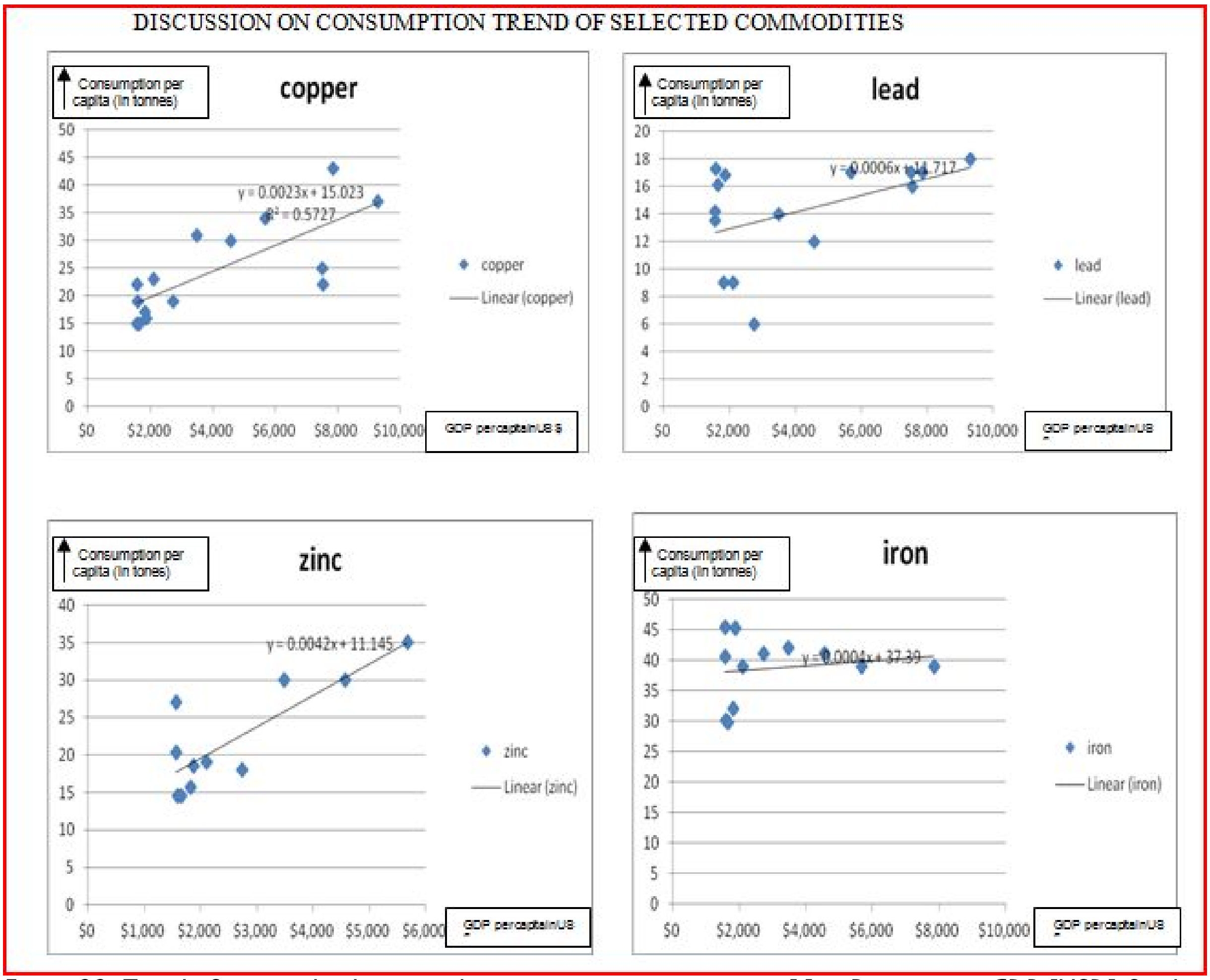


Figure 22: Trend of copper, lead, zinc and iron per capita consumption [t] in Romania vs. GDP [USD] for the years 1996-2007 (Source: Marinescu et al., 2013).

5.4 Supply and demand scenarios

The establishment of an efficient minerals policy strategy requires the analysis of the existing and future demand and supply situation. Objectives and action plans of a minerals policy / strategy must be based on a detailed analysis of the minerals economy of a country. It is necessary to provide the environment for a balance between demand and supply. Hereby, accurate and complete statistics are essential. The structure of minerals economies / consumption can be regarded and differentiated considering production, imports and exports of mineral commodities. In economics, demand is defined as the quantity of goods or services that will be purchased per unit of time at a given price. In simple term, it means one's capacity and inclination to consume.

Demand forecasting vs. foresight: Demand forecasting, including different scenarios for the needed raw materials, is crucial to determine the objectives and actions of the mineral strategy of a country (cf. Chapter 4). It is recommended to develop differentiated scenarios (and policies) long-, mid- and short-term (10-15 years). This includes demand forecasting (short- and mid-term) as well as a supply and demand foresight study (long-term). Supply and demand are strongly interrelated with economics (global, European, national), technology and research development, the changing political landscape (European, global), as well as they interconnect with several other areas (energy, resource-efficiency, consumer behaviour, etc.), therefore forecasting tools do not provide information in sufficient quality to enable longer-term policy making to ensure planning for 'an adequate access to minerals'. Hence, strategic foresight needs to be applied in the form of comprehensive foresight exercises. This section discusses both demand forecast and foresight.

Demand forecasting tools

There are several standard methods of minerals demand forecasting. In the following two examples are given related to metallic minerals including scrap, applied in three different projects. The following standard methods of mineral demand forecasting have been applied in the EU-Project EXTRACT-IT ('Defining FET research topics supporting the ICT challenges of mineral extraction under extreme geo-environmental conditions'; Tiess, 2012): Time Series, Macroeconomic variable (GDP), End-use.

Time Series analysis of consumption data – The consumption was calculated on the basis of production, import and export for each of the years 2000-04 and 2006-2010.

Macroeconomic variable (GDP) – Mineral production / consumption in a country constitutes an important element in computation of GDP in that country. In this method, it is assumed that the growth of consumption of minerals would be in tune with that of the GDP. The year-to-year GDP growth rate values during the period 2002-2011 published by the World Bank were averaged to arrive at an average growth rate during that period. As in the case of consumption, this rate was taken as the Compound Annual Growth Rate (CAGR) for future years and applied to yield the consumption of 2010 to arrive at the demands in 2020, 2025, 2030.

End-use method – Minerals are consumed for manufacturing some product. So, it can be reasonably assumed that growth in the production of the end-use commodities should be in tune with that in the mineral consumption.

Based on Table 5 the countries can be grouped according to their degree of vulnerability with regard to certain minerals / metals as follows:

1. ***Most comfortably placed***
   Sweden with regard to only one mineral namely **iron ore**, its present production being about 2.5 times its projected demand in 2030.
2. ***Most precarious situation***

a. Rare earth compounds in Spain, Turkey and Germany where their present production is nil while the demand is rising at a high rate.
b. Antimony in Spain and France (same as above)
c. Bauxite in Irish republic (same as above)
d. Cobalt in Belgium and Finland (same as above)
e. Copper in Germany (same as above)
f. Iron ore in Slovakia and Spain (same as above)
g. Lead in Germany (same as above) and also in Spain where demand in 2030 is projected to exceed the present mine production by over 800 times
h. Zinc in Belgium where present production of ore / concentrates is nil while demand is rising and also the metal industries are in place.

3. ***Highly critical***
   a. Iron ore in Germany: The demand in 2030 is projected to exceed the present mine production by 142 times.
   b. Copper in Finland: The demand in 2030 is projected to exceed the present mine production by 53 times.
4. ***Critical***
   a. Zinc in Finland and Spain: The demands in 2030 are projected to exceed the present mine productions by 9 and 4 times respectively
   b. Iron ore in Austria: The demand in 2030 is projected to exceed the present mine production by 9 times
   c. Copper in Spain: The demand in 2030 is projected to exceed the present mine production by 6 times
   d. Lead in Poland: The demand in 2030 is projected to exceed the present mine production by 5 times
5. ***Moderately critical***
   a. Alumina in France and Germany: The demands in 2030 are projected to exceed the present productions by 2.5 and 1.8 times respectively)
   b. Bauxite in Greece: The demand in 2030 is projected to exceed the present mine production by 1.9 times
   c. Copper in Sweden: The demand in 2030 is projected to exceed the present mine production by 2.5 times.

Amongst the countries and minerals / metals analysed, Sweden seems to be the only net exporting country, but with respect to only one mineral namely iron ore.

Scrap

Metal scrap is generated at three life-cycle stages namely:

a. During processing of the metal before they are subject to manufacturing processes
b. During manufacturing consumer products using the respective metal
c. As end-of-life scrap due to discarding the consumer products

Scrap is the principal mineral raw-material recycled for production of secondary metals. The published data were analysed. It was observed that there was no report of production of scrap of any of the minerals / metals in any of the countries. But the countries both imported and exported. The published data in respect of the relevant metals and countries are summarized in Table 6.

Table 5: Summary of the productions and demands of different minerals/metals in different countries – demand forecast using time series/GDP/end-use method (Tiess, 2012).

Mineral	Country	Unit	Production (2010)	Actual consumption (2010)	Projected demand		
					2020	2025	2030
Alumina	France	Mt	0.48	0.94	1.05	1.11	1.18
	Germany	Mt	1.00	1.24	1.48	1.60	1.78
Antimony metal	Spain	t	Nil	2623	4500	5400	6350
	France	t	Nil	8923	14400	18350	23300
Bauxite	Greece	Mt	1.90	1.77	2.50	2.98	3.61
	Irish Republic	Mt	Nil	4.11	6.01	7.31	8.87
Cobalt ore (recoverable metal content in parentheses)	Belgium	Ore in Mt & metal content in t	Nil	0.37 (1110)	1.45 (4350)	1.88 (5650)	2.43 (7300)
	Finland	Metal content in t	Negligible	2.57 (9413)	3.77 (11300)	4.13 (12400)	4.53 (13600)
Copper ore	Germany	Ore in Mt	Nil	7.04	12.85	17.88	25.29
	Finland	Ore in Mt	0.10	3.51	4.44	4.88	5.28
	Spain	Ore in Mt	2.17	6.89	10.40	11.40	12.80
	Sweden	Ore in Mt	3.06	3.91	6.66	7.80	8.82
Iron ore	Austria	Mt	2.07	11.38	14.63	16.65	18.93
	Germany	Mt	0.39	43.63	48.96	52.09	55.48
	Slovakia	Mt	Nil	5.74	8.37	10.15	12.20
	Spain	Mt	Nil	5.87	6.50	6.84	7.23
	Sweden	Mt	25.29	4.63	6.88	8.45	10.43
Lead	Germany	Tonnes of contained lead in ore, concentrate, imported unwrought lead and imported scrap taken together	Nil	224,069	330,000	407,000	513,000
	Poland		44200 (t of metal in ore only)	75,336	121,680	159,350	212,560
	Spain		300 (t of metal in ore)	132,925	178,000	205,000	241,000
Rare earth compounds	Spain	t	Nil	674	912	1032	1152
	Turkey	t	Nil	246	800	1000	1250
	Germany	t	Nil	10404	15750	18400	21100
Zinc	Belgium	Tonnes of metal content in ores & concentrates	Nil	123,377	278,740	356,670	401,940
	Finland	Tonnes of metal content in ores & concentrates	55562 (metal in ores)	237,535	337,590	403,850	486,230
	Spain	Mt of metal content in ores & concentrates	0.52	0.82	1.42	1.72	2.00

Table 6: Import-export of scrap of different metals by different countries and their production (Tiess, 2012).

Mineral	Source metal of scrap	Country	Production	Total import during 2000-1010*	Total export during 2000-1010*	Net surplus or deficit import
Alumina	Aluminium	France	Not reported	1.80 Mt	3.15 Mt	Deficit
		Germany	Not reported	4.81 Mt	6.43 Mt	Deficit
Bauxite	Aluminium	Greece	Not reported	245,578 t	156,019 t	Surplus
		Irish Republic	Not reported	4,283 t	179,438 t	Deficit
Copper	Copper	Germany	Not reported	4.92 Mt	4.59 Mt	Surplus
		Finland	Not reported	40,962 t	252,507 t	Deficit
		Spain	Not reported	780,556 t	778,540 t	Balance
		Sweden	Not reported	670,650 t	43,223 t	Surplus
Iron ore	Pig iron	Austria	Not reported	10.67 Mt	5.88 Mt	Surplus
		Germany	Not reported	47.02 Mt	121.17 Mt	Deficit
		Slovakia	Not reported	2.82 Mt	4.47 Mt	Deficit
		Spain	Not reported	62.98 Mt	1.59 Mt	Surplus
		Sweden	Not reported	3.02 Mt	6.21 Mt	Deficit
Lead	Lead	Germany	Not reported	234,969 t	129,621 t	Surplus
		Poland	Not reported	14,803 t	15,928 t	Balance
		Spain	Not reported	279,832 t	57,356 t	Surplus
Platinum group of metals (PGM)	PGM	Poland	Not reported	2,648 kg	141,258 kg	Deficit
		UK	Not reported	9,030 t	24,210 t	Deficit
Zinc	Zinc	Belgium	Not reported	525,876 t	26,190 t	Surplus
		Finland	Not reported	9,242 t	35,896 t	Deficit
		Spain	Not reported	49,870 t	108,063 t	Deficit

* Except 2006

From this table it emerges that there are two countries namely Spain and Poland where import and export with regard to copper and lead respectively are more or less in balance. Eleven of the remaining 19 countries and minerals there is net deficit and in 9, there is net surplus. But the first and foremost issue glaringly conspicuous is the poor quality of the data which leaves many questions unanswered as follows:

1) No production data of scrap is available. Nil production of scrap is impossible to accept because there is bound to be at least end-of-life scrap on account of disposed consumables if not that generated during the upstream operations.
2) The net deficit of import-export can only be explained by one or both of the following two ways.
    a. There is definite production albeit the data have not been collected, compiled and published.
    b. The data on import and export are incomplete.
3) In case of surplus net import, it is apparent that there was domestic utilisation of the surplus imported scrap. But even this does not answer the question whether this had already been processed in the exporting country or the processing was after import.

In case of net deficit import and absence of data on production, the question remains wherefrom the exportable scrap came.

Practically no scrap is recycled without any processing to make the specifications acceptable to those of the user industries. Such processing facilities may be independent or a part of the user industrial units. If the processed scrap was clubbed with the other minerals for production of the end-products, then the overall picture would be prone to distortion in absence of a break-up between the primary and the secondary minerals. Besides, there is no question of any scrap pertaining to antimony metal, cobalt metal and rare earth compounds.

Some policy conclusions can be drawn from the above:

1. **Issue of reliable data and data collection**. Especially, the data issue has to be mentioned i.e. the *scarcity of reliable* mineral consumption data at EU-level and national level. This also concerns the issue of collection, processing and publishing data. Thus, the attempt was made to use BGS-data; however, as the analysis indicates, the (BGS) data are inhomogeneous, fragmented. This is one of the remarkable issues within the EU and its Member States: there is a considerable gap in the minerals consumption knowledge base at EU-/national level which in turn affects the possibilities of developing minerals policy strategies in Europe[3].
2. There will be a **strong increase in demand** of metals / metallic minerals (at global level; cp. Mackenzie, 2015) by the European metal industries which form an important backbone of the economies of the European countries. Presently, most of the countries depend on imports of minerals.
   But before the backdrop of increasing resource-nationalism when the mineral-exporting countries are refusing to let go their minerals except in processed form, the desirability of achieving self-sufficiency (in the supply of metals) can never be overestimated. This will call for extension of existing mines depth-wise and also laterally. One further alternative is to *exploring* the known geological occurrences with a view to developing them to productive mines. Many of these deposits, being too remote or too dangerous or too deep, might have hitherto been considered cost-intensive and not minable, but the time for dedicated efforts of R&D for developing innovative cost-effective technologies is never too soon.
3. **Recycling of scrap** will go a *long way* to reduce dependence on primary minerals – indigenous or imported. However, in none of the European countries studied there was *any report* of scrap production. In most cases, scrap recycling is energy-intensive and not environment-friendly. But here also, concerted efforts of R&D for developing innovative cost-effective and environment-friendly technologies are urgently called for. But before that, systems of organized collection and reporting of scrap are *sine-qua-non*.

[3] H2020 projects such as Minventory, Minerals4EU intended to bridge this gap. E.g.: From September 2013 to August 2015, BGS participated in the Minerals4EU project funded by the European Union 7th Framework Programme. This project was designed to contribute towards the recommendations of the EU's Raw Materials Initiative and has delivered a web portal with spatial data on Europe's mineral resources, the most comprehensive European Minerals Yearbook ever produced and a foresight study. These deliverables can be accessed on this link: http://minerals4eu.brgm-rec.fr/.

However, for any success in the above-suggested efforts, various kinds of governmental initiatives based on a coherent European minerals policy framework will be required.

5.5 System dynamics approach

Demand forecasts can also be generated by the use of System Dynamics (SD) Modelling Simulations (this approach is more *detailed*). In order to achieve accurate results it is crucial to identify at least the most important parameters within the respective value chain. Crucial parameter arrays in the interrelations are the economic benchmarks of GDP and population, as the consumption is in this case simulated as a function of GDP per capita. On the other hand, technical parameters have to be implemented as well: Since mining machinery, processing methods and the fields of application are developed under high pace and will become more and more efficient in the future, it is more than just legitimate to take these issues into account when simulating scenarios. All identified parameters then have to be interlinked with mathematical equations and some of them require calibration with e.g. formulae derived from the analysis of historic data (e.g. via regression analysis).

Figure 23 is illustrating an example of SD: Aggregates demand forecasting in Lower Austria and Vienna applied in the ANTAG project (Tiess & Kriz, 2010). The target of ANTAG was to create and use a model representing the national market of aggregates in order to simulate longer term effects (costs, environmental and societal impacts) of supply decisions (production restructuring, intensified recycling, import), of political decisions (additional reduction of exploitable areas, taxation of environmental and societal impacts) and developments decisions (infrastructure)[4].

Figure 23 also illustrates the output of a parametrised model run. The development of GDP per capita and the resulting aggregates consumption are plotted for the period of 2000 to 2030. Starting from 2010 a levelling off with a peak of aggregates demand of approx. 45 billion tonnes is predicted after around two decades, after this time a decoupling of GDP and consumption is expected. Supply actions are needed based on the Austrian mineral resources plan (see below).

The system dynamics approach involves:

- Defining problems dynamically, in terms of trends / possible scenarios over time.
- Striving for an endogenous, behavioural and transparent view of the significant dynamics of a system, a focus inward on the characteristics of a system that themselves generate or exacerbate the perceived problem.
- Thinking of all concepts in the real system as continuous quantities interconnected in loops of information feedback and circular causality.
- Identifying independent (in-use or dormant) stocks or accumulations (levels) in the system and their inflows and outflows (rates).
- Formulating a behavioural model capable of reproducing, by itself, the dynamic problem of concern. The model is usually a computer simulation model expressed in nonlinear

[4] Aggregates planning policy project: Austria – France [ANTAG]. Cooperation with University of Leoben and École des mines de Paris: "Long term anticipating the access to the aggregate resource by breaking form present practice (2007-2010)".

equations, but is occasionally left unquantified as a diagram capturing the stock-and-flow / causal feedback structure of the system.

- Deriving understandings and applicable policy insights from the resulting model.
- Implementing changes resulting from model-based understandings and insights.

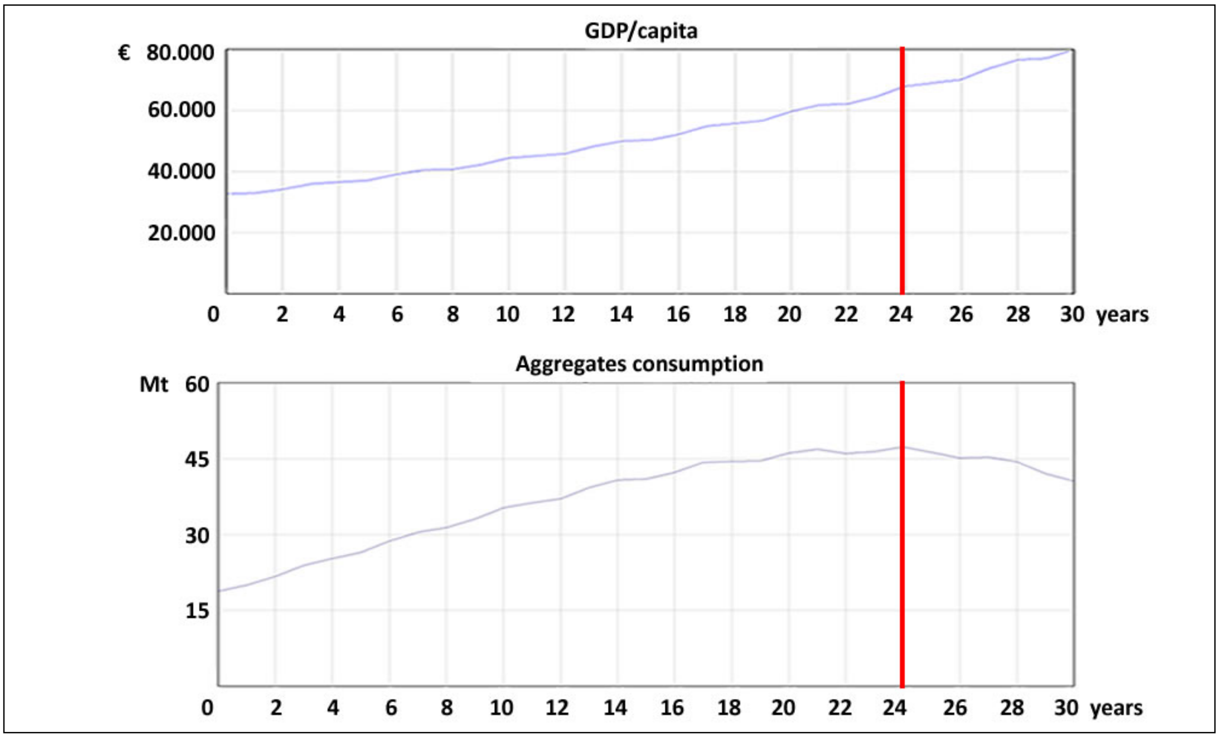


Figure 23: Aggregate consumption as a function of GDP growth in Lower Austria and Vienna for the period 2000 to 2030, simulated with the system dynamics model (Tiess & Kriz, 2011a).

Conceptually, the feedback concept is at the heart of the system dynamics approach. Diagrams of loops of information feedback and circular causality are tools for conceptualizing the structure of a complex system and for communicating model-based insights. Intuitively, a feedback loop exists when information resulting from some action travels through a system and eventually returns in some form to its point of origin, potentially influencing future action. If the tendency in the loop is to reinforce the initial action, the loop is called a positive or reinforcing feedback loop; if the tendency is to oppose the initial action, the loop is called a negative or balancing feedback loop.

The sign of the loop is called its polarity. Balancing loops can be variously characterized as goal-seeking, equilibrating, or stabilizing processes. They can sometimes generate oscillations, as when a pendulum seeking its equilibrium goal gathers momentum and overshoots it. Reinforcing loops are sources of growth or accelerating collapse; they are disequilibrating and destabilising. Combined, reinforcing and balancing circular causal feedback processes can generate all manner of dynamic patterns. Created with this method, the software toolbox consists of mathematical sub-models interlinking specific parameters of the mineral resources supply chain. Identifying the main parameters and drafting loops is the first step for setting up a new model. The generated sub-models were afterwards arranged by several categories such as ‘construction materials’, ‘oil & gas’ and ‘metallic mineral resources’.

5.6 Demand scenarios per mineral when developing a minerals policy strategy

In order to provide adequate scenarios for the need of (energy and) non-energy minerals demand and to generate a coherent framework for a sustainable minerals policy, well-founded demand forecasts are essential and build the basis for further development of minerals policy structures. For instance, to generate a computerised software toolbox indicating future trends in terms of mineral resources based on System Dynamics Modelling. This was applied for the Development of a Bulgarian Mining Industry Strategy, commissioned by the Bulgarian Chamber of Mines and Geology in 2011 (Tiess & Kriz, 2011b). The generated sub-model consists of various parameters such as different growth rates, GDP and population. Each single parameter had to be individually calibrated with mathematical equations. Fundamental basis for this task was to compile relevant data over a certain time period which was later converted to equations using the regression analysis method. Data from BGS, USGS and the National Statistical Institute of Bulgaria was used. Figure 24, Figure 25 and Figure 26 illustrates demand forecasts for selected metallic, industrial and construction minerals respectively. The various material streams are strongly dependent on each other. The supply side of certain minerals may be determined by the demand for another material to which they are by-products.

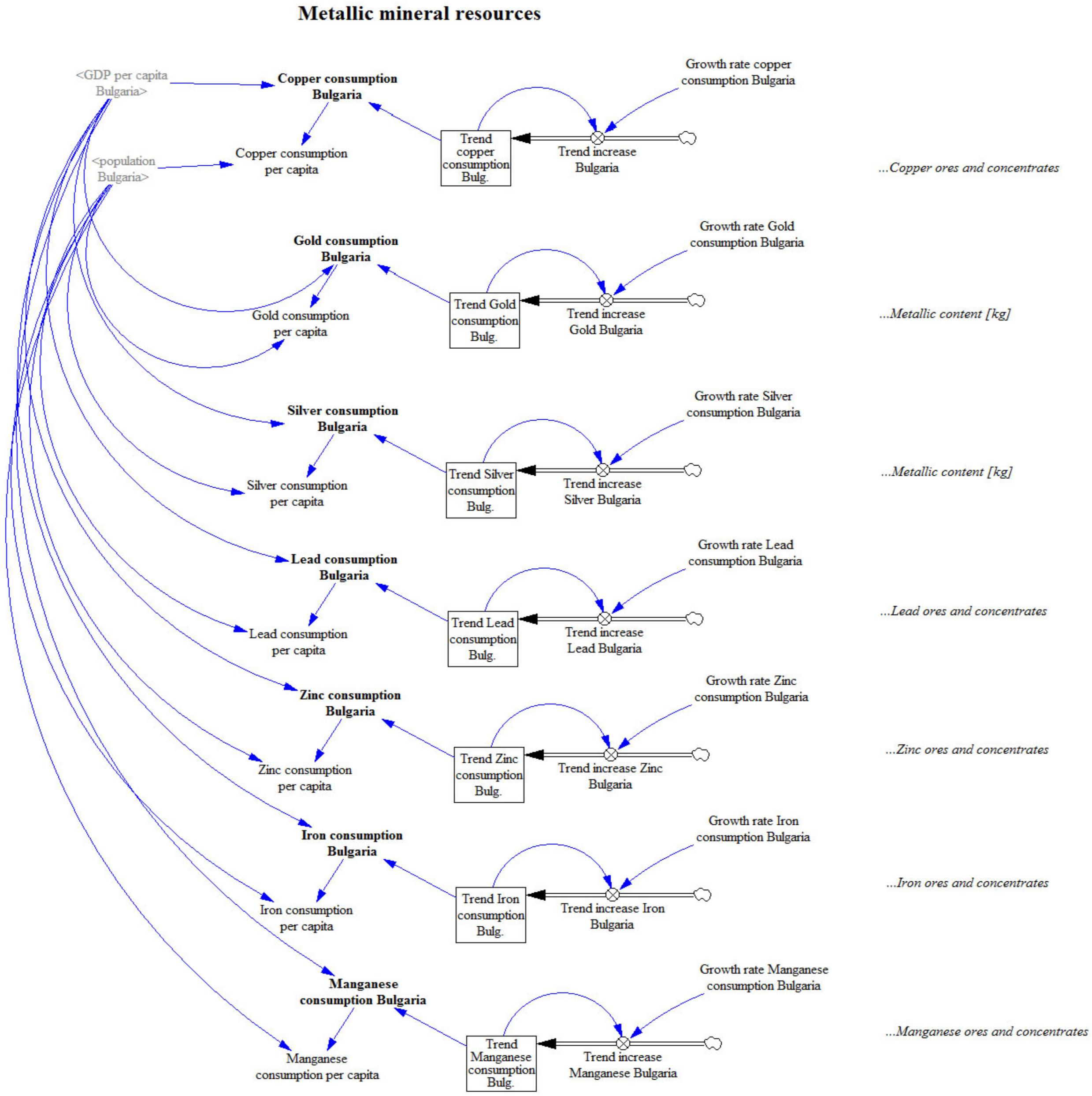


Figure 24: Example for a System Dynamics Model used for forecasting in MICA – Metallic Mineral Resources. (source: Tiess & Kriz, 2011b).

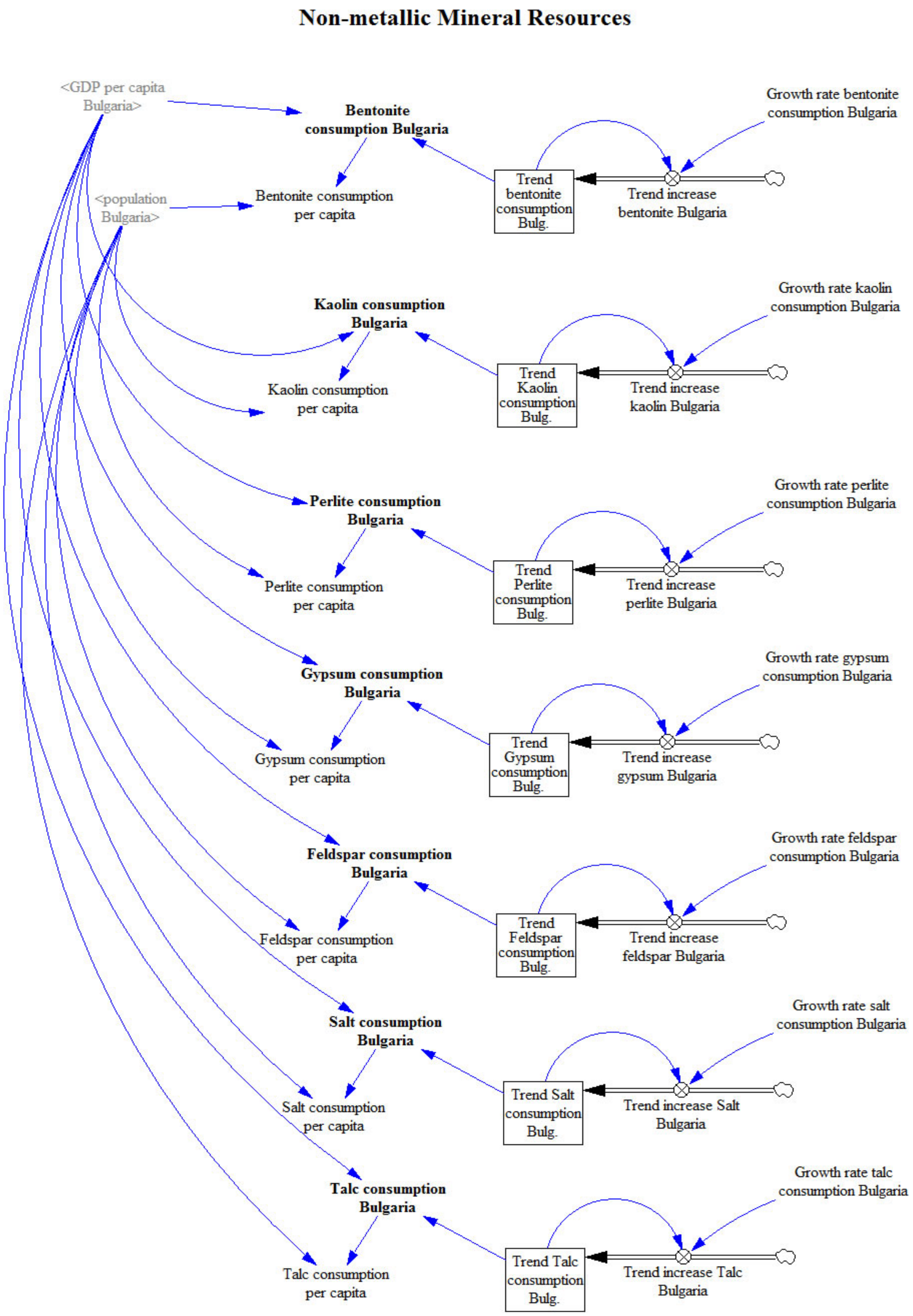


Figure 25: Example for a System Dynamics Model used for forecasting in MICA – Non-Metallic Mineral Resources. (Source: Tiess & Kriz, 2011b).

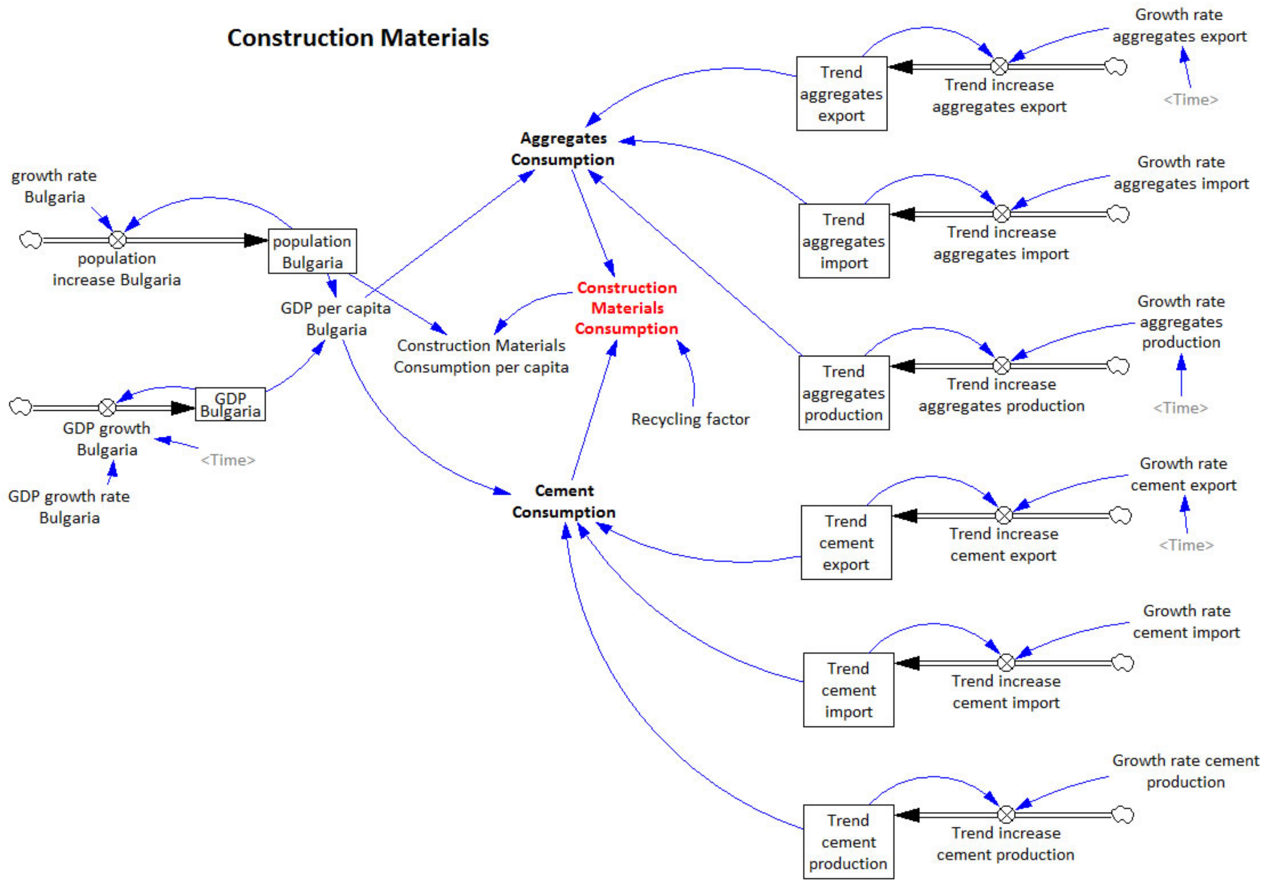


Figure 26: Example for a System Dynamics Model used for forecasting in MICA – Construction Materials (source: Tiess & Kriz, 2011b).

Example copper forecast – The economic importance of a sector in a country's economy is usually measured by its contribution to the GDP as well as by the job-creating effects of the respective industry. The copper forecasts (30 years) were generated by the use of System Dynamics Modelling Simulations. Crucial parameter arrays in the interrelations are the economic benchmarks of GDP and population, as the consumption is in this case simulated as a function of GDP per capita. The total annual copper consumption was calculated by using trend lines which have been derived from BGS data. The (trend) starting point >0< is equivalent to year 2007. Compared with the need and supply situation of copper as illustrated in Figure 27 (imports versus production), the need of appropriate corresponding policies is visible.

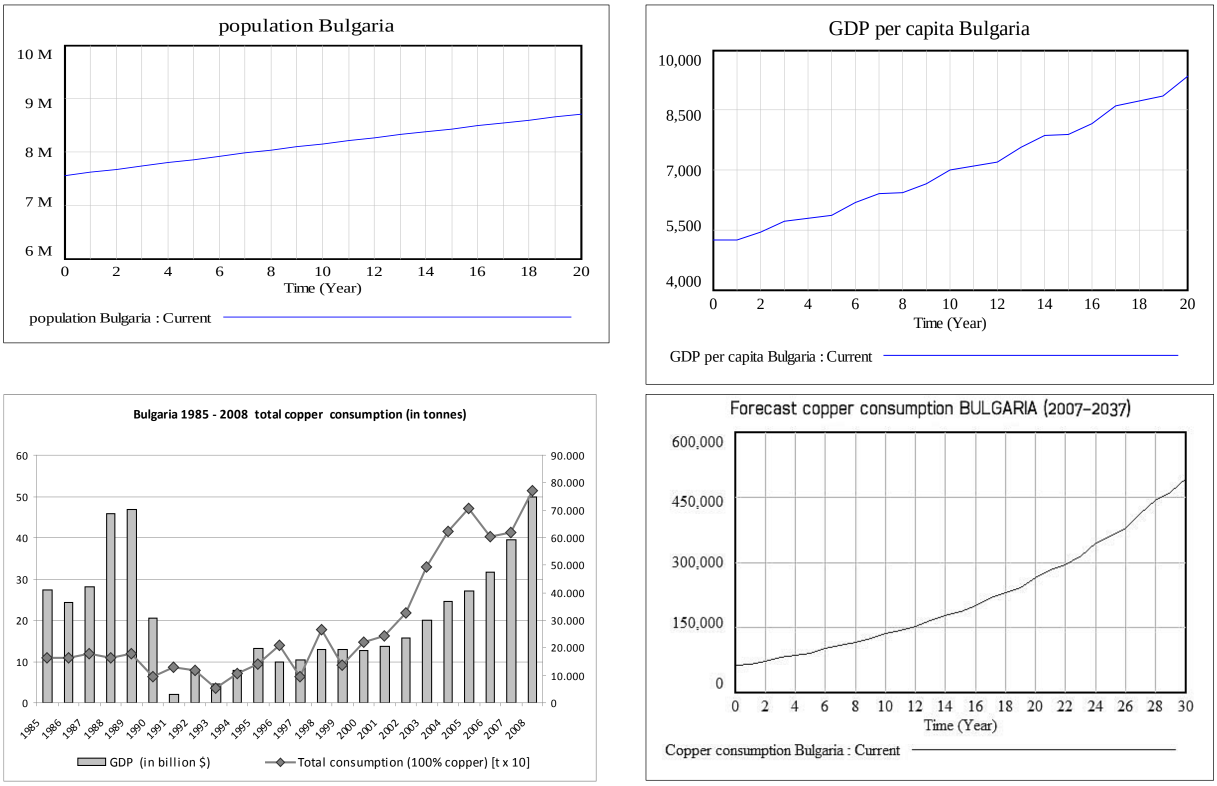


Figure 27: Example for a copper demand forecast vs. population forecast for Bulgaria. Simulation period: 20 years. Starting point >0< is the year 2007; GDP/capita forecast for Bulgaria in US-Dollars (Source: Tiess & Kriz, 2011b).

5.7 Cross linkage between scenarios for different materials

The harmonisation between sectoral policies bearing on sustainable resource management is one of the most important objectives of a minerals policy framework. Various material streams are strongly dependent on each other. The supply side of certain materials may be determined by the demand for another material to which they are by-products.

To achieve an approximate harmonisation between sectoral policies targeting different mineral elements is a challenging task, yet of essence in attaining sustainable resource management. The challenge arises for instance from the inter-dependency of material streams. This is due to the geological occurrence of minerals that determines why certain commodities need to be mined as individual products while others need to be mined as co- or by-products to make mining profitable (Maxwell, 2013). Among the individually mined products is bauxite, coal, gold, iron ore, and diamonds, but some of them can also be by-products from other types of mines. Also 'lower value-to-weight' minerals such as gravel, gypsum, limestone, sand, manganese, salt and talc are mined as individual products (Maxwell, 2013).

This joint production with a main-, by- and co-product for reasons of profitability applies to major mineral commodities such as of copper and gold, gold and silver, nickel and cobalt, copper and molybdenum, and tin, tantalum and lithium or silver, lead and zinc (Maxwell, 2013, p. 71). For instance, at the well-known Australian Olympic Dam mine the main product in terms of tonnage is copper, while uranium and gold arise as by-products, but there have been times, when the uranium prices were so high, that the income from this commodity was higher than that from copper (https://en.wikipedia.org/wiki/Olympic_Dam_mine). Further, the case of the speciality metals known as rare earth elements (REE) is also illustrative: REE are mined as by- or co-products, such as of iron ore in China, or as in the advanced mineral exploration project development plans, as a co-product, such as in the case of the exploration firm 'Tanbreez', which holds rights to a mineral deposit in South Greenland, where plans are to mine REE-containing minerals with tantalum, niobium, and zirconium.

Importantly, the decision on the main product of a mining operation is the key to its economic viability, as its price alone is going to determine the mine output (Tilton, 1985). In contrast, a by-product has no significance for the mine output, as its price is not a determinant factor in it (ibid). However, in the case of co-products, the prices of two or more minerals affect the output. Thus, the co-product mine planning is strongly influenced by prices of mineral commodities and therefore, such mine plans require a certain degree of flexibility in adjusting output, if some of the mineral commodity prices change significantly. For instance, the USD/lb prices of uranium in October 2016 were the lowest in a 12-year period. For a mine plan like that of 'Greenland Minerals and Energy' that holds rights to a mineral deposit in South Greenland (another deposit than the mentioned deposit that Tanbreez holds), with plans of co-producing uranium and rare earth elements, among others, such drop in prices is critical for the planned venture. In already operating mines, price drops of by- and co-produced minerals might mean that the overall volume output of the by-product or co-product be significantly reduced with an impact on the available market volume.

6. Foresight tools for RMI

6.1 Conceptual Relationships

Raw materials intelligence is intended to contribute to develop our capability of meeting our future needs. In order to understand what our future needs might be, we need tools and methods that help to scope likely futures and that help to map the road(s) to desirable futures. Foresight and Futures science or 'futurology' (Flechtheim, 1946), therefore, is an important element supporting policy-making. Foresight in the first instance describes the intuitive assessment of risks and planning for eventualities. As such, it is a key trait that distinguishes humans from many other species. It perhaps is also a key factor in the evolution of the human species, being both, a contributing factor and a result. Foresight requires a consciousness of the present and the past together with the capability of learning. It requires the capability to abstract and project in order to draw conclusions for future behaviour.

Foresight might extend to rather different time-scales. Time-scales in the order of months to a few years might be considered the realm of 'planning' *sensu strictu*, as essential boundary conditions are not likely to shift significantly. Foresight studies for time-scales that go beyond that will have to deal with increasingly speculative aspects and a much more complex set of variables. Methods that essentially support planning over shorter time-frames are the subject of WP4. The boundaries between the more operational tools discussed under WP4 and the more strategic and speculative tools subject of this WP5 are not so clear-cut. In fact, the operational tools and the insights generated with them are important to inform foresight studies with longer time-frames.

Figure 28 provides a short overview of methods and tools used to support strategic planning and policy-making at a wide variety of organisational levels, ranging from individual enterprise to EU-level and generalised scientific studies. Some of the entries are individual methods, while others are groups of methods / methodologies.

This overview has not been structured other than into qualitative, semi-quantitative, and quantitative methods, and by trying to categorise them as 'normative' or 'explorative'. There are several ways to classify foresight methods, for example they can be: i) exploratory (exploring possible futures) or ii) normative: planning how to get to a preferable future, etc. The distinction between exploratory and normative foresight methods is not so clear-cut, as for instance, normative methods might be bound by what is considered possible at any one time, thus bounding trajectories. In some instances, qualitative methods can be combined with quantitative methods in order to make semi-quantitative predictions. In other cases the methods themselves may be quantitative, but their parametrisation would be only possible using qualitative methods.

It should be noted that the methods discussed are not necessarily alternatives, but are often elements in a more complex system of methods that support each other. For instance, qualitative methods, such as expert panels or focus groups, can be used to parametrise scenario analyses that themselves are supported by (numerical) mechanistic system models. Often techniques, such as brainstorming or delphi methods are used to extract the views and ideas of those involved.

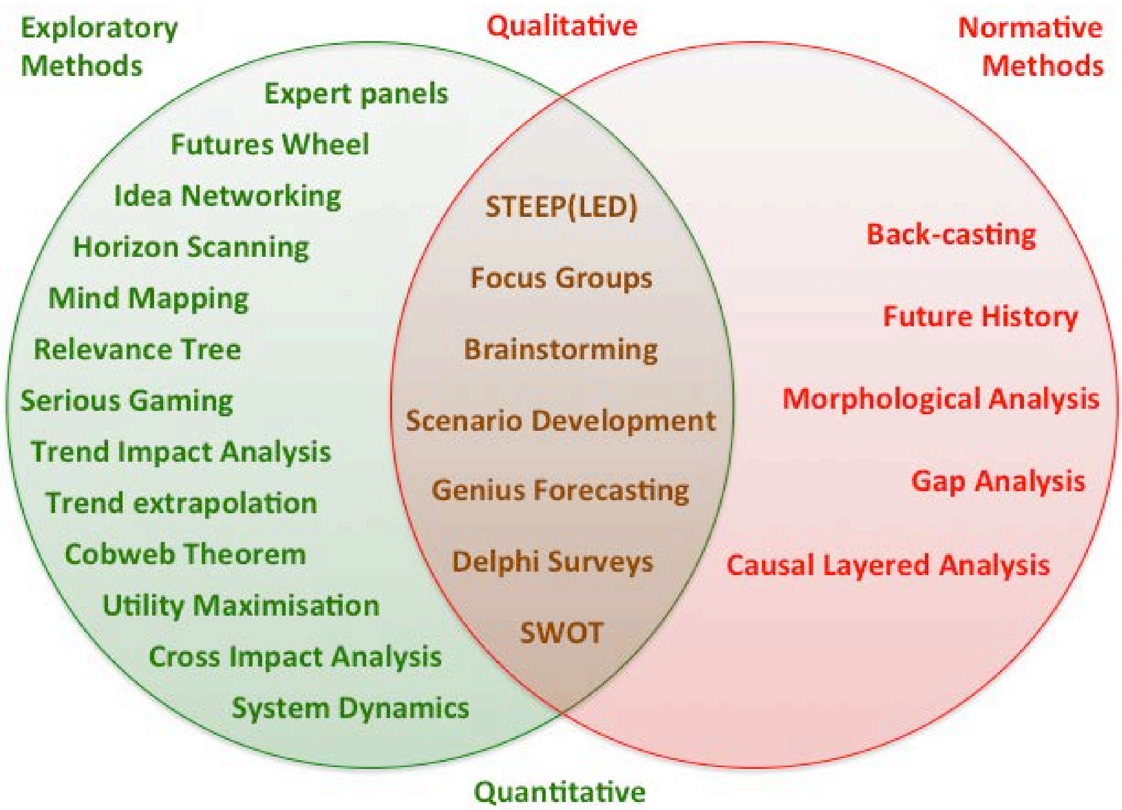


Figure 28: Conceptual relationship between different methods that can be used for futures studies to support raw materials intelligence.

The methods discussed below could also be categorised into those that are based on a reductionist-structuralist analysis and model building, and those that employ a more intuitive and 'holistic' approach. Futures research often is not driven by the desire to understand what possible futures may look like, but rather to understand the possible ways to a desired or desirable future. As a result, the boundaries of empirical and interpretative research are transgressed and critical positions are taken, by comparing the research results with predetermined value systems (usually that of the author or those, who fund the research). Research undertaken to support policy-making is likely to develop into 'action research' (e.g. Todhunter, 2001). Action research is an interactive inquiry process that balances problem solving actions implemented in a collaborative context with data-driven collaborative/participatory analysis or research to understand underlying causes enabling future predictions about change (Reason, 2006).

6.2 Methodology for identifying / preservation of mineral resources

In order to promote investment in mining industries, the EU (EC, 2011) considered of particular importance definition of a planning policy for minerals which includes:

- long-term and regional estimates of minerals consumption
- digital geological database,
- transparent methodology for identifying mineral resources,
- identification and preservation of the minerals resources taking into account other land uses;

Minerals planning policy is an essential part of minerals policy (Tiess, 2011). Minerals planning policy is defined as the protection of mineral deposits through land-use planning. It is particularly responsible for the availability of and access to deposits (Department of the Environment, 1995).

Within land-use planning, different types of use are considered. The extraction of minerals is of importance with respect to land-use and environment protection land uses. Mineral deposits feature three characteristics: they are location-bound, regional and have an exhaustible nature. Due to these properties the existence of deposits and their extent and constitution need to be determined as soon as possible. Whether or not a deposit can be used later on is a question of land-use planning under consideration of all other aspects. The earlier and more complete information on deposits is collected, the better the solution of possible use conflicts in land-use planning will turn out. Thus, the cooperation of Geological Surveys with public land-use planning authorities is of great importance.

All EU member states develop land-use plans which are in line with national land-use planning principles. According to the principle of planning hierarchy minerals should be considered comprehensively on lower planning levels (regional and local level, operational level). The characteristics of mining cause some implications on land-use and land-use planning. Due to the exhaustibility of deposits, mining sites are only used temporarily and become available for other use again after the termination of mining activities and recultivation. Since mining activities are bound to the location of deposits, potential conflicts with other claims of use of deposits arise. When weighing interests of several parties it should be considered that the possibility for mining to fall back on other sites or areas is very limited, compared to other types of use (Department of Mining and Tunnelling, 2004).

Example – Austrian mineral resources plan

The purpose of the Austrian Mineral Resources Plan was to perform the groundwork required in preparation for activities by private enterprises (Weber, 2012). This involved systematically and objectively identifying potential mineral zones and then after carefully weighing up competing land use interests in a mineral planning process designed to avoid conflicts with mineral extraction, enshrining these zones in regional planning to ensure their conflict-free future use. This requires the protection of deposits by the federal government and provinces by means of measures to safeguard minerals.

