Non Paper: Some preliminary reflections with regard to critical raw materials for the EU

1. Rationale

In November 2008 the Commission adopted the Communication[1] "The raw materials initiative – meeting our critical needs for growth and jobs in Europe" which underlined the importance of securing reliable and undistorted access to raw materials. Particular attention is given to the EU's critical dependence on certain non-energy materials.

The Communication proposed, as a priority action, to identify a common list of critical non-energy raw materials, in close cooperation with Member States and stakeholders.

In order to launch the discussion, this paper presents an overview of existing approaches to criticality in various countries, before outlining the way forward to the development of an EU approach.

2. Overview of criticality assessments by Member States and other countries

A number of industrialised countries have recognised their critical dependence on particular raw materials and are pursuing specific policies for safeguarding their access to raw materials.

USA

In 2008, the US National Research Council (NRC) released a report[2] on the criticality of non-energy raw minerals for the US economy. According to the NRC, a mineral can only be critical if it performs an essential function for which few or no substitutes exist. This definition relates criticality to demand for a material in key uses which deliver essential economic (social or other) functions, rather than to overall demand across all applications. In addition, for a mineral to be classified as critical, there has to be a high probability of supply restrictions. This two-dimensional definition of criticality is reflected in a matrix-based assessment methodology.

On the vertical axis, the impact of supply restriction (or importance in use) relates to considerations based on three indicators:
- value of national consumption
- proportion of national consumption in applications where substitution is difficult or impossible
- evaluation of growth in emerging uses that could lead to a fast/substantial increase in demand.

The perspective adopted is predominantly a short to medium term perspective (less than a decade).

On the horizontal axis, the risks of supply restrictions are measured. In general, 5 variables are considered, which are relevant to the long-term perspective of criticality:
- geologic (resource) availability

[1] COM(2008)699. 4 November