The Austrian Mineral Resources Plan was carried out with a view to achieve a consensus between the federal government and the provinces regarding the protection of all mineral resources in long-term regional planning. The complexity of the subject matter meant that scientists had to shift through an abundance of extremely heterogeneous and detailed information to identify and fill in gaps, but above all, they had to develop methods that would make it possible to objectively identify mineral occurrences worthy of safeguarding on the basis of clear criteria. The evaluation methods described below for the individual groups of minerals (construction materials, industrial minerals and metal ores) were therefore specifically developed for this purpose. As knowledge of occurrences of natural resources is increasing constantly, it will be necessary to update the evaluation at regular intervals. Just as regional development plans have to be continuously adapted to keep up with current developments, the Austrian Mineral Resources Plan should also be understood as a 'work in progress'. As regional planning laws in the provinces contain no uniform definition of mineral areas worthy of safeguarding, they were defined as:

For the purposes of the Austrian Mineral Resources Plan, mineral areas are defined as all areas which have been identified using objective and systematic analytical methods and which contain minerals. In view of expected technological advances and bearing in mind ecological and social aspects it is assumed that it will be possible to use such materials commercially in the medium to long term. Mineral areas worthy of safeguarding as defined by the Austrian Mineral Resources Plan are mineral areas, which have no or minimal conflicts with other land use plans. They follow a traceable mineral planning process designed to avoid conflicts with mineral extraction. They should be kept for the extraction of minerals, but there should be no mandatory requirement to actually use the occurrences for mineral extraction. Work was carried out in two phases so that the positive and negative experiences of the federal and provincial administrative authorities, companies, interest groups and the scientific community could be taken into account (Figure 29).

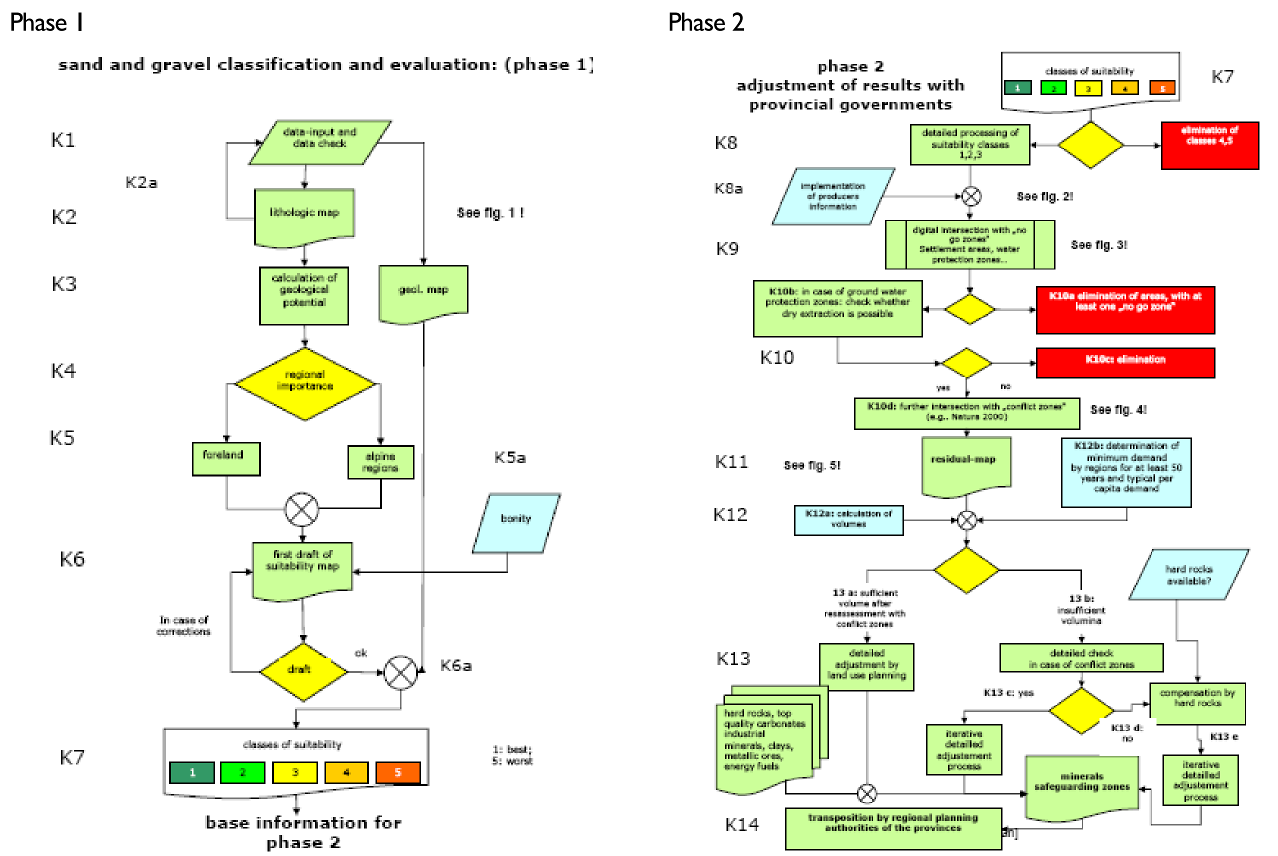


Figure 29: Austrian Mineral Resources Plan - methodology for identifying mineral resources (source: Weber, 2012).

Identification and preservation of the minerals resources taking into account other land uses; Sand and gravel classification, evaluation (phase 1) versus adjustment of results with land use planning (provincial government) (Weber 2012).

7. A RMI policy framework based on the System Dynamics model

7.1 General considerations

The System Dynamics model (SDM) approach allows to integrate the different tools and aspects identified within WP4 (Bide et al., 2016) and also the key policies from WP5 (see above). System dynamics is a computer-aided approach to policy analysis and design. It applies to dynamic problems arising in complex social, managerial, economic, or ecological systems – literally any dynamic systems characterized by interdependence, mutual interaction, information feedback, and circular causality. The System Dynamics Approach: begins with defining problems dynamically, proceeds through mapping and modelling stages, to steps for building confidence in the model and its policy implications.

The System Dynamics model integrates the different tools and aspects identified previously using the Pruyt model (Figure 30). Pruyt (2010) developed a basic model for minerals that can be adapted for the RMI (policy) framework. It has the flexibility to include the key aspects identified in Chapter 5, such as for example primary and secondary materials, monitoring the effectiveness and impact of regulations and policies, different supply and demand scenarios, and the monitoring of the status of mineral deposits of public importance. In other words: The Pruyt model can be expanded to include different parts of the supply chain all the way from resources / reserves all the way along to final product.

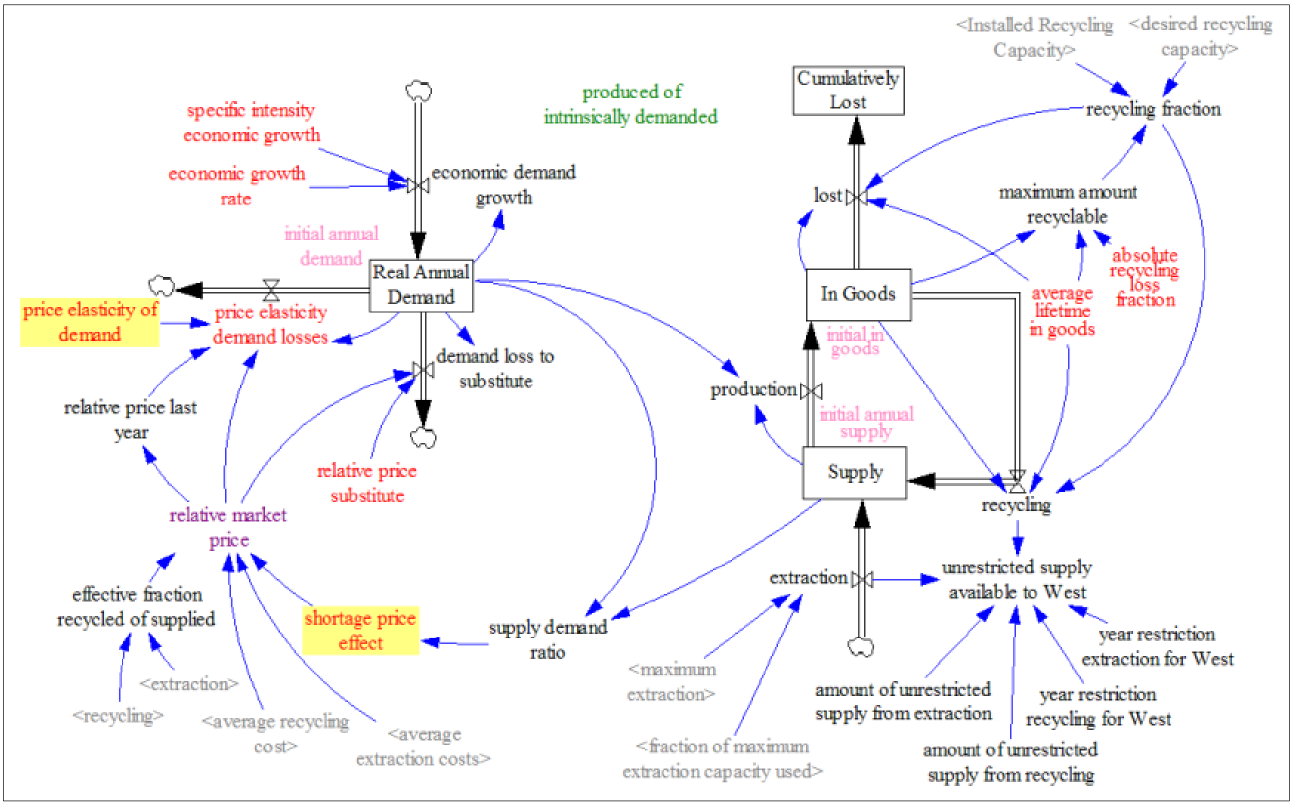


Figure 30: Demand and supply view using system dynamics (Pruyt 2010).

For designing an effective minerals policy, all the trends / flows for demand and supply of primary and secondary materials should be understood fully. In order to 'gauge' the trends, appropriate tools are needed. Material flow analysis (MFA) is, for instance, a tool that can be used to study the flows of different metallic, industrial, construction minerals within the administrative borders of a Member State (cf. Bide et al., 2016). There will be input from European Mineral Statistics, e.g. those of the British Geological Survey, which will help to identifying how the flows occur within the value chains. This requires data e.g. on the consumption of ores and ore concentrates, unwrought metals and alloys, etc. in the respective sections of the value chain.

Government ministries (e.g. those for economy, industry, environment, etc.) play a leading role in shaping the minerals policy of a country. The SDM approach attempts to integrate the role of such ministries in a generic manner so that it would be applicable to all MS. This flexibility will give us the ability to study how different policies on different parts of the supply chain will have impacts on the overall minerals demand/supply of a country.

The model is developed keeping in mind mainly metallic minerals due to the fact that the many variables need to parametrised in the most realistic way in order to obtain reliable trends that affect directly or indirectly the demand and supply of these minerals. Primary and secondary minerals are fundamental to Europe's economy and growth. They represent the most important link in the value chain of industrial goods production, which plays a prominent role as a source of prosperity in Europe.

Possible mineral / metal scarcity receives ever more attention as a potential supply security threat and a challenge for civil protection for many European countries. Shortening the remaining years until exhaustion of high-volume minerals /metals poses a threat to the continuation of our way of life. Potential strategic / speculative behaviour of state and private actors the rare earth elements (REE) market may also hinder or block the transition of our societies towards more sustainable ones. These rare earth elements are required in ever larger quantities for many innovative – often 'greener'– technologies such as hybrid cars, flat screens, solar cells, led lamps, mobile phones, consumer electronics, etc. However, these elements occur in quite dispersed geological settings and their extraction / production is expensive. Hence, it is important to assess whether these natural and/or artificial constraints may actually lead to temporary and/or structural scarcity, which may, in turn, hinder the transition towards more sustainable societies.

The present model has been developed based on copper intelligence capacity analysis as an example, making a variety of assumptions that are explained in the following. This current version of the model takes into account the demand and supply of copper. The behaviour of the market may differ in case of REE, owing to their low availability, or in case of precious metals due to their high prices.

7.2 A MICA System Dynamics model (SDM) for copper at global level

It is important to know the global development of basic metallic minerals for the establishment of any minerals policy framework.

The System Dynamics (SDM) model was developed on the basis of Equation 5.1 and using copper as an example. The MICA SD model starts the analysis taking 2005 as base year. Taking 2005 as the base year, the model works to estimate the supply, demand and price of copper. The model can be used to estimate the global demand, supply, prices of metals and energy up to the year of 2050 with the time gap being that of one year. The model has different sections which will explain the various aspects of capacity available for copper production, global demand and supply of copper as well as their prices. The whole model has been broken down in too many fragments so as to explain the factors, parameters etc. for proper understanding of the model. It will also be followed by the graphs wherever necessary.

Some facts about copper

The global demand for copper continues to grow: world refined usage has more than tripled in the last 50 years thanks to expanding sectors such as electrical and electronic products, building construction, industrial machinery and equipment, transportation equipment, and consumer and general products (cf. Figure 31).

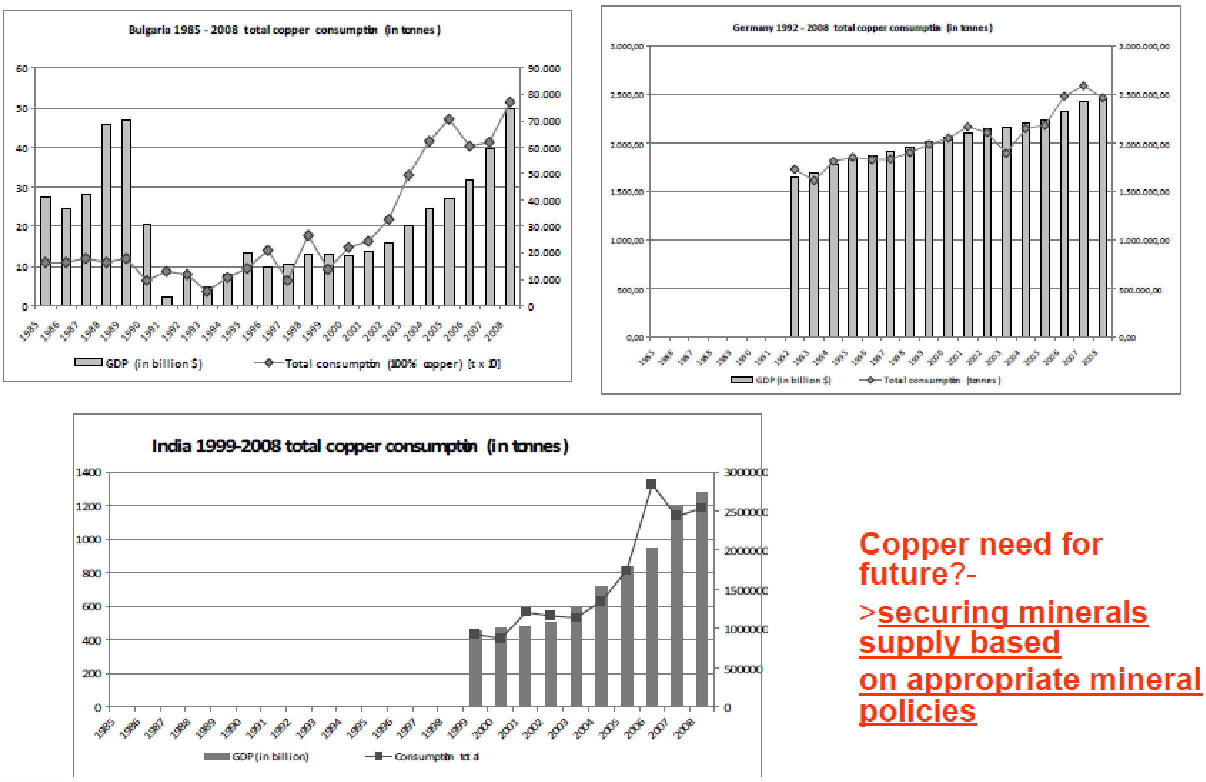


Figure 31: Copper consumption in Bulgaria, Germany and India (based on data from BGS, 2010).

Some of the highlights of 2014 copper production and usage are listed below. In the chapters that follow, more in-depth information is presented on copper production, trade, usage, and recycling.

Copper Production Highlights

Copper mine production. Preliminary figures indicate that global copper mine production in 2013 reached 18.1 million tons. The largest producer of mined copper was Chile (almost 5.8 million tons) (ICSG, 2015).

Smelter production in 2013 reached around 16.8 million tons. China was the largest producer of blister and anode copper in 2013 (over 5.7 million tons) (ICSG, 2015).

Refinery Production in 2013 was 20.9 million tons, including 3.8 million tons of secondary refined production (ICSG, 2015).

Figure 32 shows an example of a prediction of yearly production using the SDM model.

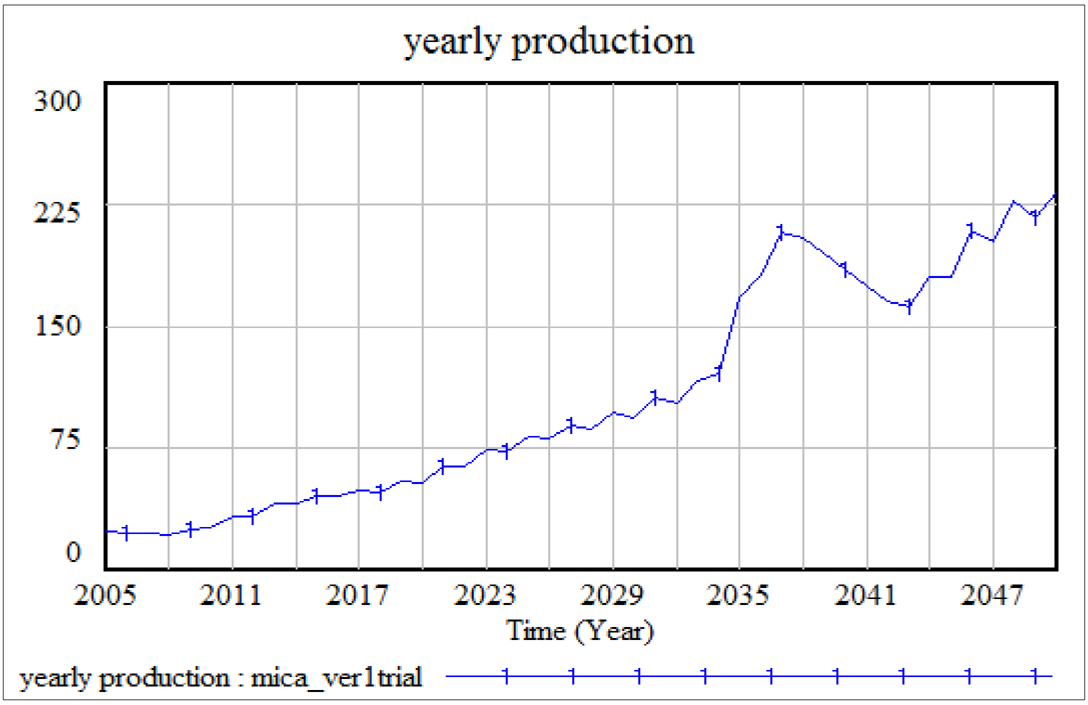


Figure 32: Predicted development of annual copper production to 2050 (Original figure).

Copper Usage Highlights

Refined copper usage (usage by semi *fabricator* plants or the first users of copper) in 2013 reached 21.2 million tons. China was also the largest consumer of refined copper in 2013 with apparent usage of over 9.5 million tons. Equipment was the largest copper end-use sector in 2012 year, followed by building construction and infrastructure.

New copper applications being developed include antimicrobial copper touch surfaces, lead-free brass plumbing, high tech copper wire, heat exchangers, and new consumer products as well.

Copper Reserves and Resources

Typically, the future availability of minerals is based on the concept of reserves and resources. Reserves are deposits that have been discovered, evaluated and assessed to be economically profitable to mine. Resources are far bigger and include reserves, discovered deposits that are potentially profitable, and undiscovered deposits that are predicted based on preliminary geological surveys. According to the United States Geological Survey (USGS, 2015), copper reserves amount to 690 million tons (Mt) and identified and undiscovered copper resources are currently estimated to be around 2,100 Mt and 3,500 Mt, respectively (basis 2013). The latter does not take into account the vast amounts of copper found in deep sea nodules and land-based and submarine massive sulfides. Current and future exploration opportunities will lead to increases in both reserves and known resources.

7.3 Model components

The SDM consists of a number of sub-models that describe particular aspects of copper use in society, namely:

- Mining and extraction of copper
- Global supply of copper
- Recycling of copper
- Global Demand for copper
- Price of Copper
- Global copper extraction capacity
- Resources and Reserves of copper
- Copper flow model

In the following these sub-models and their mathematical formulation are discussed.

Mining and extraction of copper

The primary step of obtaining copper is through mining of copper ore (e.g. chalcopyrite) and then following smelting and refining process. The extraction cost (Figure 33) primarily includes the cost of machinery cost, operation cost, manpower cost and overhead cost etc.

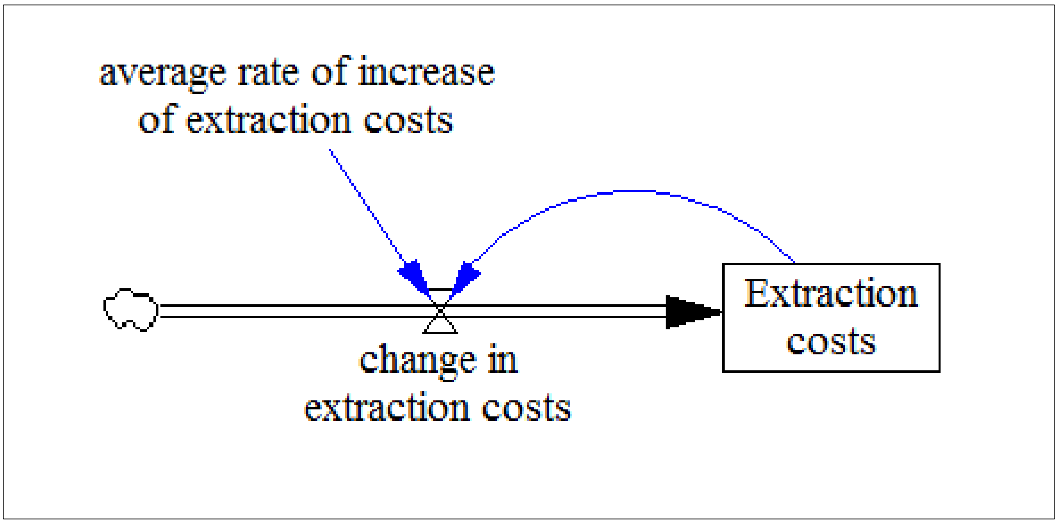


Figure 33: Conceptual model in the SDM for estimating extraction costs (Original figure).

The extraction costs have been dynamic, as the prices of these factors are changing. Observing the long run, the extraction costs have increased due to wage inflation, high energy prices, technology cost (new machines which are partially or fully automated are expensive) (Jamasmie, 2015). As in the last few years the oil prices have decreased, the drilling costs have decreased and the global competition in the technology has led to a slight decrease in the extraction cost.

The average rate of increase of the extraction cost added to the previous rate will give the present rate of extraction cost:

$[\ new\ rate\ of\ extraction = previous\ year\ rate\ of\ extration + change\ in\ the\ rate]$

$[change\ in\ the\ rate = previous\ year\ rate * average\ rate\ of\ increase\ of\ extraction\ cost(\%)\ ]$

There are many other cost factors that need to be taken into consideration following mining, including the refining of the copper ores, which is also the part of extraction cost. The mobilisation of technology and the energy cost will be the main expenses apart from the man-power cost. Taking into account these factors, system dynamics will be able to forecast the extraction cost of copper and the cost of those parameters directly or indirectly affecting the extraction cost.

Global supply of copper

This section of the SDM explains the global supply of copper (Figure 34). The model includes yearly production of primary copper from mining as well as recycled copper (secondary copper) as a part of global supply. The yearly production of primary copper (copper mine production) in 2005 was 14.9 Mt (ICSG, 2015) out of total 21.7 Mt of copper used globally (ICSG, 2015). The yearly consumption is the rate at which refined copper is being used globally, which is obtained from supply. An average 'life-time' of around 15 years is assumed for copper. Product life-time is used to indicate the useful time for a particular product before it gets disposed. This in turn will give us an indication of how much recycling is possible because we can know how much of the waste is being processed for extraction. Finally recycled products re-enter the supply chain after being treated. This also reduces the need for minerals.

It has been observed from the data of mine production, total copper production and recycling data that the global copper uses include 30%~35% of the recycled copper. For convenience we have assumed that 35% of total copper use comes from recycling of scrap of manufactured goods (e.g. electronics equipment) and melted high grade scrap. Not all of the copper entering the recycling system can actually be recovered; some part of it is lost during the process. Recycling part will be explained in detail in the next section.

The mathematical equation involving the supply is yearly production from mines plus recycled minus the yearly consumption which is equivalent to the demand. For the recycled copper, the equation used here is recyclable minus lost copper during recycling.

$M_C = M_{PR} + M_I – M_E – M_W$ (cf. Equation 5.1)

Where M_C = minerals consumed; M_{PR} = production of primary and secondary minerals (recycling); M_{PR} = $M_{PR(PRIM)}$ + $M_{PR(SEC)}$; M_I = minerals imported; M_E = minerals exported; M_W = Minerals going to waste, i.e. non-recoverable.

This is built into a MFA model (cf. Figure 34).

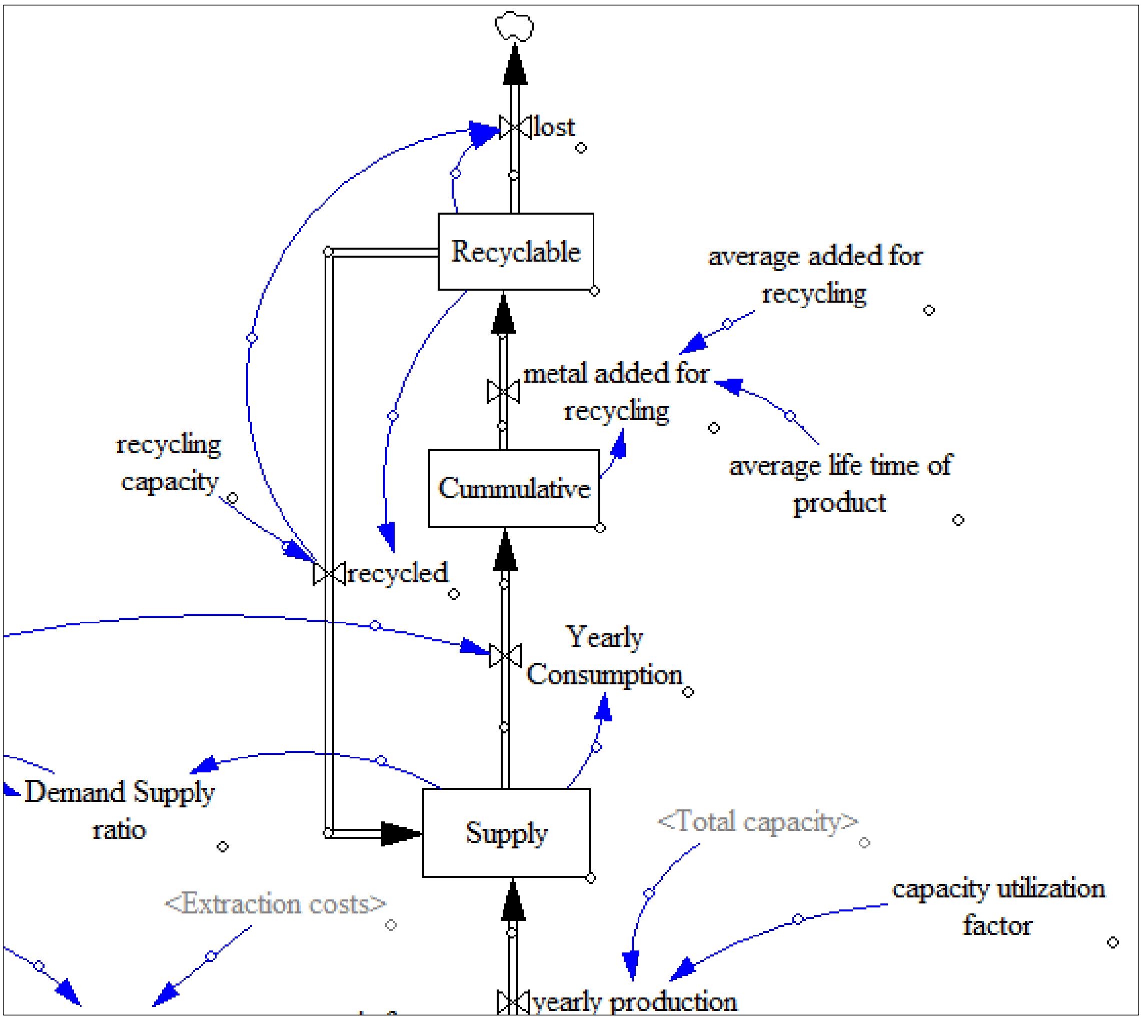


Figure 34: Copper supply balance (blue arrows represent relationships between two objects. The flows are represented by the arrows with black heads and a valve in between them).

Recycling

Copper is among the few materials that do not degrade or lose their chemical or physical properties in the recycling process. Considering this, the existing copper reservoir in use (in-uses stocks) can well be considered a legitimate part of world copper reserves. In the recent decades, an increasing emphasis has been placed on the sustainability of material uses in which the concept of re-use and recycling of metals plays an important role in the material choice and acceptance of products. If appropriately managed, recycling has the potential to extend the use of resources and to minimize energy use, some emissions, and waste disposal requirements. Closing metal loops through increased re-use and recycling enhances the overall resource productivity and, therefore, represents one of the key elements of society's transition towards more sustainable production and consumption patterns. It is widely recognized that recycling is not in opposition to primary metal production, but is a necessary and beneficial complement.

While recycling is a key element of the paradigm of a 'circular economy' (REF to EU-policy), it has to be understood that for thermodynamic and socio-economic reasons recycling can never be 100% efficient and effective. There will always be process losses and the collection of metal-containing waste will not be 100% effective. There will also be dispersive losses due to wear.

The recycling component, hence, can be written as:

Equation 7.1:

$$M_R = M_S - M_{RL} - M_U - M_{DL} - M_W$$

Where M_R = metal recycled; M_S = societal stocks of metal; M_{RL} = recycling processes losses; M_U = inaccessible / uncollected stocks; M_{DL} = dispersive losses due to corrosion and wear; M_W = metals lost in non-recoverable waste streams.

Global Demand for Copper

The dynamics of the global demand of copper is covered in this part of the SDM. The change in demand for copper over time can be determined as a function of the global economic growth rate and the specific intensity of the metal (the specific intensity of metal accounts for the changes that occur in the metal consumption patterns due to economic and technological developments, as well as other factors). In the model, the growth rates have been defined through a discrete look-up function of time, i.e. the growth rate assumes different values depending on the year. Changes in the demand of copper can be obtained by multiplying the growth rates, specific intensity of the metal, and demand. The present demand will be calculated by adding 'the change in demand' to the previous year's demand (Figure 35).

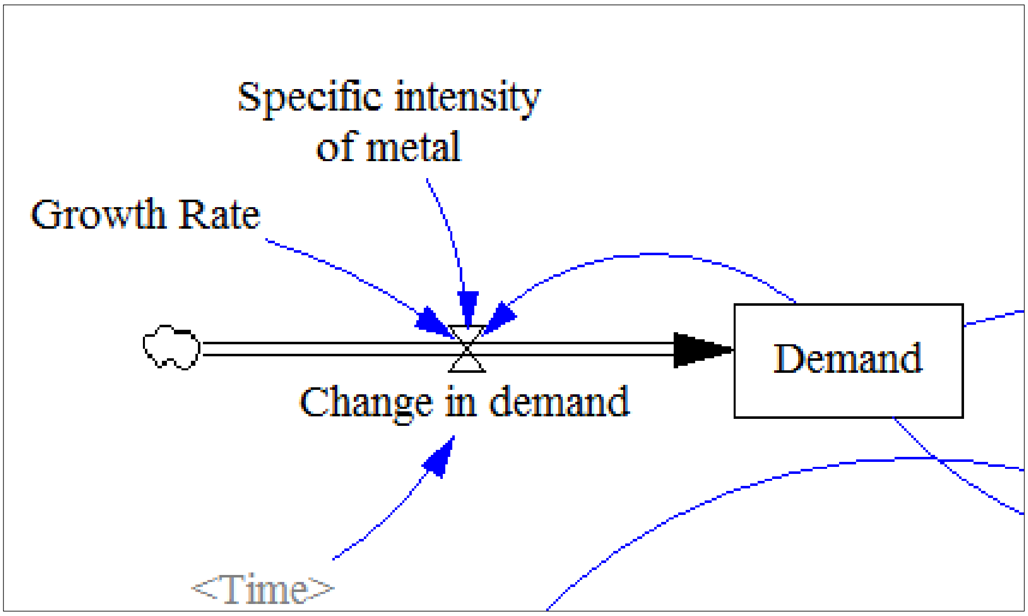


Figure 35: Conceptual model for demand in the SDM (Original drawing).

It can be seen that the demand for copper is continuously increasing as the *growth rate is positive*. As global GDP is increasing every year, the demand of copper is increasing (Figure 36).

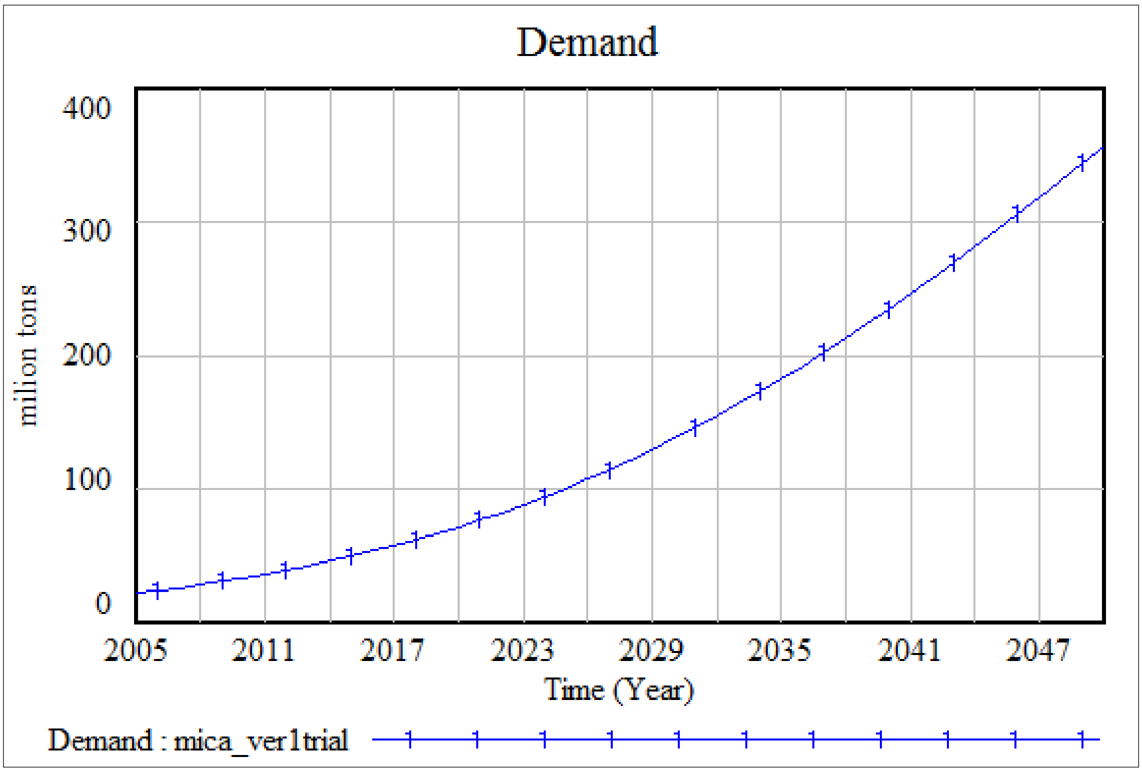


Figure 36: Copper demand, predicted with SDM (Original graphic).

Price of Copper

This part of the SDM covers the dynamics of prices and the factors on which prices depend on. It is based on the Cobweb theorem of demand and supply, which is directly influenced by the demand-supply ratio. A change in metal price may be positive or negative, depending on the ratio. If demand is greater than the supply, change in price is positive, i.e. prices increase, and if the supply is greater than the demand then change in price is negative, i.e. prices decrease. The demand supply ratio R is the difference between actual demand supply ratio and unity:

Equation 7.2:

$$R= (D/S)-1$$

Where D is the demand and S the supply.

The equation is normalised so that its value will range from -1 to 1. In other words, if e.g. D=100 and S=100, i.e. they are equal, the result of the equation is 0, leading to no change in price (as per the assumptions made by the model). If D>S, then the result is within the range of 0 and1, indicating rise in price and vice versa.

The price amplification factor [price amplification factor is the relation between supply demand ratio and the change in price] is adjusted as per the intrinsic value [the market value of the constituent metal] of the metal. Here we considered 2.4 (2.4 is an appropriate value to match data obtained from the model with actual prices). There is no absolute measurement of amplification factor; it is obtained by adjusting data. The change in metal price of the present year is influenced directly by the metal price of the previous year.

The copper price as modelled by the SDM is approx. matching the real global data (up to 2015), but there is a little difference between the actual and estimated copper prices. There are many other economic parameters that should be considered in order to get better results. We can see in Figure 37 that the copper price is increasing from 2005, the base year for the model calculations.

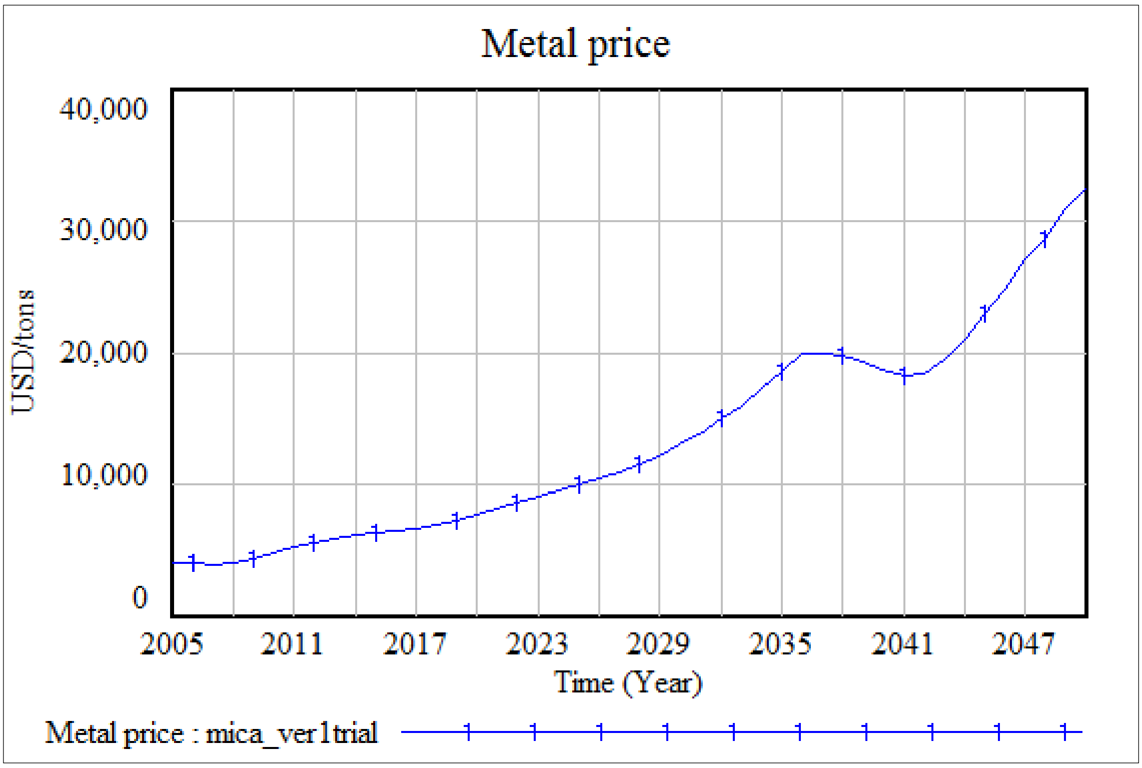


Figure 37: Result of SD model for copper price (Original graphics).

Global copper extraction capacity

This part of the SDM covers the global capacity need of copper extraction based on the global demand and supply of copper. With the demand for copper increasing every year, mine output has to be increased or new mines have to be opened in order to cope with the demand. 'Desired capacity increase' is the variable that describes how much more is needed in order to satisfy the global demand. It can be obtained as the ratio of the difference of demand and supply to the capacity utilisation factor. Its value has been set at 85% in general (The World Copper Factbook, 2015), but de facto it can be more or less Governments / decision makers may be always ready to face the new demand challenges; hence there is exogenous capacity that is always on stand-by, considering the historical demand of copper. Suppose the demand of copper increases instantly, new mines cannot be opened instantly. Hence, governments / decision makers may be ready to face the challenges by permitting / constructing new mines. Planned capacity is decided based on the greater values between 'the exogenous capacity' and 'desired capacity increase'; the greater one will be accepted as the planned capacity. Hence, planned capacity each year is being added up to the 'capacity under construction' and finally it is commissioned to achieve the targets governments have to always plan the commissioning of mines depending on the demand and supply scenario. Hence planning is very crucial to meet the demand in future.

Target capacity is the sum of the capacity under construction and the total capacity. Total capacity will be obtained by the 'addition to capacity' which is directly influenced by the 'average construction time', and the commissioning capacity. The integration of the 'addition to capacity" will give us the 'total capacity'. The 'total capacity' will eventually decrease due to 'decommissioning' of capacity, as there is finite life of the mines (Figure 38).

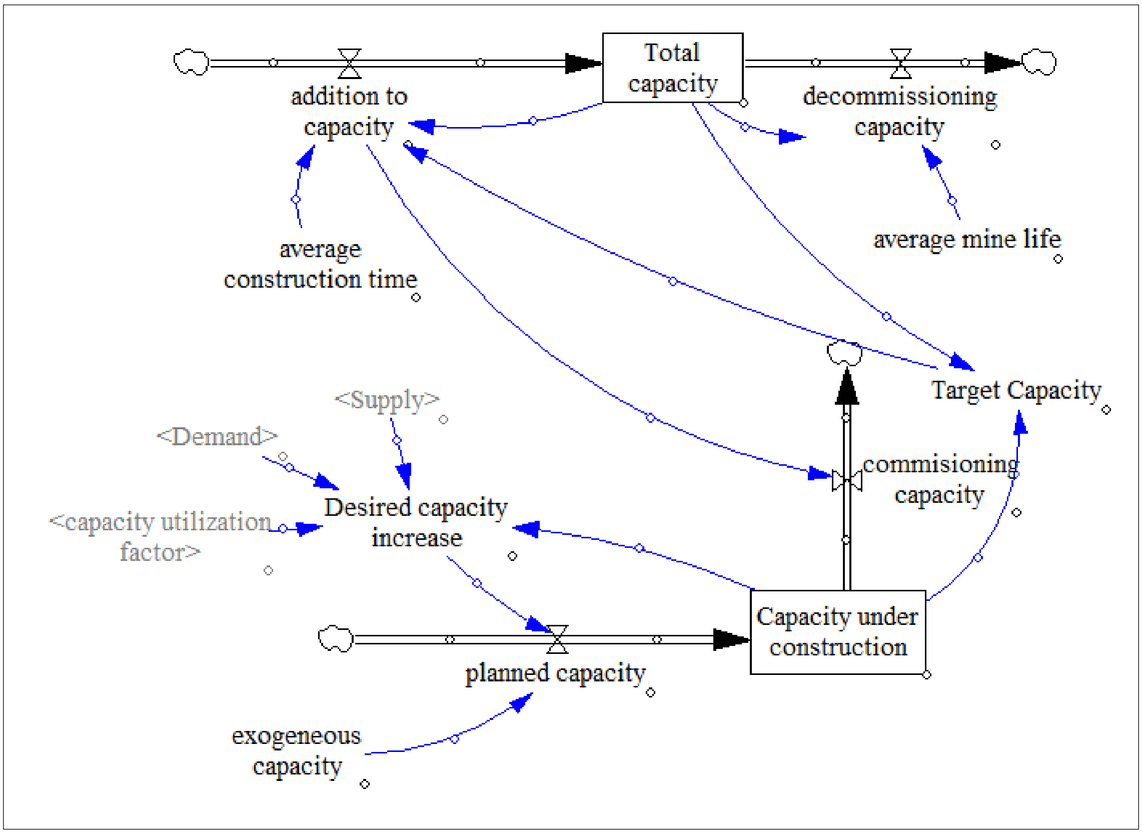


Figure 38: Conceptual model for capacity addition in the SDM (Original graphics).

Resources and Reserves

In this part of the SDM we are trying to estimate how the resources are converted in to reserves, which influence the global copper production (Figure 39). Resources are the probable amounts of ores that are the assets for a country's economy whereas Reserves are the proven part of resources which can be extracted with current technology and is economical. The question of conversion when resources become economical enough for extraction with the technology of the time depends on many factors one of which is the price of the metal. The profitability factor and economical factor attempts to capture this aspect. They work on the principal that whenever the price of the metal is high enough (and hence more potential profits), the cut-off grade of the metal is lowered and resources are added to the current reserves.

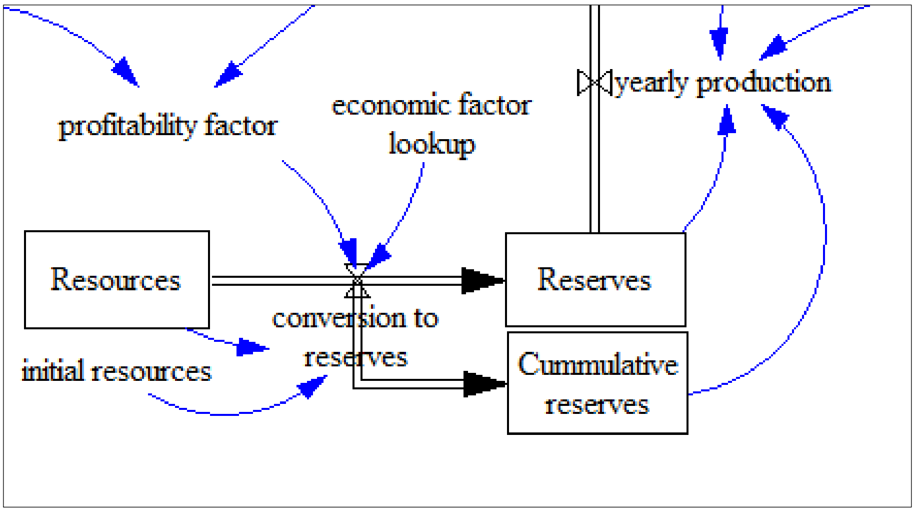


Figure 39: Conceptual model in the SDM for the conversion of resources into reserves (Original graphics).

In Europe, there has been an initiative to protect and designate certain deposits as Mineral Deposits of Public Importance (MDoPI) (MINATURA2020, www.minatura2020.eu). The model will treat MDoPI in a special way so that we can see the importance of these deposits to the EU economy with and without them.

The value of the copper resources that are converted into reserves over a certain time interval is obtained by multiplying the profitability factor, economic factor and the ratio of resources to initial resources (before the time interval); see Equation 7.3.

Equation 7.3:
Conversion to reserves = (Resources/initial resources) x profitability factor

This formulation is used to indicate that mineral resources are finite resources and that they decrease overtime as a result of mining. The result of the equation will be 0, when there are no more resources left. Thus, reserves are obtained by integration Equation 7.3 over a selected time interval.

Copper Flow Model

A comprehensive study of the stocks, flows and recycling rates for copper has been developed by the Fraunhofer Institute (Glöser et al., 2013). This study aims to answer the question of how much copper is recycled compared to the amount of available copper scrap. In doing so the model reconstructs the history of copper stocks and flows but does not provide future-oriented scenarios. However, this complex, three-year study has resulted in a much improved understanding of how copper is used and re-used by society. The flow was adapted in the model (Figure 40). The expected outcome shows a huge potential for renewable scrap from the flow (because of the cumulative copper usage).

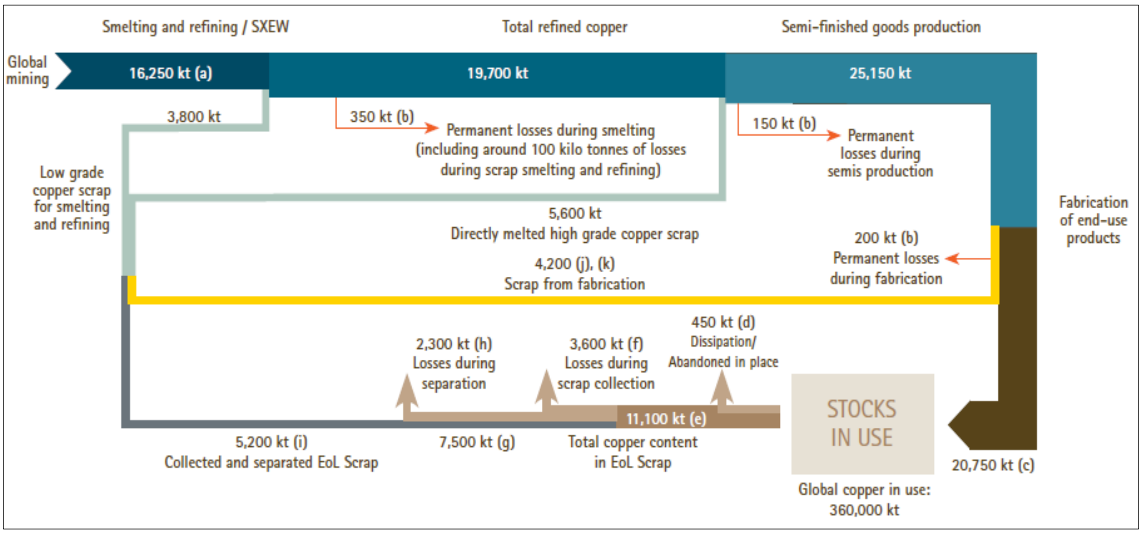


Figure 40: Industry Global Flows of Copper (Glöser et al., 2013).

8. Systemic Minerals Policy Effect Assessment

8.1 Level of minerals policy

Minerals policy takes place on several administrational levels: the European Union level, the national level, the regional and the local level (Table 7).

Table 7: Principles for an effective Minerals policy framework.

	International	European	National	Regional / Local
Policies	Provide a Global Framework based on international cooperation which can ensure availability of minerals in resource deficit nations as well by encouraging favourable trade practices	Provide a level playing field based on secure access to minerals > Raw Material Initiative + follow-ups	National minerals policy framework Commitment to regulatory and knowledge framework Incorporate minerals in land-use planning	Identify and protect reserves of mineral resources
Intention	To Promote International Cooperation and Coordination of mineral resources	Consider minerals as key resource	Consider Public Interest, harmonizing sectoral policies	Autonomy from local political pressures Indicate time length to obtain a permit, or extension of existing permits
RMI-context	Global material flow analyses; raw material diplomacy dialog EU vs. e.g. USA, China, Japan, Russia / technical matters	H2020 projects e.g. CRM (>SCRREEN) MDoPI (>MINATURA), MIN-FUTURE etc.	Analyses of mineral consumption based on MC-scenarios, future MC trends with e.g. system dynamics modelling; minerals planning using GIS application	Collection of data
Policy Implementation	Coordinate all country's NMPs; Ensure uniform policy standards	Monitor national minerals policies	Focus on National interests, coordinate with regional policies. Ensure international standard practices	Give certainty to operators
Impact	Better Resource utilisation at Global level. Supply of minerals to mineral deficit countries	Better Resource utilisation and coordination at EU level	Assess reserves of authorised available resources	Number of permit applications, refusals

As this report aims to provide the wider context, it focuses largely on the wider, international context. Her we also examine the pertinent UN conventions and treaties, as well as the policies of some major world-players in minerals, such as China, Africa, and some of the BRICS countries (cf. Appendix 4, page 218). While other major suppliers, such as Canada and Australia in general have more co-operative relationships with Europe, the latter increasingly develop policies that are focused on their own development goals or position in the world market. These considerations appear to be particularly relevant with respect to the accessibility of minerals, e.g. constraints due to social licensing issues or due to resources nationalism.

8.2 Geopolitics and minerals

Focus of European minerals supply security

The minerals economy provides an essential contribution to employment and value added and thus is crucial for the European Union industry. Minerals are the most important link in the value chain of industrial goods production, which plays a prominent role as a source of prosperity in Europe. A secure supply with mineral resources for the European industry/economy is absolutely necessary. Occurrence and consumption of fossil, metallic and industrial minerals are distributed unequally on a worldwide range. However, a structural change has taken place on the global mineral markets. The old rule of thumb by Pareto (1919) according to which 20% of the world population (in Europe, USA and Japan) are consuming more than 80% of the total resources/ minerals production is not valid any more. With the integration of India, the People's Republic of China and other populous emerging countries such as Brazil and Russia into the world economy, but also Indonesia, today more than half of the world's population claims an increasing share in raw materials. Thus, the global demand for raw materials stands at the bottom of a new growth curve. It is assumed that by 2030 the worldwide need for raw materials will have doubled. This endangers the security of European minerals supply.

Estimates by the OECD Development Centre (OECD, 2010) suggest that today's developing and emerging countries are likely to account for nearly 60% of world GDP by 2030. Increasing income in these countries means also a growing demand for manufactured industrial goods, which opens new trade options for the export-oriented European industry. Measured by their population, the leading African markets, the so-called 'African Lions' Algeria, Botswana, Egypt, Libya, Mauritius, Morocco, South Africa and Tunisia are strongly participating (have even overtaken the BRIC states related to their economic performance per capita in 2008). China has become the major trade partner of Brazil, India and South Africa; South-South links are of increasing importance as a motor of growth in developing and emerging countries.

Liberal market economies (e.g. EU, USA, Japan,) vs. planned economy paradigms (e.g. China; Russia)

Regarding the European mineral supply security: the access to deposits outside and inside in Europe has been increasingly limited for various reasons, for instance limited exploration over the last decades, environmental issues, or competition for different land-use. There is no comprehensive minerals knowledge at European level so far. The EU Raw Material Initiative provides a general framework. This is important; however, what still is missing is the (establishment of) a comprehensive EU minerals knowledge base; also mentioned in the H2020-documents of the European Innovation Partnership on Raw Materials (SC5-13, p. 52, published in 2013): "There is no raw materials knowledge infrastructure at EU-level".

Oligopolistic structures in supplier countries may lead to market distortions also in Europe. For many raw materials, particularly metals, Europe is dependent on imports, a fact to which has been paid little attention as yet, but in times of increasing raw materials prices public awareness is growing.

Booming prices of fossil fuels, of coke and steel are striking examples of recent years. Recent disturbances on the international raw material markets were often caused by discrepancies of supply and demand which were also enhanced by rapid volatilities of these market factors. At the same time, developing and emerging countries have increasingly claimed stronger consideration of their interests by political means. Consequences for Europe are uncertainties of supply and problems with availability. Deficiencies of supply in import dependent countries like Europe and Japan have recently led to reductions of production. Volatile prices on the international commodity markets impact directly the costs of downstream production sectors and thus influence economy as a whole. Increasing demand together with lacking awareness of the raw materials matter sometimes leads to paradox situations. Mineral security is not a secondary problem of single industrial sectors. It is, on the contrary, a basic prerequisite for the stability of the complete value added chain, relevant for job preservation and thus economic prosperity. Changing conditions on the world market require a proactive economic policy of the European Union and its member states. Further prosperous development of the European economy is crucially dependent on undisturbed and, applying the scale of international competition, profitable supply with mineral raw and base materials.

In view of the described risks and problems, safeguarding the supply with raw materials on the basis of a minerals policy will be a permanent challenge for the European Union and all European countries. Appropriate measures for securing the supply with raw materials have to be taken. A successful coherent minerals policy will have to take over essential tasks to solve these problems. In this respect: In particular (what is one mayor aim of MICA), enhancement and extension of existing RMI tools/instruments can guarantee (European) domestic security of supply (including recycling, substitution and resource efficiency) and provide a sustainable strategic European minerals policy.

With respect to minerals knowledge: The USGS minerals yearbooks represent an impressive knowledge not only in the USA but at global level as such. Available resources to maintain this knowledge level are impressive.

The minerals strategy of **China** focuses on increasing the domestic capability of mineral resources supply. The intention is the promotion of exploration, and also the development of a competitive mining industry. China encourages foreign businesses to invest in prospection and exploitation of mineral resources in the country. Domestic mining enterprises are to cooperate with international mining companies, draw on advanced international experience, import advanced technology and operate in accordance with international practices. Furthermore, China is consequently acquiring external mining rights. EU versus China: EU-external risks and problems of the European raw materials supply exist due to instabilities in producing countries and an increasing conglomeration of mining areas and businesses on the international commodity markets. Politically induced, i.e. intended, restrictions of raw materials access/availability in form of trade distorting measures belong to the central problems in raw materials supply security. At the international commodity markets there are tendencies to favour trade distorting national measures both on the supply and on the demand side of domestic commodities, making raw materials export more difficult. Distortion happens for example by recovering value added tax on imports, discriminating license systems or prohibitive high export duties, which in fact equal an export prohibition. This can be seen as an attempt to provide strategic industrial-political advantages at the expense of trade partners. Unsatisfactory political competition control mechanisms are another problem. China for instance subsidizes the import of raw materials, conferring advantages to its industry. At the same time, China limits exports of certain domestically abundant natural resources, such as rare earths, which can distort availability and price of raw materials in world markets (double pricing) (BDI, 2007).

The **Russian Federation** has developed a resource strategy. With the "Governmental Ordinance No.494-r of 2003 regarding validation of the Bases of state policy in the sphere of utilisation of minerals and the use of subsoil" the basis for strategic planning and use of the minerals is created (Government of the Russian Federation, 2003). The Ministry for Natural Resources together with further national organs is responsible to establish a fundamental strategy. The main tasks lie in securing minerals as well as in the efficient mineral management for the sustainable development of the Russian economy, as well as intensified use of domestic deposits to the benefit of present and future generations. An essential element of the strategy is the preservation of the geopolitical interests.

Minerals for humanity vs. national or corporate interests

The market structure for mineral supply is important: since the early 1980s, a decline in the influence of state-owned mining corporations is noted, however from the mid-1990s numerous of the major mineral sectors displayed a trend towards greater concentration (Maxwell, 2013). Importantly, also the number of buyers exerts an influence over the competitiveness of particular mineral markets and their structures. Traditionally, the relative competitive mineral sectors included gold and copper. The iron ore sector, as well as the minor mineral sectors are characterised by few sellers and few buyers. Major non-ferrous metals, as well as gold and silver, however, are nowadays recognised as more competitive, partially as a result of the increase in their respective market size (Crowson, 2013).

Market power by producers is reflected in their price setting by so-called producer prices or list prices which have the purpose of guaranteeing a profit (Maxwell, 2013). In contrast to that are firms which are price-takers of the competitive outcome. These latter firms adjust their output according to market prices (ibid.). However, the output adjustment by price-taking firms is contested, including by drawing on the case of zinc and lead for which mineral prices have been low for long periods of time (ibid.). While adjustments in production volumes are made, these are constrained by, and vary according to several factors: first, current output and inventory levels can be adjusted in the short term, and so can be mine capacity, yet the size of reserves available for mining is an adjustment that takes long time, as does the establishment of a new mine from the application procedures to obtain mining permits to the construction of the mining facilities, the ramp-up and production to planned volumes.

Irrespective of the socio-economic system adopted, almost all planners agree that industrialisation and industrial production are a source and means of economic welfare, so the process of industrialisation still dominates globally all concepts of economic policy.

The way to maintain the standard of living in industrialised nations and to enhance socio-economic development in Third World countries is to increase the production of industrial goods. The industrialisation process increases the global demand for minerals. Some minerals will become relatively scarce, leading to the exploration and development of new deposits. At the same time an increasing gap will develop between the mineral importing and exporting countries. Consequently, this means: the exploitation and utilisation of minerals increasingly endangers the environment, mineral costs tend to rise due to more remote and lower grade deposits being opened up, costly measures to protect the environment and increasing taxation imposed by mineral exporting countries. These developments have on one hand led to an expansion in world trade but on the other caused problems for the world markets for numerous minerals, in particular:

- Strong, usually short-term ***price fluctuations***
- Substantial ***fluctuations in the earnings*** of producing countries,
- ***Low transparency*** of mineral markets due to the high level of supply side concentration
- ***Limitation of access to some mineral markets*** due to customs barriers and trade structures
- ***Uncertainty of medium and long-term supply*** due to decline in exploration activities in the last years, production problems in exporting countries and export quotas imposed by international cartels.
- Problems concerning the ***availability of deposits***

There is a certain conflict potential between mineral exporters and importers. The mineral dependent (industrialised) countries (as well several emerging economies) are striving for a long-term safe, adequate and preferably affordable supply. The mineral exporting countries, however, are primarily concerned with stabilisation and continued increases of sales revenues from the export of minerals and the provision of investment capital for mining projects. The resource-poor developing countries have to rely on international assistance, because they would lack, otherwise, the basis for industrialisation (Gocht, 1983).

The conflict potential can be met by comprehensive planning in advance. The search for prize mechanisms capable of compromise is in this respect an essential challenge of an international minerals policy. This has to be seen against the background of an inequitable consumption. The rich world uses far more minerals per head of population than the poor world. For example, in a 77-year lifespan, the average North American will consume around 600 tonnes of construction minerals and 550 tonnes of fuel, while the average 77-year-old Ethiopian, Bangladeshi or Nepali will have consumed less than 5 tonnes of these commodities (Petterson et al., 2005). In spite of the unequally distributed demand for minerals, many of the richer countries, particularly the more densely populated areas, are drafting increasingly prescriptive and constraining planning policies and regulations. Environmental designation of areas often excludes mining options. In other words: there is a remarkable demand for minerals in countries, while at the same time, mineral production is shifted to third countries and thus mineral imports increase. This is obviously an inconsistency in mineral distribution policy.

Therefore, one important objective of any international minerals policy is to avoid conflict between minerals producing and consuming countries over distribution of mineral commodities by setting up a distribution system acceptable to all parties. The latter includes stable production and supply, meeting demand requirements, competitive prices and trade. In the 2011 Communication, the Commission stated that the EU will actively pursue a "Raw Materials Diplomacy" with a view to securing access to raw materials, in particular the critical ones, through strategic partnerships and policy dialogues. The Raw Materials Diplomacy aims to engage with partners though strategic partnerships and policy dialogues to exchange information and work together to address the challenges on raw materials' markets. This path has been pursued with the United States, Japan, Russia, Argentina, Brazil, Colombia, Mexico, Uruguay, Greenland, China and countries of the Union for the Mediterranean while further dialogues are in preparation (EC, 2013).

8.3 SWOT analyses of minerals policy options – International / EU

The set of policies developed by important countries like BRICS etc. and EU-MS will be subject to a SWOT analysis. Of particular importance, will be aspects of implementation and market / industry / stakeholder acceptance of policies. Effective enforcements of policies – monitoring, legal framework, mining legislation – cross link to EU project on mining legal framework; which kind of incentives are used to implement policies, e.g. tax incentives, subventions, legal sanctions.

Financial incentives of mining investments

While taxes are the brakes, incentives may be accelerators in the mining development. Such incentives – beyond their financial value – may bring government cooperation and support a much more valuable item in mining investments.

Several European mining countries do not use these tools (Ireland, Portugal); others make significant efforts to pull in capital to mining investments, as part of their regional development policy. **Sweden**'s North – Norbotten, Vesterbotten – is one of the well-known success stories from the end of the 20th century of positive results on combined incentives to mine developments, explorations. **Finland**, through its national minerals policy, offers a refund on expenditures related to exploration and mining R&D activities, and set up a special funding scheme in The Finnish Industry Investment, according to National Minerals Strategy, ear marked capitalisation to be invested in mining sector projects and companies. Finland also participates in the financing of transport infrastructure investments needed for starting of new mines (railroads, roads, harbours). Loans for mining companies are granted e.g. by Finnvera (specialised financing company owned by the State of Finland). In 2011 Finland launched the Green Mining Program through Tekes (the Finnish Funding Agency for Innovation) aiming at the development of intelligent and minimum-impact (invisible) mines and the development of new mineral resources. Until June 2016 the total investment portfolio had reached € 115 million, of which Tekes had contributed with 55, companies € 53 million and universities € 7 million. **Poland** provides 50% royalty reduction over by-product productions. **Spain** applies a special 10 years depreciation scheme to write off mining and exploration investment costs.

Collection of relevant features

The minerals policies and strategies of several countries at the international and EU level (see the list below) have been revised and scanned. The analysis was focused on stand-alone documents that clearly described the strategic objectives of the countries towards the future, both for primary and secondary mineral resources.

- European Union
- USA and Japan

- Africa and the Africa Mining Vision
- Tanzania
- Malaysia
- BRICS

The information was collected for four variables:

- General information, type of publication and, if necessary, kind of minerals covered
- Objectives
- Actions / monitoring / updating
- RMI context (which tools/methods have been used in such policies/strategies, if identifiable in the documents)
- Commitments to the regulatory framework (if applicable)

The results of the analysis are presented below in Table 8 and Table 9.

Table 8 International Raw Material Policies and Strategies for selected countries.

Countries / International context	General info, Publication, kind of minerals covered	Objectives	Actions / Monitoring / Updating	RMI context	Commitments to regulatory framework	Remarks
China	State Council of the People's Republic (2006): China's Policy on Mineral Resources	Sustainable development and Rational Utilisation of Minerals. Protection of Resources	China's Program of Action for Sustainable Development in the Early 21st Century	Policy development concerning use of mineral resources in the long term – First 20 years of this century. Increase domestic reserve of minerals which are having high market demand especially in the west – Hence, ensuring long term market control Sustainability to be of key importance Inviting International organisations for exploration and resource development with objective of importing advance technology in Mining		www.chinamining.org/Invest-ment/2006-08-04/1154674314d441.html

	The Energy Development Strategy Action Plan (2014-2020) published by the State Council in 2015 (www.sehenstar.com/ShowNews/?133-1.html) and13th 5-year development plan (2016-2020) published by	The Energy Development Strategy Action Plan aims to reduce China's high energy consumption through a set of measures and mandatory targets, promoting a more efficient, self-sufficient, green and innovative energy production and consumption. The targets include a cap on annual primary energy consumption set at 4.8bn tonnes of the standard coal equivalent until 2020, with a need to limit the annual growth rate of primary energy consumption to 3.5% for the next six years (www.lse.ac.uk/GranthamInstitute/law/energy-development-strategy-action-plan-2014-2020/) Transition towards low-carbon development: energy intensity reduction and carbon intensity reduction (18% reduction from 2015 level by 2020) Positive development of natural gas, nuclear power, renewable energy and other clean energy sources, reducing coal consumption, promote the continued optimisation of energy structure.	No details disclosed on monitoring	No details disclosed (at least in English versions) on the tools/methods used		

Russia	Currently the minerals policy of Russian Federation is governed by the "Strategy of the geological industry development until 2030" (2012) and the "Reproduction and use of natural resources" state program (2014). Published by the Government of the Russian Federation	Strategic goal of the geological sector until 2030: create high-performance, innovation-oriented system of geological study and reproduction of the mineral resource base Main objective of the minerals policy is to ensure the country's economic reserves of minerals and geological information on mineral resources. These goals are achieved by solving problems on improvement of geological exploration in Russia and its continental shelf and the Arctic and Antarctic, obtaining geological information, ensuring the reproduction of the mineral resource base and the rational use of mineral resources base.	Creation of the Rosgeologia (ROSGEO) State exploration company to deal with various problems such as lack of general geological knowledge of the country, lack of reserve in the state of large and medium-sized mineral deposits, reducing size of the newly discovered mineral deposits, incompleteness organisational form of the public sector geological industry and poor technical condition of its member organisations exploration, the loss of a significant part of the scientific and technological capacity, aging, and shortage of staff	•policy development concerning use of mineral resources in the long term (20, 30, 50 years); •analysis and assessment of prospects for domestic consumption, exports, imports of minerals and development of proposals to meet deficits of minerals; •development of measures to establish strategic public mineral reserves, to form sufficient storage of strategic reserves; •timely and regular funding from federal budget to carry out geological studies in terms of national security, anticipation, identification and assessment of strategic minerals, to meet the needs of industries in geological information on mineral resources; •monitoring and evaluation of mineral resource base; promoting activities of mining companies including through budgetary funds		http://faolex.fao.org/docs/texts/rus40699.doc No info on Russia´s scrap recycling-reuse policy
India	Ministry of Mines / India (2008): NATIONAL MINERALS POLICY	Resource Independence and Technological Advancement		Focus on Exploration and Exploitation of existing reserves by encouraging Public and Private players both Environmental Impact Assessment and Sustainable development Socio-Economic benefit of Mineral extraction and development is of prime importance		http://mines.nic.in/writereaddata/Content/88753b05_NMP2008[1].pdf

South Africa	Department of Minerals and Energy (1998): Minerals policy development in South Africa	Resource exploitation for Economic Development of the Nation		Focus on Economic Development of the country based on mineral resource. Resource sector must enhance overall development of the country – GDP, Infrastructure etc. International Cooperation to be encouraged to increase investment, import better technology		

USA	Critical Materials Strategy (2010) published by the U.S. Department of Energy (DoE)	This report examines the role of rare earth metals and other materials in the clean energy economy and the risks of supply shortages.	The DoE will: 1) develop its first integrated research agenda addressing critical materials 2) work closely with international partners, including Japan and Europe, to reduce vulnerability to supply disruptions and address critical material needs. DOE's strategy with respect to critical materials rests on three pillars. First, diversified global supply chains are essential. To manage supply risk, multiple sources of materials are required. Second, substitutes must be developed. Third, recycling, reuse and more efficient use could significantly lower world demand for newly extracted materials. Research into recycling processes coupled with well-designed policies will help make recycling economically viable over time. In the document program and policy directions and the critical material supply chain are identified	The study provides estimations on future demand for key materials (e.g. rare earths). When estimating the expected demand in non-clean energy technologies (e.g. mobile communication devices) the analysis assumes that demand for key materials increases at the rate of growth for the global economy projected in the International Energy Agency's World Energy Outlook 2009, i.e. it uses compound annual growth rates. To account for uncertainties (e.g. the rate of future technology deployment for wind turbines over the period 2010-2025) High Penetration case and a Low Penetration case were developed. For each material, the high and low assumptions for rates of technology deployment, market share and material intensity were combined and added to the non-clean energy demand to develop four distinct demand trajectories. Two trajectories, labelled Trajectory A and Trajectory B, reflect the slower rate of penetration for each application and represent combinations of the Low Penetration case with the high and low assumptions respectively for material intensity. Similarly, two trajectories, called Trajectory C and Trajectory D, represent combinations of the High Penetration case with the respective low and high material intensity assumptions The study also conducted "criticality assessments"- analyses that combine the importance of a material to the clean energy economy and supply risk with respect to that material. Short- and medium-term scores for "Impact of Supply Disruption" and "Supply Risk" are based on a weighted average of two attributes. For each attribute, key materials were assigned qualitative factor scores of 1 (least critical) to 4 (most critical). It is important		

Japan	JOGMEC Annual Report 2016 (JOGMEC´s policy summarises Japan´s resources policy)	Main goal: Secure a stable supply of raw materials for Japanese industries Increasing number of import countries to increase supply diversification. Invest in international resource exploration and exploitation Strengthening resource diplomacy via human resource formation, harnessing technical capabilities to strengthen relationships with resource-producing countries (e.g. Australia, Mozambique)	Multi-faceted approaches to oil and gas, coal, and metal-rich producing countries Provision of financial assistance via equity capital and liability guarantees for exploration and development of oil/gas, coal and metals exploration, development and recycling, geothermal resource development, all for Japanese companies operating inland or abroad Conducts land-based and marine geological joint venture surveys by Japanese companies operating overseas and via partnerships (joint studies, memorandums of understanding) Conducts R&D activities from the perspective of building and strengthening relations with oil and gas producing countries, satisfying Japanese companies' needs, and securing resources Overall management of national petroleum stockpiles (oil, LPG) and rare metals stockpiling Providing technical support to entities implementing mine pollution control projects, conducting technology development, and providing information and extending financial support to private companies Collecting, analysing and providing information: as a specialist organisation supplying data on upstream oil and gas operations, JOGMEC surveys and analyses a wide range of issues, including the global energy and non-energy resource and situation, regulations and tax regimes in oil and gas producing countries, information on newly opened exploration areas, and shares the results of its surveys and	Japan has an almost 100% import dependency rate on various important minerals (in 2014 a 99.7 % on oil, 97.6 % on gas, 100 % on copper ore, 99.4 % on coal) needed for the processing industries and thus Japan is regularly working on maintaining the stability of its foreign resource supplies. No forecasts of future mineral demand has been identified in JOGMEC´s documents		

	3rd Fundamental Plan for Establishing a Sound Material-Cycle Society published by the Japanese Ministry of the Environment (2013)	Reduce consumption of natural resources and minimise the environmental load (3Rs policy, targets for individual recycling laws)	In latest decades, the Japanese Government made significant efforts to promote eco-friendly society. 3R (Recycle – Reuse – Reduce) Months and 3R National Conventions have been held annually since 2006. Along with several other promotion steps (3R marks on products), the Eco-Town programme was started in which the localities highly protecting the environment are certified as Eco-Towns. Monitoring of following Material Flow Analysis indicators (and progress towards targets): Resource productivity (GDP/input of natural resources) Cyclical use rate (= amount of cyclical use / amount of cyclical use + natural resources input) Final disposal amount (amount of landfill disposal waste) Fundamental plans are revised every 5 years; the 1st plan was developed in two years (2001-2002) with 17 working group meetings and 9 public hearings (from business, NGOs, and local governments).			

	MEXT (Ministry of Education, Culture, Sports, Science and Technology), METI (Ministry of Economy, Trade and Industry), Japan Science and Technology Agency National Institute for Materials Science (NIMS)	The "Element strategy": understand the function of each element deeply and conduct research to substitute critical elements. Drastic Substitution of rare and harmful elements and rare metal substitution material development project (30 to 80% reduction of In, Dy, W, Pt, Tb, Eu, Ce)	JST Action: Creation of Innovative Functions of Intelligent Materials on the Basis of Element Strategy (www.element.jst.go.jp/en/greeting/) Conduct research and development to create innovative properties and functions of intelligent materials by multilaterally and systematically elucidating and understanding problems common in the expression of a variety of functions, such as structure, interface, and electron correlation, and controlling the functions.	Substitution of elements. No clear description of tools and methods applied in the framework documents.		

Brazil	National Mining Plan 2030. Geology, Mining and Mineral Processing published by the Brazilian Ministry of Mines and Energy (2011)	Guide the medium and long-term policies so that they can contribute to the foundation for the country's sustainable development over the next 20 years	1) Ensure Effective Public Governance of the Mineral Sector 2) Ensure Expansion of geological Knowledge in the National Territory 3) Establish guidelines for strategic minerals. Such minerals are considered strategic if: 1) they are minerals that the country imports in large scale such as potassium, phosphate, metallurgical coal and for which there is possibility of import in the near future, as is the case with uranium, 2) Minerals whose demand is increasing and which are expected to expand further in the coming decades because of use in high-tech products, such as rare earths, lithium, tantalum, terbium and cobalt, and 3) minerals for which Brazil presents a natural comparative advantages and gained international leadership, such as iron ore and niobium. 4) Establish Mining Guidelines in Areas with Legal Restrictions 5) Implement the formalisation Programs and strengthening of SMEs 6) Extend the content of R&D in geology, mining and mineral processing 7) Stimulate Training and Qualification Programs of Human Resources 8) Promote the expansion of Infrastructure and Logistics 9) Promoting Sustainable Production of the Mineral Sector 10) Stimulating Value Aggregation in the Chain Production of Minerals with Competitiveness 11) Promoting Sustainable Development in Regions of Mining Base	4 Scenarios were developed (on the way to sustainability, unequal development, intermittent growth, threat of stagnation) to evaluate possible pathways of development from 2010 until 2030 observing the possible behaviour of: - Quantitative indicators: population, GDP, national GDP rate, GDP/capita, growth in GDP/capita - Qualitative indicators: national demand, world demand, minerals supply, infrastructure bottlenecks, lack of skilled labour, regulatory framework, geological knowledge, conflicts, mining regions, society´s perception on minerals sector Such scenarios were based on the World Economic Forum´s "Mining & Metal scenarios to 2030" publication (scenarios are of qualitative character), Brazil´s National Energetic Plan 2030 with national growth scenarios and constant global economy growth rates, an estimated Brazilian population in 2030 of 216.4 million (slightly adapted in each scenario) and based on 2009´s national GDP on which growth projections were established. Recycling of minerals is out of the scope of the Ministry of Mines and Energy and therefore the topic is not treated in the document.		www.mining.com/web/reflections-on-the-new-mining-regulatory-framework-in-brazil-2/

Table 9 EU – Selected countries.

Countries / **European** context	General info, Publication, stakeholders involved	Objectives	Actions / Monitoring / Updating	RMI context	Commitments to regulatory framework	Remarks
Austria	Metallic, industrial, construction minerals Austrian minerals policy & strategy, the Austrian Raw Materials Alliance Austrian mineral resources plan (described above) Austrian Resource Efficiency Action Plan (REAP - 2012)	Similar to the RMI: 1) **Securing minerals supply from domestic resources** (realisation of the Austrian Mineral Resources Plan) 2) **Securing minerals supply from non-EU countries** (trade policy, raw materials partnerships, raw materials diplomacy e.g. with Mongolia) 3) Promoting **resources efficiency** (substitution, recycling, development of new methods with reduced minerals input)	The Austrian Minerals Policy is understood as a cross-sectional matter from different policy areas, it is part of: industrial and economic, trade & foreign, R&D, energy, climate and environment, security and defence policies Austrian Mineral Resources plan, regularly monitored and updated The REAP sets targets for increasing resource use efficiency. It identifies the major fields where action is required and it introduces instruments and measures for a concrete increase in resource efficiency in Austria. The 2012 REAP identifies resource efficient production, public procurement, the circular economy and awareness rising as its major fields of action. REAP is an on-going process, i.e. regularly monitored via progress reports	1) The Austrian Mineral Resources Plan is based on analyses of domestic mineral potential, future demand of minerals, land use planning aspects (including areas with potential land use conflicts and conflict-free areas). First, mineral deposits worthy of being protected were identified via development of type-specific (geological) evaluation methods for surface-near (e.g. lithological maps) and deeply-seated deposits assessing location, quality, quantity Second, future demand (long-term estimates of minimum demand, especially construction materials using a 50 year period, longer for ores), was estimated using average annual consumption per capita measures (m3/a or t/a). The consumption figures were adjusted linearly for the required period, using the approach of a long-term decreasing primary raw material consumption and an increasing resource productivity. Annual consumption figures were based on talks with representatives of minerals association, and were cross-checked with results of the ANTAG project which used System Dynamics for modelling future construction mineral needs (Tiess & Kritz, 2010) Third, resource suitability maps were created using a GIS system to carry out matrix calculations, adjustments and calibration 2) The Herfindahl-Hirschmann Index (HHI) has been used in Austria as an indicator of	Raw material priority zones to be included in the land use plan laws	https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy/sustainable-supply-eu_en

Countries / **European** context	General info, Publication, stakeholders involved	Objectives	Actions / Monitoring / Updating	RMI context	Commitments to regulatory framework	Remarks
				market concentration and market structure for raw materials 3) Absolute decoupling goals: Increase of resource efficiency GDP/DMC +50% (2008-2020) Reduction of resource use: DMC -20% (2008-2020) DMC = domestic material consumption. Indicators to monitor the use of materials and resource efficiency include GDP as well as domestic material intensity (DMI), DMC and raw material consumption (RMC) of biomass, metals, minerals and fossil fuels.		
Denmark	Regional Mineral and Raw Material Resources plans	The plans establish the general guidelines for extraction of mineral and raw material resources in each region.	Plans are updated every 4 years The plan covers a 12 year period and every 4th year the Regional Councils are obliged to review the plan in order to assess the need for adjustments or review. An 8-week public hearing process is connected to each update of the plan, where everyone can provide comments or reservations towards the content of the plan.	Denmark has a decentralised (regional) raw materials strategy and implementation approach based on a spatial planning to ensure the supply of raw materials from domestic and foreign sources. **Land use planning and regional raw material plans**: the Regional Councils are the Danish authorities responsible for surveying raw materials within their respective jurisdictions and planning for their extraction and supply. The Regional Councils develop a plan for extraction and supply of raw materials in their particular region of Denmark based on the survey and expectation of demands for raw material (forecasts of future mineral consumption). Each plan contains, besides the forecasts, an assessment of the mineral and raw material resource supplies in the region, Guidelines for mineral and raw material resource extraction, determination of extraction areas, identification of areas of	Regional raw material plans are legally binding for local Council/municipal planning. The local councils have a great deal of responsibility for planning in both town and country. The local councils have to review their planning on a regular basis. In the first half of each 4-year election period, each local council has to present a political strategy for local authority planning and decide how the current plan needs amending	https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy/sustainable-supply-eu_en

Countries / **European** context	General info, Publication, stakeholders involved	Objectives	Actions / Monitoring / Updating	RMI context	Commitments to regulatory framework	Remarks
				interest, mapping the deposits of mineral and raw material resources and a declaration of the known mineral and raw material resources The plan indicates in which areas it is permitted to extract raw materials (in Danish: '*råstofindvindingsområder*') and which areas might be of interest with regard to later resource needs.		
Finland	"Finland's Mineral Strategy" published by the Ministry of Employment and Economy (2010) "Making Finland a leader in sustainable extractive industry – action plan" published by the Ministry of Employment & the Economy (2013) Metallic, industrial, construction minerals	1)Promoting domestic growth 2)Solutions for global mineral challenges 3)Mitigating environmental impact 4) Green mining (invisible and intelligent mining) and dialogue as steps towards solving population concerns as to the potential harmful impacts of mining 5) Promoting cooperation with the Nordic countries and Russia 6) Attracting the best talent to the industry with high-quality research teams and inspirational top professors 7) Safeguarding the mineral reserves of	Separate action plan developed related to> Strengthening minerals policy. An expert working group is appointed to develop policy alternatives and to monitor implementation of the objectives. Improve the minerals sector's financing opportunities and increase Finnish ownership. Securing the supply of minerals. Reducing the environmental impact of minerals sector and increasing its productivity Strengthening R&D capabilities and expertise The Extractive Industry Working Group under the Ministry of Employment and the Economy monitors the implementation of measures in the action plan (2013) and is responsible for updating it In 2011 Finland launched the Green Mining Program through Tekes (the Finnish Funding Agency for Innovation) aiming at the development of	„Finland's Mineral Strategy" is based on analyses of domestic potential (e.g. discovery potential), mining industry Finland, through its national minerals policy, offers a refund on expenditures related to exploration and mining R&D activities, and set up a special funding scheme in The Finnish Industry Investment, according to National Minerals Strategy, ear marked capitalisation to be invested in mining sector projects and companies. Finland also participates in the financing of transport infrastructure investments needed for starting of new mines (railroads, roads, harbours). Loans for mining companies are granted e.g. by Finnvera (specialised financing company owned by the State of Finland) Impediments to the recycling of aggregates are eliminated by developing incentives for recycling and re-use, and through logistic solutions relating to management of stockpiles, rates of consumption data and designation of intermediate storage sites serving multiple municipalities Finland´s plan for making Finland a leader in	Permit processing times are significantly reduced and permitting procedures are refined. This is to be achieved in part by improved cooperation between different authorities and by arranging joint hearings in the event of appeals being lodged against applications The supply and sustainable utilisation of mineral resources are regarded as integral to land use planning	https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy/sustainable-supply-eu_en

Coun-tries / **Euro-pean** context	General info, Publication, stakeholders involved	Objectives	Actions / Monitoring / Updating	RMI context	Commitments to regu-latory framework	Remarks
		the future through long-term research into Finland´s mineral potential and reserves	intelligent and minimum-impact (invisible) mines and the develop-ment of new mineral resources. Until June 2016 the total invest-ment portfolio had reached € 115 million, of which Tekes had con-tributed with 55, companies € 53 million and universities € 7 million.	sustainable extractive industry includes measures to be taken by the industry to obtain society's support for its activities		
France	"National strat-egy for the sustainable management of terrestrial and marine aggre-gates and of quarried mate-rials and sub-stances" (2012)	Sustainable supply of aggregates and quar-ried materials within a perspective of main-taining France´s self-sufficiency while respecting sustainable development´s three pillars: environmental, social and economic. This includes develop recycling and use of recycled materials and framing the use and development of marine aggregates in an integrated mari-time policy	Selected actions: • Identify foreseeable needs by region and identify priorities at national and regional levels • Implement a principle of proximity by optimizing the distance between extraction, processing and consumption sites, and prioritize local pro-duction and consumption • Promote practices causing the least environmental impact • Privilege and develop the transport of aggregates by wa-ter or rail, or by any other ecological transport mode • Improve the use of recycled aggregates by means of tech-nical guides and incentives for the use of these materials in public projects	No information is available on the meth-ods/tools used or recommended for identi-fying foreseeable future needs by region	The implementation of this strategy involves the amendment of certain regulations applicable to the ex-tractive activities in conjunction with im-plementation of major national strategies, among them: - Evolving the scale, content and scope of quarry departmental schemas (this is under-way and Schémas départementaux des carrières", soon to be replaced by the "sché-mas régionaux des carrières" (from 1 January of 2020). Improving regulatory tools and their applica-tion and act on taxation (Establishing a greener	

Countries / **European** context	General info, Publication, stakeholders involved	Objectives	Actions / Monitoring / Updating	RMI context	Commitments to regulatory framework	Remarks
					tax system on aggregates and quarry materials).	
	"The strategic metals" Plan of Action (2010) Published by Minister for Ecology, Energy, Sustainable Development and See	Improving access to strategic metallic minerals 1)Encouraging exploration 2)Developing new exploration tools 3)Improving recycling policy	Creation of the Committee for Strategic Metals (COMES), results since its creation (2011): 1) Publication of 16 monographs of substances, panoramas of the strategic metal market 2) Creation of the Vulnerability Analysis Tool for non-energy critical materials (by the PIPAME - interministerial foresight and anticipation of economic change group) 3) Creation of an economic intelligence network and an associated internet portal dedicated to non-energy mineral raw materials (Mineralinfo.fr) 4) Reflections on the establishment of a certification system for recycling processes to avoid the illegal export of waste, the potential definition of recycling targets for certain REP sectors or the ownership of the extracted materials.	The PIPAME published a study called "Economic challenges associated with strategic metals for the automotive and aeronautics industries" (2013) in which it aimed to analyse development scenarios up to 10 years ahead of the market (prospective analysis of future global demand and supply and their balance) situation for each of a number of selected metals in order to determine whether high shortage risks or risks of significant price increase exist in the production chain. Low and high-level hypothesis scenarios are created using low and high average annual growth rates (in French: *Taux Moyen de Croissance Annuel - TMCA*) (of supply and demand). For the global supply, the number of mining projects expected to begin are considered. Such PIPAME study is of relevance for RMI Scenario Development methods.		https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy/sustainable-supply-eu_en
Ger-	Title: "**The**	internal - e.g. re-	In 2010 the German Mineral Re-			https://ec.

Coun-tries / **Euro-pean** context	General info, Publication, stakeholders involved	Objectives	Actions / Monitoring / Updating	RMI context	Commitments to regu-latory framework	Remarks
many	**German Gov-ernment's raw materials strategy Safe-guarding a sustainable supply of non-energy min-eral resources for Germany"** Published by Minister of Employment and Economy (2010)	source efficiency, i.e. extracting resources in an environmental-friendly way but also with high efficiency; recycling)	sources Agency (DERA) was cre-ated with the aims of, inter alia: a) establishing a raw materials infor-mation System to improve trans-parency in the raw material mar-kets, b) to provide advice and support for companies and business associations: support should go to SMEs in particular as they reduce their raw materials supply risks, c) specialist support for the Federal Government on setting up and implementing assis-tance programmes in the fields of exploring for and extracting raw materials, and of raw materials and materials efficiency			europa.eu/growth/sectors/raw-materi-als/policy-strategy/sustainable-supply-eu_en Internal and external aspect of NMP
		external - e.g. im-proving raw materials diplomacy) objectives	Raw material partnerships with Mongolia (2011), Kazakhstan (2012), Peru (2014). "Alliance for securing raw materials" (*Allianz zur Rohstoffsicherung*) (2012)	Raw materials diplomacy is another key element of the German resources strategy.		
	Raw materials of strategic economic im-portance for high-tech made in Germany published by the Federal Ministry of Education & Research (2013)	To expand research and development along the value chain of (mainly) metals and industrial minerals with particular eco-nomic leverage and importance for the high-tech sector	Availability of funds for research by the German Federal Ministry of Education and Research toward increasing the domestic supply of raw materials of strategic economic importance. Training & education: Higher edu-cation institutions are gearing the courses they offer to the increasing demand for skilled labour and the			

Coun-tries / **Euro-pean** context	General info, Publication, stakeholders involved	Objectives	Actions / Monitoring / Updating	RMI context	Commitments to regu-latory framework	Remarks
			corresponding rising demand for higher education places on raw materials-relevant courses			
	German Cli-mate Action Plan (CAP) 2050 (2016) The Action Plan 2050 is particu-larly of im-portance for the coal mining industry in Germany: the climate targets can only be reached if coal-fired power generation is reduced step-by-step.	The plan outlines measures by which Germany can meet its various national greenhouse gas emis-sions reduction goals through to 2050 and service its interna-tional commitments under the 2016 Paris Climate Agreement. The Climate Action Plan 2050 introduces Germany's first spe-cific target corridors for each economic sector.	The CAP 2050: • Develops concrete guiding principles for individual fields of action for 2050. • outlines robust transformative paths for all sectors, look at critical path dependencies and present interdependencies be-tween different fields of action • specifies concrete milestones, reduction steps and strategic measures to reach the interim 2030 goal The CAP 2050 is not an inflexible instrument; it is a timetable for the move to a climate-neutral econ-omy. It will be reviewed every five years, in accordance with the revision of Paris Agreement com-mitments. The first update of the plan is projected for late 2019 or early 2020, when signatories to the Agreement must submit revised goals.	Attaining the objectives of the CAP require various specific measures of importance for RMI, e.g.: - National welfare index (NWI) - Harmonisation of environmental monitor-ing: statistical and georeferenced Environ-mental data and contribute to transparency in particular in the implementation of measures. Georeferenced data is not only suitable for monitoring purposes. They can also make an important contribution to the visualisation of the implementation progress in situ and thus increase the resonance and acceptance of the activities		
Greece	Title: „National Policy for the Exploitation of Mineral Re-sources" Published by	1) sufficient , mineral supply to society 2) maximisation of benefit and minimisa-tion of negative ef-	Establishment of a Forum for the Implementation of the National Policy Adequate land-use planning Codification and modernisation of		Main features of the licensing regulatory framework shall be as follows ‚stability of investment	https://ec.europa.eu/growth/sectors/raw-materi-als/policy-

Countries / **European** context	General info, Publication, stakeholders involved	Objectives	Actions / Monitoring / Updating	RMI context	Commitments to regulatory framework	Remarks
	MINISTER OF ENVIRONMENT, ENERGY & CLIMATE CHANGE (2012/13) Metallic, industrial, construction minerals	fects of mining 3) best eco-efficient production practices	mining legislation		conditions reasonable time frame for issuing approvals promotion of implementation of Best Available Techniques Strengthening role of inspection authorities	strategy/sustainable-supply-eu_en
Netherlands	Title:“ Policy Document on raw materials“ Published by the Dutch Government (2012)	1) **Supply**: Securing availability and improving sustainability of minerals by seeking new supplies, closing cycles (re-use, recycling) 2) **Demand**: Restrict national mineral demand 3) **Improve efficiency** mineral consumption within Dutch economy	Make optimum use of raw materials in the Netherlands and the EU to reduce dependence on raw materials from outside the EU. The Dutch government will focus on: **Supply** • The removal of rules that create unnecessary barriers • New initiatives aimed at sustainable solutions for raw materials shortages • Helping to create a Phosphates Action Plan, to encourage businesses, knowledge • Promote international stability and increase transparency of contracts and financial flows **Demand** • With its own public purchasing policy and operational management the Government will encourage efficient, sus-	Integrated policy between primary and secondary mineral resources, strong support to research initiatives seeking new solutions and improving resource efficiency Public procurement and chain agreement policies as a government-demand-led instrument		https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy/sustainable-supply-eu_en

Countries / **European** context	General info, Publication, stakeholders involved	Objectives	Actions / Monitoring / Updating	RMI context	Commitments to regulatory framework	Remarks
			tainable and innovative use and re-use of raw materials • In the Government's own management operations, paying attention to the recovery of strategic raw materials by making chain agreements about product design, better use of waste flows, the purchase of services instead of products and the recovery of phosphates from waste water. **Efficiency** • Encourage agreements on raw materials deliveries, not just between governments but also with international businesses, sectors and consumers • Promote, extend and scale up the implementation of the Sustainable Trade Initiative, partly by seeking cooperation within the EU.			
	"A Circular Economy in the Netherlands by 2050. Government-wide Programme for a Circular Economy" Published by the Dutch Ministry	1) Raw materials in existing supply chains are utilised in a high-quality manner 2) In cases in which new raw materials are needed, fossil-based, critical and non-sustainably produced raw materials are	5 Intervention areas are addressed: a) Fostering legislation and regulations: develop legal frameworks that encourage innovation, promote dynamics, and support investments (smart regulation programme) b) intelligent market incentives (encourage the market to move in the direction of a circular economy	The document discusses for each of the 5 intervention areas barriers and opportunities, i.e. partly SWOT analysis elements.	Intervention a) deals with modifications in the legal framework	

Countries / **European** context	General info, Publication, stakeholders involved	Objectives	Actions / Monitoring / Updating	RMI context	Commitments to regulatory framework	Remarks
	of Infrastructure and the Environment and the Ministry of Economic Affairs (2016)	replaced by sustainably produced, renewable, and generally available raw materials 3) We develop new production methods, design new products and organise areas differently. We also promote new ways of consumption	through targeted price incentives and regulations, e.g. CO2 market incentive in the chemical and plastics sectors, Phasing out subsidies that are detrimental to the circular economy) c) Financing (private financing, co-financing e.g. via Juncker fund – European Fund for Structure Investments); d) Knowledge and innovation (to provide those who play a central role in society with the information required to take decisions) e) International cooperation.			
Portugal	Title: "National Strategy for Geological Resources - Mineral Resources" (ENRG-RM) DRAFT PRESIDENCY OF THE COUNCIL OF MINISTERS (2012) Resolution of the Council of Ministers No 78/2012 Metallic, industrial, construc-	ensuring investment and proper exploitation; Sustainable at economic, social, environmental and territorial levels Promotes growth of national economy, by ensuring mineral supply and reinforces its importance of GDP and exports;	Axis A - Adequacy of sector bases, by redefining role of State and revision of rules , mining; Axis B - Development of knowledge of national potential, through improvement of collection methods and systematisation of information for better use of resources Axis C - Dissemination and promotion of national potential, through communication initiatives and creation of a Mining Investor Assistance Office (GAIM) within the General Directorate of Energy and Geology, to act as a one-stop-shop; Axis D - Economical, social, environmental and territorial sustaina-	Tools and methods used for the design of the ENRG-RM are not explicitly described in the document. Recycling is included in AXIS D	Axis A: Adequacy of the applicable standards, by updating legal instruments, restructuring of contractual legal discipline, clarification of applied pre-contractual rules Support and monitor investor, through creation of a Mining Investor Assistant Office within the General Directorate for Energy and Geology to function as a one-stop-shop and implementation of a single account manager	https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy/sustainable-supply-eu_en

Coun-tries / **Euro-pean** context	General info, Publication, stakeholders involved	Objectives	Actions / Monitoring / Updating	RMI context	Commitments to regu-latory framework	Remarks
	tion minerals		bility. Monitoring of the National Land Use Planning Policy (PNPOT) and other instruments of territorial management. Preparation of geo-logical resources sector plan, under the Legal Instruments of Land Management and respective as-sessment of environmental effects. A systematically monitoring of ENRG-RM is intended so that necessary interventions can be done to maximize synergies, cor-rect deficiencies and enhance or even change framework actions currently proposed. Monitoring and evaluation of ENRG-RM will be performed on an annual basis through a set of quantitative and qualitative indicators created for this purpose, enabling the efficient assessment of developments		system.	
Sweden	Title: „Sweden's Minerals Strat-egy" Published by the Minister of Enterprise, Energy and Communica-tions (2012/13) Metallic, indus-trial, construc-tion minerals	5 strategic objec-tives/areas: 1-mining industry in harmony with envi-ronment, cultural values and other activities (greater resource efficiency, better dialogue and synergy with other industries, mining communities with	Action plan – 19 actions (2014-2016) addressing mining & quarry-ing; Monitoring of the strategy's imple-mentation and goal achievement was proposed via a national miner-als forum Mineral Strategy V2.0 is currently (January 2017) under discussion	„Sweden's Minerals Strategy" was based on analyses of domestic potential, mining indus-try The Swedish Minerals Strategy was devel-oped with the support of the Geological Survey of Sweden and during the process, challenges, strengths and measures were identified in an open dialogue with actors from the industry and with other who con-tribute to or are affected by the industry's operations, i.e. partly a SWOT analysis was used as the chosen method.	Better information when applying for exploration permits More efficient environ-mental assessment with shorter lead times Land use and consider-ing different interests	https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy/sustainable-supply-eu_en Internal and

Coun-tries / **Euro-pean** context	General info, Publication, stakeholders involved	Objectives	Actions / Monitoring / Updating	RMI context	Commitments to regu-latory framework	Remarks
		attractive natural and cultural environ-ments) 2-Dialogue and coop-eration to promote innovation and growth. 3-Framework condi-tions and infrastruc-ture for competitive-ness and growth 4-Fnnovative mining industry with excel-lent knowledge base 5-Internationally renowned, active and attractive mining industry		In early 2012, the Minister for Enterprise is-sued an open invitation for actors to de-scribe in writing their expectations of the minerals strategy. About forty written con-tributions were submitted from enterprises, agencies and interest group. In addition, four dialogue meetings have been arranged to discuss areas that, based on the analysis of the contributions, have been deemed of particular importance to discuss within the framework of the strategy. Currently, a seminar is foreseen to take place on January 30th 2017 with flashbacks and future thinking on the Mineral Strategy V 2.0.		external aspect of NMP
UK	Title: „Resource Security Action Plan: Making the most of valuable Materials" published by Minister of State for Busi-ness and Enter-prise (2012) Metallic, indus-trial, construc-tion minerals	1-Innovative ap-proaches and new solutions to secure minerals 2-present new busi-ness opportunities 3-Resource efficiency; recycling	Not explicitly listed			https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy/sustainable-supply-eu_en

SWOT analysis

International context (all except the EU and its Member States)

STRENGHTS	OPPORTUNITIES
• Willingness of International Cooperation: leads to easy access of raw material data which is a basic requirement for a comprehensive policy, forecasting and analysis of global demand & supply • Globalisation – Ease of Trade due to various multilateral trade agreements. This means ensured applicability of RMI objectives internationally • There is an increasing understanding that primary and secondary mineral resources must be managed together as complimentary in minerals policies (e.g. US DoE on critical raw materials, Japan´s JOGMEC objective) • Wide understanding among industrial countries that diversification of sources is needed to reduce supply risks • Japan´s JOGMEC multi-faceted approach provides a good example of complimentary diverse strategies and actions of how Japan invests to attain similar objectives to those established in the pillars of the EU´s RMI (JOGMEC is one of the leading government agencies doing this but is supported by a network of private institutions closely linked to the public sector) • USA: USGS minerals yearbook covering the global context • Monitoring of progress in resource efficiency is implemented by various countries via indicators and targets (e.g. Japan) • For the issue of recycling, Extended Producer Responsibility (EPR) is being implemented in many places throughout the world (China, USA: 25 federal states, Canada, Japan, various EU MS such as Belgium, Germany, Ireland, UK) • USA: good legal coverage of the Extended Producer Responsibility policy (nowadays 25 federal states have passed legislation mandating state-wide e-waste recycling, no federal law exists yet)	• Both developing countries and developed countries interested in cooperation at international level (developing countries for economic development and developed countries for diversifying supply sources) • Raw material dialogue between EU and important countries like BRICS; BRICS and African Nations – All these would provide good opportunities for data access and comprehensive planning in form of RMI at global scale • Initiatives on transparency like the EITI and the GRI are gaining in strength and are an opportunity for the mining countries to increase their transparency via reporting and information sharing • Global initiatives like UNEP´s International Resource Panel are promoting a science-based approach towards the global analysis of the minerals value chain, promoting the use of science-based tools and methods for the design of smart minerals policies, e.g. for recycling of metals • Many countries (especially developing ones) have yet to implement the EPR waste management system as an effective way to improve collection rates, e.g. of WEEE

WEAKNESSES	THREATS
• In some countries, minerals policies or strategies are either not existing or not publicly available in a stand-alone document (e.g. USA) • Mineral consumption (future demand) generally not considered in the design of minerals policies (exceptions: Russia, Brazil) • Demand forecasting and foresight tools considered in this report (with the exception of focus groups, scenario development and SWOT analysis) are rarely used for the formulation of minerals policy/strategy • Despite an increasing understanding that primary and secondary mineral resources need to be managed together, some developing countries still separate the management of resources and do not integrate them in their minerals policies/strategies (e.g. Brazil) • The design of public policies on raw materials is in many cases not based on multi-variable foresight methods (e.g. system dynamics) and does not consider in-use stocks; often projections of future mineral demand or supply are based on short or medium-term forecasts based on flow-driven scenarios (e.g. extrapolating assumptions of economic growth using indicators like the GDP or GDP per capita alone). • The implementation of 'fitness checks'[5] assessing whether policies are 'fit for purpose' is generally not performed • Little information is published on the process of how minerals policies/strategies are designed and monitored • Also little information is published on how consensus is reached; this allows room for thinking that policies are defined only by government officers and may not be put into discussion with non-governmental stakeholders. As an opportunity, summarised information could be disclosed on the policy design and testing process and its regular updates. • Lack of smart economic incentives to increase recycling rates (e.g. rates	• Resource Nationalism – Approach by certain nations to guard their reserve and not participating in International trade of raw materials (Like China, Indonesia) • Trade monopolisation – By favouring one nation over another for supplying specific minerals. This leads to lack of trust among nations and failure of cooperation in field of RMI

[5] A fitness check is a comprehensive evaluation of a policy assessing whether it is achieving its objectives/purposes and delivering as expected. Its aim is to identify excessive regulatory burdens, overlaps, gaps, inconsistencies and/or obsolete measures which may have appeared over time, and to help to identify the cumulative impact of legislation. Findings serve as a basis for drawing policy conclusions on the future of the relevant regulatory framework and to conclude whether a modification is necessary in the policy itself.

of metals are often tied to international metal prices which are volatile and affected by cyclical variations and could be stabilised if smart financial support was provided to ensure long-term attractive prices for recyclers)	

European context

General vs. country specific

STRENGHTS	OPPORTUNITIES
• Strong political will by the EC to develop, regularly update and promote its raw materials policy framework (RMI, EIP-RM) and a smart allocation of EU´s funds to H2020 projects working on innovative ways to tackle challenges along the minerals value chain • Many EU MSs (e.g. Sweden, Finland, Netherlands, Germany) show strong will towards regional and international cooperation, both within and outside the EU, in order to become more competitive and make use of cooperation advantages • Some EU MSs (e.g. Sweden, Finland) design and regularly update their minerals policies based on open dialogues with the industry and with other stakeholders who contribute to or are affected by the industry's operations in which they identify challenges, strengths and measures need to improve a sustainable management of mineral development programs or projects. • European countries – All are mostly developed hence apply advanced resource analysis (see also MINVENTORY project) • in MINATURA2020: Austria, Poland, Sweden, UK were mentioned in terms of best practices of planning policy; in MINLEX Denmark & Belgium were identified applying spatial planning to regulate land uses, including mining • Most of the minerals policy frameworks are covering all non-energy minerals; e.g. Finland, Sweden´s mineral strategy is based on a good resources analyses, industry analyses. • Sweden: monitoring/updating its minerals policy, V2.0 is currently discussed • Climate change is a main concern influencing the minerals policy and strategy in some Member States (Germany takes the lead) • Several MS checked their CRM potential and included it in the policy development, like Finland (Finnish minerals strategy) • Strong stakeholder involvement in Finland's mineral strategy development (cp., last side of document) and in Sweden too acceptance of stakeholders affected by mining activities is a topic of relevance in all minerals policies; Finland is particularly ambitious and wants to become a leader in social acceptance; for that it	• Improve and update raw material dialogues between EU countries and mineral rich countries. • Willingness among EU member nations to develop strategy as a single entity to secure raw material for all the member countries • New H2020-financed projects are expected to promote further cooperation and innovative approaches for the EU on key areas involving cooperation, recycling, development of global MFA analysis for coordinated mineral strategies: INTRAW (international cooperation in R&D, education and trade), MINFUTURE (Global material flows and demand-supply forecasting for mineral strategies), FORAM (Towards a World Forum on Raw Materials), SCRREEN (Solutions for CRitical Raw materials - a European Expert Network), etc. • Positive influence of EU minerals policy actions in MS > e.g. Poland will publish its new minerals policy in 2017 – considering RMI context, i.e. based on resources analyses, valorisation, integrating land use planning etc. (cp. MINATURA D2.2)

destines substantial funding to the development of intelligent and minimum-impact (invisible) mines (Green Mining) • Monitoring of progress in resource efficiency is implemented by various countries via MFA indicators and targets (e.g. Austria in the REAP plan) • Integration of primary and secondary mineral resources in the minerals policies (e.g. Finland, Sweden, Portugal, Netherlands, France) • Greece: policy requires appropriate collection of minerals production data • Mineral planning policy i.e. MDoPI protection via land use planning: Austria and Sweden. Sweden provides selected MDoPI; in this respect as well Finland.	
WEAKNESSES • Mineral consumption analyses generally not considered (or at least no mention in the document analysed), no demand forecasting, no foresight (except Austria, France) • Issue of minerals yearbook – only few MS have it, but only production data, no import/export data; issue of reliable data, and data collection (methods); • Ineffective stakeholder consultations, lacking of clear rules how to communicate streamlined (not in Finland and Sweden) • In general, no comprehensive (if any) analyses of the use of minerals/value chain, mining and related industrial sectors – i.e. demand issue • The design of public policies on minerals is usually not based on multi-variable dynamic modelling (e.g. system dynamics) (an exception is the Austrian Mineral Resources Plan which cross-checked its forecasts of future demand with results by the ANTAG project which used system dynamics) • Implementation versus monitoring • Stakeholder acceptance	**THREATS** • Only several minerals policy frameworks from EU-28. • A comprehensive RMI context is poor in terms of data/available tools/methods in general; which might influence policy making • Minerals policies are mostly only focussed on the domestic part (internal aspect of minerals policy framework), but ignore the external context (positive Austria: issues raw material diplomacy as well Germany) • Lack of mineral resources and dependence of most of European countries on other nations for raw material makes it a tougher task to create a strong framework for securing raw materials. • Establishment of a minerals policy framework versus implementation/monitoring/adaption; if we compare, most of the EU minerals policies are published in 2012 (in relation to the publication of the Raw Material Initiative follow up in 2011) – but there is no indication of adaption (there may be exceptions, cf. Sweden's mineral strategy, V2.0-discussion, Netherlands and the circular economy in 2016) • Issue of reliable data and data collection. Especially, the data issue has to be mentioned i.e. the scarcity of reliable mineral consumption data at EU-level and national level. Which also concerns the issue of collection, processing and publishing data. Thus, the attempt was made to use BGS-data; however, as the analysis indicates, the (BGS) data are inhomogeneous, fragmented. This is one of the remarkable issues within the EU and its Member States: there is a consider-

	able gap in the minerals knowledge base at EU-/national level which in turn affects the possibilities of developing minerals policy strategies in Europe. There will be strong increase in demand of metals/metallic minerals by the European metal industries which form an important backbone of the economies of the European countries. Presently, most of the countries depend on import of minerals. But in the backdrop of increasing resource-nationalism when the mineral-exporting countries are refusing to let go their minerals except in processed form, the desirability of achieving self-sufficiency can never be overestimated. This will call for extension of existing mines depth-wise and also laterally. One further alternative is to exploring the known geological occurrences with a view to developing them to productive mines. Many of these deposits, being too remote or too dangerous or too deep, might have hitherto been considered cost-intensive and not minable, but the time for dedicated efforts of R & D for developing innovative cost-effective technologies is never too soon. • Recycling of scrap will go a long way to reduce dependence on primary minerals—indigenous or imported. However, in none of the European countries studied there was any report of scrap production. Most of the scraps currently imported are exported. In other words, there appears to be more interest in trading than feeding the domestic metal industries for recycling. In most cases, scrap recycling is energy-intensive and not environment-friendly. But here also, concerted efforts of R & D for developing innovative cost-effective and environment-friendly technologies are urgently called for. But before that, systems of organized collection and reporting of scrap are sine-qua-non.

9. Conclusions

To create structures of a secure and economically profitable minerals supply, the European Union has to pursue an active minerals policy. In opposition to the past years and in the sense as discussed in Chapter 4, the EU has to implement structures of such a policy which render a cost-optimal contribution to the GDP of the Union. First of all, the frame conditions and instruments for a sectoral minerals policy on EU level are to be created, a policy for securing the supply with mineral raw materials. This means the establishment of a consistent and coherent policy for the supply of the European Union with raw materials and commodities *within the frame of the general EU policy*, considering the background of changing global supply conditions. Inherent element is a comprehensive and appropriate EU mineral intelligence (RMI) base – the basic/fundament for a coherent EU policy framework.

The EU Raw Material Initiative provides a general framework, but in fact it is not based on systematic EU raw materials intelligence (RMI). Such knowledge base still is lacking. Ideally each Member State should provide a national mineral yearbook including in-depth minerals consumption analyses – which in turn would be the basic for structure of an EU Minerals Yearbook. In terms of concrete actions it will be necessary to invest in the development of harmonised approaches for assessing minerals including the production, import and export of primary and secondary minerals within the EU, their effective recycling and substitution (whenever possible) together with the more efficient use of European resources. A visionary, high-impact approach is thus required that covers Europe and has the power to connect European actors on raw materials development and policy making: A comprehensive EU-mineral mineral intelligence (RMI) is necessary; otherwise no EU (or national) mineral strategy can be developed in a realistic way. The best return on investment is *not* the development of yet another top-bottom European study that is based on incomplete and often incompatible datasets, but rather the development of a new knowledge environment that is based on a re-consideration of how raw materials data are collected and understood:

- The identification of existing knowledge gaps on EU and national level;
- A better understanding of contemporary minerals research activities on both, at national level and on a European scale by improving the quality of co-ordination in research and innovation actions in the field of raw materials intelligence;
- The development of a harmonised European approach that will address these gaps and it will support European standardisation and certification efforts of national primary and secondary raw materials data;
- The development of a new 'knowledge standard' based on a best possible compromise in terms of existing national methods/standards that will make it relatively easy to upgrade the existing systems;
- The development of a set of guidelines for reporting that will result in comparable and compatible datasets all over Europe using a uniform terminology;
- The definition of a i) minimum and ii) optimum set of criteria for the development of 'National Mineral Yearbooks' to be defined in a way that they support the EU Raw Materials Initiative;
- Setting European protocols for supply/demand forecasting based on current and emerging technologies with detailed description as to how forecast should be done i.e. harmonising demand forecasting methodologies as well;

- The creation of a interoperable software platform that will store and process the data reported by the Member States and provide access to raw material data sources via its querying functions;
- The conception and development of a multi-stakeholder internet portal providing information on raw materials resources consumption within the EU;
- The validation of the harmonised methodology via a demonstration exercise as a direct support to the successful implementation of the Raw Materials Initiative and related activities;
- Increasing Europe's capacities for a timely response to a number of scenarios that concern future raw material challenges;
- Identifying the major trends, uncertainties, key decision points, driving forces, needs for future research against the different timeframes;
- Formulating the ideas for possible future actions with high European common interest and increasing efficiency and effectiveness of the EU research activities related to multi-disciplinary raw materials research;
- Converting key findings into recommendations (policy, regulatory, strategic, security, etc) for Member States and the European Commission;
- Providing both generic and specific recommendations on the security of supply with regards to metallic, industrial and construction minerals;

The cumulative impact of these individual actions on European minerals policies and strategies would be far reaching. It would result in the creation of a permanent knowledge-network supporting the work of an independent European agency that will have the capacity to evaluate information on raw materials according to state-of-the-art, harmonised methodology.

All future appropriate contributions that lead to the creation of a European Union minerals policy and accelerate this process are of particular importance. However, the consequences of the delay have to be realized. All EU partners in commodity trading have already established their raw materials strategies, which mean a clear advantage in global competition. The USA, Australia, the so-called BRIC states Brazil, Russian Federation, India and China as well as Indonesia, several Latin American and African states and many developing countries have clearly defined minerals policies. Should the European debate on minerals policy again encounter any obstacles and cause further interruptions, consequences might be augmented and intensified.

What would be the consequences if no consistent/harmonised EU minerals policy framework will be established? Price fluctuations and distortions of competition on the international commodity markets could cause further serious consequences for the EU industries. Rises in price of strategic raw materials such as iron ore could actually persist, particularly considering the increasing tendency of mergers of market controlling mining companies. Here actions have to be taken immediately. Unless an agreeable balance between ecological and mining interests can be established, the frame conditions concerning cost-intensive and extended permitting processes will deteriorate even more (no cost-optimal contribution to the EU-GDP, passive minerals policy). This would cause a further reduction of competitiveness of the raw materials industry; produce precarious legal conditions and boost shifting and closing of industrial plants. Shifting abroad industrial sites, e.g. cement or steel plants, brings about increased imports and ecological impact.

The establishment of a coherent comprehensive European Union minerals intelligence framework is the need of the moment.

Such framework should consider the findings arising from the review of existing national minerals policies in the EU and its comparison with international ones. This analysis revealed that there is a general lack of modelling and use of RMI tools/methods for the design of minerals policies. Policies are often based on scenarios (often qualitative or a mixture of qualitative and quantitative) or SWOT analysis based on expert knowledge, but rarely dynamic multi-variable modelling techniques (e.g. system dynamics) are employed to design policies, test effects and make informed decisions.

Moreover, the review has also found that future mineral consumption (or demand) is not commonly modelled to forecast the mineral needs of local, regional or national jurisdictions (despite some exceptions such as Austria or France).

There seems to be an increasing understanding and uptake of the resource efficiency concepts, and minerals policies tend to integrate primary and secondary mineral resources, especially in developed countries. Land use planning is also increasingly being considered a key tool towards a sustainable management of mineral resources in all available EU Member States minerals policies. In terms of implementation and monitoring, most EU minerals policies are subject to regular monitoring and update every four or 5 years.

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11. Glossary of terms

Mineral deposit	The occurrence of a mineral, independent of it economic value
GDP	Gross Domestic Product
NGO	Non-Governmental Organisation
Price amplificator	The relation between demand/supply ratio and the actual change in price of the product. It is a dimensionless factor.
Reserve	Mineral reserves are resources known to be economically feasible for extraction.
Resource	A concentration or occurrence of material of intrinsic economic interest in or on the earth's crust in such form, quality and quantity that there are reasonable prospects for eventual economic extraction.
SWOT (analysis)	Strengths-Weaknesses-Opportunities-Threats (analysis)

Appendix 1: Foresight tools for RMI

In the following an overview over a selection of foresight methods is given. This overview informed the respective Factsheets compiled for WP6.

Overview over qualitative foresight methods

Qualitative methods largely rely on experts' knowledge and opinion, but may also sample other stakeholders' insights, views, and opinions. As such they are often quite subjective.

The methods presented below can be, in principle, grouped into 'normative' and 'exploratory' methods. 'Normative' means here, that the methods are designed to achieve a desired future that is based on the norms, values, ethical convictions, etc. of certain groups of stakeholders. 'Exploratory' methods, to the contrary, try to extrapolate the presence into the future, using certain assumptions, scenarios, or regression methods. Borders between the two groups of methods (and quantitative methods) are not clear-cut, as normative methods can have also exploratory elements in the sense that e.g. technologies or the pace of technology developments are constraining the trajectory towards a desirable future. On the other hand, exploratory methods often also have normative constraints in the sense that when building scenarios certain desirable situations are favoured.

Back-casting

A preferable future is envisioned, and then the necessary steps are identified that are needed to reach that future.

The term 'Back-casting' was coined by Robinson (Robinson, 1982) as a futures method to develop normative scenarios and explore their feasibility and implications. Back-casting is a method to develop normative scenarios and explore their feasibility and implications. It is as a tool with which to connect desirable long term future scenarios to the present situation by means of a participatory process.

After creating a vision of a desirable future, alternative solutions are set out, with the participation of important stakeholders. Those alternative solutions are explored, and decisive factors and properties identified. Back-casting is used in complex situations with many stakeholders where, although there is a desired future vision, it is unclear how to reach it. It leads to research plans for implementation of the actions needed and participation is an essential feature. It can be characterised as a social learning process and the long term perspective makes it possible to let go of the present way of meeting certain specific social needs.

The method is used in situations where there is a normative objective and fundamentally uncertain future events that influence these objectives. The knowledge about the system conditions and the underlying social dynamics can also have a powerful impact on the environment, but are unpredictable. The need for participation of stakeholders is strong and the future vision cannot be realised by a hierarchical approach, or limited stakeholders. The desired future cannot be achieved by simply extrapolation from the present arrangements, but need a fundamental different approach of fulfilling the social need.

The main characteristic of the Back-casting approach is to involve stakeholders at an early stage in the foresight process and develop a future long term vision of the desired scenario. Then all participants can translate this back to actual action.

A positive aspect of the method is the ability to freely discuss problems with stakeholders who have conflicting interests (because of the long term perspective). Also content and process is integrated in a practical approach. The negative side to Back-casting is the somewhat long project time needed. This leads to the possibility that the representatives change, leading to delays. Also the technological character can sometimes be to dominant, 'scaring' representatives, and the budget needed is relatively high. A very important aspect often forgotten is the follow up monitoring and evaluation of progress.

Gap analysis is closely related to back-casting and involves structuring and comparing the current state with a desired or probable future state to determine the gap that exists between them. ***Future history*** likewise is closely related to back-casting. It is based on developing a postulated history of the future and a timeline of events for this future history.

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Brainstorming

Informal group discussion that is meant to inspire new ideas about the future. It is a method of eliciting ideas without judgement or filtering. It is often used in the early stages of futures workshops and in many other contexts. It involves encouraging wild and unconstrained suggestions and listing ideas as they emerge. It is a technique that can be applied in a variety of settings in support of some of the other methods discussed here.

The main objective of brainstorming is to elicit ideas from a group of people. Used in a structured way, this technique can be highly effective way of moving participants out of conflict and towards consensus. Brainstorming is founded on the principle that the quantity of ideas increases their quality. The objective is to generate as many creative solutions as possible within a set time. Every idea is presented and listed without comment or evaluation. Deferring the judgment of ideas improves the volume of participant input and consequently the value and encourages creativity. All opinions are considered equal. At the end, grouping ideas to reduce redundancy, allows for related ideas to be brought together.

It is a useful and very widely used technique to extract the most creative thinking out of expert committees and consultation groups. It can be used every time when large quantity of information is generated before problem solving, decision making, or planning - and in scenario analysis.

Citizens' panel or Focus Groups

Groups of citizens are given the mission to think about a future issue and formulate a common view. Their views can be analysed statistically (see below).

A focus group is a form of qualitative research in which a group of people are asked about their perceptions, opinions, beliefs, and attitudes towards (infrastructure) planning, policies, technologies, 'futures', etc. Originally developed as an instrument of marketing research – according to Packard (1957) the term was coined by Ernst Dichter (https://en.wikipedia.org/wiki/Ernest_Dichter), the method is now used frequently in societal and policy-making research, and in participatory decision-finding processes. Questions are asked in an interactive group setting, where participants are invited to discuss the issues at stake with other group members. During this process, the researcher either takes notes or records the vital points emerging from the group discussion. Care should be noted to select members of the group carefully for effective and authoritative responses.

The method is particularly popular in a participatory decision-finding context, as it can be used as an occasion for participants to learn from one another as they exchange and build on one another's views, so that the participants can experience the research as an enriching encounter. This counteracts the 'extractive' nature of research that seeks to 'mine' participants for data (with no benefit for them) as criticized in particular indigenous people-oriented authors (and others sharing similar sentiments).

A wide variety of variants of focus groups is possible, for instance

- **Two-way focus group -** one focus group watches another focus group and discusses the observed interactions and conclusion
- **Dual moderator focus group** - one moderator ensures the session progresses smoothly, while another ensures that all the topics are covered
- **Duelling moderator focus group** (fencing-moderator) - two moderators deliberately take opposite sides on the issue under discussion
- **Respondent moderator focus group -** one and only one of the respondents is asked to act as the moderator temporarily
- **Mini focus groups -** groups are composed of four or five members rather than the usual 6 to 12
- **Teleconference focus groups -** telephone network is used
- **On-line focus groups -** computers connected via the internet are used

The main problem, which is common to all participatory processes, is that identifying and motivating a representative selection of stakeholders is difficult. There is a likely bias towards those, who have a vested interest in the subject or are otherwise emotionally, politically, or ideologically motivated. Certain group dynamics, such as participants wanting to please each other or the moderator, confrontation, or inhibition to speak in the presence of peers, elders, the other sex, etc. may (culturally) skew the results. The evaluation of the group discussion may also introduce a significant amount of bias, due to the inevitable interpretation by the moderator/evaluator. A particular problem can arise, when the moderator/evaluator does not come from the same cultural background as the group and when there is a language barrier in addition.

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Expert panels

Experts working together over a longer period of time to review the futures related to their area of expertise.

From a methodological point of view this can organised in a similar way as Focus Groups. While 'experts' in the first instance are asked to provide their professional opinion, similar group dynamic considerations as in Focus Groups may apply. Those, who are most outspoken and skilled in group-work may dominate and thus skew the outcomes. Therefore, expert panels may also be organised as Delphi surveys, foregoing the interactive aspect.

In foresight exercises, the expert panel have usually the following functions:

1. Gathering relevant information and knowledge;
2. Synthesizing the information gathered;
3. Diffusing the foresight process and its results to much wider constituencies;
4. Influencing foresight in terms of follow-up actions; and
5. Stimulating new insights and creative views and providing a vision of future possibilities, as well as creating new networks.

It is typically organized to bring together legitimate 'expertise', but it can also serve as an attempt to include creative, imaginative and visionary perspectives (Georghiou et al., 2008).

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Futures Wheel

The Futures wheel (Figure 41) is a method for graphical visualisation of direct and indirect future consequences of a particular change or development. It was invented by J. C. Glenn in 1971and is a way of organizing thinking and questioning about the future (Glenn, 2009). It is closely related to 'idea networking', being a kind of structured 'brainstorming'.

To start a Futures wheel in a group brainstorming session, the central term describing the issue to be evaluated is positioned in the centre of the page (or drawing area). Then, events or consequences following directly from that development are positioned around it. Next, the (indirect) consequences of the direct consequences are positioned around the first level consequences. The terms may be connected as nodes in a tree (or even a web). The levels will often be marked by concentric circles. With it, possible impacts can be collected and put down in a structured way. The use of interconnecting lines makes it possible to visualize interrelationships of the causes and resulting changes. Thus, Futures wheels can assist in developing multi-dimensional concepts about possible future development.

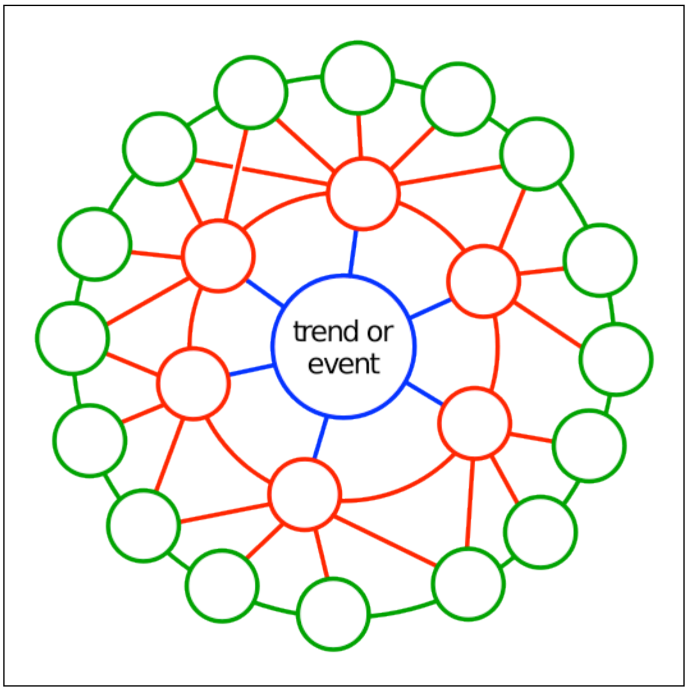

Figure 41: Futures Wheel by J.C. Glenn (CC BY 2.5, https://en.wikipedia.org/w/index.php?curid=8613285).

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Idea Networking

Idea networking is a qualitative means of undertaking a cluster analysis or concept mapping of any collection of statements. Networking lists of statements acts to reduce them into a handful of clusters or categories. The statements might be source from interviews, text, web sites, focus groups, SWOT analysis or community consultation. Idea networking is inductive, as it does not assume any prior classification system to cluster the statements. Rather keywords or issues in the statements are individually linked (paired). These links can then be entered into network software to be displayed as a network with clusters. When named, these clusters provide emergent categories, meta themes, frames or concepts which represent, structure or sense-make the collection of statements.

An idea network can be constructed by listing several tens of statements relevant to the subject and assigning each of them a reference number. In a next step a table is constructed, in which each is statement is linked (paired) with other statements and a reason for this linkage is given.

60 to 200 statements are listed and assigned reference numbers. A table is constructed showing which statements (by reference number) are linked (paired) and why. For example, statement 1 maybe linked to statements 4, 23, 45, 67, 89 and 107 because they all are about the minerals (see Table 10).

Table 10 Example of input to idea-network.

Statement No.	**Linked to**	**Rationale (because they are about ...)**
1	4, 23, 45, 67, 89, 107	Minerals
2	16, 29, 46, 81	Extraction
3	23, 45, 67, 89, 107	Processing
4	13, 16, 34, 78, 81	Remediation
etc.		

The number of links per statement should not exceed around half a dozen or so; more will result in a congested network diagram (see Figure 42). This may require to grade links according to their importance or to divide them into sub-sets. For instance, minerals may be divided into metallic, non-metallic, sulfidic, carbonatic, ones etc. Statements may be also linked to each other for more than one reason. While the linkages should be restricted, there may be a large number of reasons. In fact, clustering of linkages may become more apparent, if this happens for a variety of reasons.

The network analysis is usually performed using specialised computer software. Modern network diagramming software, with node repulsion algorithms, allows useful visual representation of these networks revealing clusters of nodes. It provides a multi-dimensional alternative to ‘post-it’ notes in clusters. So-called force-directed graphical software maybe used to draw the network of clusters.

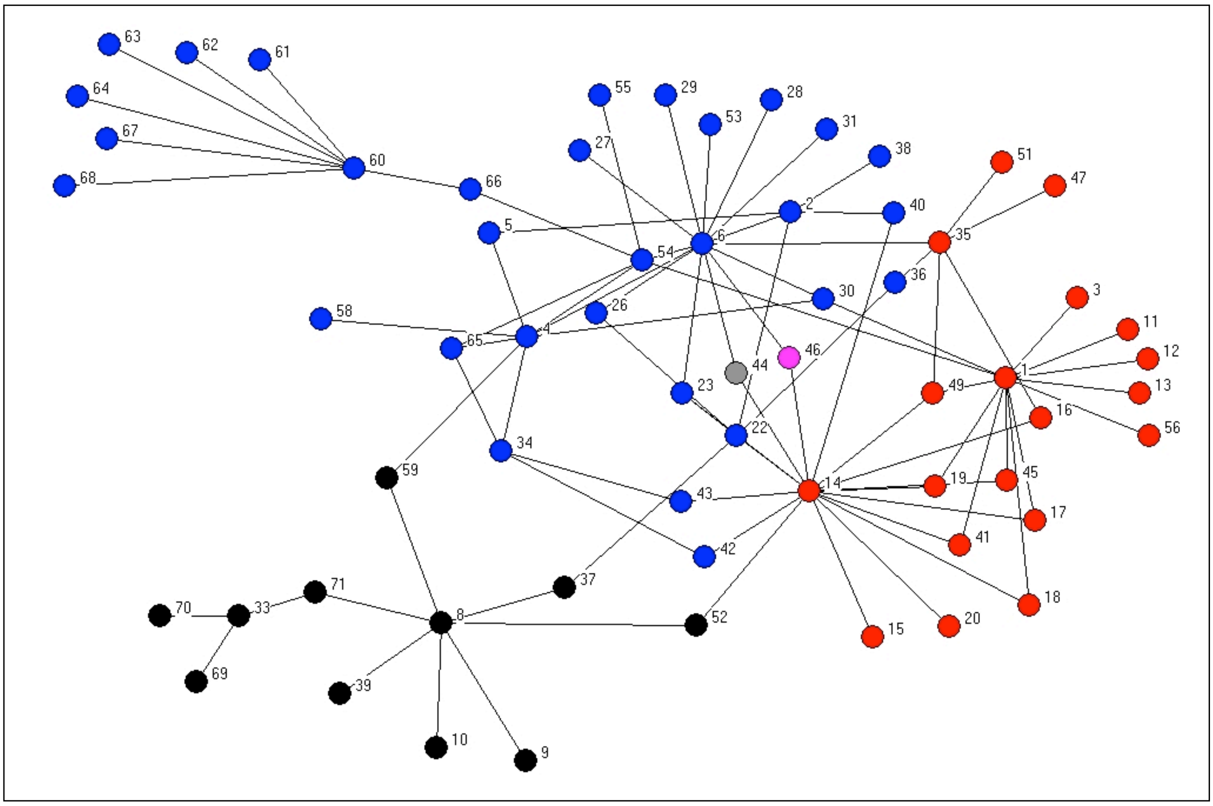

Figure 42: Example of an idea-network (Source: Wikimedia).

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Genius forecasting

Preparation of future projections based on an outstanding individual's creativity, expertise and visions. The method is based on a combination of intuition, insight, and luck. Psychics and crystal ball readers are the most extreme case of genius forecasting. Their forecasts are based exclusively on intuition. Science fiction writers have sometimes described new technologies with uncanny accuracy. There are many examples where men and women have been remarkable successful at predicting the future. There are also many examples of wrong forecasts. The weakness in genius forecasting is that it's impossible to recognize a good forecast until the forecast has come to pass.

In life-style marketing this has developed into a profession, the trend-scout.

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Horizon scanning

Horizon scanning is a technique for detecting early signs of potentially important developments through a systematic examination of potential threats and opportunities, with emphasis on new technology and its effects on the issue at hand. The method calls for determining what is constant, what changes, and what constantly changes. It explores novel and unexpected issues as well as persistent problems and trends, including matters at the margins of current thinking that challenge past assumptions. There are two major known approaches that can be outlined (Figure 43): the exploratory scanning approach that focuses on a wide variety of data from different 'signal' sources; and the issue centred approach, that seeks to identify core documents ('primary signals') describing parts of potential issues.

The selection of the best combination of scanning methods and approaches for policy engagement is subject to contextual issues such as objectives, capacities, resources, organisational culture and timeline as well as content issues such as the potential risks and urgency around the topic examined, depth and width of implications, public awareness and concerns.

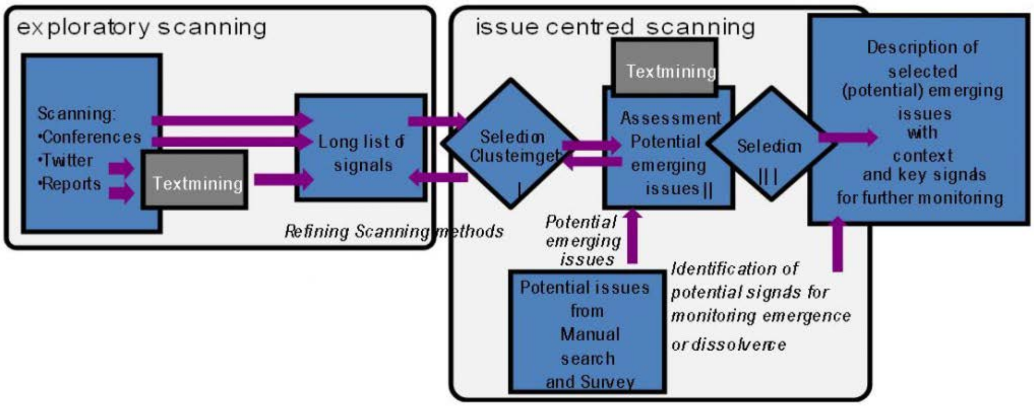

Figure 43: Horizon Scanning Approaches (Source: www.foresight-platform.eu/).

Horizon scanning is often based on desk research, helping to develop the big picture behind the issues to be examined. Desk research involves a wide variety of sources, such as the Internet, government ministries and agencies, non-governmental organisations, international organisations and companies, research communities, and on-line and off-line databases and journals. Horizon scanning can also be undertaken by small groups of experts who are at the forefront in the area of concern: They share their perspectives and knowledge with each other so as to 'scan' how new phenomena might influence the future. In this sense, Horizon Scanning is more of an application for Delphi Surveys, Focus Groups, or Genius Forecasting, than a method in itself.

A comprehensive 'scan of the horizon' can provide the background to develop strategies for anticipating future developments and thereby gain lead time. It can also be a way to assess trends to feed into a scenario development process.

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Mindmapping

Mind-mapping is one of the many methods of visualising the relationships between a large number of entities and factors by means of graphical representation in a tree-like diagram. Like the 'Futures Wheel' a mind-map can be the outcome of a structured group brainstorming exercise, but can also be used by individuals to structure thoughts. Although the concept as such has existed, if not for millennia, then for centuries, the term itself was coined by Antony Buzan in the 1970s (Buzan & Buzan, 1993; www.tonybuzan.com). These authors suggest the following approach for creating mind maps (Figure 44):

1. Start in the centre with an image of the topic, using at least 3 colours.
2. Use images, symbols, codes, and dimensions throughout your mind map.
3. Select key words and print using upper or lower case letters.
4. Each word/image is best alone and sitting on its own line.
5. The lines should be connected, starting from the central image. The lines become thinner as they radiate out from the centre.
6. Make the lines the same length as the word/image they support.
7. Use multiple colours throughout the mind map, for visual stimulation and also for encoding or grouping.
8. Develop your own personal style of mind mapping.
9. Use emphasis and show associations in your mind map.
10. Keep the mind map clear by using radial hierarchy or outlines to embrace your branches.

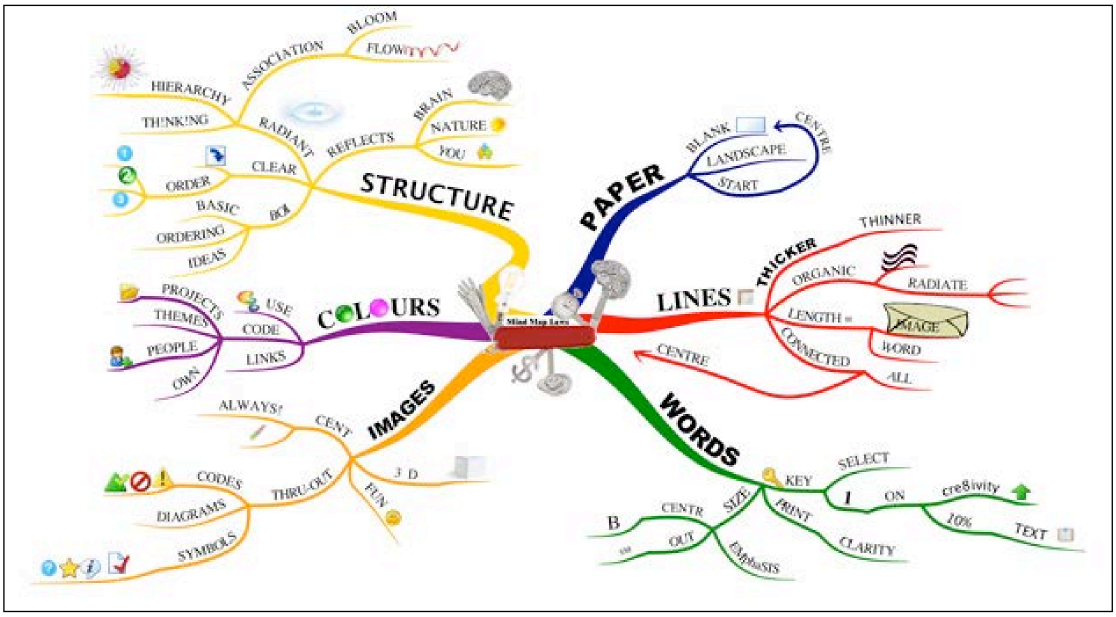

Figure 44: Example of a Mind-Map (www.tonybuzan.com/about/mind-mapping/).

Mind-maps are used to generate, visualise, structure, and classify ideas, and as an aid to organizing information for a wide variety of applications, including complex system assessment and strategy development. When used in a group brainstorming context the grouping and organising may be undertaken in later step, when the relationships between the different elements are established. While in many settings a coloured-pen and flip-chart approach is appropriate, computer programs are available (e.g. iMindMap marketed by Buzan, https://imindmap.com/software/) that generate mind-maps and make the accessible to further processing and evaluation. Thus, mind-maps can be used to develop search strategies and algorithms for expert-systems, such as that to be developed within the MICA-project.

As noted before, there are other variants for graphically representing hierarchies and relationships. Mind maps start out from a single element, while concept maps interconnect multiple elements. Concept maps delineate multi-dimensional relationship more in the form of a cob-web, while mind-maps are based on radial hierarchies and tree-like structures.

In addition to being a tool for organising information, mind-maps are also promoted as a mnemonic aid, particularly appealing to persons with a predominantly visual memory.

References

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Morphological analysis

Morphological Analysis originated in strategic planning and is a normative forecasting methods that starts with defining a ‘future’ and then seeks to identify the circumstances, actions, technologies, etc. required to arrive at it. The method was developed by Fritz Zwicky (Zwicky 1969, Zwicky & Wilson, 1967) for exploring all the possible solutions to a multi-dimensional, non-quantified complex problem. As a problem-structuring and problem-solving technique, Morphological Analysis is designed for multi-dimensional, non-quantifiable problems, where causal modelling and simulation do not function well, or at all. Morphological Analysis systematically investigates relationships in order to map potential solutions in response to a future challenge. Thus, an overall perspective of possible solutions and their interdependencies is obtained.

The approach was developed to address seemingly non-reducible complexity: using the technique of cross-consistency assessment (CCA) (Ritchey, 1998), the method allows for reduction by identifying the possible solutions that actually exist, eliminating the illogical solution combinations in a grid box, rather than reducing the number of variables involved. There are two principal types of inconsistencies involved here: purely logical contradictions (i.e. those based on the nature of the concepts involved) and empirical constraints (i.e. relationships judged be highly improbable or implausible on empirical grounds). Normative constraints can also be applied, although these must be used sparingly and clearly marked as such. One must be very careful not to allow prejudice to rule such judgments (Ritchey, 2009).

The purpose of Morphological Analysis is to organise information in a relevant and useful way in order to help solve a problem or stimulate new ways of thinking. It has often been used for new product development, but also in constructing scenarios in a wide variety of field. The method is especially suitable for pitting strategy models against scenarios or futures projections. In such cases, two complementary morphological fields are developed: one for generating different possible futures projections based on factors which cannot be directly controlled (an 'external world' field); and one for modelling strategy or system variables which can -- more or less -- be controlled (an 'internal world' or strategy field). These two fields can then be linked by cross-consistency assessments in order to establish which strategies would be most effective and flexible for different ranges of scenarios. Figure 45 illustrates the case for 'Extended Producer Responsibility System' in Sweden (Ritchey, 2009).

SCENARIO	Buyer behaviour	Consumption patterns Total: Private import:	Consumer sorting behaviour (trends)	National environmental policy	Price of new raw material vs reclaimed material	Production technology: volume of materials	Technology development: reclaiming technology	EU-directives for import and export of waste
Global Crisis (Production gone wild)	Willing to pay more for green products	Total: Up Private import: Up	Voluntary (ideologically driven)	At the forefront; Holistic approach (legal & econ.)	New: High Reclaimed: High	Much less than today	Very rapid increases	Less restricted than today
Raw Material Depletion	Will to buy green, but will not pay more	Total: Status Quo Private import: Up	Will sort for compensation/ reward	At forefront, but no holistic approach (legal only)	New: High Reclaimed: Low	Somewhat less than today	Substantial increases	Same as today
Current policies (Negative trend)	No interest in buying green products	Total: Up Private import: SQ	Will sort if facing sanctions	Ideological, based on voluntary acceptance	New: Low Reclaimed: High	Same as today	Only marginal increases	More restrictive than today
Current policies (Positive trend)		Total: SQ Private import: SQ	Will resist sorting	Least possible adaptation	New: Low Reclaimed: Low			
Green-house effect (Stop emissions)								
Batman: High-tech solutions								
Dematerialised production (New materials)								
Green market (ideological paradise)								

Figure 45: Scenarios for 'Extended Producer Responsibility System' in Sweden (Ritchey, 2009).

Morphological analysis involves mapping a complex issue to obtain a wide perspective of existing solutions and future possibilities. The approach can be based on five basic steps:

1. Formulation and definition of a problem;
2. Identification and characterisation of all parameters towards a solution;
3. Construction of a multi-dimensional matrix (morphological box) the combinations of which will contain all possible solutions;
4. Evaluation of the outcome based on feasibility and achievement of desired goals; and
5. In-depth analysis of the best options considering available resources.

Steps 1, 4, and 5 often stem from a different analysis, whereas steps 2 and 3 form the heart of morphological analysis. Step 2 can involve developing a relevance tree to help define a given topic. Once the parameters are identified, a morphological box can be constructed that lists parameters along a single axis. The second axis is determined by the nature of the problem.

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Relevance Tree

A relevance tree is an analytic technique that subdivides a broad topic into increasingly smaller subtopics thereby showing 'all' possible paths to the objective, and provides a forecast of associated costs, durations and probabilities for each element.

Relevance trees are used to analyse situations with distinct levels of complexity, in which each successive lower level involves finer distinctions or subdivisions. It can be used to identify problems and solutions, establish feasibility, select the 'optimum' solution, and deduce the requirements of specific policies, technologies, etc. It may also be used to estimate the overall cost and duration of implementing policies or increase technological performance, thereby scheduling a detailed R&D programme.

A relevance tree looks much like an organisational chart and presents information in a hierarchical structure. The hierarchy begins at a high level of abstraction and descends with greater degrees of detail to succeeding level of the tree. The entries at a particular level are intended to describe, in a 'complete' manner, the item to which they are connected in the level above. Ideally, each entry at a particular level is orthogonal, that is, it should not overlap with any other entry, thus being mutually exclusive of other entries. Finally, the items at the same level should be addressed from the same point of view. If done properly, the structure can lead to a clearer understanding of the topic under analysis.

Scenario development

Creating visions of possible futures or developing and illustrating specific aspects of a possible future using narratives based on rational assessments and what-if-type reasoning. It often takes the form of a narrative or a 'story-board' describing the envisioned developments. Depending on the purpose three main groups of scenario analyses can be distinguished:

- Baseline trend scenarios (predicting futures by extrapolation)

- Normative scenarios (describing desirable futures)
- Explorative scenarios (describing possible futures)

Trend scenario development is a common tool used by governments and their supporting agencies. A key aspect is making rational and well-founded assumptions that have to be clearly documented. The purpose is to deduct envelopes for futures, based on the extrapolation and aggregation of single variables. These assumptions are frequently used to parametrise or drive mechanistic models that describe known relations, e.g. materials or energy needs for certain industrial activities or individual consumption patterns. By varying the assumptions and, hence, the parametrisation of the models 'what if'-type scenarios can be developed. These scenarios either describe likely or probable futures on the basis of extrapolating current trends and patterns, or allow exploring the effect of policies and technologies on futures. Policies are designed to achieve certain desirable futures (e.g. maximum emissions of Greenhouse Gases, reductions of consumption, minimising materials usage, etc.), but their effect in a complex web of actors and processes typically is difficult to predict. Scenario-building can help to explore the possible reaction of actors to policy changes. The same applies to technology developments, the effect of which may depend on a multitude of variables that are difficult to predict. Scenario development supported by mechanistic modelling also allows performing sensitivity analyses that in turn allow identifying important variables and assumptions. This in turn allows targeting policy measures and/or supporting for technology development.

Scenario development can be pushed to any level of complexity, but with increasing number of variables and assumptions error margins increase to a level, where little value in the predictions remains.

A helpful tool in scenario analysis is a priori developed Features, Events, and Processes (FEP) database that list all elements and their properties that may be relevant to the scenarios. Such a database ensures a clear understanding of the variables and factors that enter the scenario building and also ensures that the same FEPs are used in all scenarios investigated.

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Serious gaming

Although the term 'gaming' tends to be associated mainly with digital computer games, the concept as a predictive tool probably originates in the early 19th century. The table-top war-game was invented by the Prussian officer George Leopold von Reiswitz (Reiswitz, 1812) towards the end of the Napoleonic Wars. This game became popular at the court and among the high-ranking officers. Subsequently, it was formally adopted by the Prussian Chief-of-Staff Helmut von Moltke, who regularly organised table-top war games, in order to train staff officers and to develop large-scale and long-term military strategies, which contributed to the Prussian military successes in the later 19th century (Ref. ?). Such exercises are now commonly undertaken in the military realm, but also at corporate level. The qualification 'serious' in the term indicates that such games are not played for entertainment purposes, but are designed to simulate real-world processes for training or planning purposes. A 'serious' game is a competitive exercise between two or more parties that has pre-determined objectives and that evolves according to a set of rules, akin to a game of chess. The players introduce intuition and psychology and thus a stochastic element into the decision-making process. The players, or rather their aliases in the game, are given certain properties and resources. Their actions have to follow a certain set of rules that describe, for instance actions that are physically, legally, etc. possible. Already von Reiswitz realised that the outcome of (military) actions is a chance process and simulated this by throwing dices. This has not changed since in principle and stochastic processes are simulated by throwing dices, either physically or digitally through random number generators. There are techniques to uncertainty ('fog of war') into the game, such as that each party plays on separate tables, so that the actual position is hidden from the other. Typically a referee or 'game-master' presides over the game and makes judgements on the performance of the players involved. Monitoring such a game as it evolves allows observing contributing and hindering factors, resources needs, the interdependencies of processes, and the weighing judgements.

Role playing can be a variant of serious gaming with a view to map behavioural patterns for a given (future) situation by identifying with the actors in that particular situation.

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SWOT analysis

An analysis of the Strengths, Weaknesses, Opportunities, and Threats (SWOT) is performed in a systematic way, categorising internal factors (strengths and weaknesses) and external factors (opportunities and threats). A SWOT analysis as such is not used to elucidate possible futures, but will help to assess ways of action and trajectories proposed as an output from other methods. It allows judging their feasibility and the probability of success. In essence it is a structured representation of a risk analysis and is often applied to projects, policies, or products. A SWOT analysis further gives indications, where improvements are needed to achieve a given objective and which factors or properties could be critical to success.

A SWOT analysis typically is presented in form of a matrix (Figure 46), but also graphical representations are possible. The matrix can be populated by a wide variety of qualitative and quantitative methods, including brainstorming, expert opinion, or mechanistic analyses.

Strengths	Weaknesses
• Strength 1 • Strength 2 • Strength 3 •	• Weakness 1 • Weakness 2 • Weakness 3 • ....
Opportunities	**Threats**
• Opportunity 1 • Opportunity 2 • Opportunity 3 •	• Threat 1 • Threat 2 • Threat 3 • ....

Figure 46: SWOT-matrix.

Wild Cards and Weak Signals

The term 'wild card' for low-probability events that have a high impact and that were not expected to occur was coined by Nassim Taleb in his book 'The Black Swan' (2007). The Black Swan-metaphor refers to an event hitherto thought to be extremely unlikely or impossible, such as the occurrence of black swans that were only discovered in Australia in the late 17th century. Wildcard events take the society concerned by surprise and may profoundly change it. Examples are the attack on the World Trade Centre (WTC) in New York in September 2001, the end of the Soviet Union, the Internet, or the development of the personal computer. While with hindsight these phenomena can be explained, the concerned society of the time was not able to foresee them. From an epistemic point of view this is not a question of unpredictability, but a question of data availability, of (conceptual) models used, and also of cognitive bias. Strong reliance on statistics and the assumption of normal distributions can lead to a serious vulnerability to black swan events. While reliance on statistics in itself does not necessarily vulnerable, it is the inadequate database on which the statistics are founded. An example are the recent major floods in central Europe that were not predicted in their severity due to the fact that our database of flood events that is used to calibrate the hydrological models describes a past world, but not what it looks today, with all the changes in land-use for instance. This describes the epistemological problem that predictions become more and more uncertain the rarer the events are that we are trying to predict. We depend more and more on theoretical extrapolations with a probably insufficient database to parametrise the theoretical models. Taleb (2007) also claims that the believe in the normal distribution of events leads to misjudgements, as many frequency distributions of events are skewed.

Wildcards or Black Swan events are relative, relative to the cognitive space and experience of a society. Thus the attack on the WTC could not be predicted within the mainstream society of the USA, but of course was not a Black Swan event from the perspective of the perpetrators. The cognitive space of a given society often is limited by the socio-cultural framework, but also by 'professional blindness'. Modern societies are particularly vulnerable to such bias, because of the extensive and wide-spread application of risk management. However, risk management often is very weak in addressing unknown risks. Addressing known risks results in a false sense of security and complacency. In addition, the paradigm of 'professionalism' can lead to focussing only on those aspects of a larger system, e.g. a society, the respective professional is familiar with, ignoring the whole system.

Therefore, modern society requires strategies to deal not only with the 'known unknowns', but also with the 'unknown unknowns'. This applies in particular to futures studies, were trends and developments need to be recognised early in order to be able to take action. This amounts to filter the 'noise' of a multitude of developments from those that might become trends. The term of 'weak signals' refers to early indications of upcoming events that statistically remain below the level of noise, but with hindsight would be interpreted as e.g. the onset of a trend or the initiation of a Black Swan event. Deconvolution of complex and noisy signals with the view to recognise meaningful 'weak' signals is the pre-occupation of e.g. financial and economic analysts. Strategies, such as Horizon Scanning or Trends Scouting can be applied to this. The problem of how to deal with 'emergence' (Lewes, 1875) is also closely related to this subject.

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Overview over semi-quantitative foresight methods

Causal layered analysis

Causal Layered Analysis (CLA) is a technique used in strategic planning and futures studies to more effectively shape the future. The technique was pioneered by Sohail Inayatullah, a Pakistani-Australian futures studies researcher. It is less concerned with predicting a particular, but opening up the past and the present to create alternative futures. CLA was developed in a post-structuralist tradition, by questioning the epistemic of empirical and epistemic research, with the view to open-up the discourse to 'critical' and 'action' research (Inayatullah, 2005). A participatory and reflexive approach, aiming to understand and utilise interest and power distributions is at the core of the method. It also involves elements of cultural criticism, as it denounces the typical positivist and reductionist approaches prevalent in the Western world. Inayatullah (2005) states that "the goal of critical research is to ... disturb present power relations by making problematic our categories and evoking other places or scenarios of the future". Causal Layered Analysis is based on the assumption that in the way in which ones constructs and frames a problem changes the policy solution and the actors responsible for the transformation. It proceeds across four layers Inayatullah (2005):

1. **Litany**. This includes quantitative trends, often exaggerated and used for political purposes. The result could be a feeling of apathy, helplessness, or projected action ("why don't they do anything about it"). The litany is the most visible and obvious, requiring few analytical skills.

2. **Social causes**. This level is concerned with the underlying economic, cultural, political, and historical factors. It is a level of technical explanations and academic analysis.
3. **Structure** and **discourse.** At this level a reflexive approach is introduced that questions the paradigms legitimising and supporting structures as well as the foundations of the litany. The task is seen as to find deeper social, linguistic, and cultural structures that are actor-invariant.
4. **Metaphor** and **myth.** These are the deep stories, the collective archetypes, the unconscious, often emotive dimensions of the problem.

Conventional academic analysis tends to stay in Layer 2, while CAL moves up and down these four layers of „understanding". Its key methodological utility is that it allows for research that brings in many perspectives. Inayatullah (2005) maintains that policies that do not touch the worldview or myth level will be useless.

References

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Delphi survey

The Delphi method is based on structural surveys and makes use of information from the experience and knowledge of the participants, who are mainly experts. It therefore yields both qualitative and quantitative results and draws on exploratory, predictive even normative elements. In the most common form, the opinions sought concern the particular developments that are likely to take place. Delphi surveys are frequently used in Technology Foresight studies and related exercises. Instead of trying to forecast the time scales of particular developments, the surveys can be constructed to help identify and prioritise policy goals, for example.

Delphi surveys are usually performed in two or more 'rounds' in which, in the second and later rounds of the survey, the results of the previous round are given as feedback (Cuhls, 1998). Therefore, the experts answer from the second round on under the influence of their colleagues' opinions, and this is what differentiates Delphi surveys from ordinary opinion surveys. The idea is that the respondents can learn from the views of others, without being unduly influenced by the people who talk loudest at meetings, or who have most prestige, etc. Ideally, significant dissenters from a developing consensus would be required to explain their reasons for their views, and this would serve as useful intelligence for others. Giving feedback and the anonymity of the Delphi survey are important characteristics. Wechsler (1978, pp. 23f) describes a 'Standard-Delphi-Method' in the following way: "It is a survey which is steered by a monitor group, comprises several rounds of a group of experts, who are anonymous to each other and for whose subjective-intuitive prognoses a consensus is aimed at. After each survey round, a standard feedback about the statistical group judgement calculated from median and quartiles of single prognoses is given and if possible, the arguments and counter arguments of the extreme answers are fed back..."

Characteristics of Delphi surveys are therefore specified as (Häder & Häder, 1995):

- they are designed to tackle issues that are formulated as statements and for which only uncertain and incomplete knowledge exists;
- they sample experts' judgments made in the face of uncertainty;
- the experts involved need to be selected on the basis of their knowledge and experience so that they are able to give a competent assessment;
- the method puts emphasis on the psychological processes during communication rather than the quantitative evaluation.
- they try to make use of self-fulfilling and self-destroying prophecies in the sense of shaping or even 'creating' the future.

Delphi surveys are a valuable tool for communication and for exchanging opinions on a topic, making experts' tacit knowledge of the future more explicit. It is also useful for longer-term assessments where extrapolations make no sense. They are conducted anonymously in order not to let anyone lose face in the event of a change of opinion. The methodology is designed to avoid domination by particular individuals.

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STEEP analysis

STEEP stands for Social, Technological, Economical, Environmental, and Political Road-mapping. STEEP analyses are conducted in order to obtain a detailed overview over which external macro-environmental factors influence the trends that are being investigated. The range of factors covered depends on the purpose and such analyses are consequently known under different acronyms. The legal, ethics, and demographic dimension can also be added (STEEPLED), which can be highly relevant in the European context. A STEEP(LED) analysis can provide input to a following SWOT analysis.

Stakeholder analyses

Anticipating and evaluating stakeholder reactions to a given development, taking into account their motivations and interests in order to identify potential alliances, conflicts and strategies. These analyses can be performed in a wide variety of ways, ranging from external expert assessments to semi-participatory exercises, such as Focus Groups (see above). However, they involve the interpretation of researches, rather than the self-interpretation of the stakeholders themselves. Essentially, WP2 is concerned with such stakeholder analyses and will provide the relevant input to the project.

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Utility maximisation and choice modelling

Utility maximisation is one of the many (micro-)economic theories. Utility, in the language of economics, is a measure of preferences of some set of goods and services over others. It reflects a desire or want and the satisfaction derived from fulfilling it. The theory is based on the assumption that people always behave 'rational', meaning that they weigh the objective costs and benefits of each choice, which also assumes that people have a full set of information on the costs and benefits the choices may entail. Therefore, making choices is an optimisation problem. However, on an individual basis, the behaviour frequently is not 'rational' and a wide variety of psychological, cultural, ethical, or ideological aspects may play a role. Behavioural economist developed a variety of models to account for these deviations. Prospect theory, for instances, notes the reference dependence of choices, loss aversion, and non-linear probability weighting (over-weighting of small probabilities and under-weighting of large probabilities).

Utility maximisation modelling can be used to predict envelopes of economic behaviour. It can be combined with Serious Gaming in order to evaluate the (stated/revealed) preferences.

Choice modelling attempts to predict the preference of individuals or groups of people in the case of social choices. The method originates in statistical economy and mathematical psychology. Discrete choice modelling evaluates the preference of one over two or more alternatives (e.g. which brand to buy), while other variants evaluate the ranking that is placed on several choices (e.g. how much to buy of a certain commodity).

The strength of choice modelling is that trade-offs between attributes are considered, and that the reference frame is made explicit (e.g. the number and types of alternatives). Its weakness is that non-probabilistic (deterministic) decision-making by the individual violates the underlying random utility theory. The choices also need to be independent from each other. The models can be applied to actual data sets of peoples' preferences ('revealed preference') or on hypothetical data sets, whereby people are asked what choices they would make ('stated preference').

Choice modelling and its many variants have been applied to wide variety of problems, such a marketing, infrastructure planning, health service planning, product development, policy development, etc. Often these models are used to assess peoples' 'willingness to pay' (e.g. for goods, services, a clean environment, etc.) or their 'willingness to accept' (e.g. inconveniences from environmental protection measures, environmental detriments, etc.).

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DPSIR-frameworks

The analysis of Drivers, Pressures, Status (of the environment), Indicators to measure the efficacy of (policy) Responses (to environmental etc. impacts) is a form of systems analysis. It can provide the logical framework for scenario analyses and quantitative models (Figure 47).

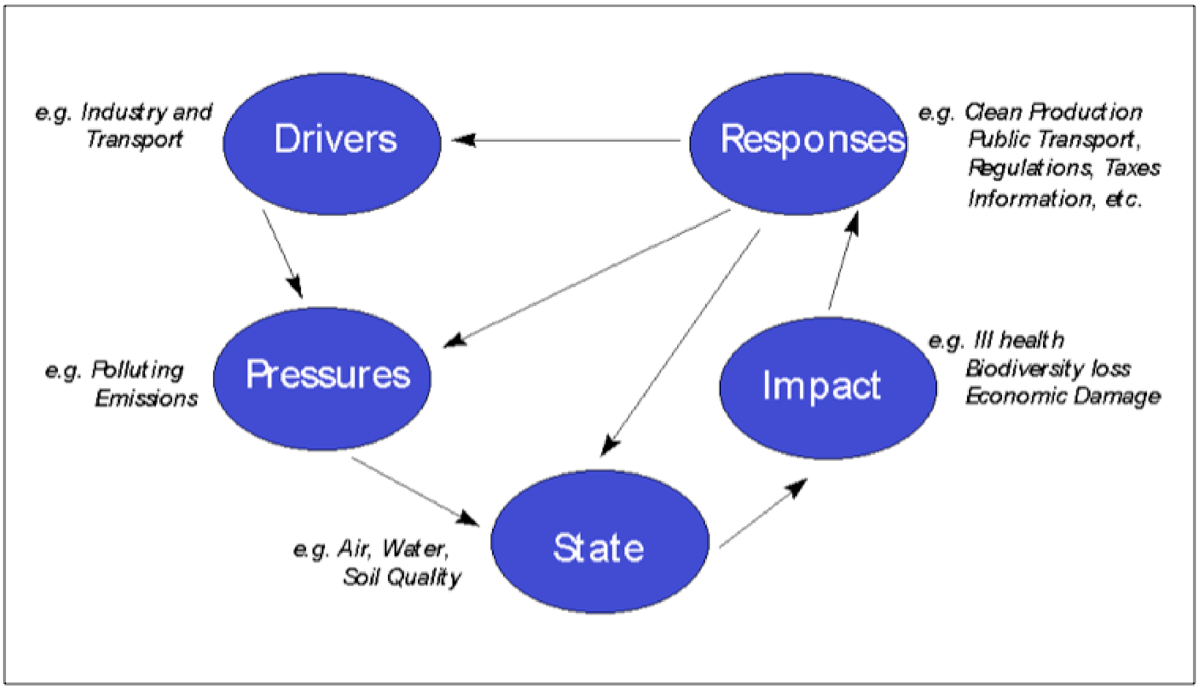


Figure 47: DPSIR-framework for environmental impacts. (Source: www.eea.europa.eu/publications/92-9167-059-6-sum/page002.html).

Drivers are underlying economic developments or consumer behaviours. Thus, for instance, increasing wealth leads to the desire of individual mobility, which in turn leads to greenhouse gas emissions that constitute a Pressure on the environment. The Status would be e.g. the current atmospheric CO_2-levels. In this case a policy response could be to increase fuel taxes in order to dampen consumption. The associated Indicator would be the amount of fuel consumed in the market for individual transport. The benefit of the DPSIR-framework is that it goes beyond a mere description of mechanistic relationships by trying to identify root causes, namely the Drivers. This provides guidance as to where Responses should be targeted at.

References

Smeets, E., Weterings, R. (1999): Environmental indicators: Typology and overview.- EEA Technical report No. 25: 19 p., Copenhagen (European Environment Agency), www.eea.europa.eu/publications/TEC25 (accessed 27.06.16).

Cross-Impact Analysis

Cross-impact analysis (CIA) is a methodology developed originally by Theodore Gordon and Olaf Helmer in 1966 to help determine how relationships between events would impact resulting events and reduce uncertainty in the future (Gordon, 1994). This group of methods aims to monitor the impact of interactions between a set of projections, when those interactions may not have been taken into consideration when individual futures were produced. CIA was originally developed as a card game, where each card described an event (in economic and business development) and where the probabilities that a certain event may take place were determined using dodecahedron dice. The cards also contained information on cross-impacts and estimates of their probability to occur.

Developing a CIA thus consists initially in developing a catalogue of processes and events, complemented by an assessment of their respective cross-impacts. This catalogue can be developed in a variety of ways, including expert opinion, delphi surveys, focus groups, etc. For certain types of analyses, Features, Events, and Processes (FEP) databases may already exist. Once the catalogue has been developed, the next step is to estimate the initial probability of each event. These probabilities indicate the likelihood that each event will occur by some future year. In the initial application of CIA the probability of each event is specified, assuming that the other events have not occurred. Thus, the probability of each event is judged in isolation and CIA is used to adjust the probabilities for the influences of the other events. A certain bias may occur due to 'experts' judging probabilities may unconsciously already considering cross-impacts. The next step in the analysis is to estimate the conditional probabilities.

Typically, impacts are estimated in response to the question, "If event m occurs, what is the new probability of event n?" Thus, if the probability of event n were originally judged to be 0.50, it might be judged that the probability of event n would be 0.75, if event m occurred. The entire cross-impact matrix is completed by asking this question for each combination of occurring event and impacted event. These new, conditional events are bounded in their probabilities by the probabilities of the initiating events. When the initial probabilities are estimated with reference to other event probabilities (that is, not considering each event in isolation), some additional information enters into the estimation of the impact matrix. For each event combination, there are limits on the conditional probabilities that can exist. A simple example can illustrate these limits. Suppose we consider two events, n and m: event n has a 50% chance of occurring in the next year, and event m has a 60% chance of occurring. Thus, out of 100 hypothetical futures, event n would occur in 50 of them and event m in 60. Obviously, events m and n would occur together in at least 10 of the futures. The calculation for a range of conditional probabilities that will satisfy this consistency requirement is easy and involves mainly multiplying the respective probabilities. A matrix of conditional probabilities is developed in this way (see Gordon, 1994), for a description of the procedure). However, the collection of data can be tedious. A ten-by-ten matrix requires that 90 conditional probability judgments be made, 40-by-40 matrix requires that 1,560 judgments be made. The calculations are performed with the aid of a computer.

Once the matrix has been developed, it can be used for e.g. testing the sensitivity of the system to policy decisions focusing on particular elements of the matrix.

This method assumes that, somehow and in some applications, conditional probabilities are more accurate than estimates of a priori probabilities; this is unproved. Nevertheless, the disaggregation required by the method is usually illuminating. Inserting a cross-impact matrix into another model, e.g. a System Dynamics Model, often adds power to that model by bringing into its scope future external events that may, in the limit, change the structure of the model.

References

Gordon, T.J. (1994): Cross Impact Method.- United Nations University Millennium Project, 25 p., http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.202.7337&rep=rep1&type=pdf (accessed 02.06.16)

Overview over quantitative foresight methods

Bibliometrics

Statistical analysis of (scientific, technical, political) publications in a given field and their evolution over time allows to map and to extrapolate certain trends. Common indicators studied in bibliometrics are:

- Publication counts: provide an estimate of research interest and total research output for a given field.
- Number of citations and impact factor: it is assumed that the higher the number of citations the more influential the work is.
- Co-citation and co-word analysis: it measures linkages among publications and patents.

Bibliometrics can be a valuable tool that allows the identification of emerging research fields that can offer disruptive technologies in the short, middle or long run, as well as informing innovation forecasting models. This method might involve certain services like the Science Citation Index or text mining, which would require building algorithms for extracting multiword phrase frequencies and phrase proximities from the different types of textual databases. Bibliometrics has been used widely in combination with other methods such as patents analysis, literature reviews, scenarios and expert panels, being an important source of data.

References

www.foresight-platform.eu/community/forlearn/how-to-do-foresight/methods/analysis/bibliometrics/ (accessed 14.09.16)

Trend Extrapolation

This attempt to identify trends based on the assumption that the future is a continuation of the past. This is often a valid assumption over short term horizons, but becomes increasingly uncertain when creating medium and long term forecasts. The method can be based on regression or probabilistic analyses.

The stability of the (economic, social, etc.) system is the key factor in determining, whether trend extrapolation is an appropriate forecasting tool. The concept of 'developmental inertia' embodies the idea that some items are more easily changed than others. Fashion is an example of an area that shows relatively little inertia. It is difficult to produce reliable mathematical forecasts for fashion trends. Energy consumption, on the other hand, contains substantial inertia and mathematical techniques work well. The longer a time-series of data is, the more reliable a trend extrapolation based on it will be. Disruptive events may cause abrupt change, but this does not necessarily change the long-term trend. An example would be the oil-crises in the 1970s, which prompted some rethinking on (mobile) energy consumption, but did not change fundamentally the general trend of increasing (individual) mobility.

A trend analysis is based on the mathematical description of an observed behaviour. Trends can have a variety of shapes, ranging from linear, to logarithmic, exponential, or cyclic etc. The analysis proceeds essentially in two steps, the first being to search for a best fit to a mathematical model and the second being the extrapolation beyond the observed data, i.e. into the future. The mathematical model is chosen to best represent the observed data e.g. by fitting parameters using regression techniques. The most simple would be linear regression using a least-square method. Regression can also be applied to higher order polynomials. In general, the fewer fitting parameters the mathematical model contains, the more robust for forecasting purposes it would be. Weighted averaging, splines, Autoregressive Integrated Moving Averages (ARIMA) and other Box-Jenkins time-series analyses and similar curve-fitting techniques usually involve a larger number of fitting parameters and, therefore, have less (long-term) predictive power. Harmonic, spectral, or decompositional analyses go beyond regression by trying to identify and represent higher-order periodic variations around a general trend. Depending on the subject and time-scale of the investigation, such periodic variations may occur on a daily, weekly, monthly, seasonal, yearly or other type of time-scale. Examples for the latter may be up- and down-turns of the economy, or cycles in technology development. There may be other components that appear as purely random and could be caused by sampling errors etc.

Trend analysis is essentially a mathematical model and does not include any interpretation on the cause of the observed features. It would be, however, possible to attribute the model variables and fitting parameters to certain economic, societal, etc. mechanisms.

The underlying mathematical model can be subject to a sensitivity analysis in order to test its robustness and, hence, the robustness of forecasts.

References

Asteriou, D., Hall, S.G. (2011): ARIMA Models and the Box–Jenkins Methodology.- Applied Econometrics (Second ed.): 265–286 (Palgrave MacMillan).

Box, G., Jenkins, G. (1970): Time Series Analysis: Forecasting and Control.- p., San Francisco (Holden-Day).

Trend impact analysis

Extrapolate historical data into the future, whilst systematically examining the effects of possible future events that may affect the trend that is extrapolated.

Trend impact analysis is a simple forecasting approach that extrapolates historical data into the future, while taking into account unprecedented future events. This method permits an analyst to include and systematically examine the effects of possible future events that are expected to affect the trend that is extrapolated. The events can include technological, political, social, economic, and value-oriented changes.

The point of departure is the 'surprise-free' projection based on historical data, assuming an absence of unprecedented future events. Expert opinions are then used to identify future events that might cause deviations from the surprise-free projection and calibrate their likelihood and potential strength. A 'high-impact' event would strongly affect the trend, positively or negatively, compared to the surprise-free projection. By combining surprise-free extrapolations with judgments about the probabilities and impacts of selected future events, trend impact analysis provides a solid basis for building scenarios.

References

Georghiou, L., Cassingena Harper, J, Keenan, M., Miles, I., Popper, R. (2008): The Handbook of Technology Foresight. Concepts and Practice.- ISBN 978 1 84844 810 0.

System dynamics modelling

Demand forecasts, for instance, can be generated by the use of System Dynamics Modelling Simulations: in order to achieve meaningful model outputs, it is crucial to identify the most important parameters within the value chain of the commodity under investigation. Crucial parameters are the economic benchmarks, such as the gross domestic product (GDP) and population figures, as the mineral consumption is simulated as a function of GDP per capita (Figure 48). In addition, certain mechanistic parameters have to be considered as well: for instance, mining machinery, processing methods, and their fields of application are developed under a certain pace and will become more and more efficient in the future: these efficiency gains have to be taken into account when simulating scenarios. A conceptual model is then built that relates the various system variables identified in a mechanistic way. Then, mathematical formulations have to be found that describe these relationships in a quantitative way. Finally, this mathematical model may be implemented as a numerical model that solves the above mathematical formulations (typically partial differential equations). A wide variety of equation solving strategies is available, including finite-difference- and finite-element-schemes, as well as stochastic schemes, such as random-walk-models. Modern numerical mathematics toolboxes, e.g. MatLab™ (www.mathworks.com) aid the modeller in setting up tailor-made models. The model is verified and calibrated using sets of historical data, before it is ready to be used for predictive purposes. Figure 48 is an example for a conceptual model as the basis for aggregates demand forecasting in Lower Austria and Vienna.

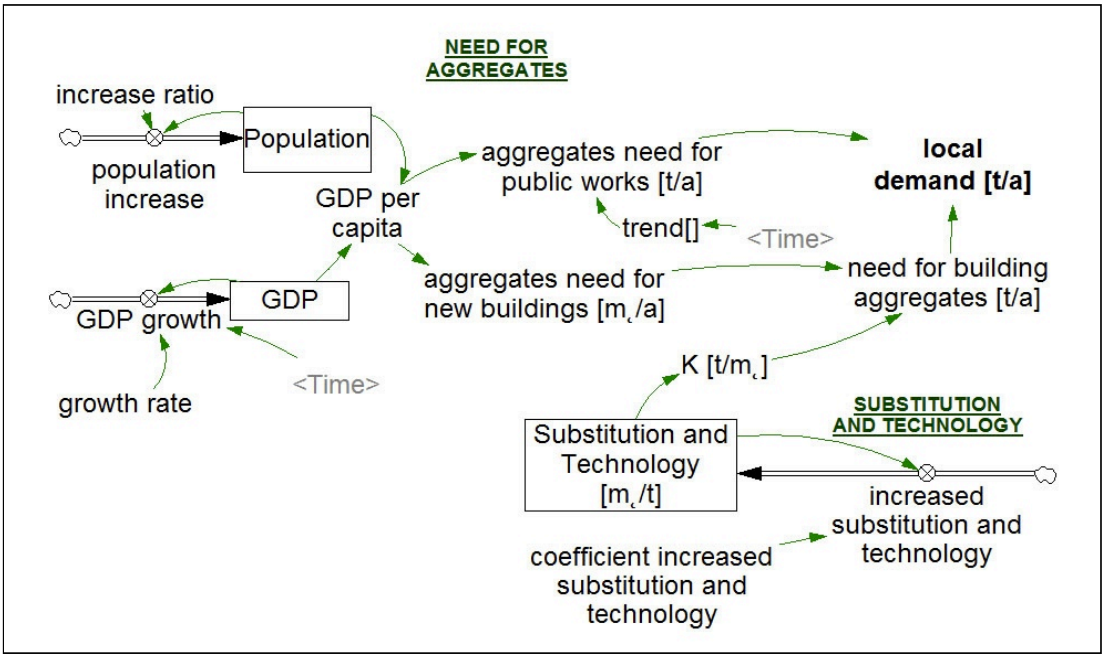


Figure 48: Conceptual system dynamics model for predicting aggregate demand. The Lower Austria and Vienna regions are used as examples, based on GDP and population figures as driving variables (Source: Tiess & Kriz, 2011).

Figure 49 illustrates the output from a parametrised model run. The development of GDP per capita and the resulting aggregates consumption are plotted for the period of 2010 to 2030. Starting from 2010 a peak of aggregates demand of approx. 45 billion tonnes is predicted after around two decades, which amounts to nearly 50% of the 2010 total production in Austria; after this time a decoupling of GDP and consumption is expected.

Note: Quantitative and semi-quantitative methods can be based on either deterministic or probabilistic approaches. Deterministic models employ discrete mathematical functions that are usually parametrised (calibrated) against historical data. Probabilistic methods replace some or all parameters with probability density functions (PDFs). Repeating the calculations while sampling the PDFs provides an envelope of possible futures. Alternatively, ‘particle tracking’ or ‘random-walk’ methods allow following the evolution along a randomised path.

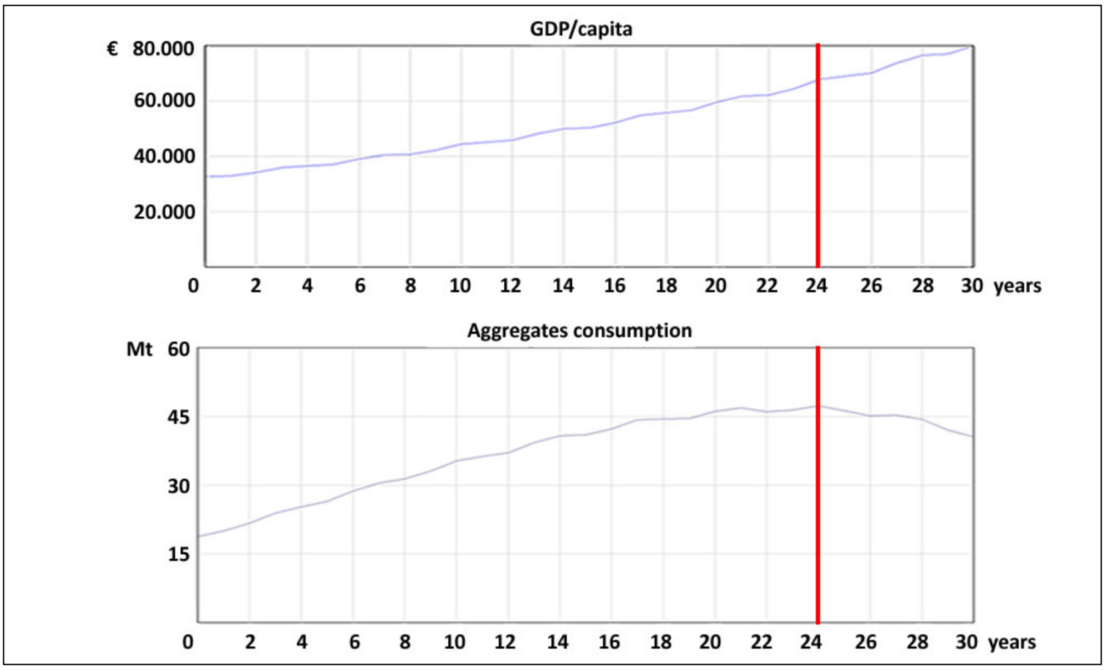


Figure 49: Predicted aggregate consumption as a function of GDP growth in Lower Austria and Vienna for the period 2010 to 2030. Simulated with the system dynamics model illustrated in Figure 48 (Tiess & Kriz, 2011).

Global Value Chain (GVC) Analysis

GVC Analysis can be both, an instrument of (academic) analysis and research, as well as a tool to improve a value-chain or a network of value chains (cf. Figure 50). GVC goes beyond a simple Life-Cycle (LCA) or Material Flow (MFA) Analysis, as it also looks at governance and other types of management issues. The conclusions to be drawn from the analysis depend on the reference framework used and can guide actions for improvement or change.

It may be noted that there are two fundamental types of value chain governance: those that are driven by the buyers and those that are driven by the producers. Gereffi et al. (2005) identified five GVC patterns:

- **Hierarchical** chains represent the fully internalised operations of vertically integrated firms.
- **Quasi-hierarchical** (or **captive** chains) involve suppliers or intermediate customers with low levels of capabilities, who require high levels of support and are the subject of well-developed supply chain management from lead firms (often called the chain governor).
- **Relational** and **modular** chain governance exhibit durable relations between lead firms and their suppliers and customers in the chain, but with low levels of chain governance often because the main suppliers in the chain possess their own unique competences (and/or infrastructure) and can operate independently of the lead firm.
- **Market** chains represent the classic arm's length relationships found in many commodity markets.

GVC together with other, predictive methods, such as back-casting, would allow to develop strategies to ensure a sustained raw materials to the European Union.

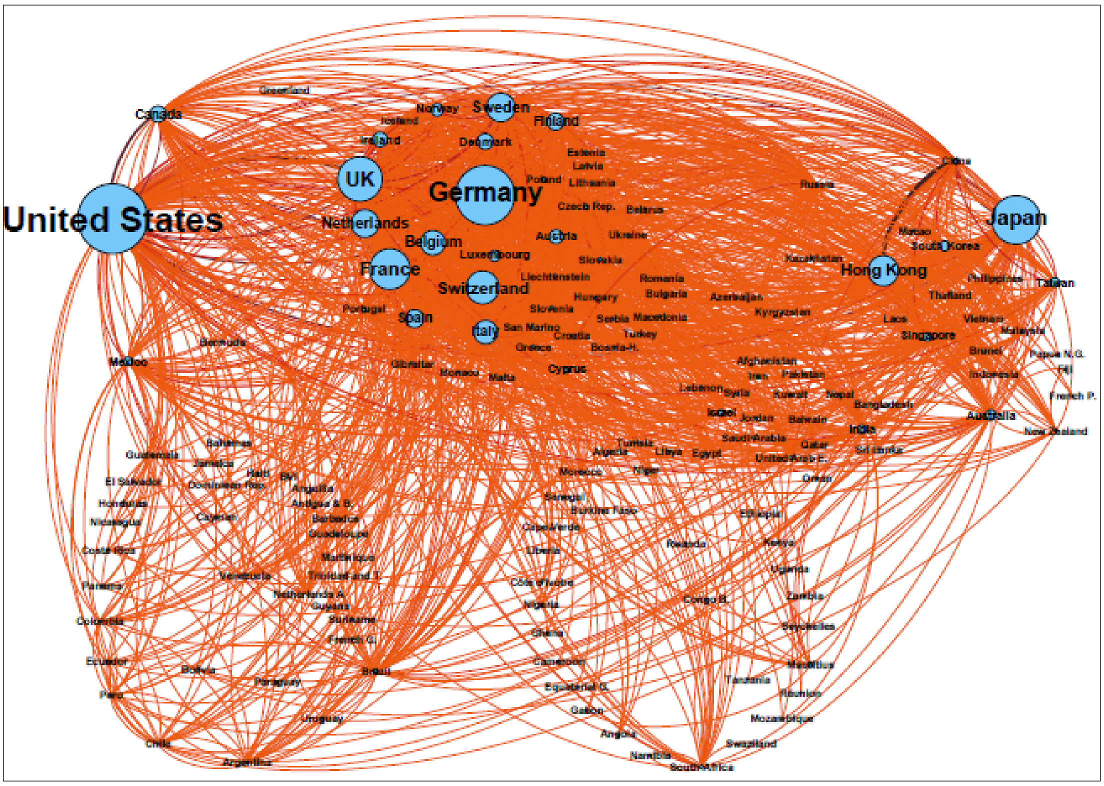


Figure 50: Example of vertically linked foreign subsidiaries and their parents (Source: [http://voxeu.org/ article/latin-Americas-missing-global-value-chains](http://voxeu.org/article/latin-Americas-missing-global-value-chains)).

References

Gereffi, G., Humphrey, J., Sturgeon, T. (2005): The governance of global value chains.- Review of International Political Economy, 12(1): 78-104 DOI: 10.1080/09692290500049805

Appendix 2: United Nations conventions and treaties

Overview

This Appendix is concerned with a range of relevant international conventions and treaties that may pertain to minerals use at certain stages of their life-cycle. Other conventions pertain, for instance, to the protection of particular environmental compartments, such as the sea, or of the natural and cultural heritage. The latter (e.g. the World Heritage Convention) are of particular policy-making relevance, as they can control or prevent access to minerals. Such potential resources- and land-use conflicts are, for instance, the subject of the H2020 project MINATURA2020 (www.minatura2020.eu).

Although not directly addressing mining, certain conventions do have a bearing on mining, as they intend to regulate the movement of wastes (e.g. the Basel Convention) or the disposal of waste in the sea (e.g. the London Convention).

Table 11 provides an overview over the conventions considered relevant.

Table 11: Mining-relevant UN conventions and treaties

Short Name	Title	Location/Date	URL
Aarhus Convention	Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters	Aarhus, Denmark, 25 June 1998	www.unece.org/env/pp/documents/cep43e.pdf
Basel Convention	Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal	Basel, Switzerland, 22 March 1989	www.basel.int
Espoo Convention	Convention on Environmental Impact Assessment in a Transboundary Context	Espoo, Finland, 25 February 1991	www.unece.org/env/eia/
UN Water Convention	Convention on the Protection of the Marine Environment of the Baltic Sea Area	Helsinki, Finland, 17 March 1992	www.unece.org/env/water.html
Industrial Accidents Convention	Convention on the Transboundary Effects of Industrial Accidents	Helsinki, Finland, 17 March 1992	www.unece.org/env/teia.html
London Convention	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter	London, UK, 13 November 1972	www.imo.org/en/OurWork/Environment/LCLP/Pages/default.aspx
Ramsar Convention	Ramsar Convention on Wetlands	Ramsar, India, 2 February 1971	www.ramsar.org
UNFCC	UN Framework Convention on Climate Change	Rio de Janeiro, Brazil, 9 May 1992	http://unfccc.int
World Heritage Convention	Convention Concerning the Protection of the World Cultural and Natural Heritage	Paris, France, 16. November 1972	http://whc.unesco.org

For the Aarhus, Basel, Espoo, Helsinki, UNFCC conventions the EU is a contracting party, but not for the London, Ramsar, and the World Heritage Convention, while various Member States are.

Aarhus Convention

The European Union wishes to keep citizens informed and involved in environmental matters and to improve the application of environmental legislation by approving the Convention on access to information, public participation and access to justice in environmental matters.

The Aarhus Convention was adopted on 25th June 1998 in the Danish city of Aarhus at the Fourth Ministerial Conference in the 'Environment for Europe' process. The Convention was signed by Albania, Armenia, Austria, Belarus, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, European Union, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kazakhstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Netherlands, Norway, Poland, Portugal, Republic of Moldova, Romania, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom of Great Britain and Northern Ireland in 1998.

The Convention, in force since 30 October 2001, is based on the premise that greater public awareness of and involvement in environmental matters will improve environmental protection. It is designed to help protect the right of every person of present and future generations to live in an environment adequate to his or her health and well-being. To this end, the Convention provides for action in three areas:

- ensuring public access to environmental information held by the public authorities;
- fostering public participation in decision-making which affects the environment;
- extending the conditions of access to justice in environmental matters.

The Community has undertaken to take the necessary measures to ensure the effective application of the Convention. The first pillar of the Convention on public access to information was implemented at Community level by Directive 2003/04/EC on public access to environmental information. The second pillar, which deals with public participation in environmental procedures, was transposed by Directive 2003/35/EC. A proposal for a Directive published in October 2003 was intended to transpose the 3rd pillar that guarantees public access to justice in environmental matters. Finally, a Regulation adopted in 2006 is intended to guarantee the application of the provisions and principles of the Convention by Community institutions and bodies.

Council Decision 2005/370/EC of 17 February 2005 on the conclusion, on behalf of the European Community, of the Convention on access to information, public participation in decision-making and access to justice in environmental matters approves the Aarhus Convention on behalf of the Community.

The preamble to the Aarhus Convention sets out the aspirations and goals that show its origins as well as guiding its future path. In particular the preamble emphasizes two main concepts:

environmental rights as human rights; and the importance of access to information, public participation and access to justice to sustainable and environmentally sound development.
The Convention stands on three pillars:

Pillar I - Access to information

Pillar II - Public participation in decision-making

Pillar III - Access to justice

I. Access to information
The Convention determines the definition of *'environmental information'*: it means any information in written, visual, aural, electronic or any other material from on:

a) The state of elements of the environment, such as air and atmosphere, water, soil, land, landscape and natural sites, biological diversity and its components, including genetically modified organisms, and the interaction among these elements;
b) (b) Factors, such as substances, energy, noise and radiation, and activities or measures, including administrative measures, environmental agreements, policies, legislation, plans and programmes, affecting or likely to affect the elements of the environment within the scope of subparagraph (a) above, and cost-benefit and other economic analyses and assumptions used in environmental decision-making;
c) (c) The state of human health and safety, conditions of human life, cultural sites and built structures, inasmuch as they are or may be affected by the state of the elements of the environment or, through these elements, by the factors, activities or measures referred to in subparagraph (b) above.

The access to information pillar is split in two. The first part concerns the right of the public to seek information from public authorities and the obligation of public authorities to provide information in response to a request. This type of access to information is called "passive", and is covered by article 4 ('Access to environmental information'). The Convention lays down precise rights and duties regarding access to information, including deadlines for providing information and the grounds on which public authorities may refuse access to certain types of information.

Access may be refused in three cases:

- the public authority does not hold the requested information;
- the request is manifestly unreasonable or formulated in too general a manner;
- the request concerns material in the course of completion.

Requests may also be refused on grounds of confidentiality of the proceedings of public authorities, national defence and public security, to further the course of justice or to respect the confidentiality of commercial and industrial information, intellectual property rights, the confidentiality of personal data and the interests of a third party who has volunteered the information, though all these grounds for refusal must be interpreted in a restrictive way, taking into account the public interest served by disclosure of the information.

A decision to refuse access must state the reasons for the refusal and indicate what forms of appeal are open to the applicant.

The second part of the information pillar concerns the right of the public to receive information and the obligation of authorities to collect and disseminate information of public interest without the need for a specific request. This is called "active" access to information, and is covered by article 5 ('Collection and dissemination of environmental information').

Public authorities must keep the information they hold up to date, and to this end establish publicly accessible lists, registers and files. The use should be promoted of electronic databases containing reports on the state of the environment, legislation, national plans and policies and international conventions.

II. Public participation in decision-making

According to the Convention *'the public'* means one or more natural or legal persons, and, in accordance with national legislation or practice, their associations, organisations or groups; and *'the public concerned'* means the public affected or likely to be affected by, or having an interest in, the environmental decision-making; for the purposes of this definition, non-governmental organisations promoting environmental protection and meeting any requirements under national law shall be deemed to have an interest.

The public participation pillar is divided into three parts. The first part concerns the participation of the public that may be affected by or is otherwise interested in decision-making on a specific activity, and is covered by article 6 ('Public participation in decisions on specific activities').

This must be ensured through the authorisation procedure for certain specific activities (mainly of an industrial nature) listed in Annex I to the Convention. The final decision to authorise the activity must take due account of the outcome of the public participation.

The public must be informed, early in the decision-making procedure, of the following:

- the matter on which the decision is to be taken;
- the nature of the decision;
- the authority responsible;
- the procedure to be used, including the practical details of the consultation procedure;
- the procedure for an environmental impact assessment (if any).

The second part concerns the participation of the public in the development of plans, programmes and policies relating to the environment, and is covered by article 7 ('Public participation concerning plans, programmes and policies relating to the environment').

A streamlined procedure has been set up for the formulation of environmental plans and programmes.

Finally, article 8 ('Public participation during the preparation of executive regulations and/or generally applicable legally binding normative instruments') covers participation of the public in the preparation of laws, rules and legally binding norms. The Convention also invites the parties to promote public participation in the preparation of environmental policies as well as standards and legislation that may have a significant effect on the environment.

III. Access to justice

The third pillar of the Aarhus Convention is the access to justice pillar, contained in article 9 ('Access to justice'). Regarding access to justice, all persons who feel their rights to access to information have been impaired (request for information ignored, wrongfully refused, inadequately answered) must have access, in the appropriate circumstances, to a review procedure under national legislation.

Access to justice is also ensured in the event of the Convention's participation procedure being infringed. Access to justice is also allowed for the settlement of disputes relating to acts or omissions by private persons and public authorities who contravene provisions of national law relating to the environment.

The Aarhus Convention has become the most important international agreement on environmental rights. Article 9 (Access to justice) of the Convention defines the three fundamental rights on access to environmental information and participation. Paragraph 1 of the article secures the access to justice upon violation of right on requested information, Paragraph 2 provides the right on access to justice if the right to participate in the authorisation process on projects having possible significant effect on the environment is not secured. Paragraph 2 may have high importance for the permitting procedures of mineral resource projects as it is reflected by law cases. It is important to note that environmental associations in relation to Article 9(2) are not required to prove impairment of their rights or sufficient interest.

Basel Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (http://www.basel.int) was adopted on 22 March 1989 and entered into force on 5 May 1992. The original Arabic, Chinese, English, French, Russian and Spanish texts of the Basel Convention are equally authentic. They are deposited with the Secretary General of the United Nations, at the United Nations Treaty Section in New York.

In essence the objective of the Convention is

- the reduction of hazardous waste generation and the promotion of environmentally sound management of hazardous wastes, wherever the place of disposal;
- the restriction of transboundary movements of hazardous wastes except where it is perceived to be in accordance with the principles of environmentally sound management; and
- a regulatory system applying to cases where transboundary movements are permissible.

In particular
Article 1 set out the *scope*.
Article 2 *defines* the terms used in the Convention
Article 3 requires the parties to submit their *national definitions of hazardous wastes*.
Article 4 sets out the *general obligations* of the parties.
Article 5 requires the *designation of competent authorities and focal points*.
Article 6 defines the information flow on *transboundary movements between parties*.
Article 7 concern the *transboundary movement from a party through states which are not parties*.
Article 8 defines the *duty to re-import*.
Article 9 concerns *illegal traffic* of wastes.
Article 10 stipulates *international co-operation* between the parties.
Article 11 encourages *bilateral, multilateral and regional agreements*.
Article 12 calls for *consultations on liability*.
Article 13 regulates the *transmission of information*.
Article 14 provides for *financial aspects*.
Article 15 establishes the *Conference of Parties*.
Article 16 sets out the role and function of the *Secretariat* (www.basel.int).
Article 17 and 18 rule on the *amendments of the Convention* and *adoption and amendment of annexes*.
Article 19 and 20 provide for *verification* and the *settling of disputes*.
Article 21 to 27 rule on the *signature*, the *ratification, acceptance, formal confirmation or approval*, the *accession*, the *right to vote*, the *entry into force*, *reservations and declarations*, and *withdrawal*.
Articles 28 and 29 determine the *depository* and the *authenticity of the text*.
Annex I determines the wastes and waste streams to be controlled.
Annex II list categories of waste requiring special consideration.
Annex III provides a list of hazard characteristics.
Annex IV describes what constitutes (non-recoverable) disposal operations
Annex VA and VB sets out the shipping documentation requirements
Annex VI provides for arbitration procedures
Annex VII has not yet entered into force
Annexes VIII and IX provide lists of the hazardous substances subject of the Convention

Mining and milling wastes per se are not likely to fall under the Convention due to their nature and quantities. However, certain materials that would have been considered 'waste' previously become secondary raw materials under the circular economy paradigm and, hence, may need to be shipped across borders for (re-)processing. This requires particular attention by the authorities as this may facilitate the false declaration of wastes that in reality are destined for illegal dumping in developing countries.

References

UNEP United Nations Enviromental Programme (1989): Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.- 120 p., www.basel.int/Portals/4/BaselConvention/docs/text/BaselConventionText-e.pdf

Espoo Convention

The Convention on Environmental Impact Assessment in a Transboundary Context was adopted in Espoo (Finland) on 25 February 1991 and entered into force on 10 September 1997 (UNECE, 1991). The Convention sets out the obligations of Parties to assess the environmental impact of certain activities at an early stage of planning. It also lays down the general obligation of states to notify and consult each other on all major projects under consideration that are likely to have a significant adverse environmental impact across boundaries.

The Espoo Convention is intended to help make developments sustainable by promoting international cooperation in assessing the likely impact of a proposed activity on the environment. It applies, in particular, to activities that could damage the environment in other countries. Ultimately, the Espoo Convention is aimed at preventing, mitigating and monitoring such environmental damage.

The Espoo Convention ensures that explicit consideration is given to environmental factors well before the final decision is taken. It also ensures that the people living in areas likely to be affected by an adverse impact are told of the proposed activity (UNECE, 2006). It provides an opportunity for these people to make comments or raise objections to the proposed activity and participate in relevant environmental impact assessment procedures; and it ensures that these comments and objections are transmitted to the competent authority and are taken into account in the final decision.

While the Espoo-Convention provides for the opportunity of all affected parties to contribute, the guidelines for implementation (UNECE, 2006) note that it is unclear how this can be effected in an international, trans-boundary context. This report cites a case where the same information as for national stakeholders was made available in translation to equivalent stakeholders in a neighbouring country. Thus, Finland informed the Russian public about a planned new nuclear power plant. The additional costs arising from such undertaking are usually met by the proponent of a project according to the 'polluter pays' principle. There may be also instances where the proponent country's government or an international body (e.g. EBRD) meets such costs.

By the end of 2005 there were 41 Parties to the Espoo Convention: Albania, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bulgaria, Canada, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Kazakhstan, Kyrgyzstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Republic of Moldova, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, the former Yugoslav Republic of Macedonia, Ukraine, United Kingdom and the European Community. At their second meeting, the Parties adopted an amendment to the Convention allowing non-UNECE member States to become Parties.

The convention consists of *20 Articles and 7 Appendices.*

Article 1 provides some relevant *definitions*, such as parties, party of origin, affected party, concerned parties, proposed activity, environmental impact assessment, impact, transboundary impact, competent authority, the public.
Article 2 defines in *general provisions* the obligations of the parties.
Article 3 regulates *notification* obligations for activities as listed in Appendix I
Article 4 sets out the general rules for the *preparation of the environmental impact assessment documentation* as detailed in Appendix II
Article 5 prescribes the processes for *consultations on the basis of the environmental impact assessment documentation* as per Appendix II.
Article 6 sets out the general rules for communicating the *final decision*.
Article 7 describes the needs, conditions and rights for *post-project analyses*.
Article 8 suggests that parties may enter into bi- or multi-lateral agreements to fulfil their obligations under this Convention.
Article 9 encourages to support the implementation of the Convention by *research programmes*.
Article 10 specifies that the *Appendices* form an integral part of the Convention.
Articles 11 and 12 regulate the *periodical meeting of the parties* and their respective *voting rights*.
Article 13 determines UNECE as the *secretariat* for the Convention.
Article 14 sets out the rules for *amending* the Convention.
Article 15 determines the rules for *settling disputes*.
Articles 16 to 19 set out the rules for *signature*, *ratification*, *acceptance*, *approval*, *accession*, *entry into force*, and *withdrawal*.
Article 20 determines that the authentic text of the Convention is deposited with UN Secretary General.
Appendix I (second amendment) lists the activities to which the Convention is applicable. For raw materials activities are particularly relevant:

Activity #10. (a) Waste-disposal installations for the incineration, chemical treatment or landfill of toxic and dangerous wastes; (b) Waste-disposal installations for the incineration or chemical treatment of non-hazardous waste with a capacity exceeding 100 metric tons per day.
Activity #11. Large dams and reservoirs.
Activity #12. Groundwater abstraction activities or artificial groundwater recharge schemes where the annual volume of water to be abstracted or recharged amounts to 10 million cubic metres or more.
Activity #14. Major quarries, mining, on-site extraction and processing of metal ores or coal.

Appendix II outlines the minimum documentation on the relevant activities to be submitted:

(a) description of the proposed activity and its purpose;
(b) description, where appropriate, of reasonable alternatives (for example, locational or technological) to the proposed activity and also the no-action alternatives;
(c) description of the environment likely to be significantly affected by the proposed activity and its alternatives:
(d) description of the potential environmental impact of the proposed activity and its alternatives and an estimation of its significance:
(e) description of mitigation measures to keep adverse environmental impact to a minimum;

(f) explicit indication of predictive methods and underlying assumptions as well as the relevant environmental data used);
(g) (g) An identification of gaps in knowledge and uncertainties encountered in compiling the required information;
(h) where appropriate, an outline for monitoring and management programmes and any plans for post-project analysis), and
(i) (non-technical summary including a visual presentation as appropriate (maps, graphs, etc.).

Appendix III sets out the general criteria to assist in the determination of the environmental significance of activities not listed in Appendix I. Relevant criteria could be:
(a) Size: proposed activities which are large for the type of the activity;
(b) Location: proposed activities which are located in or close to an area of special environmental sensitivity or importance (such as wetlands designated under the Ramsar Convention, national parks, nature reserves, sites of special scientific interest, or sites of archaeological, cultural or historical importance), also, proposed activities in locations where the characteristics of proposed development would be likely to have significant effects on the population;
(c) Effects: proposed activities with particularly complex and potentially adverse effects, including those giving rise to serious effects on humans or on valued species or organisms, those which threaten the existing or potential use of an affected area and those causing additional loading which cannot be sustained by the carrying capacity of the environment.

Appendix IV sets out the procedure for *inquiries* to determine, whether an activity would fall under the Convention.
Appendix V describes the *purpose of post-project analyses*
Appendix VI describes the elements of *bi- or multi-lateral co-operation*
Appendx VII describes the process for *arbitration*

References
UNECE United Nations Economic Commission for Europe (1991): Convention on Environmental Impact Assessment in a Transboundary Context.- Espoo, Finland, 25 February 1991. www.unece.org/fileadmin/DAM/env/eia/documents/legaltexts/Espoo_Convention_authentic_ENG.pdf (accessed 27.01.17)

Lugano Convention

The Council of Europe's Convention on Civil Liability for Damage Resulting from Activities Dangerous to the Environment (Lugano Convention) was concluded on 21.061993. The Convention constituted an important milestone in the historical development of European initiatives on environmental civil liability. It was the first international instrument of its kind to attempt to set out a comprehensive framework for liability in respect of environmental damage and the first to focus on the need for legal systems to employ environmental protection-oriented sanctions on persons found liable of causing significant environmental damage. From an EU perspective, though, the Lugano Convention is now largely of historical interest only. A number of

EU member states indicated relatively early on that they had serious reservations about acceding to it, notably Denmark, the UK and Germany. The EU member states remained divided over a number of years after the Convention was tabled for signature as to whether to adopt it as an appropriate model for the basis of a common liability framework. Of the nine signatories (Cyprus, Finland, Greece, Iceland, Italy, Liechtenstein, Luxembourg, Netherlands, Portugal) to the Convention, seven are EU member states. However, no nation state has proceeded to ratify the Convention, and it may not enter into force unless at least three states do so.

More significantly, since the adoption in 2004 of specific EU rules on environmental civil liability in the form of the Environmental Liability Directive 2004/35 (EP, 2004, plus amendments), the Lugano Convention is no longer relevant in respect of civil liability issues arising from environmental damage caused and occurring within the territory of the EU. It is needed to take into consideration, however, that while the Lugano Convention regulated the liability for traditional damages (e.g. loss of life, personal injuries and property damages) the ELD doesn't cover the liability for these damages. This Convention aims at ensuring adequate compensation for damage resulting from activities dangerous to the environment and also provides for means of prevention and reinstatement.

References

CoE Council of Europe (1993): Convention on Civil Liability for Damage Resulting from Activities Dangerous to the Environment.- European Treaty Series No. 150: 16 p., Brussels. https://rm.coe.int/CoERMPublicCommonSearchServices/DisplayDCTMContent?documentId=090000168007c079.

CEU Council of European (2004): Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage.- OJ L134/56-75, 30.04.2004, http://eur-lex.europa.eu/legal-content/EN/ TXT/PDF/?uri=CELEX:32004L0035&from=EN.

UN Water Convention

The Convention on the protection and use of transboundary watercourses and international lakes was signed on 17 March 1992 in Helsinki (UNECE, 1992). The main objectives of the Convention are the protection and use of transboundary watercourses and international lakes as well as the protection of the environment from the transboundary impacts. It aims to protect and ensure the quantity, quality and sustainable use of transboundary water resources by facilitating cooperation. It provides an intergovernmental platform for the day-to-day development and advancement of transboundary cooperation. Initially negotiated as a regional instrument, it turned into a universally available legal framework for transboundary water cooperation, following the entry into force of amendments in February 2013, opening it to all UN Member States. As of 1st March 2016, countries outside the ECE region can accede to the Convention. The United Nations Economic Commission for Europe provides the Secretariat for the Convention.

The regulations of the Convention can be divided into two main categories. There are provisions which oblige each contracting parties, and there are specific provisions relating only to riparian parties. “Riparian parties" are the parties bordering the same transboundary waters.

Part I
Article 1 sets out the relevant *definitions*.
Article 2 sets out the *provisions* for all parties to take all appropriate measures to prevent, control and reduce any transboundary impact.
Article 3 describes *prevention, control and reduction* of transboundary impacts.
Article 4 stipulates the set-up of *monitoring* programmes.
Article 5 encourages *research and development* to support the Convention.
Articles 6 to 8 details the *exchange of information*, the *responsibility and liability* of parties, and the *protection of information*.

Part II concerns *provisions relating to riparian parties*
Article 9 encourages *bilateral and mulitlateral co-operation*.
Articles 10 and 11 rules on *consultations* and *joint monitoring and assessment*.
Article 12 encourages *common research and development*.
Article 13 rules on *exchange of information between riparian parties*.
Articles 14 to 16 provide for *warning and alarm systems*, *mutual assistance*, and for *public information*.
Part III concerns the *institutional and final provisions*
Article 17 to 19 detail the *meeting of the parties*, their *rights to vote*, and the role of the *Secretariat*.
Article 20 makes the Annexes an integral part of the Convention
Articles 21 and 22 rule on *amendments* and the *settling of disputes*.
Articles 23 and 24 rule on the *signatures* and the *depositary* of the Convention.
Articles 25 to 27 rule on the *ratification, acceptance, approval and accession*, the *entry into force*, and *withdrawal*.

Article 28 determines the *authenticity of the text*.
Annex I provides a *definition of the term "best available technology*" as stipulated in the Convention for protective measures.
Annex II gives *guidelines for developing best environmental practices*.
Annex III gives *guidelines for developing water-quality objectives and criteria*.
Annex IV rules on *arbitration*.

For the prevention, control and reduction of transboundary impact the parties have to adopt concrete measures, including:

- control and prevention of the emission of pollutants through the application of low and non-waste technology
- prior licensing of waste-water discharges
- stricter requirements, even leading to prohibition in individual cases
- biological treatment or equivalent processes in a step-by-step approach;
- reduction of nutrient inputs from industrial and municipal sources;

- reduction of inputs of nutrients and hazardous substances from diffuse sources;
- environmental impact assessment and other means of assessment;
- sustainable water-resources management, including the application of the ecosystems approach;
- contingency planning;
- additional specific measures for the prevention of the pollution of groundwater;
- the minimisation of the risk of accidental pollution.

References

UNECE United Nations Economic Commission for Europe (1992): Convention on the Protection and Use of Transboundary Watercourses and International Lakes done at Helsinki, on 17 March 1992.- 21 p., Geneva (UNECE) www.unece.org/fileadmin/DAM/env/water/pdf/watercon.pdf (accessed 27.01.17).

Industrial Accidents Convention

The Convention on the Transboundary Effects of Industrial Accidents was adopted on 17 March, 1992 in Helsinki and amended on 19 March 2008 (UNECE, 2008). The United Nations Economic Commission for Europe provides the Secretariat.

The main aim of the Convention is to prevent the industrial accidents which could have transboundary effects and to prepare for, and respond to, accidents if they occur.

Article 1 *defines* relevant terms
Article 2 defines the *scope* and not covered activities (particularly seabed-mining and releases into the sea are excluded, cf. London Convention)
Article 3 outlines the *general provisions* operators shall make to avoid accidents
Article 4 concerns the *identification, consultation and advice* with respect to hazardous activities.
Article 5 encourages *voluntary extension* of the scope of the Convention
Article 6 stipulates measures for the *prevention* of accidents
Article 7 concerns the *decision-making on siting* of relevant facilities
Article 8 calls for *emergency preparedness.*
Article 9 provides for *information to, and participation of the public.*
Article 10 calls for *industrial accident notification systems*.
Articles 11 to 13 calls for *response*, *mutual assistance*, and to develop a system for covering *responsibility and liability*.
Article 14 encourages *research and development* in support of the Convention
Article 15 and 16 call for parties to *exchange information* and *technology*.
Article 17 defines *competent authorities and points of contact.*
Article 18 to 20 detail the *Conference of Parties*, their *rights to vote*, and the *Secretariat.*
Article 21 provides for the *settlement of disputes*.
Article 22 details the *limitations on the supply of information*.
Article 23 stipulates that parties shall report periodically on the *implementation* of the Convention.

Articles 24 encourages *bilateral and multilateral agreements.*
Article 25 and 26 defines the status of the *annexes* and the procedures for *amendments.*
Articles 27 to 31 concern the *signature*, the *depositary, ratification, acceptance, approval and accession*, the *entry into force*, and *withdrawal.*
Article 32 determines the *authenticity* of the text
Annex I provides a list of *hazardous substances for the purposes of defining hazardous activities.*
Annex II concerns the *inquiry commission procedure pursuant to Articles 4 and 5.*
Annex III details the *procedures pursuant to Article 4.*
Annex IV details *preventive measures pursuant to Article 6.*
Annex V describes procedures for *analysis and evaluation.*
Annex VI gives guidance on *decision-making on siting pursuant to Article 7.*
Annex VII gives guidance on *emergency preparedness measures pursuant to Article 8.*
Annex VIII gives guidance on *information to the public pursuant to Article 9.*
Annex IX gives guidance on *industrial accident notification systems pursuant to Article 10.*
Annex X gives guidance on *mutual assistance pursuant to Article 12.*
Annex XI gives guidance on *exchange of information pursuant to Article 15.*
Annex XII details the *tasks for mutual assistance pursuant to Article 18, paragraph 4.*
Annex XIII concerns the *arbitration* procedures

Within the framework of their legal systems, the Parties shall establish policies on developments covered by the Convention that could have transboundary effects from industrial accident so as to minimize the ensuing risks.

In 2003 a Protocol on Civil Liability and Compensation for Damage Caused by the Transboundary Effects of Industrial Accidents on Transboundary Waters was adopted in Kiev. One of the concrete origins of the Protocol was the cyanide spill from a gold mine in Baia Mare, Romania, in 2000 that afflicted the Danube and Tisza Rivers.

References

UNECE United Nations Economic Commission for Europe (2008): Convention on the Trans-boundary Effects of Industrial Accidents as amended on 19 March 2008.- 116 p., Geneva (UNECE) www.unece.org/fileadmin/DAM/env/documents/2013/TEIA/1321013_ENG_Web.pdf (accessed 27.01.17).

London Convention

The ‘Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972’, the ‘London Convention’ for short, is one of the first global conventions to protect the marine environment from human activities and has been in force since 1975. Its objective is to promote the effective control of all sources of marine pollution and to take all practicable steps to prevent pollution of the sea by dumping of wastes and other matter. Currently, 87 States are Parties to this Convention.

In 1996, the 'London Protocol' was agreed to further modernise the Convention and, eventually, replace it. Under the Protocol all dumping is prohibited, except for possibly acceptable wastes on the so-called 'reverse list'. The Protocol entered into force on 24 March 2006 and there are currently 48 Parties to the Protocol.

The objective of the London Convention and Protocol is to promote the effective control of all sources of marine pollution. Contracting Parties shall take effective measures to prevent pollution of the marine environment caused by dumping at sea (see articles I and II of the Convention and article 2 of the Protocol).

The purpose of the London Convention is to control all sources of marine pollution and prevent pollution of the sea through regulation of dumping into the sea of waste materials. A so-called 'black- and grey-list' approach is applied for wastes, which can be considered for disposal at sea according to the hazard they present to the environment. For the blacklist items dumping is prohibited. Dumping of the grey-listed materials requires a special permit from a designated national authority under strict control and provided certain conditions are met. All other materials or substances can be dumped after a general permit has been issued. Mining and milling wastes, will normally fall into the grey-list, but depending on their constituents (e.g. cyanide, arsenic etc.) may fall into the black-list.

The purpose of the Protocol is similar to that of the Convention, but the Protocol is more restrictive: application of a 'precautionary approach' is included as a general obligation; a 'reverse list' approach is adopted, which implies that all dumping is prohibited unless explicitly permitted; incineration of wastes at sea is prohibited; export of wastes for the purpose of dumping or incineration at sea is prohibited. Extended compliance procedures and technical assistance provisions have been included, while a so-called transitional period allows new Contracting Parties to phase in compliance with the Protocol over a period of five years, provided certain conditions are met.

References

IMO International Maritime Organisation (1972): Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter.- 16 p., London (IMO) www.imo.org/en/OurWork/Environment/LCLP/Documents/LC1972.pdf (accessed 27.01.17).

IMO International Maritime Organisation (2006): 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (as amended in 2006).- 25 p., London (IMO) www.imo.org/en/OurWork/Environment/LCLP/Documents/PROTOCOLAmended2006.pdf (accessed 27.01.17).

Ramsar Convention

The Convention on Wetlands of International Importance, called the Ramsar Convention, is the intergovernmental treaty that provides the framework for the conservation and wise use of wetlands and their resources (UNESCO, 1994). The Convention was adopted in the Iranian city of

Ramsar in 1971 and came into force in 1975. Since then, almost 90% of UN member states, from all the world's geographic regions, have acceded to become 'Contracting Parties'. The secretariat is provided by UNESCO and it is co-located with the International Union for the Conservation of Nature (IUCN) in Gland, Switzerland.

The Convention's mission is "the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world". Wetlands are among the most diverse and productive ecosystems. They provide essential services and supply all our fresh water. However they continue to be degraded and converted to other uses.

The Convention uses a broad definition of wetlands. It includes all lakes and rivers, underground aquifers, swamps and marshes, wet grasslands, peat-lands, oases, estuaries, deltas and tidal flats, mangroves and other coastal areas, coral reefs, and all human-made sites such as fish ponds, rice paddies, reservoirs and salt pans.

Under the 'three pillars' of the Convention, the Contracting Parties commit to:

- work towards the wise use of all their wetlands;
- designate suitable wetlands for the list of Wetlands of International Importance (the "Ramsar List") and ensure their effective management;
- cooperate internationally on transboundary wetlands, shared wetland systems and shared species.

Although the Ramsar-Convention does not specifically address mining and milling projects or other elements of the mineral raw materials value chain, these are relevant, as their emissions and other impacts (such as groundwater-table changes) can negatively affect wetlands. However, there are various examples for the co-existence of Ramsar- and mining sites. In fact, open-pit mining typically leaves behind lakes that develop, when the mines are flooded after their closure. With adequate management of the closure process, these former open-pit mines can become future Ramsar-sites. This added-value can be relevant in the permitting process.

References

UNESCO United Nations Educational, Scientific and Cultural Organisation (1994): Convention on Wetlands of International Importance especially as Waterfowl Habitat. Ramsar, Iran, 2.2.1971, as amended by the Protocol of 3.12.1982, and the Amendments of 28.5.198.- 6 p., www.ramsar.org/sites/default/files/documents/library/current_convention_text_e.pdf (accessed 27.01.17).

UN Framework Convention on Climate Change (UNFCCC)

The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty negotiated at the Earth Summit in Rio de Janeiro from 3 to 14 June 1992, then entered into force on 21 March 1994. The UNFCCC objective is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (UN, 1992). The framework set no binding limits on greenhouse gas emissions for individual countries and contains no enforcement mechanisms. Instead, the framework outlines how specific international treaties (called 'protocols' or 'Agreements') may be negotiated to set binding limits on greenhouse gases. A total of 197 countries have ratified the Convention. The secretariat is based in Bonn, Germany.

The UNFCC) will have an indirect, but potentially decisive impact on the minerals sector. Substantial changes to the mix of energy conversion systems, such as the phasing out the use of coal and the more wide-spread introduction of wind- and sun-based systems, will change the supply (e.g. as by-product) and demand (e.g. for certain metals) of minerals. Thus, coal mining may eventually be reduced to supply the steel-industry with the required coke. Most notable also is the increasing demand of REE for high-power magnets in the dynamos of wind-mills. Photovoltaic systems have specific mineral requirements and the increasing use of batteries in transport will impact the demand for certain metals. Energy policies aiming to curb energy use with a view to achieve CO_2 emission reductions as agreed under the UNFCC may also have an influence on the supply and production routes for certain energy-intensive minerals, such as aluminium for instance. These are policy and not market-driven changes.

The UNFCC as well as EU and national climate-related policies are supported by the Intergovernmental Panel on Climate Change (IPCC, www.ipcc.ch) which is the leading international body for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP, www.unep.org) and the World Meteorological Organization (WMO, www.wmo.int) in 1988 to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts. In the same year, the UN General Assembly endorsed the action by WMO and UNEP in jointly establishing the IPCC. The IPCC reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. It does not conduct any research nor does it monitor climate related data or parameters.

As an intergovernmental body, membership of the IPCC is open to all member countries of the United Nations (UN) and WMO. Currently 195 countries are Members of the IPCC. Governments participate in the review process and the plenary sessions, where main decisions about the IPCC work programme are taken and reports are accepted, adopted and approved. The IPCC Bureau Members, including the Chair, are also elected during the plenary Sessions.

IPCC findings and recommendation do have an indirect influence on the world mineral markets, as their recommendations influence governmental energy policies and private as well as industry's attitude towards certain energy conversion systems and materials use.

A possible climate change appears to be related to the constantly increasing release of carbon from fossil carbon reservoirs. Virtually all societies in the world are involved in this release of fossil carbon to a greater or lesser extent. As energy is required during the production and use of minerals, there is significant carbon releases associated with it.

Energy policies reflecting the IPCC recommendations will thus also change mineral requirements due to changing needs in different energy conversion systems.

Reference

UN United Nations (1992): United Nations Framework Convention on Climate Change.- 33 p., http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf (accessed 27.01.17).

World Heritage Convention (WHC)

The Convention Concerning the Protection of the World Cultural and Natural Heritage was adopted by the General Conference of UNESCO on 16 November 1972 (UNESCO, 1972). The Convention came into force on 17 December 1975. As of June 2016, it has been ratified by 192 states, including 188 UN member states plus the Cook Islands, the Holy See, Niue, and the Palestinian territories. The secretariat is provided by UNESCO's World Heritage Centre in Paris (http://whc.unesco.org).

To be included on the World Heritage List, sites must be of outstanding universal value and meet at least one out of ten selection criteria. These criteria are explained in the Operational Guidelines for the Implementation of the World Heritage Convention (UNESCO, 2105) which, besides the text of the Convention, is the main working tool on World Heritage. The criteria are regularly revised by the Committee to reflect the evolution of the World Heritage concept itself. Until the end of 2004, World Heritage sites were selected on the basis of six cultural and four natural criteria. With the adoption of the revised Operational Guidelines for the Implementation of the World Heritage Convention, only one set of ten criteria exists:

i. to represent a masterpiece of human creative genius;
ii. to exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design;
iii. to bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared;
iv. to be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history;
v. to be an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change;
vi. to be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance. (The Committee considers that this criterion should preferably be used in conjunction with other criteria);

vii. to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance;
viii. to be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features;
ix. to be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals;
x. to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

The World Heritage Convention is of particular relevance to the mineral raw materials sector as the secretariat categorically emphasises the incompatibility of extractive activities with the status as World Heritage Site (pers. Comm. Mechthild Rössler, Director WHC). This has repercussions for the possible re-opening of mining areas and the re-working of mining and milling residues. Various historic mining regions around Europe have become World Heritage areas since the closure of their activities. The H2020-project MINATURA2020 (www.minatura2020.eu) addresses such potential land-use conflicts.

Reference

UNESCO United Nations Educational, Scientific and Cultural Organisation (1972): Convention Concerning the Protection of the World Cultural and Natural Heritage. Adopted by the General Conference at its seventeenth session, Paris, 16 November 1972.- 17 p., Paris (UNESCO World Heritage Centre) http://whc.unesco.org/archive/convention-en.pdf (accessed 27.01.17).

UNESCO United Nations Educational, Scientific and Cultural Organisation (2015): Operational Guidelines for the Implementation of the World Heritage Convention.- WHC.15/01 8 July 2015: 175 p., Paris (UNESCO World Heritage Centre) http://whc.unesco.org/document/137843 (accessed 27.01.17).

UN Convention to Combat Desertification (UNCCD)

The Rio Conference called on the United Nations General Assembly to establish an Intergovern-mental Negotiating Committee (INCD) to prepare, by June 1994, a Convention to Combat Desertification, particularly in Africa. In December 1992, the General Assembly agreed and adopted resolution 47/188 on this matter. The '*United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa*' (UN, 1994) was adopted in Paris on 17 June 1994 and entered into force on 26 December 1996. 194 countries and the European Union are Parties as at April 2015. The secretariat is located in Bonn, Germany.

The Convention addresses specifically the arid, semi-arid and dry sub-humid areas, known as the drylands, where some of the most vulnerable ecosystems and peoples can be found. Although the Convention is particularly concerned with the effect of agricultural practices and urbanisation, human-induced land-degradation by mining and its residues are also within its remit. Most of the European territories probably would not fall into this category, but European headquartered mining companies operate in relevant regions.

In order to be compatible with the UNCCD, extractive operations should not contribute to desertification by, for instance, lowering groundwater tables, dust generation from uncovered mining and processing residues, or removal of top-soil without adequate remediation measures.

Reference

UN United Nations (1994): United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa.- 54 p., Paris (UN) www2.unccd.int/sites/default/files/relevant-links/2017-01/UNCCD_Convention_ENG_0.pdf (accessed 27.01.17).

Appendix 3: EU mineral related Policies, Directives and Regulations

National level

Policies and regulations on mineral raw materials are very diverse and reflect their complex history and diversity of objectives. For this reason various H2020 are trying to summarise these policies and regulations with a view to work out commonalities and to assess the scope and need for harmonisation. Thus the H2020 project MIN-GUIDE (www.min-guide.eu) is concerned *inter alia* with the minerals policies of the EU Member States. The MIN-GUIDE deliverable D2.1 provides a summary of minerals policy profiles for EU28 (Endl et al., 2016). Individual policy profiles can be downloaded from www.min-guide.eu/project-results.

The H2020 project MINATURA2020 (www.minatura2020.eu) undertook a multi-sectoral analysis for a range of selected EU countries focusing particularly on the interplay between mineral and land-use policies (Horváth et al., 2016). The MINATURA2020 provides also information on the minerals and land-use related information on the participating countries.

This section provides a brief overview over the status raw materials policies in the EU Member States.

Belgium. There is no specific raw material policy in place in Belgium, but various related policy documents have been published. The Region of Flanders published its Sustainable Materials Management Strategy in 2012, focussing on the maximisation of secondary raw material use in production processes, and the minimisation of environmental impacts resulting from mineral extraction and processing. The 4th Environmental Policy Plan (MINA 4) 2011-2015 was published in 2010 by the Flemish government. The plan actions are expected to stimulate an environmental friendly production and consumption in general.

Bulgaria does not have any policy instruments regarding raw materials are in place. The National Development Programme *Bulgaria 2020* was published in December 2012.

Cyprus. The Republic of Cyprus created the Committee for the Sustainable Development of Mineral Resources in Cyprus to issue recommendations on mineral resources. This plan discusses minerals resources securing supply, conservation, efficient use and recycling of mineral resources. It indicates the relevance of raw material criticality in the future and proposes certain possible actions. In addition to this, a proposal for a Green Economy Programme was elaborated.

Czech Republic. 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". This document focuses on a range of raw materials from both primary and secondary sources. An updated version of the minerals policy was issued in 2012, which reflects CRM.

Denmark, particularly **Greenland,** has a significant potential of critical raw materials. Greenland is known for high geological potential for Rare Earth Element (REE) deposits, and a number of large deposits are being explored in an advanced stage. The "Kingdom of Denmark, Strategy for the Arctic 2011-2020" is the strategy most obviously related to raw materials, aiming sustainable growth and social sustainability in the development of the Arctic region. In 2013 the Danish Ministry of the Environment published the strategy "Denmark without waste. Recycle more - incinerate less", which has little connection to the raw materials policy.

Estonia has very general strategies: in 2005 the Estonian Ministry of the Environment issued the sustainable development strategy "Sustainable Estonia 21" and in 2007 it issued the Estonian Environmental Strategy 2030. In 2012 the Estonian government issued its national reform programme "Estonia 2020". The "Estonia 2020" targets at securing supply of raw material in general, the other two strategies aim at increasing sustainability.

Finland

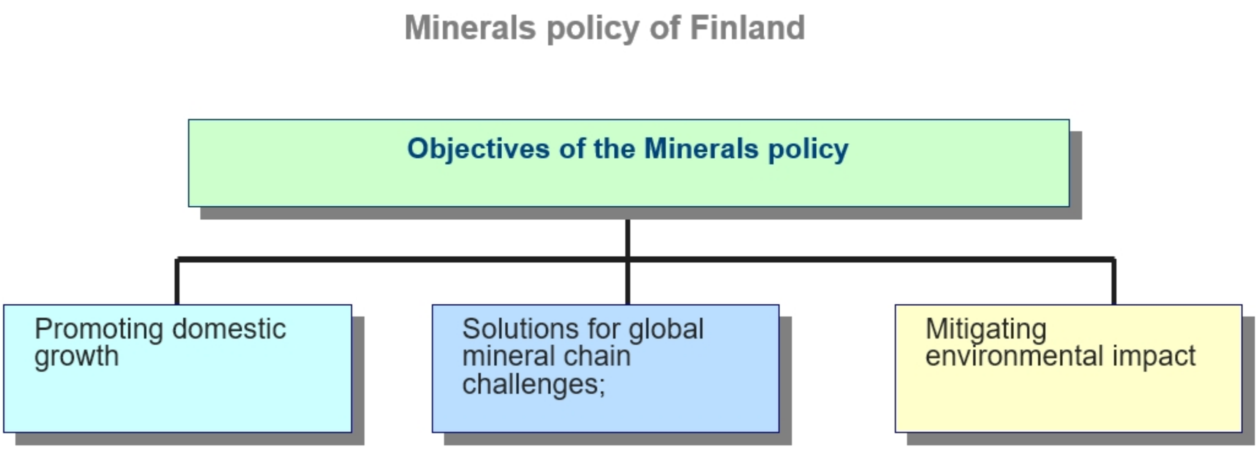


Figure 51: Finland – Objectives of minerals policy (DG Growth 2017, https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy/sustainable-supply-eu_en).

France. The minerals policies were inspired by the German policies and strategies. The French National Sustainability Strategy 2010-2013 treats resource efficiency as a central topic. The aim of the strategy is to strengthen France position in the field of "Green Economy". France has also its national raw materials strategy, defining goals for industrial, construction and metallic minerals (Figure 52). A "Strategic Metals Plan" was implemented in 2010, highlighting the fields of resource scarcity and its effects in the French economy. As a consequence, the "Committee for Strategic Metals" ("COMES") was created by the French ministry of industry.

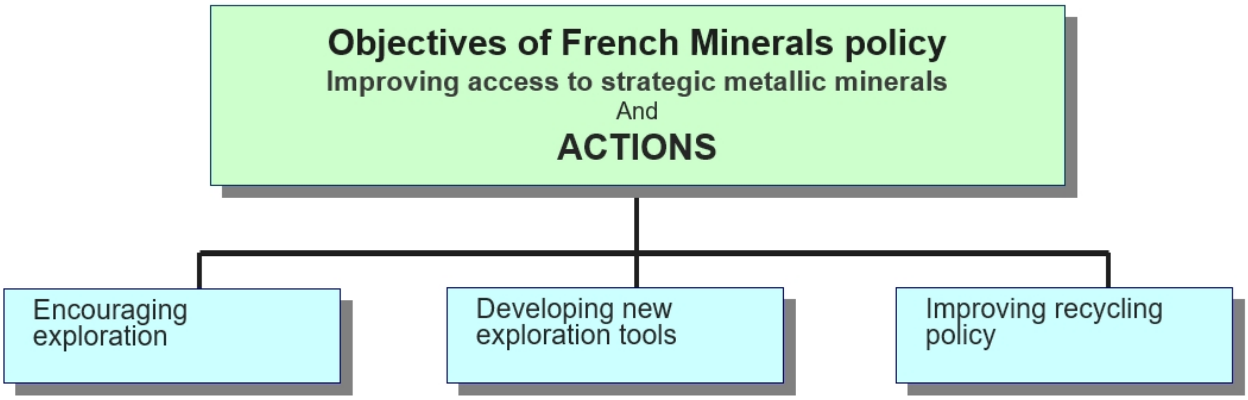
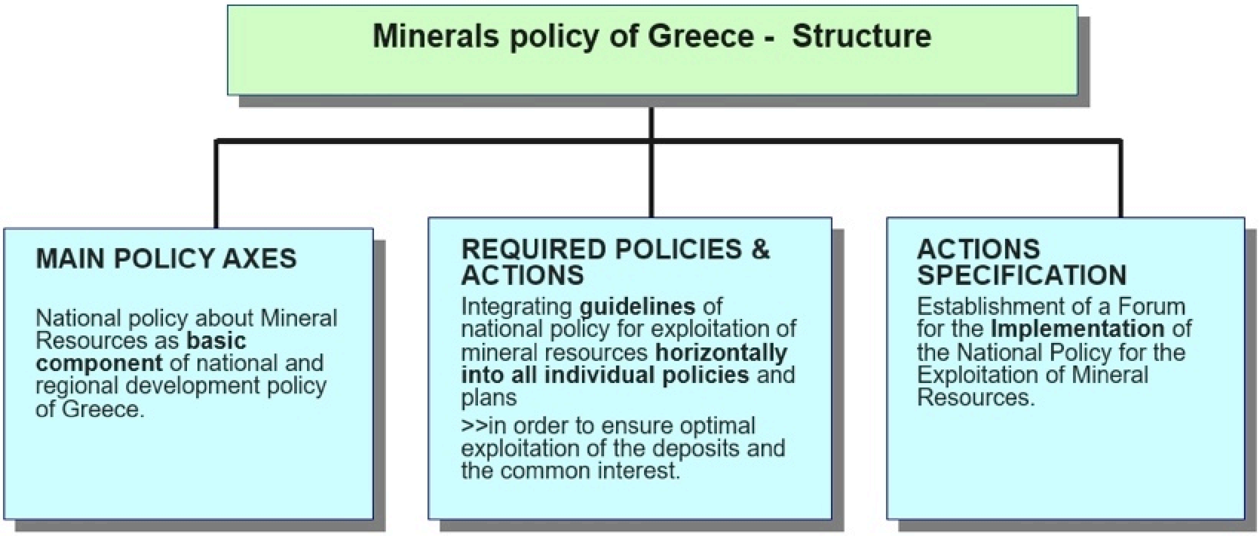


Figure 52: France – Objectives and actions of French metallic policy (DG Growth 2017, https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy/sustainable-supply-eu_en).

Germany. Its Raw Materials Strategy was published in 2010 by the Federal Ministry of Economics and Technology. The key goal of this is to secure a sustainable supply of non-energetic mineral raw materials for the German economy. The German Resource Efficiency Program 'ProgRess' was launched in 2012 by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety published the. The programme was developed in a dialogue of several stakeholders and is mainly motivated by environmental concerns and aims to reach the ambitious target set in the general sustainability strategy (see above) on resource efficiency. ProgRess formulates more concrete targets and comprises three parts: evaluating the potential of resource efficiency in Germany and globally, developing specific measures, and giving specific best practice examples. The German Raw Materials Agency "DERA" (Deutsche Rohstoffagentur, 2013) was founded in 2010.

Greece



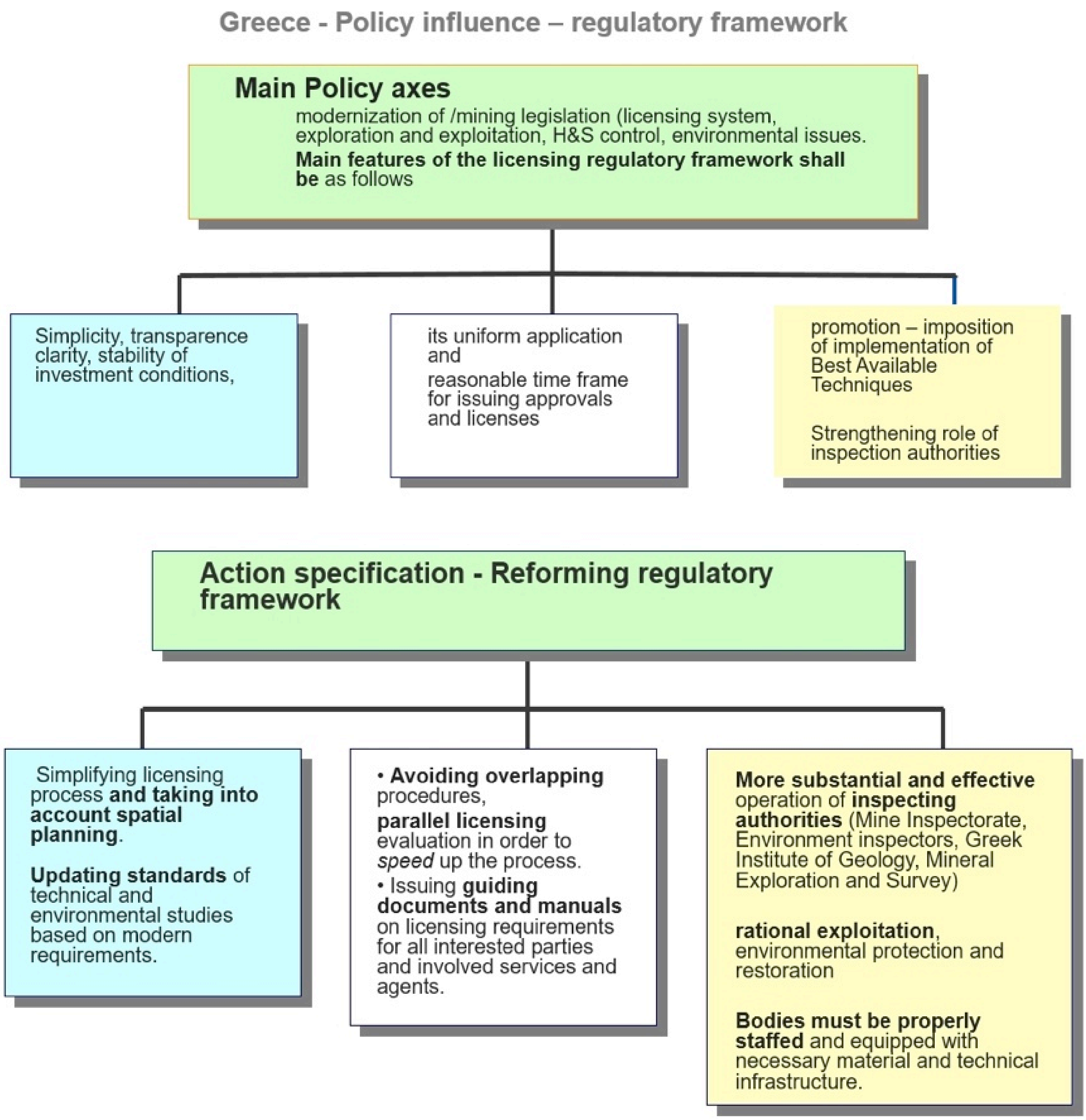


Figure 53: Greece – Structure an policy influence versus regulatory framework (DG Growth 2017, https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy/sustainable-supply-eu_en).

Hungary. Its Action Plan on Mineral Resources Management and Utilisation was issued in 2013. It is an implementation to the National Energy Strategy (Ministry of National Development, 2012), and it makes explicit references to the RMI of the EU. 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. Currently, it is under strategic assessment, and its approval and finalisation is expected in 2016. The Hungarian government proposes, among other things, to prepare a national minerals policy.

Ireland has a significant mining and ore processing activity, but there is no direct minerals policy established. The Irish Department of the Environment, Community and Local Government Issued a sustainability strategy under the name of "Our Sustainable Future: A Framework for Sustainable Development in Ireland" in 2012.

Italy. In 2002, the Ministry of the Environment issued a National Sustainability Strategy. It contained, among other things, concepts for increasing resource efficiency. Italy is currently discussing how to implement the RMI of the EU.

Latvia first introduced a National Environmental Policy Plan in 1995. This Plan was replaced by a new version in 2004 which aimed at covering the time between 2004 and 2008. The focus concerning raw materials was on recycling and on substitution, efficiency and resource conservation. The successor of this plan was the environmental policy strategy 2009-2015.

Lithuania. Its National Sustainable Development Strategy was introduced in 2003. An important priority of this program was the reduction of the environmental impact from different sectors of the economy. This targets the inclusion of environmental concerns in the development strategies and re-use of raw materials. Apparently, a Lithuanian State Strategy of Use of Underground Resources is under preparation with the aim of ensuring the rational use of mineral resources.

Malta. Its Strategic Plan for Environment and Development (SPED) was developed to replace the Maltese Structure Plan of 1990. The focus of SPED is on the Maltese environment as well as on its development. A Sustainable Development Strategy for Malta (2006-2017) was published in 2006 by the National Commission for Sustainable Development. Concerning minerals, one of the main strategic directions, with regard to the construction industry, is to conserve mineral resources by minimising waste and promoting the reduction and reuse of building materials.

The Netherlands. The main relevant Dutch policy is the "Raw Material Document" ('Grondstoffennotitie') which was issued first in 2011. It covers both biotic and non-biotic raw materials with a slight focus on the latter one. Since extension of land towards and protection of existing land from the sea is a crucial question in Netherlands, the Ministry of Infrastructure and Environment has a very prominent role in the Dutch resource efficiency policy. Policies related to resources have primarily an environmental and sustainability character. Primary policy goals of the Raw Material Document are to increase R&D expenditures, to preserve free trade and to support sustainable development.

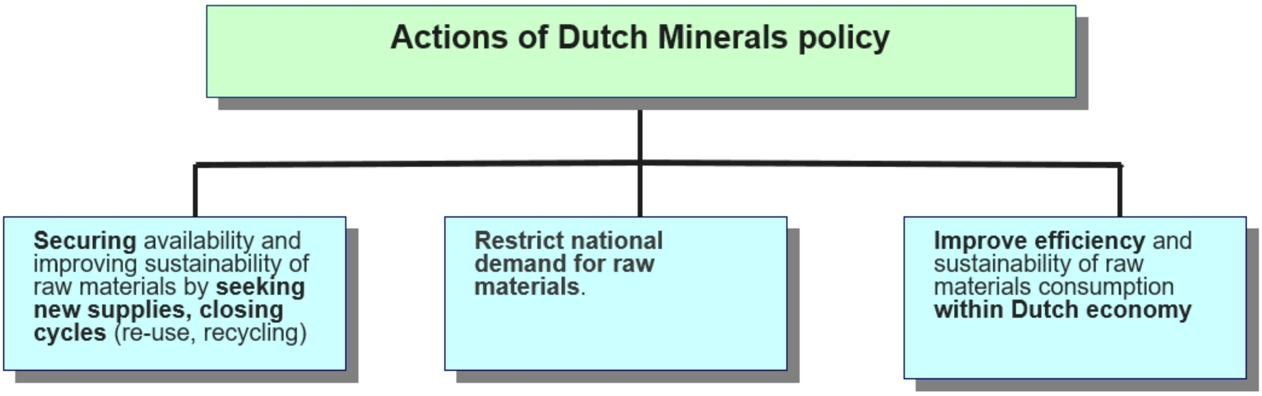
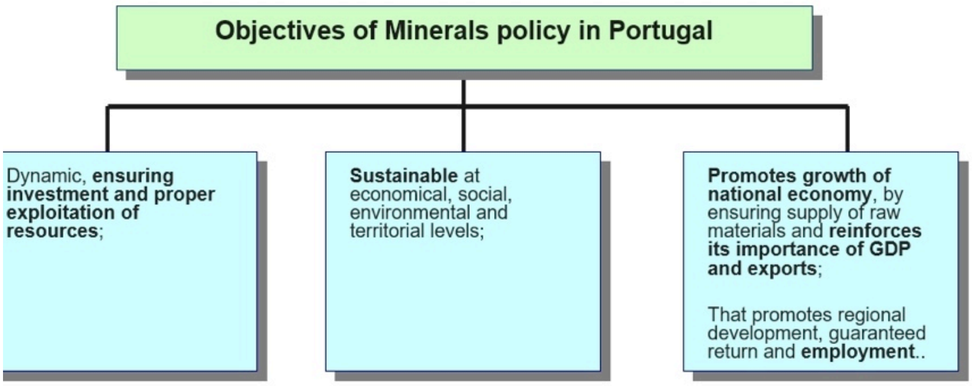


Figure 54: Minerals policy of Netherlands – actions (DG Growth 2017, https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy/sustainable-supply-eu_en).

Poland has two strategies that are related to raw materials: the Operational Strategy of the Polish geological survey for the period between 2010 and 2015 and the National Environment Policy for 2009–2012, published by the Polish Council of Ministers. The focus of the Operational Strategy is to ensure raw materials security in supply, while the Environmental Policy targets resource conservation and optimal supply. The environmental policy proposes specific actions until 2016, which include improving the regulatory framework for the protection of mineral resources and underground water reserves.

Portugal



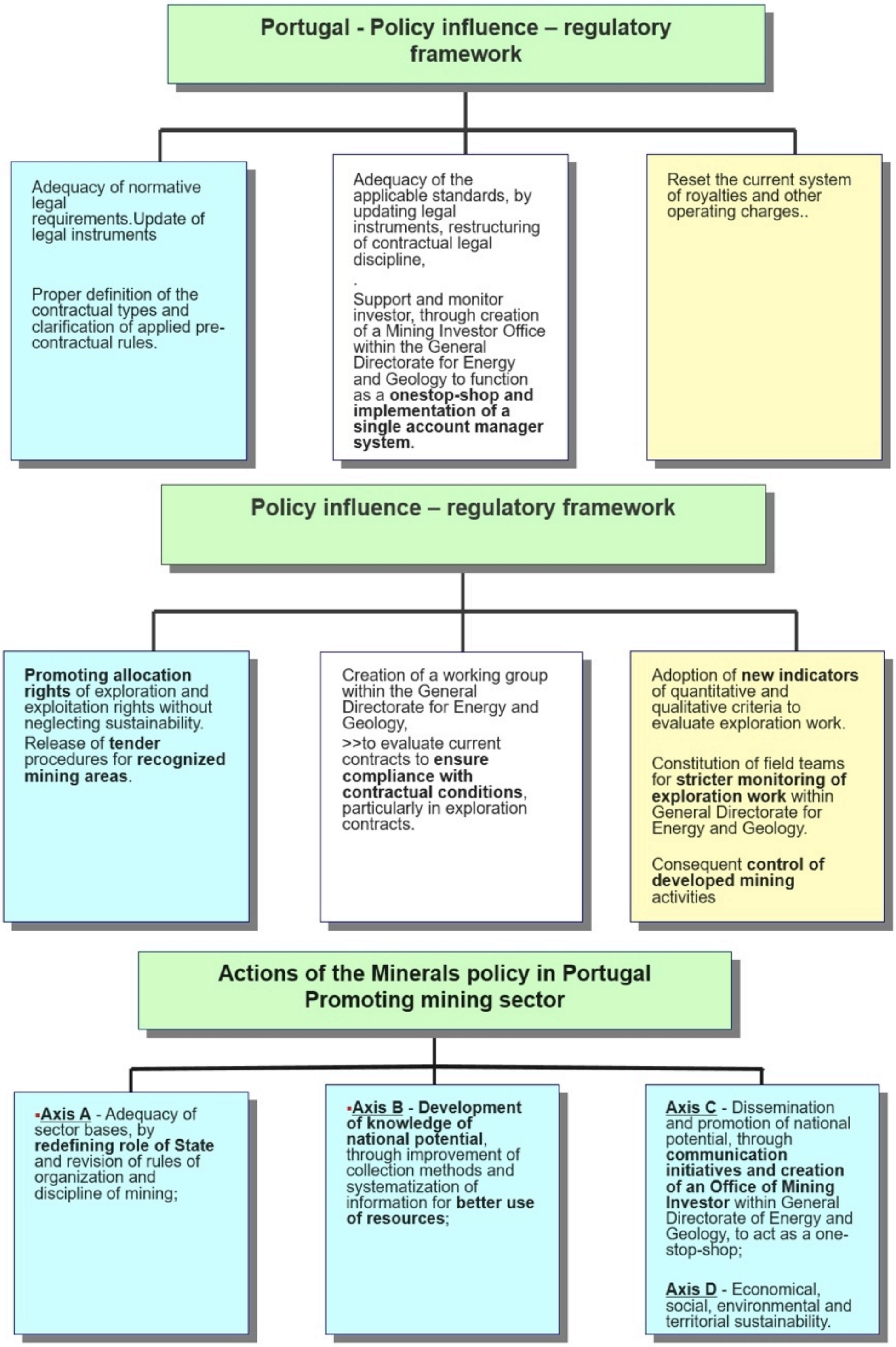


Figure 55: Portugal – Policy influence versus regulatory framework (DG Growth 2017, https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy/sustainable-supply-eu_en).

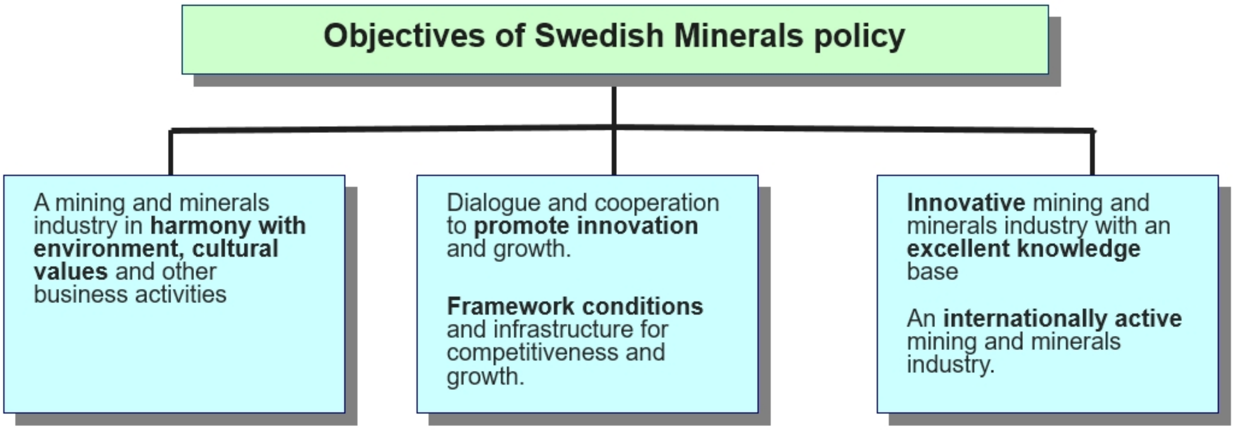
Romania. Its report "The Strategy of the Mining Industry 2012-2035" ("Strategia Industriei Miniere 2012-2035") issued by the Ministry of Economy is a kind of minerals policy document, describing the situation and objectives concerning the mineral resources in Romania. The report refers to the European RMI and to the list of the initially identified 14 Critical Raw Materials. This document is regularly renewed, since the previous version envisaged the policy for the period 2008-2020.

Slovakia has had a Raw Material Policy Proposal since 2004, created by the Ministry of Economy and Ministry of Environment. The proposal has specific aims over different time spans. Short-term aims relate to resource efficiency in production processes and decrease the impact of mining on the environment. 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

Slovenia. Its National Mineral Resource Management Programme exists from 2009. It focuses on efficient mineral resource management and covers the entire mining cycle from exploration, mine development and extraction to closure and remediation. The general aims and objectives of the management programme relay to the increase of sustainability of the mineral resource use. There is also a National Mining Strategy since 2011 with an extensive focus on efficient mineral resource management.

Spain. Similarly to Ireland, the county also has an important and diversified mining sector, although at the moment, no strategy related to raw materials has been implemented by the Spanish Government.

Sweden



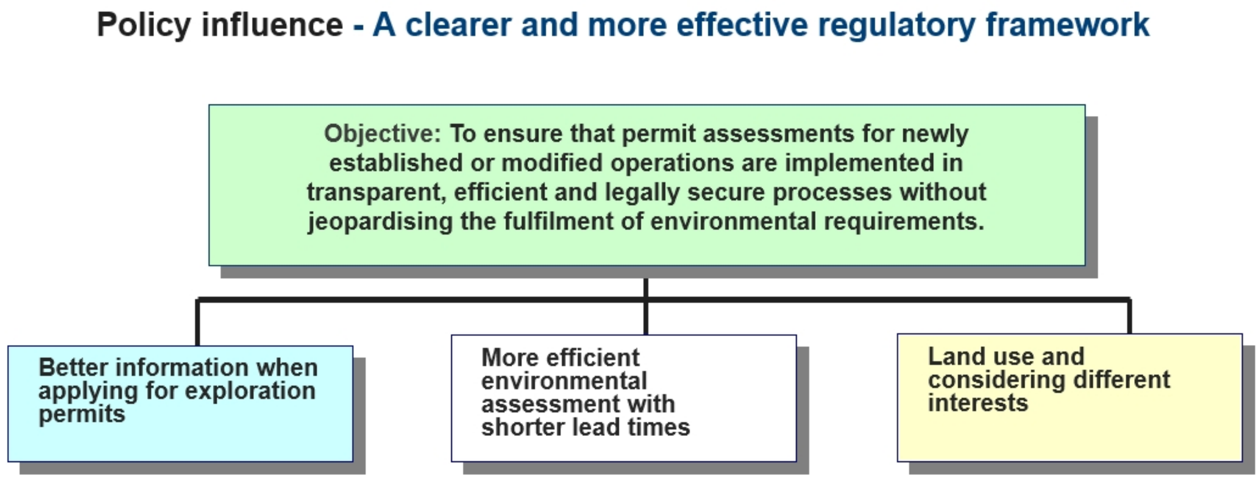


Figure 56: Sweden – Objectives and policy influence versus regulatory framework (DG Growth 2017, https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy/sustainable-supply-eu_en).

United Kingdom. The UK does not have a national raw materials strategy, but does have its Government's national policy on minerals and planning issues under the Minerals Policy Statement series. Mineral planning for aggregate extraction has a long-lasting history and a well-established regulatory framework. The national mineral planning policy of the Government in England is exercised through Mineral Planning Guidance Notes (MPGs) and Marine Mineral Guidance Notes (MMGs).

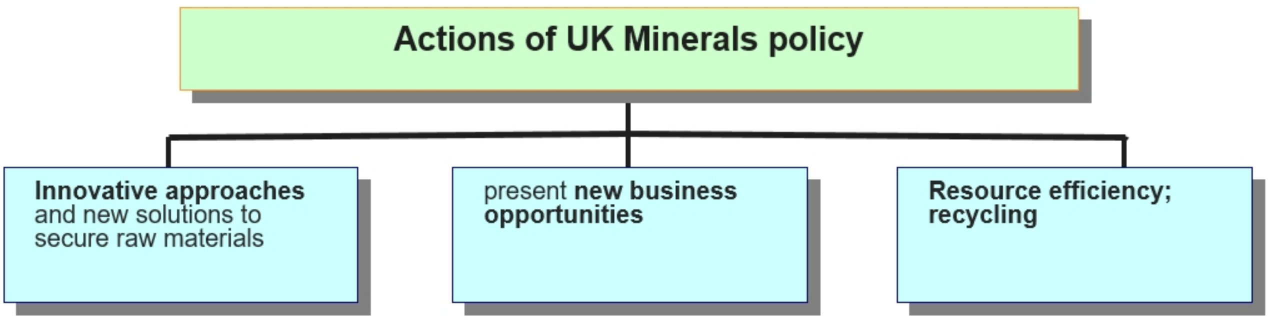


Figure 57: Actions of UK minerals policy (DG Growth 2017, https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy/sustainable-supply-eu_en).

EU Minerals related policies and regulations

Raw materials policy framework

In the Commission Communication of 4 November 2008 "The raw materials initiative – meeting our critical needs for growth and jobs in Europe" (COM(2008)0699) and in the Communication of 2 February 2011 "Tackling the challenges in commodity markets and on raw materials" (COM (2011)0025, 2011 Communication (EC, 2011)) the Commission recognized that securing reliable and undistorted access to raw materials is an important factor for the EU's competitiveness. The Communications launched and respectively reinforced the Raw Materials Initiative (RMI), an integrated strategy aimed at responding to different challenges related to access to non-energy and non-agricultural raw materials. The Raw Materials Initiative is based on three pillars: (1) ensuring a level-playing field in access to resources in third countries; (2) fostering a sustainable supply of raw materials from European sources; and (3) boosting resource efficiency and recycling (EC, 2008).

The European Commission has taken measures to improve the long-term availability of minerals through implementation of the Raw Material Initiative in 2008. According to the initiative, maintaining transparency in the world market for minerals must be encouraged. Production and consumption must move towards improvements in reducing waste and conserving resources, and in promoting sustainable utilisation and recycling of minerals. Measures must be taken by the EU and individual member countries to promote the utilisation of mineral resources within the EU, while enhancing expertise and developing new technology in the sector. A favourable operating environment must be secured by developing and integrating legislation, permit procedures and land use planning. The Raw Materials Initiative also aims to create a uniform minerals policy for the EU and member c

Action proposals defined in the EU's Raw Material Initiative 2008: (Internal versus external aspect of minerals policies)

1. Define critical minerals.
2. Launch of EU strategic raw materials diplomacy with major industrialised and resource rich countries.
3. Include provisions on access to and sustainable management of minerals in all bilateral and multilateral trade agreement s and regulatory dialogues as appropriate.
4. Identify and challenge trade distortion measures taken by third countries using all available mechanisms and instruments.
5. Promote the sustainable access to minerals in the field of development policy through the use of budget support, cooperation strategies and other instruments.
6. Improve the regulatory framework related to access to land.
7. Encourage better networking between national geological surveys with the aim of increasing the EU's knowledge base.
8. Promote skills and focussed research on innovative exploration and extraction technologies, recycling, materials substitution and resource efficiency.
9. Increase resource efficiency and foster substitution of minerals.
10. Promote recycling and facilitate the use of secondary minerals in the EU.

The Council endorsed the reinforced Raw Materials Initiative in its Conclusions on tackling the challenges on raw materials and in commodity markets of 10 March 2011. In order to promote investment in mining industries, the EU (EC, 2011) considered of particular importance (internal aspect of a NMP):

1. definition of a **national policy for minerals**, to ensure that these resources are exploited in an economically viable and harmonized manner with other national policies based on sustainability, including a commitment to create a legal framework and appropriate information;

2. definition of a **planning policy for minerals** which includes
    - long-term and regional estimates of minerals demand as well as the
    - digital geological database,
    - transparent methodology for identifying mineral resources,
    - identification and preservation of the minerals resources taking into account other land uses, and
3. creation of authorisation procedure for exploring and extracting minerals that is clear and comprehensible to offer security and to contribute to simplification of administrative process.

In the report on an effective mineral strategy for Europe (2011/2056(INI) the European Parliament asked to be regularly informed on the development of non-energy raw materials in the framework of the RMI and on the fulfilment of the latter's objectives via an annual progress report, also focusing on policy coherence with regard to trade, development and environmental policies and social impacts, as well as data on Critical Raw Materials (CRM). The European Parliament also endorsed the strategy in its Resolution of 13 September 2011. The Commission adopted its Common Position on this Resolution on 7 December 2011.

The current state of play with respect to the implementation of the Raw Materials Initiative is presented in the European Commission's report (2013), On the implementation of the Raw Materials Initiative - COM/2013/0442 and on DG Growth's website https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy/sustainable-supply-eu_en. Figure 58 provides an overview about the various (policy) stakeholders at EU- and national level.

In the 2011 Communication, the Commission stated that the EU will actively pursue a "Raw Materials Diplomacy" with a view to securing access to raw materials, in particular the critical ones, through strategic partnerships and policy dialogues. The Raw Materials Diplomacy aims to engage with partners though strategic partnerships and policy dialogues to exchange information and work together to address the challenges on raw materials' markets. This path has been pursued with the United States, Japan, Russia, Argentina, Brazil, Colombia, Mexico, Uruguay, Greenland, China and countries of the Union for the Mediterranean while further dialogues are in preparation (EC, 2013).

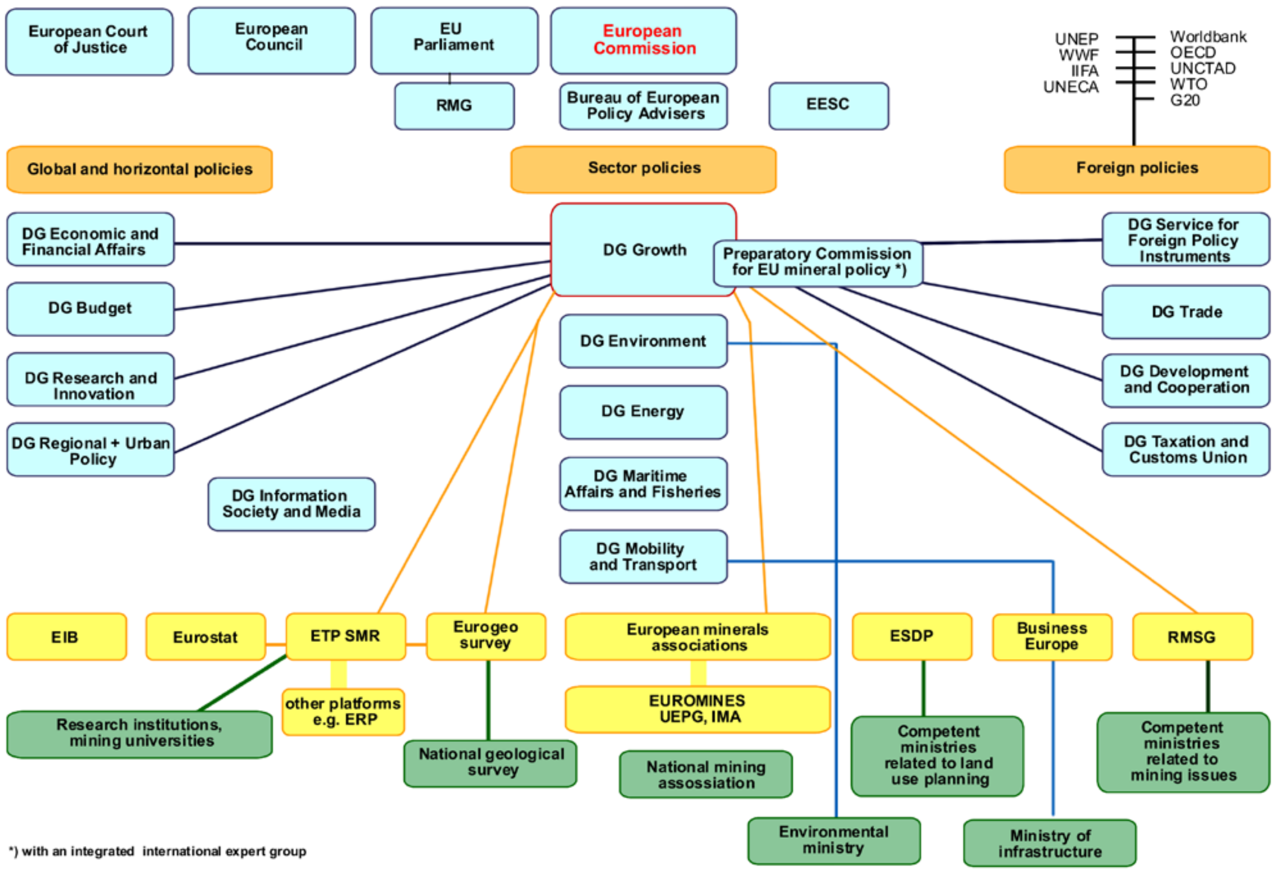


Figure 58: Organigram and interrelation of EU-Minerals policy (Tiess, 2011, updated 2017).

Minerals policy implications of European Innovation Partnerships (EIP)

European Innovation Partnerships (EIPs) are a new approach to EU research and innovation. EIPs are challenge-driven, focusing on societal benefits and a rapid modernisation of the associated sectors and markets. EIPs act across the whole research and innovation chain, bringing together all relevant actors at EU, national and regional levels in order to: (i) step up research and development efforts; (ii) coordinate investments in demonstration and pilots; (iii) anticipate and fast-track any necessary regulation and standards; and (iv) mobilise 'demand' in particular through better coordinated public procurement to ensure that any breakthroughs are quickly brought to market. Rather than taking the above steps independently, as is currently the case, the aim of the EIPs is to design and implement them in parallel to cut lead times (http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=eip).

As all EIPs concern the anthroposphere, their strategic views will impact the supply and demand of raw materials over the medium or longer term. Some EIPs concern directly raw materials. The most relevant EIPs are the ones on

- Raw Materials (https://ec.europa.eu/growth/tools-databases/eip-raw-materials/en/content/european-innovation-partnership-eip-raw-materials)

- Smart Cities and Communities (http://ec.europa.eu/eip/smartcities/)
- Water (http://ec.europa.eu/environment/water/innovationpartnership/)

The overall effect of the EIPs on specific raw materials is difficult to judge at present. A key aim is, however, to reduce the life-cycle carbon emissions and, by proxy, the energy consumption.

Minerals policy implications of the European Technology Platforms

European Technology Platforms (ETPs) are industry-led stakeholder fora recognised by the European Commission as key actors in driving innovation, knowledge transfer and European competitiveness (Table 12). ETPs develop strategic research agendas (SRAs) and roadmaps for action at EU and national level to be supported by both private and public funding. They mobilise stakeholders to deliver on agreed priorities and share information across the EU. By working effectively together, they also help deliver solutions to major challenges of key concern to citizens.

Table 12: Overview over current Technology platforms.

Bio-based economy	**Energy**	**Environment**	**ICT**	**Production and processes**	**Transport**
EATIP	Biofuels	WssTP	ARTEMIS	ECTP	ACARE
ETPGAH	EU PV TP		ENIAC	ESTEP	ALICE
FABRE TP	TP OCEAN		EPoSS	EuMaT	ERRAC
Food for Life	RHC		ETP4HPC	FTC	ERTRAC
Forest-based	SmartGrids		euRobotics	Manufuture	Waterborne
Plants	SNETP		NEM	Nanomedicine	
TP Organics	ETIPWind		NESSI	SMR	
	ZEP		Networld 2020	SusChem	
			Photonics 21		

Closely related to the ETPs is the European Strategic Energy Technology Plan (SET-Plan, https://ec.europa.eu/energy/en/topics/technology-and-innovation/strategic-energy-technology-plan) that aims to accelerate the development and deployment of low-carbon technologies. It seeks to improve new technologies and bring down costs by co-ordinating research and helping to finance projects. The SET-Plan promotes research and innovation efforts across Europe by supporting technologies with the greatest impact on the EU's transformation to low-carbon energy systems. It promotes cooperation amongst EU countries, companies, research institutions, and the EU itself.

The Strategic Transport Technology Plan (STTP, http://ec.europa.eu/transport/themes/research/sttp_en) sets ambitious objectives for reducing Europe's dependence on imported oil, improving the environment, reducing accidents and sharply cutting greenhouse-gas emissions.

In general, the SRAs advocate a life-cycle approach and call for a reduction of raw materials use and increased energy efficiency of the associated processes. As new products and services are explored, the SRAs will re-shape the supply and demand of various raw materials.

EU Regulatory Instruments

EU Directives relevant to the mineral raw materials sector come from a wide variety of policy-making and regulatory realms, such as the environment *s.s.*, water and air emissions, resources and energy conservation, nature conservation, etc. The European Commission initiated a study to summarise policy and legal instruments on both, EU and national level (MIN-LEX, in prep.). This study produced a large range of fact-sheets on:

1. **Internal market legislation**: eight items, including the principal Directives relevant to the topic of the MINLEX project: Professional Qualifications Directive, Services Directive, Concessions Directive, Public Procurement Directive, Utilities Procurement Directive, Market Surveillance Directive, Accounting Directive, and Transparency Directive.
2. **Environmental legislation**: 19 items, covering the principal environmental and industrial risk items (EIA, SEA, Environmental Liability, REACH, etc.).
3. **Waste legislation**: 13 items where the Extractive Waste Directive[6] and its commission decisions are discussed, among other waste-related items (Waste Framework Directive, Landfill Directive).
4. **Water legislation**: six items, including onshore surface water and groundwater topics, as well as strategic directives concerning the marine environment.
5. **Nature conservation legislation:** the two major pieces, the Habitats and the Birds Directive.
6. **Noise and atmospheric pollution:** eight items.
7. **Health and safety**: 24 items covering different aspects of occupational health and safety.
8. **Statistics, nomenclature** and **information management:** seven different items**.**
9. **Other relevant legislation**: 11 items that are resource-related pieces and cover energy minerals or topics such as underground CO_2 storage. Court case analysis indicated that some cases from the energy minerals sector may be important and relevant to the project, if the reason for appeal concerns some general internal market principle.

In order to better understand the relevance and potential and actual impacts of certain EU Directives and regulations, it is helpful to order these according to the life-cycle of mineral raw material use, namely exploration, extraction, beneficiation / processing, intermediates, final products, wastes (including those from mining), recycling, and long-term management of mining

[6] The Directive 2006/21/EC has traditionally been called 'Mining Waste Directive' (including official EU websites), but it is now also termed 'Extractive Waste Directive' in some recent official EU documents. Because of that and because the term 'extractive' is more comprehensive that 'mining', the name used throughout this study to refer to such Directive is 'Extractive Waste Directive'.

and milling sites. It must be noted, however, that some of these domains are not passed through sequentially, but may be relevant simultaneously.

Table 13 provides an overview over the current EU directives and regulations that may be relevant to the production and use of raw materials.

Table 13: Mineral life-cycle relevance of EU Directives and Regulations.

	Need Identification	Project Planning and Exploration	Extraction	Beneficiation/ milling	Intermediates	Final products	Recycling
Planning							
91/689/EEC - Hazardous waste	x	x	x	x	x	x	x
1999/45/EC – Dangerous Materials		x		x			x
2000/60/EC – Water Framework			x	x			x
2001/42/EC – Strategic Environmental Impact Assessment		x				x	
2006/21/EC – Mine Waste		x	x	x			x
2012/18/EU – Seveso Directive III				x			x
2012/19/EU – WEEE						x	x
2002/95/EC – Restrictions of Hazardous Substances (RoHS)	x	x				x	x
Operation							
91/689/EEC - Hazardous waste		x	x	x	x	x	x
97/11/EC – Environmental Impact Assessment		x	x	x			x
2000/60/EC – Water Framework			x	x			x
2006/21/EC – Mine Waste		x	x	x			x
2012/18/EU – Seveso Directive III				x			x
2012/19/EU – WEEE-Direcive				x	x	x	x
Stewardship							
91/689/EEC - Hazardous waste		x	x	x	x	x	x
97/11/EC – Environmental Impact Assessment			x			x	x
2000/60/EC – Water Framework			x	x			x
2012/19/EU – WEEE						x	x
2009/125/EC - Ecodesign Directive						x	x

Background to the current EU regulatory and policy framework

With raising awareness of the importance of a system thinking approach (Meadows, 2008) and the need to incorporate a life cycle (LC) perspective into policy-making, several *product-oriented instruments* have been put into place within the EU policy framework to facilitate higher resource efficiency rates in various phases of the life cycle.

European Commission (EC, 2001) instigated a *Green Paper on Integrated Product Policy (IPP),* followed by an EC (2003) communication on IPP. The concept, featuring, as per the EC Communication (2003, p.5) five key principles, namely "life-cycle thinking; working with the market; stakeholder involvement; continuous improvement [of products]; and a variety of policy instruments", was seen as a measure to reduce the life cycle impact of products from cradle to grave, in other words, from raw material extraction and production to disposal and to incorporate multiple instruments with the aim of achieving more eco-friendly products through co-operation with stakeholders (Figure 59).

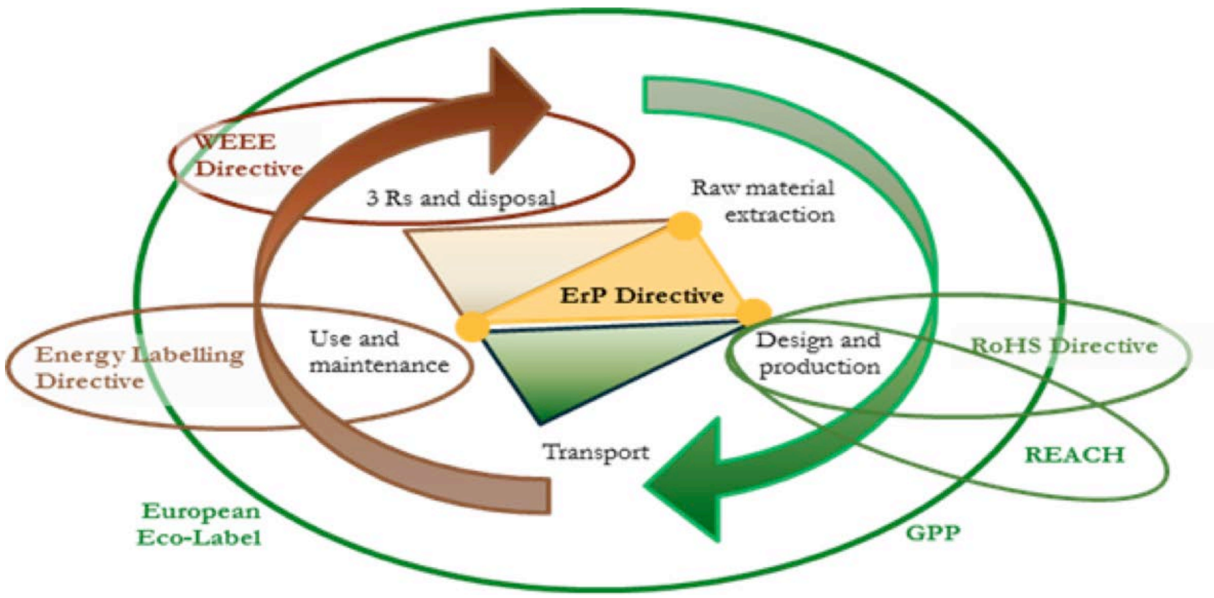


Figure 59: IPP instruments in a life cycle perspective (adapted from Remmen (2011) in Machacek (2012)).

In essence, the IPP Green paper and communication recommend *a mix of voluntary and mandatory instruments of an administrative, economic and informative nature, including differentiated taxation of products, GPP, environmental labelling, several approaches to support the further application of life cycle assessment (LCA) and eco-design in industry, as well as standardisation such as through the implementation of environmental management systems*. (EC, 2001) The communication on IPP thus expands the scope from energy-using products (EuPs) to Energy-related (ErPs) of the Ecodesign Directive.

The production phase of a product has been extended to comprise design in the figure, acknowledging the influence over the RE and performance of the product over its entire life time. Of most relevance in this phase are the *Directive 2002/95/EC on the restriction of the use of certain hazardous substances (RoHS)* in electrical and electronic equipment. It aims at limiting the use of six toxic substances including four heavy metals, namely lead, mercury, cadmium and hexavalent chromium, and two chemicals, polybrominated biphenyls and polybrominated diphenyl applying a maximum allowed concentration per weight measure, (CEU, 2003a).

The RoHS Directive is accompanied by the Regulation on the registration, evaluation and authorisation of chemicals (REACH) which seeks to improve chemical management and regulation by generating more comprehensive risk assessment data along with stricter controls of the most hazardous chemicals. According to Selin and VanDeveer (2006), the regulation constitutes one of the most complex environmental policies in European history as it eradicates the regulatory distinction between new and existing chemicals, replaces many existing chemical laws and requires approximately 30,000 existing substances to be registered between 2007 and 2018.

In the use phase, one of the two EU labelling schemes, the EU Energy Label, and the Ecodesign Directive, both of which will be described in more detail later, are most relevant for electrical and electronic products.

The last phase of the product life-cycle addresses the end-of-life (EoL) phase of the product which summarizes Reusability, Recyclability, and Recoverability, in the literature commonly dubbed as '3-Rs', and disposal. The Directive on waste electrical and electronic equipment (WEEE, 2012/19/EU) aims at achieving the European recycling and recovery of electrical and electronic equipment to diminish the quantity of e-waste for final disposal. It is designed with the principle of extended producer responsibility, which broadly summarizing, requires producers to take back WEEE and consumers to assume responsibility in returning all regulated electrical and electronic products to them. (CEU, 2003b) The WEEE and RoHS Directive jointly address the design and end-of-life phase of products, whereby the RoHS Directive can be understood as a supplement to the WEEE (Dalhammar, 2007; Selin and VanDeveer, 2006).

Green public procurement (GPP) or sustainable public procurement refers to the purchasing process and addresses procurement decisions taken by public institutions which are based on defined environmental criteria. This regulatory instrument has a model function in that it considerably influences product design due to its market potential: Public authorities have high purchasing power. On average, public procurement accounts for 12 per cent of EU gross domestic product (EC, 2001; BMWi and BMU, 2011).

It is the Ecodesign Directive 2009/125/EC, which has potential to address all phases of the life cycle of a product, and which provides the rationale for it being placed within the policy framework of Sustainable Consumption and Production (SCP) and the Sustainable Industrial Policy (SIP) Action Plan and the EU policy commitment to SIP by Europe 2020 and the two flagship initiatives on "sustainable growth", "Industrial Policy" and "A Resource Efficient Europe", shown in Figure 60.

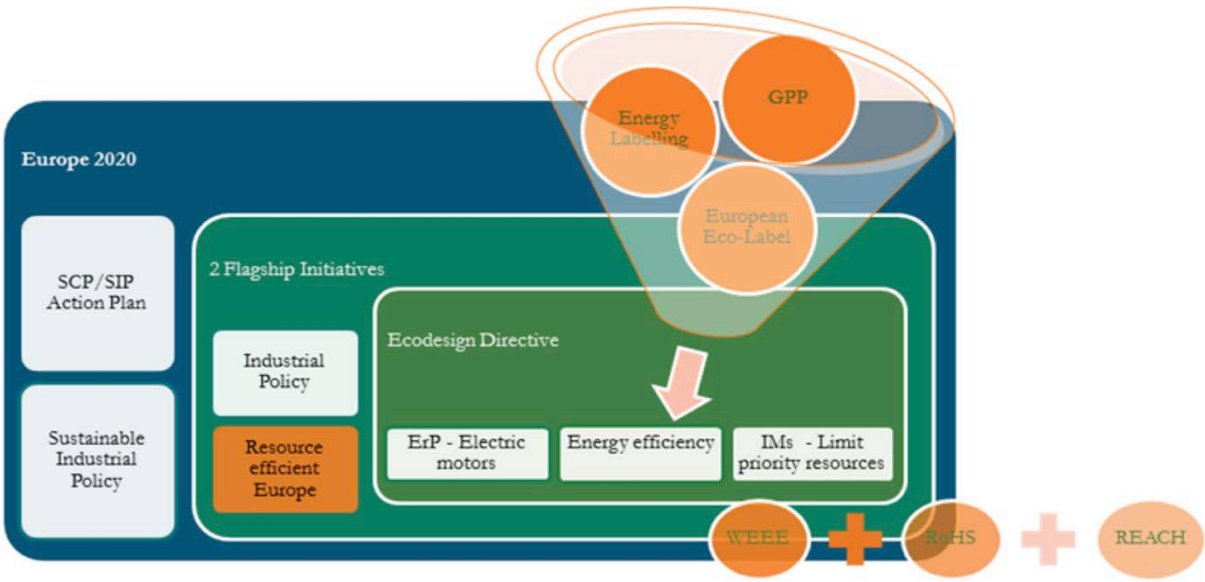


Figure 60: The Ecodesign Directive within the Europe 2020 Strategy (Machacek, 2012).

It also conceptualises the paradigm of avoidance in order reduce the amount of materials used and in consequence the amount of waste generated (Figure 61).

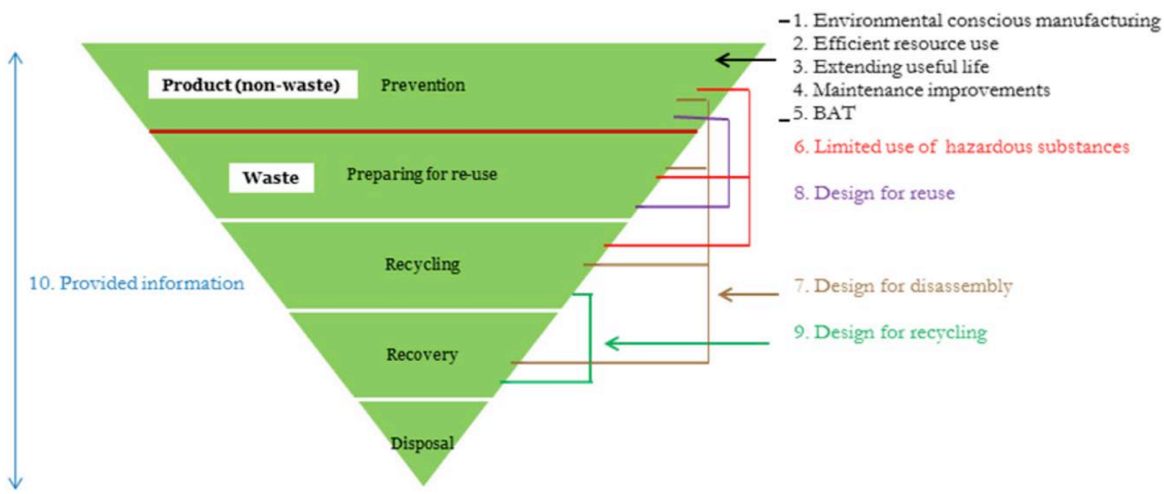


Figure 61: Links among Ecodesign strategies and the EU Waste Management Hierarchy (Machacek, 2012).

Strategic Environmental Assessment (SEA) Directive

Background

The purpose of the SEA-Directive (CEU, 2001a) is to ensure that environmental consequences of certain plans and programmes are identified and assessed during their preparation and before their adoption. The public and environmental authorities can give their opinion and all results are integrated and taken into account in the course of the planning procedure. After the adoption of the plan or programme the public is informed about the decision and the way in which it was made. In the case of likely significant transboundary effects the affected Member State and its public are informed and have the possibility to make comments, which are also integrated into the national decision making process.

SEA will contribute to more transparent planning by involving the public and by integrating environmental considerations. This will help to achieve the goal of sustainable development. The objective of the SEA Directive is to provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development, by ensuring that, in accordance with this Directive, an environmental assessment is carried out of certain plans and programmes that are likely to have significant effects on the environment.

Overview

Article 1 describes the objectives of the Directive.
Article 2 clarifies the terminology
Article 3 defines the scope and the applicability of the Directive. As for the EIA Directive (see Section 2.3) projects in the interest of civilian and military national security are excluded.
Article 4 sets out the timing and possible integration into national programming procedures of any SEA.
Article 5 sets out the reporting requirements.
Article 6 stipulates the requirements for publication of proposed programmes and plans that fall within the scope of Article 3 and the related SEA. It also calls for appropriate public consultation procedures.
Article 7 stipulates that transboundary consultations are undertaken, if the proposes programme or plan is likely to have transboundary effects.
Article 8 requires that the results from a SEA are taken into account in the final programme and plan formulation.
Article 9 sets out the decisions on proposed programmes and plans have to communicated to the public together with the results from the SEA and how these have been taken into account.
Article 10 requires that any monitoring plans and the ensuing results have to made public.
Article 11 describes the relationship of this Directive to other community legislation.
Article 12 describes how the effectiveness of the Directive shall be monitored and how Member States have to assure the quality of SEA reports.
Article 13 maps out the implementation of the Directive and its transposition into national legislation.
Articles 14 and 15 concern administrative matters of the Directive
Annex I outlines in broad terms the scope and contents of any SEA.
Annex II lists criteria that will justify drawing up an SEA for programmes and plans as stipulated in this Directive.

Implications
While EIA (see below) can look back to a history of some 20 years of development, the concept of SEA is a relatively new way of thinking about larger scale scientific and technological developments. Therefore the processes and its elements have not been very clear before the introduction of the Directive. A study commissioned by the European Commission (Sheate *et al*., 2001) identified four main models for developing SEAs:

- EIA-inspired SEA
- Policy analysis/appraisal-inspired SEA
- Integrationary SEA
- Ad hoc mechanisms of environmental integration

It appears that SEA owes much to the concepts underlying EIAs. The work by Sheate *et al*. (2001) suggests that SEA originates from two main disciplines: natural resource management and political science. These authors *inter alia* identified the following as major potential benefits from undertaking SEAs:

- ***Balancing interests and needs***: SEA allows more informed decisions to be made regarding trade-offs between environmental, economic and social factors.
- ***Selection of the most sustainable option***: Consideration of alternatives and their impacts allows the earlier integration of environmental consideration within policy making.
- ***Advocacy***: SEA can act as an advocate for the environment within policy making and planning.
- ***Awareness rising***: SEA can play a subtle environmental awareness-raising role.
- ***Co-ordination and communication***: Tiered SEA creates essential links between the different levels in the policy making and planning hierarchy, and similarly within different institutions and processes.
- ***Accountability***: SEA procedures create an auditable trail that helps increase transparency and accountability.
- ***Education and training***: SEA facilitates decision-makers, practitioners and stakeholders in learning from the process and each other.
- ***Monitoring and quality management***: SEA provides the baseline information and guidance for developing monitoring and quality management programmes.

Whilst the concept of strategic environmental assessment is relatively straightforward, implementation of the Directive poses a considerable challenge to Member States. It goes to the heart of much public-sector decision-making. In many cases it will require more structured planning and consultation procedures. Thus a formal SEA process explicitly provides for a process of assessing alternative strategic and planning option that is open to input from a wide variety of stakeholders; this applies in particular to the policy making level. However, engaging stakeholders at this level in a meaningful and effective way may be difficult. SEA should be seen as an integral part of policy making and programming process, rather than as an add-on. It is also important that SEA is not unduly constrained in order to scope all strategic options. In particular, there is a risk that due to stakeholder pressure the SEA process begins to look at individual solutions rather than at the larger scale problems.

The European Commission has developed guidance on the implementation of the SEA-Directive (EC, 200?). Member States are obliged to grant an opportunity to certain authorities and members of the public to express their opinion on the environmental report and the draft plan or programme. One of the reasons for consultation is to contribute to the quality of the information available to those responsible for the decisions that are made concerning the plan or programme. Consultation might sometimes reveal important new information that leads to substantial changes to the plan or programme and consequently its likely significant environmental effects. If so, it might be necessary to consider a revision of the report and, if the changes justified it, fresh consultation. The principal requirements on consultation in the Directive are in Article 6, but many other articles also deal with this issue. An overview of the Directive's information and consultation requirements is given in Table 14.

Table 14: Public consultation requirements stipulated by Directive 2001/42/EC (CEU, 2001b).

Stage of SEA	**Consultation requirements in domestic situations**	**Additional requirements in transboundary situations**
Determination whether a plan or programme requires an SEA	Consultation of authorities (Art. 3(6)) Information made available to the public (Art. 3(7))	
Decision on scope and level of detail of the assessment	Consultation of authorities (Art. 5(4))	
Environmental report and draft plan or programme	Information made available to the public (Art. 6(1)) Consultation of authorities (Art. 6(2)) Consultation of the public concerned (Art. 6(2))	Consultation of authorities in the Member State likely to be affected (Art. 7(2)) Consultation of the public concerned in the Member State likely to be affected (Art. 7(2))
During preparation of plan or programme	Take account of environmental report and opinions expressed under Art. 6 (Art. 8)	Take account of results of transboundary consultation (Art. 8)
Adopted plan or programme; statement according to Art. 9(1)(b), measures concerning monitoring	Information made available to authorities (Art. 9(1)) Information made available to the public (Art. 9(1))	Information made available to the consulted Member State

Reference

CEU Council of the European Union (2001b): Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment.- Official Journal L 197/30-37, 21.07.2001. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32001L0042&from=EN (accessed 27.01.17)

Environmental Impact Assessment (EIA) Directive

Background

Environmental assessment is a procedure that ensures that the environmental implications of decisions are taken into account before the decisions are made. The process involves an analysis of the likely effects on the environment, recording those effects in a report, undertaking a public consultation exercise on the report, taking into account the comments and the report when making the final decision and informing the public about that decision afterwards. In principle, environmental assessment can be undertaken for individual projects such as a dam, motorway, airport or factory ('Environmental Impact Assessment') or for plans, programmes and policies ('Strategic Environmental Assessment', see above).

The Directive was originally adopted in 1985 (Directive 85/337/EEC) and strengthened by a revision in 1997 (Directive 97/11/EC). A further amendment was adopted in 2003 (Directive 2003/35/EC) giving citizens' rights to seek judicial redress in relation to public participation. After that, this directive had been amended in 2009, by the Directive 2009/31/EC. The Directive 2011/92/EU codified Directive 85/337 and its amendments. Finally, the directive was amended as Directive 2014/52/EU, which will become applicable from 17 May 2017.

The EIA procedure ensures that environmental consequences of projects are identified and assessed before authorisation is given. The public can give its opinion and all results are taken into account in the authorisation procedure of the project. The public is informed of the decision afterwards.

The EIA Directive outlines which project categories are to be made subject to an EIA, which procedure to be followed and the content of the assessment. Certain projects that fall under specific national legislation and are relevant to national security may be exempt.

Following the signature of the Aarhus Convention (see Ch. 2.4) by the Community on 25 June 1998, the Community adopted in May 2003 Directive 2003/35/EC (CEU, 2003a) amending amongst others the EIA Directive. This Directive intends to align the provisions on public participation in accordance with the Aarhus Convention on public participation in decision-making and access to justice in environmental matters.

An IMPEL report (IMPEL, 1998) explains the interrelation between EIA, IPPC (CEU, 1996), SEVESO Directives (CEU, 2003c) and EMAS Regulation (CEU, 2001a).
The European Commission also provided a clarification on Article 2(3) (EC, 2006) that provides for the exemption of projects from EIA, if for instance, the project is in the interest of national security. Transposition of Article 2(3) into national law is optional as such, its omission resulting in more stringent national EIA legislation.

Overview

Article 1 describes the applicability of the Directive and clarifies the terminology.

Article 2 stipulates that EIAs have to be performed for projects as per Annexes I and II, that EIA procedures may be integrated into other licensing procedures, and that EIA may be waived, if a project is e.g. in the interest of national security.
Article 3 describes the scope an EIA and to which environmental compartments it would apply.
Article 4 further details the applicability of the Directive.
Article 5 specifies in general terms the types of data that need to be exchanged between the different parties.
Article 6 provides for public participation in decision making.
Article 7 provides for consultation with neighbouring countries, if the project is likely to have any impact in those countries.
Article 8 stipulates that the information and insight gathered must actually be used in the decision making process.
Article 9 provides for communication to stakeholders of the decisions taken finally.
Article 10 guarantees the confidentiality of commercially sensitive or public safety relevant information.
Article 11 stipulates that experience with the implementation of the Directive should be reviewed periodically.
Article 12 describes the rules for transposition into national legislation.
Article 13 allows Member States to lay down rules that are stricter than those of the Directive.
Annexes I & II provide a list of projects that are likely to fall within the applicability of the Directive. According to this list, basically all components of the raw materials extraction and processing value-chain will have to be subject to EIA, including mining, processing, and activities that are related to the construction and operation of mining and milling waste facilities.

The EIA Directive has profound implications on the permitting of exploration, extraction and post-extraction plans. It, thus, is one of the most important items of EU legislation that provides the frame for permitting mineral resource use. All extraction and closure operations listed in Annex I need EIA before their commencement. Activities listed in Annex II do not necessarily require systematically an EIA only if Member States prescribe. However, authorities may require EIA if there is likelihood to explore a high-grade coal, petroleum, natural gas and ores, as well as bituminous shale deposits.

The Commission published in 2009 a report on the application and the effectiveness of the EIA Directives (COM(2009)378). The results of this report were taken for the review of the EIA Directive. Objectives of the review were to increase the degree of harmonisation of national laws; simplify existing EIA procedures (i.e. screening), to reinforce the quality components of the EIA process (e.g. content of the report, alternatives, review of EIA information, monitoring, validity EIA), to ensure consistency with international obligations derived from the Aarhus and the Espoo Conventions; to ensure better coordination with sectoral policies and assessments required by other Directives (SEA, Habitats and Birds Directives, IPPC (annulled by IED Directive from 7/1/2014), IED, Water Framework Directive), and to simplify existing assessment and permitting procedures, to the extent possible.

It is important to note that the EIA Directive while providing the procedural framework, it does not establish obligatory environmental standards. Therefore, the quality control of the EIA and the subsequent permitting decision is the prerogative of the national competent authorities. National authorities always have the freedom to introduce more stringent protective measures, based on the applicable national regulations, than those stipulated in the Directives. This results potentially in differences between different MSs in EIA outcomes and decisions on which activities to exempt from EIA or not, which may have repercussions with respect to the stipulations under the Espoo and Aarhus Conventions. These differences also act against a level playing field across the EU.

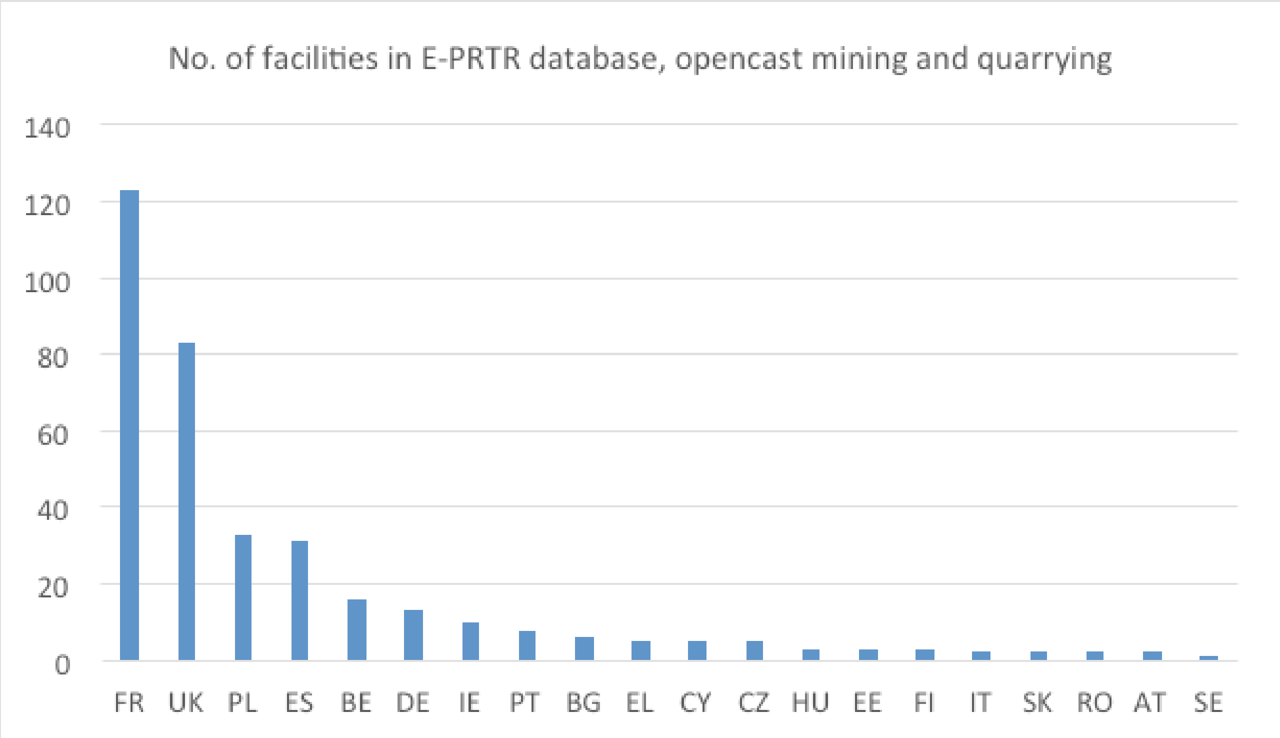


Figure 62: Number of open-cast mines and quarries in the E-PRTR database (extracted 07.12.16).

Another interesting comparison may be derived comparing the number of facilities reported to the European Pollutant Release and Transfer Register (E-PRTR) database (Figure 62). While 123 facilities are listed in the database from France (all quarries)[7], only one open pit mine is present from Sweden (Aitik). Certainly, there are differences between MSs concerning the geological potential, but this dataset shows primarily the differences in interpretation and implementation of the relevant EU legislation.

[7] To arrive at this result, the E-PRTR database needs to be filtered by "facility level", "country" (France), "activity sector 3 mineral industry", "activites 3b opencast mining and quarrying". Results belong to the year 2014 (accessed 7 December 2016)

References

CEU Council of the European Union (2014): Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment.- OJ L124/1-18, 25.04.2014, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0052&from=EN (accessed 27.01.17).

Extractive Waste Directive (EWD)

Although commonly known as 'Mine Waste Directive', the Directive 2006/21/EC (CEU, 2006) becomes increasingly known as 'Exctractive Waste Directive' reflecting the fact, that it covers not only traditional 'mines' but also quarries and processing residues from e.g. milling. The Directive entered into force on 01/05/2006, requiring transposition into national law by 01/05/2008, compliance for existing facilities by 01/05/2012 and 01/05/2014 for introducing financial guarantees.

Waste from extractive operations (i.e. waste from extraction and processing of mineral resources) is one of the largest waste streams in the EU. It involves materials that must be removed to gain access to the mineral resource, such as topsoil, overburden and waste rock, as well as tailings remaining after minerals have been extracted from the ore. Some of these wastes are inert and, hence, not likely to represent a significant pollutant threat to the environment save for smothering of river beds and possible collapse, due to geotechnical failure. However, other wastes, in particular those generated by the non-ferrous metal mining industry, may contain large quantities of dangerous substances, such as heavy metals. Through the extraction and subsequent mineral processing, metals and metal compounds tend to become chemically more available, which can result in the generation of acid or alkaline drainage. The disposal of liquid tailings in ponds with earthen dams is inherently associated with considerable risks. Dam failures can result in the dispersal of tailings that usually contain residues of processing chemicals and other dangerous substances (e.g. arsenic, heavy metals) that have not been extracted during the milling process.

The Directive applies to the management of waste resulting from the prospecting, extraction, treatment and storage of mineral resources and the working of quarries.

The Directive explicitly does not apply to operational waste (lubricants, machines, clothes, etc.) from mines, waste from offshore activities, injected water, re-injected groundwater, non-hazardous exploration waste (optional waiver for MS authorities), unpolluted soil, and peat extraction waste.

The only quantitative regulatory limit values are in Article 13 on cyanide concentration in tailings ponds.

The Directive covers the complete vertical value-chain of mining from prospection to after-closure. It clearly requires a distinct permitting procedure for the waste management facility operation.

The after-closure measures (Article 12) are rather stringent, although most of them are left to the decision of the MS competent authorities. However, in some MS following the final on-site inspection by the competent authority, manifested in a final resolution, the liability of the operator is terminated and the financial guarantee is reimbursed or waived.

It has been noted that the number of facilities being reported by MS according to Article 18 is rather uneven and does not tally with other sources of intelligence. *Inter alia* these discrepancies are attributed to some uncertainty in the MS competent authorities concerning which kind of facilities are to be included. This is one reason, why a review of this Directive may be needed. However, in the context of RMI the mapping of secondary resources, including mine and milling wastes may lead to a convergence of data on such sites.

Since the Extractive Waste Directive was issued as a response to some accidents involving mining or milling residues, it contains also provisions towards environmental liability. Article 15 provides an addition to the Environmental Liability Directive - ELD (2004/35/EC).

The EWD is supported by a Best Practice Reference document (BREF) which however currently is under review.

Reference

CEU Council of the European Union (2006): Directive 2006/21/EC of the European Parliament and of the Council of 15 March 2006 on the management of waste from extractive industries and amending Directive 2004/35/EC.- OJ L102/15-33, 11.4.2006, http://eur-lex.europa.eu/resource.html? uri=cellar:c370006a-063e-4dc7-9b05-52c37720740c.0005.02/DOC_1&format=PDF (accessed 29.01.17)

Seveso III Directive

In Europe, the catastrophic accident in the Italian town of Seveso in 1976 prompted the adoption of legislation on the prevention and control of such accidents. The so-called Seveso-Directive (Directive 82/501/EEC) was later amended in view of the lessons learned from later accidents such as Bhopal, Toulouse or Enschede resulting into Seveso-II (Directive 96/82/EC). In 2012 Seveso-III (Directive 2012/18/EU, CEU 2012) was adopted taking into account, amongst others, the changes in the EU legislation on the classification of chemicals and increased rights for citizens to access information and justice. It entered into force on 13.08.2012.

The Directive now applies to more than 10,000 industrial establishments in the EU where dangerous substances are used or stored in large quantities, mainly in the chemical, petrochemical, logistics and metal refining sectors.

Considering the very high level of industrialisation in the EU the Seveso Directive has contributed to achieving a low frequency of major accidents. The Directive is widely considered as a benchmark for industrial accident policy and has been a role model for legislation in many countries world-wide.

However, the Directive explicitly does not apply to establishments for the

- the exploration, extraction and processing, of minerals in mines and quarries, including by means of boreholes;
- the offshore exploration and exploitation of minerals, including hydrocarbons;
- the storage of gas at underground offshore sites including both dedicated storage sites and sites where exploration and exploitation of minerals, including hydrocarbons are also carried out;
- waste land-fill sites, including underground waste storage.

This does not preclude its applicability further down the value-chain of mineral raw materials and resulting wastes. The Directive in particular applies to "*disused mines and chemical and thermal processing operations and storage related to those operations which involve dangerous substances, as well as operational tailings disposal facilities, including tailing ponds or dams, containing dangerous substances*" (CEU, 2012).

Reference

CEU Council of the European Union (2012): Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC.- OJ 197/1-L197/37, 24.07.2012, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012L0018&from=HR (accessed 03.06.16).

Water Framework Directive (WFD)

Directive 2006/60/EC, the Water Framework Directive (WFD), seeks to protect and improve the quality of surface waters and groundwater. Previous European water policy had undergone a thorough restructuring process. The WFD entered into force on 22.12.2000. It lays down the following key aims that were to be achieved by 2015:

- expanding the scope of water protection to all waters, surface waters and groundwater,
- achieving 'good status' for all waters by a set deadline,
- water management based on river basins,
- 'combined approach' of emission limit values and quality standards,
- getting the prices right,
- getting the citizen involved more closely,
- streamlining legislation.

It establishes rules to halt deterioration in the status of EU water bodies, i.e. rivers, lakes and groundwater. Specifically, this includes:

- protecting all forms of water (inland*, surface*, transitional*, coastal and ground*);

- restoring the ecosystems in and around these bodies of water;
- reducing pollution in water bodies;
- guaranteeing sustainable water usage by individuals and businesses.

It thus has a double target: to improve the status of waters and to ensure waters remain clean. This requirement affects heavily the large industrial installations, among others mines, quarries and processing facilities, including the associated waste management facilities.

The Directive places clear responsibilities on national authorities. They have to:
- identify the individual river basins on their territory - that is, the surrounding land areas that drain into particular river systems;
- designate authorities to manage these basins in line with the EU rules;
- analyse the features of each river basin, including the impact of human activity and an economic assessment of water use;
- monitor the status of the water in each basin;
- register protected areas, such as those used for drinking water, which require special attention;
- produce and implement 'river-basin management plans' to prevent deterioration of surface water, protect and enhance groundwater and preserve protected areas;
- ensure the cost of water services is recovered so that the resources are used efficiently and polluters pay;
- provide for public information and consultation on their river-basin management plans.

The best model for a single system of water management is management by river basin - the natural geographical and hydrological unit, rather than according to administrative or political boundaries. Hence the WDF is implemented on the basis of River Basin Management Plans (RBMPs).

Reference

CEU Council of Europe (2000): Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.- OJ L 327/1-73, 22.12.2000, http://eurlex.europa.eu/resource.html?uri=cellar:5c835afb-2ec6-4577-bdf8-756d3d694eeb.0004.02/DOC_1&format=PDF (accessed 29.01.17).

Waste Framework Directive

Directive 2008/98/EC (CEU, 2008), which entered into force on 12.12.2008 sets the basic concepts and definitions related to waste management, such as definitions of waste, recycling, recovery. It explains when waste ceases to be waste and becomes a secondary raw material (so called end-of-waste criteria), and how to distinguish between waste and by-products. The Directive lays down some basic waste management principles: it requires that waste be managed without endangering human health and harming the environment, and in particular without risk to water, air, soil, plants or animals, without causing a nuisance through noise or odours, and without adversely affecting the countryside or places of special interest. Waste legislation and policy of the EU Member States shall apply as a priority order according to the waste management hierarchy in Figure 63.

Figure 63: EU policy on waste management (http://ec.europa.eu/environment/waste/framework/).

The Directive introduces the 'polluter pays principle' and the 'extended producer responsibility' concepts. It incorporates provisions on hazardous waste and waste oils (old Directives on hazardous waste and waste oils being repealed with the effect from 12 December 2010), and includes two new recycling and recovery targets to be achieved by 2020: 50% preparing for re-use and recycling of certain waste materials from households and other origins similar to households, and 70% preparing for re-use, recycling and other recovery of construction and demolition waste. The Directive requires that Member States adopt waste management plans and waste prevention programmes. The Directive prohibits dilution or mixing of wastes.

The Directive includes all sorts of waste in its scope, but specifically excludes (a) gaseous effluents; (b) contaminated soil (*in situ*) and buildings; (c) uncontaminated soil and other naturally occurring material excavated by construction, if the material is used *in situ*; (d) radioactive waste; (e) decommissioned explosives; (f) faecal matter, straw, non-hazardous agricultural or forestry material, and other biomass. Also excluded to the extent that they are covered by other Community legislation: (a) waste waters; (b) animal by-products and carcasses; (c) mine waste (cf. Extractive Waste Directive 2006/21/EC).

The Waste Framework Directive and the Extractive Waste Directive complement each other. However, in the future, considering the circular economy paradigm waste management regulations may be re-written with the view to better facilitate the access and recovery secondary raw materials. The decision of whether a particular waste arising from extractive operations needs to be managed under the Waste Framework or the Extractive Waste Directive may need to be taken on an economic basis and the considerations of wider impacts. Thus it may be more expedient to manage small quantities of hazardous extractive industry waste in existing hazardous waste management facilities, rather than to construct a mine waste management facility. The sometimes unclear division between the applicability of the two Directives can lead to regulatory conflicts at Member State level, in particular, when different competent authorities are charged with their respective implementation.

Reference

CEU Council of the European Union (2008): Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives.- OJ L 312/3-30, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN (ac-cessed 29.01.17).

Industrial Emissions Directive (IED)

Directive 2010/75/EU (CEU, 2010) is the main EU instrument regulating pollutant emissions from industrial installations. It is based on a Commission proposal recasting seven previously existing directives (including in particular the IPPC Directive) following an extensive review of the policy. The IED entered into force on 6 January 2011.

The IED aims to achieve a high level of protection of human health and the environment taken as a whole by reducing harmful industrial emissions across the EU, in particular through better application of Best Available Techniques (BAT). Around 50,000 installations undertaking the industrial activities listed in Annex I of the IED are required to operate in accordance with a permit (granted by the authorities in the Member States). The following industrial activities are thus covered: energy, metal production and processing, minerals, chemicals, waste management and other sectors such as pulp and paper production, slaughterhouses and the intensive rearing of poultry and pigs. This permit should contain conditions set in accordance with the principles and provisions of the IED.

The IED is based on several pillars, in particular (1) an integrated approach, (2) use of best available techniques, (3) flexibility, (4) inspections and (5) public participation.

The integrated approach means that the permits must take into account the whole environmental performance of the plant, covering e.g. emissions to air, water and land, generation of waste, use of raw materials, energy efficiency, noise, prevention of accidents, and remediation of the site upon closure. Priority should be given to preventing pollution by intervening at source and ensuring prudent use and management of natural resources.

The permit conditions including emission limit values must be based on the Best Available Techniques (BAT). In order to define BAT and the BAT-associated environmental performance at EU level, the Commission organises an exchange of information with experts from Member States, industry and environmental organisations. This work is co-ordinated by the European IPPC Bureau of the Institute for Prospective Technology Studies at the EU Joint Research Centre in Seville (Spain). This process results in BAT Reference Documents (BREFs); the BAT conclusions contained are adopted by the Commission as Implementing Decisions. The IED requires that these BAT conclusions are the reference for setting permit conditions. For certain activities, i.e. large combustion plants, waste incineration and co-incineration plants, solvent using activities and titanium dioxide production, the IED also sets EU wide emission limits for selected pollutants.

The IED allows competent authorities some flexibility to set less strict emission limit values. This is possible only in specific cases where an assessment shows that achieving the emission levels associated with BAT described in the BAT conclusions would lead to disproportionately higher costs compared to the environmental benefits due to the geographical location or the local environmental conditions or the technical characteristics of the installation. The competent authority shall always document its justification for granting such derogations.

The IED contains mandatory requirements on environmental inspections. Member States shall set up a system of environmental inspections and draw up inspection plans accordingly. The IED requires a site visit to take place at least every 1 to 3 years, using risk-based criteria.

The IED ensures that the public has a right to participate in the decision-making process, and to be informed of its consequences, by having access to permit applications, permits and the results of the monitoring of releases.

In addition, through the European Pollutant Release and Transfer Register (E-PRTR) emission data reported by Member States are made accessible in a public register, which is intended to provide environmental information on major industrial activities.

Reference

CEU Council of the European Union (2010): Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (Recast).- OJ L 334/17-119, 17.12.2010, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0075&from=EN (accessed 29.01.17).

Dangerous substances regulation and REACH

The EU has developed a concise set of regulations that aims at controlling potentially dangerous substances with respect to human and environmental exposure. Regulation (EC) No. 1272/2008 (CEU, 2008) concerns the classification, labelling and packaging of substances and their mixtures and entered into force on 10.01.2009. Workers and consumers of the EU shall be clearly informed of the hazards associated with chemicals by means of a system of classification and labelling. The aim of the regulation is to ensure that the same hazards are described and labelled in the same way in all EU countries. It lays down uniform requirements for the classification, labelling and packaging of chemical substances and mixtures according to the United Nations' Globally Harmonized System (GHS). It requires companies to classify, label and package appropriately their hazardous chemicals before placing them on the market.

Regulation (EC) No. 1907/2006 (CEU, 2006) provides a comprehensive regulatory framework for chemicals manufacture and use in Europe. It entered into force on 01.06.2007 and shifts from public authorities to the industry the responsibility for ensuring that chemicals produced, imported, sold and used in the EU are safe. The legislation applies to all chemical substances: manufactured, imported, sold, used on their own, in mixtures or in products. The legislation aims to replace the most hazardous substances by safer alternatives, where they are available. It also provides for the set-up of the European Chemicals Agency (ECHA, Helsinki).

Both regulations have implications for materials used in mining and milling operations and for certain products along the value-chain.

References

CEU Council of the European Union (2006): Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC.- OJ L 396/1-520, 30.12.2006, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02006R1907-201404 10&from=EN (accessed 29.01.17)

CEU Council of the European Union (2008c): Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006.- OJ L 353/1-1355, http://eur-lex.europa.eu/LexUriServ/ LexUriServ.do?uri=OJ:L:2008:353:0001:1355:en:PDF (accessed 29.01.17)

Electrical Waste Directive (WEEE Directive)

Waste of electrical and electronic equipment (WEEE) such as computers, TV-sets, refrigerators and cell phones is one the fastest growing waste streams in the EU, with some 9 million tonnes generated in 2005, and expected to grow to more than 12 million tonnes by 2020.

WEEE is a complex mixture of materials and components that because of their hazardous content, and if not properly managed, can cause major environmental and health problems. Moreover, the production of modern electronics requires the use of scarce and expensive resources (e.g. around

10% of total gold worldwide is used for their production). To improve the environmental management of WEEE and to contribute to a circular economy and enhance resource efficiency the improvement of collection, treatment and recycling of electronics at the end of their life is essential.

To address these problems two pieces of legislation have been put in place: The Directive on waste electrical and electronic equipment (WEEE Directive) and the Directive on the restriction of the use of certain hazardous substances (e.g. Pb, Hg, Cd, and ^{VI}Cr) in electrical and electronic equipment (RoHS Directive, 2002/95/EC).

The first WEEE Directive (Directive 2002/96/EC) entered into force in February 2003. The Directive provided for the creation of collection schemes where consumers return their WEEE free of charge. These schemes aim to increase the recycling of WEEE and/or re-use. In December 2008, the European Commission proposed to revise the Directive in order to tackle the fast increasing waste stream. The new WEEE Directive 2012/19/EU (CEU, 2012) entered into force on 13.08.2012.

An important aspect of the WEEE Directive is the Extended Producer Responsibility (EPR) policy that shifts the responsibility for waste management from governments to private industry, obliging producers, importers and/or sellers to internalise waste management costs in their product prices and ensuring the safe handling of their products, including end-of-life management.

Increasing collection rates of end-of-life products that fall under the WEEED will have effects on the raw materials markets, as the need for virgin raw materials will be reduced eventually.

References

CEU Council of Europe (2003): Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.- OJ L 37/19-23, 13.2.2003, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32002L0095&from=EN (accessed 29.01.17)

CEU Council of Europe (2012c): Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE).- OJ L 197/38-71, 24.7.2012, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012L0019&from= EN (accessed 29.01.17).

Appendix 4: World-wide minerals related policies

The minerals policies of the USA

The United States of America have pursued an exemplary strategy of securing their supply with raw and base materials since the 70s. Traditionally, this policy aims at (OECD, 1994):

- creating or maintaining a capacity of producing minerals and base materials which is sufficient to withstand a political or economic pressure from outside, this policy also includes a limited protection of their own resources; the so-called national defence stock pile, a system of strategic mineral reserves;
- comprehensive politically-based efforts to obtain the best possible access to supply sources in other countries, particularly by promotion of direct investments of American companies (on the part of the State) for prospecting, exploration, and exploitation of foreign mineral deposits, which includes an expensive geographical diversification of supply sources.

The overall strategy to reduce US reliance on uncertain sources of supply of strategic materials is based on a combination of three approaches (OECD, 1994):

- increase the diversity of world supply of strategic metals through exploration and development of promising deposits, both foreign and domestic;
- decrease demand for strategic metals through the implementation of improved manufacturing processes and recycling of strategic materials from scrap and waste;
- identify and test substitute materials for current applications and develop new materials with reduced strategic material content for future applications.

Compared to the European Union, the United States have other advantages which bring them in a better position to effectively secure their mineral supply. Those are: less dependency on mineral imports, an economic potential which allows to develop cheaper local resources and create large stocks, the performance of multinational companies which have their decision-making centres in the United States, the existence of a 'decision making authority' with full powers centralised (in this case, the Ministry of Defence) in Washington. The H2020-project INTRAW aimed inter alia to shed light on the difference between USA and the EU with respect to their raw materials strategies (Murguia, 2016b).

On 29 November 2011, the Transatlantic Economic Council (TEC) agreed to a Raw Materials Work Plan that includes preparation of a joint inventory of mineral raw materials data and analysis maintained by both sides. As part of this effort, the two sides were instructed to consider the results of on-going European Commission and United States Government studies of raw materials resource availability, trade flows, and criticality and of other supply and demand analyses, such as the 2010 European Commission report by an ad-hoc expert group on critical raw materials and the strategy of the U.S. Department of Energy on critical materials. The TEC Innovation Action Plan has been launched in the area of raw materials, covering different policy aspects including trade and substitution (EC, 2013).

The minerals policies of Japan

Japan, depends more than other countries on imports of mineral resources because of it unfavourable geologic structure. The country has aimed for years to gain a foothold in developing countries and to develop joint venture structures to become an equal partner in the international mining companies, to develop marine transport and terminal equipment and thus reducing the load on inputs. The responsible Japanese Ministry achieved these goals in an exemplary collaboration with the industry under the motto "on the domestic market competition and outwards coordination of actions“ (OECD, 1994). Japan’s economic security relies on the stability of its foreign resource supplies. Defining the national goal as comprehensive security including mineral security, the main objectives of the country’s minerals policy are the following: secure stable sources of minerals; systematically develop domestic mineral resources; actively promote development of overseas mineral resources through economic co-operation with mineral-rich developing countries; and stockpile rare metals (OECD, 1994). Japanese authorities administer their overseas exploration and development assistance programmes so as to diversify sources of supply of minerals and metals. The aim is to increase the number of countries supplying a particular mineral to Japan and to diversify sources among the greatest number of countries. The commercial agreement between Japan and Australia from 2005 has to be seen against this background: Japan, with 40% of iron ore imports and 30% of aluminium imports, is a major market for Australia in the mid- and long-term[8].

Two workshops took place in Washington in October 2011 and in Tokyo in March 2012 with a focus on research in the area of raw materials, particularly substitution. Regular trilateral meetings between the EU, US and Japan with government representatives, the European Commission and industry delegations take place in Brussels and elsewhere. The focus is on the development and implementation of new models in efficient management of critical materials (EC, 2013). The H2020-project INTRAW aimed *inter alia* to shed light on the difference between Japan and the EU with respect to their raw materials strategies (Murguia, 2016a).

African minerals policy

As mentioned, the leading African markets, the so-called "African Lions" Algeria, Botswana, Egypt, Libya, Mauritius, Morocco, South Africa, Tanzania and Tunisia are strongly developing and have even overtaken the economic performance per capita in 2008 of the BRIC states.

The African Mining Vision

The Africa Mining Vision (AMV, www.africaminingvision.org/amv_resources/AMV/Africa_Mining_Vision_English.pdf) is a pathway, formulated by African nations themselves, that puts the continent’s long term and broad development objectives at the heart of all policy making concerned with mineral extraction. The AMV sets out how mining can be used to drive continental development.

[8] Australia-Japan Free Trade Agreement – The Minerals Industry Case, October 2005; Submission to the Department of Foreign Affairs and Trade.

The Africa Mining Vision was adopted by Heads of State at the February 2009 African Union summit following the October 2008 meeting of African Ministers responsible for Mineral Resources Development. It is Africa's own response to tackling the paradox of great mineral wealth existing side by side with pervasive poverty.

The AMV aims to integrate the exploitation of the minerals endowment with larger scale for the industrialisation and development of the African continent. The vision is to integrate mining much better into development policies at local, national and regional levels. A Resource-based African Industrialisation and Development Strategy (RAIDS, Figure 64) based on using Africa's significant resources endowment (comparative advantage) to catalyse growth in other sectors could provide a viable component of an integrated and sustainable growth and development strategy for Africa.

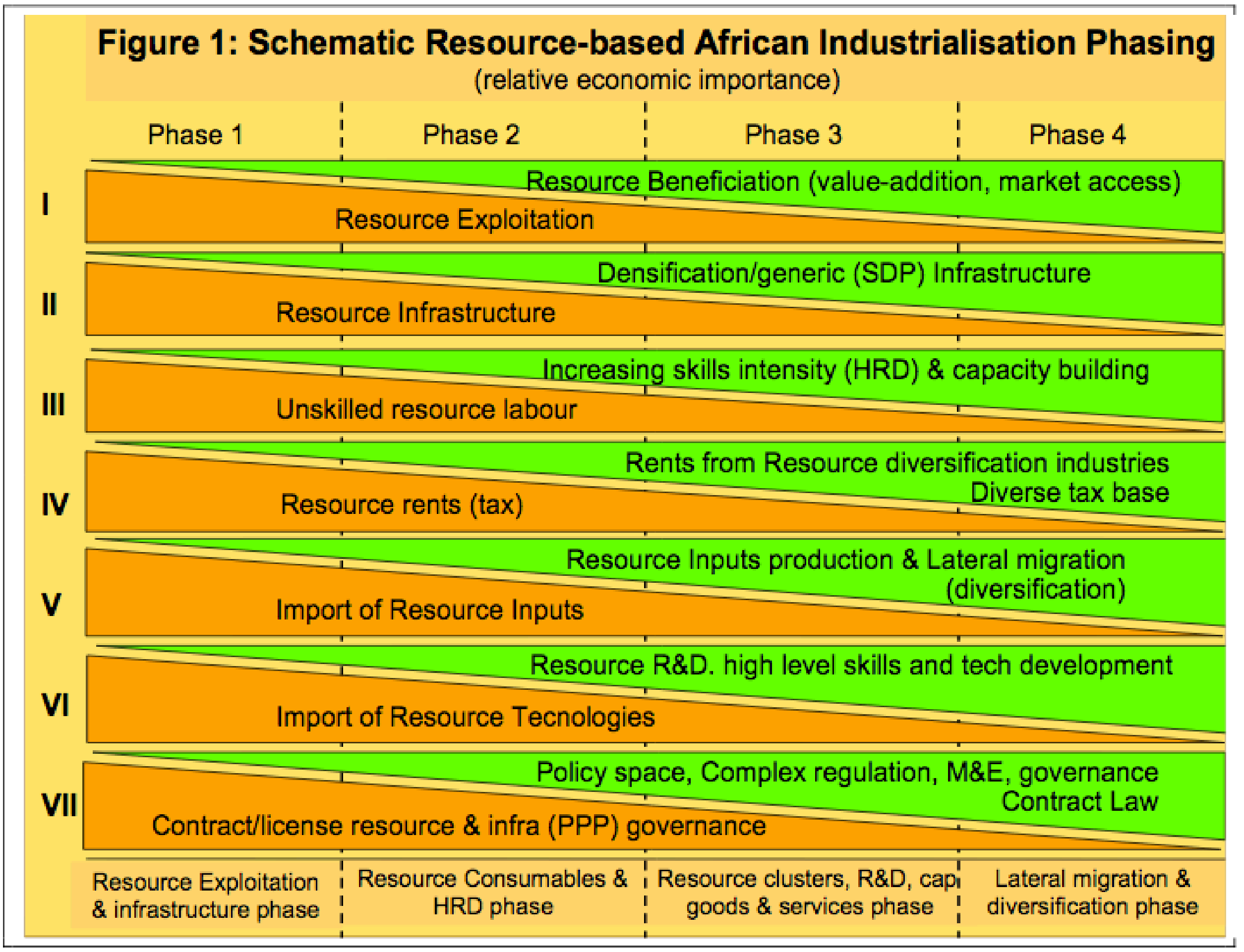


Figure 64: Vision for an industrialisation of the African continent, (Source: www.africaminingvision.org/amv_resources/AMV/Africa_Mining_Vision_English.pdf).

The AMV identifies a range of actions that should have priority:

- Facilitate and nurture human resources development and skills formation in tandem with the development of resources technological clusters through the facilitation of research and development (R&D) and the building of knowledge networks and niches involving academia, industry, the government and other players;
- Provide supporting infrastructure including roads, rail ports, energy and water and telecom;
- Encourage the establishment of strong instruments of collaboration (industry/professional associations, Chambers of Mines, cluster councils, incubator/technology packs) and foster agglomeration effects and learning processes by the establishment of a critical mass of key similar, ancillary, related and associated industry players that share information, collaborate and compete to improve the initial factor advantages, enhance competency, reinvention, innovation, technology evolution and spill-overs, and diversification;
- Promote local beneficiation and value addition of minerals to provide manufacturing feedstock;
- Promote the development of mineral resources (especially industrial minerals) for the local production of consumer and industrial goods;
- Establish an industrial base through backward and forward linkages;
- Encourage and support small and medium-scale enterprises to enter the supply chain;
- Improve the quality of the business environment, increase private sector confidence and participation, and reduce entry barriers and operating costs to achieve external economies of scale;
- Ensure compliance of industry players with the highest standards of corporate governance, and environmental, social and material stewardship;
- Harness the potential of mid-tier resources that may not necessarily attract major international companies but high net worth individuals, including local entrepreneurs;
- Establish the requisite enabling markets and common platforms for services (raising capital, commodity exchanges, legal and regulatory support, marketing support and know-how);
- Harness the potential of Public Private Partnerships (PPPs); and
- Promote regional integration and harmonisation to facilitate factor flows.

The AMV underlines that that successful mining companies and industries will be assessed according to a triple bottom line, namely financial success, contribution to social and economic development, and environmental stewardship.

The key elements to an African Mining Vision, that uses mineral resources to catalyse broad-based growth and development need to be, from looking at successful resource-based development strategies elsewhere, the maximisation of the concomitant opportunities offered by a mineral resource endowment, particularly the ‘deepening’ of the resources sector through the optimisation of linkages into the local economy.

- *Resource rents*: The use of resource differential and windfall rents to improve the basic physical and knowledge infrastructure of the nation through investment in physical infrastructure and social and human infrastructure.

- *Physical infrastructure:* The collateral use of the high-rent resource infrastructure to open up other resource potential (such as agriculture, forestry and tourism), to access zones of economic potential with lower returns (e.g. agriculture) that cannot afford their own requisite infrastructure.
- *Downstream value addition*: The use of the locational advantage (CIF-FOB) of producing crude resources to establish resource-processing industries (beneficiation) that could then provide the feedstock for manufacturing and industrialisation.
- *Upstream value-addition*: The use of the relatively large resources sector market to develop the resource supply/inputs sector (capital goods, consumables, services).
- *Technology/product development*: Resources exploitation technologies generally need adaptation to local conditions (e.g. climate, mineralogy, terrain), which provide opportunities for the development of niche technological competencies in the resource inputs sector. This sector tends to be knowledge-intensive and accordingly needs 'priming' through investment in resources HRD and R&D. However, several studies have shown that it has the capacity to later 'reinvent' itself outside the resources sector through the lateral migration of technological competencies to produce new products for other (non-resource) markets.

The African Mining Vision document provides a comprehensive analysis of the probable reasons for the failure of African states to benefit adequately from their mineral endowment:

- *Resource rents*: As per the extensive "resource curse" literature, this is the classical diversion of rents into short-term (imported) consumption and, often clandestine, foreign exchange outflows, resulting in low levels of reinvestment. However, the root cause is weak governance, particularly the lack of or ineffective appropriate institutions. This often also impacts on the state's share of the resource rents to the extent that African states with weak governance generally fail to impose resources tax regimes that ensure an equitable share of the rents, particularly windfall rents, due either to a lack of state capacity or the subversion of that capacity to produce overly investor friendly outcomes.
- *Collateral use of resource infrastructure*: To some extent, this is taken advantage by most resource-based African economies, but the development of the other sectors, particularly commercial agriculture, along and within the resource infrastructure 'catchments' is often severely constrained by the macro-economic impacts of a resource boom (strong currency or Dutch Disease) and by the failure to invest in and maintain the necessary feeder infrastructure linking to the resources infrastructure.
- *Downstream value addition*: The reasons for this failure are numerous and include the non-availability of other critical inputs, besides the crude resources, necessary for competitive beneficiation, such as energy, as well as the high entry barriers (economies of scale) of many beneficiation process (e.g. iron & steel, alumina/aluminium, and copper) and the global corporate beneficiation strategies of the transnational corporations, which often prefer to send crude resources to a central beneficiation facility in another country, or have a policy of keeping to their 'core competence' of resource extraction, and then only make the semi-processed resource available to the local market at a monopoly price (import parity price), if they have a monopoly or oligopoly position in the country concerned. This is arguably also a

governance failure to impose minimum levels of beneficiation in the mineral extraction agreement, or to establish an effective competition authority/regulator.

- *Upstream value-addition*: The main failures here are the centralised purchasing strategies of most resource extraction transnational corporations, the lack of a domestic business sector with the requisite capacity and access to capital to take up these opportunities and the lack of local human resources and technological expertise to establish these, generally knowledge-intensive, industries. Here again good governance is critical in ensuring local content minimums in the resource contracts/licenses and investing in the appropriate HRD and technology development.
- *Technology/product development (lateral migration)*: This is closely linked to the previous point, in that, in order to leverage off the resource sector, targeted investment in HRD and R&D is needed by the state and the resources companies. However, the resources TNCs generally centralise their R&D in Minority World countries (often their home bases), which generally have the necessary human resources and R&D infrastructure, including state support/incentives for technology and product development. Yet again this is arguably principally a governance failure to impose HRD and R&D conditions on the resource companies and to facilitate this process through state investment in technical HRD and R&D incentives.

A main risk for both, the African states and the mining companies alike, is the generally low level of geological knowledge of the terrain, with a few exceptions. Improved RMI would, therefore, benefit the African (potential) producer countries, as well as the European and other consumers. The AMV also notes an asymmetry in knowledge levels about the mineral endowment and the implications of its exploitation between the African state authorities and the companies interested in exploiting such resources.

The AMV calls for local development support as a compensation to granting access to the African mineral resources, namely:

- Local skills development (human resources development, HRD);
- Local professional and managerial staff complement targets;
- Local purchasing targets;
- Local minority equity (ownership) targets;
- Local beneficiation targets/milestones;
- Local R&D targets and incentives; and
- Establishment of local venture capital funds

The AMV also addresses the issue of artisanal and small-scale mining (ASM). Poor practices, mining and mine waste management techniques lead to serious issues of sustainability in addition to the well-known socio-economic issues. However, in certain sectors, such as gem-stones, ASM is the main supplier in Africa. While raising the issue, the AMV is not able to offer solutions to the problem, other than a call that authorities should recognise ASM as an important economic factor and provide an adequate governance and regulatory framework. ASM being both, a poverty-driven, as well as a poverty-alleviating activity, dealing with environmental and socio-economic impacts is closely related to the general development issues. These issues, however, are not unique to Africa.

It may be also noted that in 2007 the Southern African Development Communities' (SADC, http://www.sadc.int/) Mining Ministers adopted a framework for the 'Harmonisation of Mining Policies, Standards, Legislative and Regulatory Framework in Southern Africa' (UNECA, 2004). The themes and their objectives, as prioritised by the SADC experts are:

- *Policy, Regulations and Administration*: the aim is to adopt similar objectives for national mining policies and align administration procedures in the sector;
- *Geological and Mining Information Systems*: this aims at standardising geological data as well as increasing the availability of geological information to stimulate investment in the industry;
- *Human Resources and Institutional Capacities*: this seeks to improve the quality and quantity of available skills, and standardise qualifications as a basis for the free movement of skills in the region;
- *Safety, Health and Environment*: focuses on developing and implementing a common set of health, safety and environmental standards across the SADC mining industry;
- Investment promotion: aims at institutionalising SADC-wide mining investment forums, providing investment related information and targeting infrastructure development in potential mining areas;
- *Value Addition, Innovation and Research and Development*: to promote downstream value creation through the assembly of information on tariffs and market opportunities and developing a system of innovation to increase the competitiveness of SADC mineral value chains;
- *Artisanal and Small-Scale Mining*: this targets the upgrading of the knowledge and skills of small-scale and artisanal miners, as well as providing information and services to address their traditional lack of access to such services; and
- *Social Issues and Gender*: this seeks to encourage linkages between communities and mineral developments, and uplift the role of women in mining.

From a European perspective this means a paradigm shift in the economic relations, with Africa moving away from a supplier of minerals and towards becoming a supplier of added value products. This also means that more steps of the value-chain of the respective mineral would occur in Africa, rather than in Europe. While this, in consequence, means that more of the associated profits would remain in Africa, it also would create markets for more advanced industrial goods, such as processing equipment, and relevant know-how. The AMV aims at strengthening the African countries and their bargaining power in the minerals sector. Both, the AMV and the UNECA documents also stress the importance of RMI, namely geological knowledge, for the further development of Africa's wealth in minerals.

Example Tanzania

The mineral sector policy of **Tanzania** is designed to address the following national challenges (Ministry of Energy and Minerals, 2008): To raise significantly the contribution of the mineral sector in the national economy and increase the GDP to increase the country's foreign exchange earnings; to increase government revenues; to create gainful and secure employment in the mineral sector and provide alternative source of income particularly for the rural population; and to ensure environmental protection and management. In view of these challenges, the Government's policy of Tanzania for the mineral sector development will aim to attract and enable the private sector to take the lead in exploration, mining development, mineral beneficiation and marketing. The role of the public sector will be to stimulate and guide private mining investment by administering, regulating, and promoting the growth of the sector. Accordingly, the *policy objectives* of the Government for the mineral sector are:

- To stimulate exploration and mining development;
- To regularize and improve artisanal mining;
- To ensure that mining wealth supports sustainable economic and social development;
- To minimize or eliminate the adverse social and environmental impacts of mining development;
- To promote and facilitate mineral and mineral-based products marketing arrangements;
- To alleviate poverty especially for artisanal and small-scale miners.

BRICS minerals policies

Overview

BRICS is the acronym for an association of five major emerging national economies: Brazil, Russia, India, China and South Africa. The term BRIC was coined in 2001 by then-chairman of Goldman Sachs Asset Management, Jim O'Neill. This prompted a first informal meeting in Russia in 2009. South Africa lobbied the group and was admitted in 2010, enlarging BRIC to BRICS. The BRICS members are all leading developing or newly industrialized countries, but they are distinguished by their large, sometimes fast-growing economies and significant influence on regional affairs; all five are G-20 members. The BRICS countries are characterised by economic growth rates above those of the established industrialised countries, though these growths rates have slowed down in recent years. Some BRICS members, such as Brazil for instance, even have recently slipped into a recession. All BRICS countries are not only emerging industrial nations, but also have a significant endowment of minerals. In the case of China, Brazil, and South Africa, they are major players in the world market for certain commodities, such as rare earth elements, bauxite, or diamonds. Representing around 42% of the world population, they are also emerging as significant consumers, particularly China. India and China have the largest and fastest growing middle classes in the world, which will have a major impact on material and energy consumption in the coming decades.

BRICS as a group do not have common policies, but rather are a group of countries that share certain characteristics and relations with the developed countries.

While BRICS has evolved from a summary term to describe emerging economies to a more formal group of countries, there are other countries that share with the BRICS countries certain characteristics. Some commentators enlarge BRICS to BRIICS, including Indonesia. While the Indonesian industry certainly is not as developed as those in the other countries, it has a significant mineral endowment and a large (at ca. 250 million a third of the EU population), fast growing population. As the Indonesian economy will emerge sometime after that of the BRICS countries, it will add to the world-wide competition.

Brazil

The present minerals policy is the 2030 National Mining Plan (PNM 2030). The Ministry of Mines and Energy Ordinance No. 121/2011 ratifies PNM 2030 and is to be used as policy and regulatory guidance for the time up to 2030. Inter alia PNM 2030 calls for the creation of a National Council for Minerals policy and a National Mining Agency to replace the National Department of Mineral Production (DNPM, Departamento Nacional de Produção Mineral). The remit of the new entities would be to promote the rational use of the mineral resources of Brazil (Yoshikawa & Araujo, 2013).

Russia

The Government of the Russian Federation published in 2003 a "State policy on the use Mineral Resources and Subsoil Use" (Ordinance No. 494-r of 2003). The Ministry of Natural Resources (MNR) jointly with interested federal executive authorities is responsible for its implementation. The main tasks lie in securing minerals, in the efficient mineral management for the sustainable development of the Russian economy, as well as intensified use of domestic deposits to the benefit of present and future generations. An essential element of the strategy is the preservation of the geopolitical interests.

Russia has an important mineral potential and is one of the world's leading producers of mineral materials. At the same time, the raw-material base of the country has relatively low investment attractiveness due to unfavourable geographic and economic location of many mineral deposits and relatively low quality minerals. There is a lack of competitiveness in the industry, no long-term state strategy in the field of mineral resources, exploitation of these resources, and technological development in mining and processing of minerals. These factors are likely to be detrimental to the industry, may hamper economic development and may impair supply security. The objective of ordinance 494-r is to improve this situation. In particular, the Ordinance stipulates:

Objectives and Principles of State Policy of Mineral Resources and Subsoil Use, namely

- ensuring effective development and exploitation of the mineral resource base in Russia to ensure a sustainable economic development, the welfare of its citizens, an integrated mineral resources management for the benefit of present and future generations in Russia, the protection of the geopolitical interests of Russia, including world mineral market;
- Government policies on the use of minerals and subsoil is based on maintaining state ownership of the below-ground mineral resources;
- regulation of development and utilisation of minerals in accordance with the long-term public strategy and short-term programmes of geological studies and exploitation of minerals resources on the basis of a long-term (25-50 years) prediction of consumption levels of the main minerals types;
- granting of exploitation licenses on a competitive (auction, tender) basis;
- formation of a federal reserve fund for minerals deposits, including hydrocarbons (stock of mineral resources for future generations);
- improving the system of taxes and charges associated with subsoil use, in order to ensure equitable distribution between state and public property, creating an enabling economic

environment for the operation of the minerals industry, with a view to maintain competitiveness in the global market;
- establishing clear lines of authority between the state and its citizens in the field of use and protection of natural resources;
- promotion of an economic transition in Russia towards efficient technologies and the rational and integrated use of minerals along the value-chain.

Improving the legal and regulatory framework in the field of mineral and subsoil with a view to
- provide administrative and civil law mechanisms for the use of subsoil plots, including concession contracts and other forms of contractual relationships;
- achieve a clear division between the different authorities regulating the use of the subsoil;
- consolidate the licensing and contracting procedures for the use subsoils, considering volume and types works;
- apply economic and legal sanctions to subsoil users who violate regulations;
- promote the use of best technologies in exploration and exploitation, minimizing negative impacts on the environment;
- develop a of public monitoring system for the geological environment;
- an effective system of state control over exploration and mining, the implementation of conditions of licenses and contracts for the right to use subsoil areas;
- improve public examination results regarding geological exploration and mineral inventory system;
- review existing standards, norms and regulations in the field of subsoil use and protection of the environment to be in line with relevant international practices;
- subject government review, on a mandatory basis, project proposals for the development of mineral deposits;
- safeguard the interests of the state and subsoil user.

Improving the governance of state subsoil resources by
- consolidation of the strategic planning functions and the major regulatory and control functions of the competent authorities;
- allocation of executive and administrative functions between the various competent authorities;
- strengthening the system of state control over geological studies and use of mineral resources;
- extending the practice of public auctioning of rights for geological study, exploration and mining;
- developing measures to improve the economic responsibility of subsoil use for non-investment commitments and
- efficient use of available land for subsoil use.

Arrangements for mineral resources exploitation and efficient operation of the extractive industry
- development of long-term (20, 30, 50 year) mineral resources policies;
- fore-casts for domestic supply and demand, exports, and imports of minerals and the development of proposals to meet deficits;
- development of measures to establish strategic public mineral reserves, including groundwater reserves;

- timely and regular federal funding for geological studies with a view to support defence and national security, for studies to anticipate and identify strategic minerals, to meet the minerals needs of industry, as well as forecasting of natural geological hazards;
- monitoring and evaluation of the mineral resource base; promoting activities of mining companies to assess mineral resources, including government grants.

In order to ensure the efficient operation of the extractive industry government will

- promote mining companies that are highly competitive on the world market for production and mineral processing;
- promote the participation of small and medium enterprises;
- use of various forms of state support, protecting the interests of Russian mining companies on the world market, as well as Russian resource companies involved in major investment projects inside and outside Russia.

India

India had already defined its National Minerals policy in 1993. A new version was released in 2008, taking account of the significance of sustainability ('zero waste mining'), use of modern exploration and mining technology, considering environmental issues and establishing the necessary political framework to ensure transparency and support of private and state-run mining activities. It also proposes to substantially increase the scale of privatisation. The forward-looking policy is based on a strategy of co-operation with other nations for sustaining India's growing needs. It states that the import of machinery and technology would be freely allowed, use of foreign state of the art technology and 'participation for this purpose' is to be encouraged, in order to increase productivity, safety and minimise mining waste. Resource efficiency is to be achieved by the development of a recycling industry by 2050 and beyond (Tiess & Tiewsoh, 2011).

In 2016 a National Exploration Policy was published by the government. It is mostly a technical document dealing in detail with geological potential, mapping and encouraging private players in exploration. The national minerals policy is not applicable to energy minerals (oil, coal, nuclear fuel). Policies for petroleum, natural gas and coal are prepared respectively by their ministries and are descriptive and long-winded (i.e. separate polices for exploration, distribution, pricing and licensing etc.). The National Minerals policy of India is structured as follows (official website of Ministry of Mines (http://mines.nic.in/):

Regulation of minerals

Management of mineral resources is the responsibility of both the Central Government and the State Governments and is regulated in particular by

- The **Mines and Minerals (Development and Regulation) Act, 1957 (MMDR Act)**, that lays down the legal frame-work for the regulation of mines and development of all minerals other than petroleum and natural gas.
- The Central Government has framed the **Mineral Concession Rules, 1960 (MCR)** for regulating grant of reconnaissance permits (RP), prospecting licences (PL) and mining leases (ML) in respect of all minerals other than atomic minerals and minor minerals.

- The State Governments have framed the rules in regard to minor minerals.
- The Central Government have also framed the **Mineral Conservation and Development Rules, 1988 (MCDR),** for conservation and systematic development of minerals and applicable to all minerals except coal, nuclear fuel minerals and minor minerals

In order to make the regulatory environment conducive to private investment the procedures for grant of mineral concessions of all types, such as reconnaissance permits, prospecting licenses and mining leases, shall be transparent and seamless and security of tenure shall be guaranteed to the concessionaries. The first-in-time principle in the case of sole applicants and the selection criteria in the case of multiple applicants will be appropriately elaborated. Prospecting and mining shall be recognized as independent activities with transferability of concessions playing a key role in mineral sector development.

Role of the state in mineral development
The role to be played by the Central and State Governments in regard to mineral development has been extensively dealt in the Mines and Minerals (Development and Regulation) Act of 1957 and rules made under the Act by the Central Government and the State Governments in their respective domains. The provisions of the Act and the Rules will be reviewed and harmonised with the basic features of the new National Minerals policy.

In future the core functions of the State in mining will be facilitation and regulation of exploration and mining activities of investors and entrepreneurs, provision of infrastructure and tax collection. In mining activities, there shall be arm’s length distance between State agencies (Public Sector Undertakings) that mine and those that regulate.

There shall be transparency and fair play in the reservation of ore bodies to State agencies on such areas where private players are not holding or have not applied for exploration or mining, unless security considerations or specific public interests are involved.

Survey and exploration
The Geological Survey of India is the principal agency for geological mapping and regional mineral resources assessment of the country. It is responsible for drawing up action oriented plans towards these ends in close co-operation with all other agencies engaged in this task.

Detailed exploration on land is done by the Mineral Exploration Corporation, Directorates of Mining and Geology of the State Governments and various Central and State Public Sector Organisations. In conducting exploration for minerals special attention will be given by these government agencies to the development of strategic minerals through systematic investigation of potential sources which are difficult to otherwise access.

The Ministry of Earth Sciences (MoES) and its agencies are entrusted with the task of sea-bed exploration and mining in India’s exclusive economic zone.

Particular attention is given to the survey and exploration of minerals for which the country has a poor resource-cum-reserve base despite having the geological potential for large resources. Minerals for which there is demand within the country either for use or for export after processing will be prioritized. Exploration for lower grade hematite, magnetite, base metals, noble metals, diamonds and high grade Ilmenite will be put on the fast track.

National inventory of mineral resources
The national inventory of mineral resources will be based on a comprehensive and up-to-date review of exploration data. In coordination with Geological Survey of India, the Indian Bureau of Mines will maintain a database in digitised form, comprising both, a Resource Inventory and a Tenement Registry.

The resource inventory will be in accordance with the latest version of the UNFC system showing reserves and remaining resources as well in the traditional IBM form of resources and probable and proven reserves. The Tenement Registry will give information of both Leasehold Areas as well as Freehold Areas in terms of green field, brown field and relinquished areas, including areas not pursued by exploration license holders. The data will be maintained online, giving instant information to prospective investors on what is available for reconnaissance, prospecting and mining. Summaries of work done by public agencies will be kept in the form of meta-data in the public domain and detailed reports are made available to interested investors on cost recovery basis.

Strategy for minerals development
The Strategy for development of any mineral will keep in view its ultimate end-uses in terms of demand and supply in the short, medium and long terms. The guiding principle in the strategy of development of any mineral or mineral deposit at any location shall ordinarily be the economic cost of recovery i.e. extraction cost relative to market price and will hence be determined by the market.
Conservation strategy – Conservation of minerals shall be construed not in the restrictive sense of abstinence from consumption or preservation for use in the distant future, but as a positive concept leading to augmentation of reserve base through improvement in mining methods, beneficiation and utilisation of low grade ore and rejects and recovery of associated minerals. There shall be an adequate and effective legal and institutional framework mandating zero-waste mining as the ultimate goal and a commitment to prevent sub-optimal and unscientific mining
Mineral development and protection of environment – No mining lease will be granted to any party, private or public, without a proper mining plan including the environmental management plan approved and enforced by competent authorities. The environmental management plan should adequately provide for controlling the environmental damage, remediation of mined areas and for planting of trees according to the prescribed norms. As far as possible, reclamation and afforestation will proceed concurrently with mineral extraction.
Mine safety, relief and rehabilitation – Appropriate compensation will form an important aspect of the Sustainable Development Framework. In so far as indigenous (tribal) populations are concerned, the Framework shall incorporate models of stakeholder interest for them in the

mining operation, especially in situations where the weaker sections such as the local tribal populations are likely to be deprived of their means of livelihood as a result of mining.

Foreign trade
Minerals continue to be an important source of foreign exchange earnings. The policy of export shall keep in view the dynamics of mineral inventories as well as the short, medium and long term needs of the country. Efforts shall be made to export minerals in value-added form as far as possible. The indigenous mineral industry shall be attuned to the international economic situation in order to derive maximum advantage from foreign trade by carefully anticipating technology and demand changes in the international market for minerals.

Fiscal aspects
It will be the endeavour of government, within the limit of the budget, to design fiscal measures conducive to the promotion of mineral exploration and development including beneficiation and other forms of product refinement. In the context of the changing mineral scenario and the economies of mineral development and products, both at the national and international level fiscal changes will be examined from time to time consistent with the general tax structure and through the normal budgetary process. Mineral prices should reflect their value and the royalty structures will be designed to ensure that the producer earns and the consumer pays the true value of the minerals produced and consumed. The fiscal dispensation will generally aim to ensure that adequate compensation is forthcoming to the state in return for the concessions it grants.

Research and development
Research and development in the mineral sector has to cover the entire gamut of activities from geological survey, exploration, mining, beneficiation, concentration of minerals to development of materials. Efforts will be directed towards the development of new technologies for conversion of existing mineral resources into viable economic resources.

Appropriate technologies shall be developed to enable indigenous industries to utilise the mineral resources with which the country is abundantly endowed and as substitutes for minerals whose reserves are poor. R&D efforts shall be directed to find new and alternative uses for minerals whose traditional demand is on the wane. Indigenous technology has to be upgraded through research and appropriate absorption and adoption of technological innovations abroad.

Conclusions
Mineral wealth, though finite and non-renewable in the long term, is a major resource for development. The need for a well-planned programme of survey and exploration, management of resources which have already been discovered and those which are in the process of discovery and their optimal, economical and timely use are matters of national importance. The success of the second national minerals policy will depend largely on a national consensus to fulfil its underlying principles and objectives.

China

The People's Republic of China made considerable efforts since its institution to harness the minerals wealth of the country for the purpose of industrial and economic development. Thus, in 2003, over 92% of the country's primary energy, 80% of the industrial raw and processed materials and more than 70% of the agricultural means of production come from mineral resources.

China has come to attach great importance to sustainable development and the rational utilisation of mineral resources, and has made sustainable development a national strategy and the protection of resources an important part of this strategy. Following the UN Environmental and Development Conference in 1992 in Rio de Janeiro, the Chinese government formulated the "China Agenda 21 -- the White Paper on China's Population, Environment and Development in the 21st Century". It also implemented a "National Programme on Mineral Resources" in April 2001, and in January 2003 began to implement "China's Programme of Action for Sustainable Development in the Early 21st Century".

The European Commission was engaged in two dialogues related to raw materials with China - with the NDRC (National Development and Reform Commission), a Metals Working Group and with the Ministry of Industry and Information Technology (MIIT). The latter dialogue takes place within a Working Group on Raw Materials established in 2010. One meeting took place in March 2012 in Beijing, and the second took place in 2013 in Brussels. A workshop on recycling and a study visit for Chinese experts in Europe was planned for the second half of 2013 (EC, 2013).

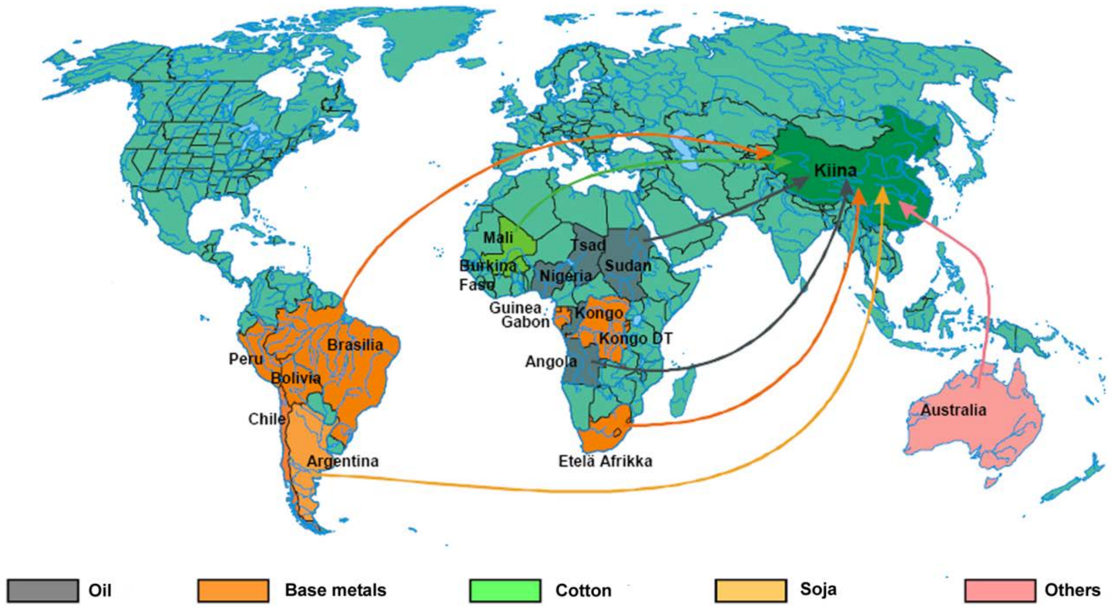


Figure 65: Chinas minerals strategy (Source: Ekdahl, 2008).

China depends to a significant degree on the exploitation of its own mineral resources to guarantee the needs of its modernisation programme. The Chinese government encourages the exploration and exploitation of the mineral resources according to market demand and to increase its domestic capability of mineral resources supply. It is an important government policy to import foreign capital and technology to exploit the country's mineral resources, make use of foreign markets and foreign mineral resources, and help Chinese mining enterprises and mineral products enter the international market. The Chinese government holds that to have foreign mining companies enter China and Chinese mining enterprises enter other countries to make the countries mutually complementary in resources is of great significance for the common prosperity and healthy development of world mineral resources. Figure 65 illustrates some of China's strategic foreign investments.

The Chinese Five-Year Plans

Planning is a key element of a socialist economy, although China embraces more and more market economy paradigms, combining the two in a 'Chinese Style' economy. Since 1953 a series of 5-Year-Plans were developed by China's Communist Party, the current 13th edition covering the years 2016 to 2020. The 13th Five-Year Plan acknowledges and promotes the fact that China has become a major player in the world economy and abandons some of the earlier policies:

Focus areas

- *Innovation*: Move up in the value chain by abandoning old heavy industry and building up bases of modern information-intensive infrastructure
- *Balancing*: Bridge the welfare gaps between countryside and cities by distributing and managing resources more efficiently
- *Greening*: Develop environmental technology industry, as well as ecological living and ecological culture
- *Opening up*: Deeper participation in supranational power structures, more international co-operation
- *Sharing*: Encourage people of China to share the fruits of economic growth, so to bridge the existing welfare gaps

Policies

- "Everyone is an entrepreneur, creativity of the masses" (大众□□，万众□新)
- "Made in China 2025" (中国制造2025) – aims to address four worrying trends:
    1. (Nationally) vital technologies lack a (domestic) core platform
    2. Chinese industrial products are perceived internationally as inferior quality
    3. Domestic industrial competition is fierce due to overly homogeneous structure
    4. Poor conversion of academic research results to practical application
- "Economy needs a Rule of Law" (建构法治□□)
- "National defence reform" - Organisational reform of the army, slashing number of highest generals, as well as concentrating branches' functions, moving some under Defence Ministry
- "Urbanisation with Chinese characteristics" (国家新型城□化)
- "Reformed one-child policy" - soon it could be called "two-child policy"

The 13th Five-Year Plan (5YP) consolidated a raft of policies that will have a significant impact on the country's commodities import and export mix. The relevant policies and their key impacts on China's commodities trade include (BMI, 2016):

Key Policies

- Tackle metals and mining sector overcapacity. Targeted retrenchment of 5 to 6 million state workers over the next two to three years, particularly in the coal and steel sectors.
- Curbing of over-capacity likely to be slow due to social and local government push-back. First, mining and metals employment is very concentrated in some areas of the country. Second, currently oversupplied sectors owe local state-owned banks USD1.5 trn and the banking sector would thus be very exposed to any rapid consolidation.
- Coal, iron ore and steel production is expected to contract by 0.7%, 17.0% and 6.6% respectively between 2015 and 2020, compared to expansions of 16.1%, 40.1% and 28.8% respectively over the previous five years. China's overall mining industry value will shrink by 7.5% between 2015 and 2020.

Impact on Trade

Although weak metals consumption growth in China will slow import growth, no collapse in imports over the next five years is expected. Instead, import growth will outpace consumption growth for most metals. The key reason for this divergence is that consolidation of the metals and mining sector will drag production growth even lower than consumption growth, reducing China's self-sufficiency.

Ores and Concentrates: Steady imports - Iron ore, copper and bauxite import growth will remain positive as the contraction of China's domestic ore production continues to outpace the slowing of demand from the metals refining sector. For instance, iron ore production is expected to decline by 10.0% in 2016, whereas steel output will only contract by 2.0%.

Refined Metals: Lower exports - Production cuts mean that one can expect China's steel and aluminium exports to peak in 2016, having surged in 2014-2015. China's steel and aluminium surpluses will narrow by 4.1% and 46.5% respectively between 2015 and 2020. China's net steel exports have already shown signs of topping out, having grown by just 2.0% in the three months to February 2016, compared to growth of 29.3% over 2015 as a whole.

The contraction expected in some formerly important areas such as heavy industry and mining is leading already to significant unemployment with difficulties to retrain and reskill this workforce. The transformation from a 'world-class manufacturer' into the 'world's leading technology centre' was already foreseen in China's 2006 National Medium to Long-term Plan (MLP) for the Development of Science and Technology (2005-2020). It focuses on innovation policy and scientific modernisation (Roborgh, 2011). This plan supports government investment in key technology and engineering projects and contains key objectives listed in the Table 15.

Table 15: Key points of the Chinese National MLP for Science and Technology Development (2006-2020). Source: van Sommeren and van Sommeren-Wang (2013).

MLP highlights
China as technological powerhouse by 2020 and global technology leader by 2050
Increase R&D investment from 1.3% to 2.5% of GDP by 2020
Contribution of technology to economic growth more than 60%
Lower dependency on imported foreign technology from 60% to no more than 30%
Lower dependency on foreign companies
Selection of 11 key sectors for technological development, 27 breakthrough technologies
4 basic research areas, 16 megaprojects
Fostering Chinese IP and brands (brand economy)
Chinese patents belong among world top 5
Chinese scientific papers belong to the most cited and rank among world top 5

Until the early years of the 21st century China has been following a rather aggressive merger and acquisition strategy, focusing particularly on minerals (e.g. Roborgh, 2011). In more recent years the focus slightly shifted to technology holders in the view of the above policy. This minerals policy is fuelled by the growing domestic demand, though the global economic slow-down in recent years also affected China. However, In the area of key metals, for instance, China is on its way to become the largest consumer of metals in the world. Between 2000 and 2008, China's consumption of key metals such as aluminium, copper, lead, nickel, tin and zinc showed an annual increase of 16.1 % and China still remains an important driver for metals demand. By comparison, metal demand in the rest of the world rose by less than 1% per year (WB, 2010). The country's share of world metal consumption rose above 50% in 2015 (Figure 66), and the country accounted for the majority of global growth over the past 15 years. However, the transition from an investment/export driven economy to one that is consumption-led could reduce demand growth for minerals (WB, 2016b).

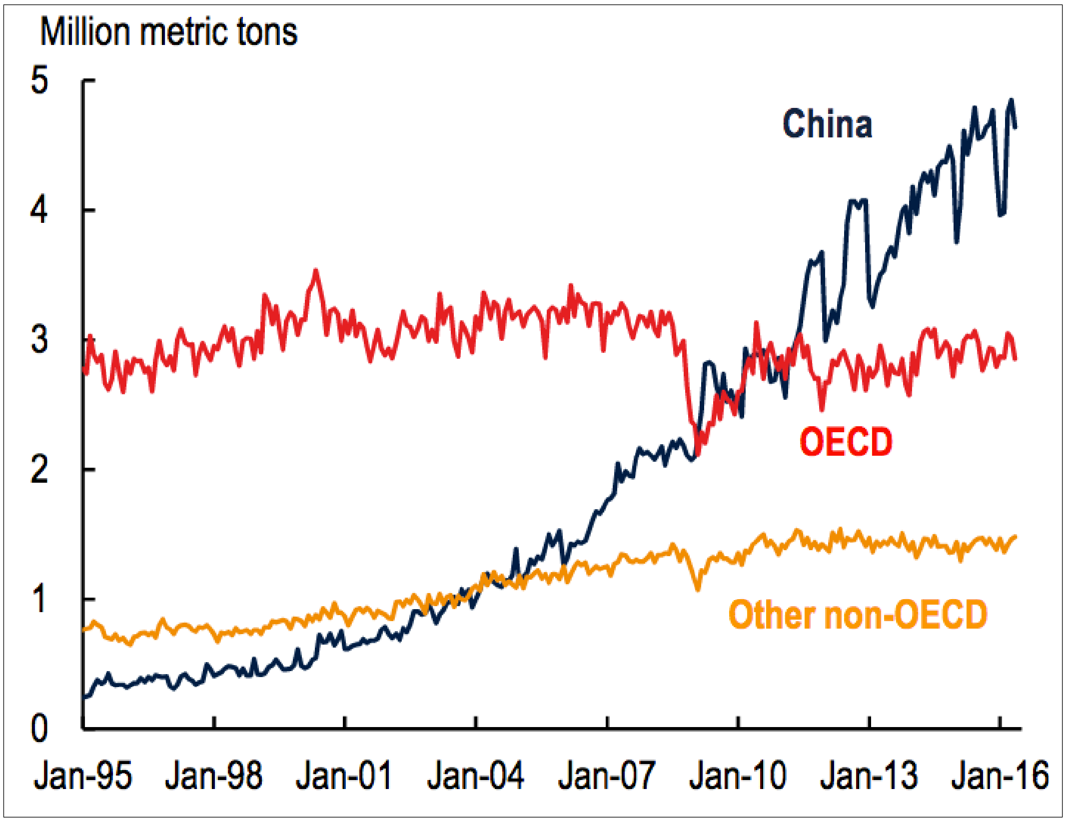


Figure 66: World refined metal consumption (Source: World Bureau of Metal Statistics, quoted in WB 2016b).

South Africa

In the past, mineral and petroleum resources were privately owned, meaning that payment for the extraction of these resources was payable to the State only under certain circumstances, e.g. where mining had been conducted on State-owned land. To bring South Africa in line with prevailing international norms, the Department of Mineral Resources, which is responsible for developing minerals policies, norms and standards as well as draft and amend mineral and related legislation, promulgated the Mineral and Petroleum Resources Development Act, 2002 (MPRDA, www.dmr.gov.za/publications/finish/109-mineral-and-petroleum-resources-development-act-2002/225-mineraland-petroleum-resources-development-actmprda/0.html) in terms of which these resources are recognised as belonging to the nation and the State as the custodian. Various amendments to this act specify particular areas of minerals policy making.

The main objectives of the Geosciences Amendment Act 16 of 2010 are to mandate the Council for Geoscience to be custodians of geotechnical information, to be national advisory authority in respect of geohazards related to infrastructure and development, and to undertake reconnaissance operations and prospecting research.

The Mineral and Petroleum Resources Laws General Amendment Bill of 2011 amends both the Mineral and Petroleum Resources Development Act 28 of 2002 and the Mineral and Petroleum Resources

Amendment Act 49 of 2008. The objects of the Mineral and Petroleum Resources Amendment Act are to strengthen the current construct of the legislation, fortify the penalty provisions, to streamline the administrative process and to provide for a single regulatory system.

The Precious Metals Amendment Bill of 2011 amends the Precious Metals Act 37 of 2005 so as provide and improve on definition of words and expressions to remove ambiguities, streamline administrative processes, improve the regulatory framework and provide for matters connected therewith.

The Directorate is currently (2017) developing regulations to the Geoscience Amendment Act 16 of 2010. The Regulations to the MPRDA, the Precious Metals Act and the Diamonds Act will be reviewed and amended immediately after the promulgation of the respective amendment Bills.

The Amended Broad Based Socio-Economic Empowerment Charter for the South African Mining and Minerals Industry of 2010 aims to promote equitable access to the nation's mineral resources to all people of South Africa, to substantially and meaningfully expand opportunities for HDSA's to enter the mining and minerals industry and to benefit from the exploitation of the nation's mineral resources, to promote employment and advance the social and economic welfare of mine communities and labour sending areas etc.

The H2020-project INTRAW aimed inter alia to shed light on the difference between South Africa and the EU with respect to their raw materials strategies (Falck et al., 2016).

Indonesia

Indonesia is a fast growing democratic developing country comprising more than 17,000 islands, founding member of ASEAN and a member of the G-20 group of major economies. It is one of the most highly mineralised countries in the world, the mining sector playing a pivotal role in the country's economy. In 2001, the Decentralisation Law No. 22/1999 came into force and caused a transfer of authority and responsibility from central to regional and local administrative governments. The new Mining Law of 4/2009 substituted its 40 year old predecessor, but lacked detailed regulations for its implementation. These were only issued in 2010, which lead to a period of great uncertainty for investors in the mining industry. The new legislation intends to foster domestic economic development, which may be interpreted as protectionist policy. For the development of a sustainable mineral resources policy, further endeavours will have to be made (Tiess & Mujiyanto, 2011).

The Indonesian reform era began in 1998, after the fall of President Suharto, with a significant change in Indonesia's political and administrative system. The most notable change was the shift from a highly centralised system of administration to a decentralised and democratic system. In the decentralised architecture, full autonomy is being placed at the regency/municipal level, with limited autonomy power at the provincial level. Under this arrangement, the authority of central government has also been reduced. Transferring political and administrative powers from the national government to subnational governments was not an easy task in the mining sector. Competing interests between different levels of government and other parties involved, e.g. the private sector and civil society, over natural resources delayed the enactment of Indonesian mining law 4/2009 by almost a decade from the commencement of the reform era (Devi & Prayago, 2013).

The main elements of the Mining Law 4/2009 are the change of Contract-of-Work regime to a licensing regime based on the designation of mining areas, recognition of the 100% foreign investment, a tendering process for mining licenses, and a ban on raw material exports. While the law recognises 100% foreign ownership, it stipulates that foreign ownership has to be reduced to at least 49% over a ten-year period and that the export of value-added products is to be favoured. Under the licence-based system, each level of government can issue a mining license dependent upon each government's authority. A separate license will be issued for exploration and exploitation respectively. The license will also consider environmental aspects.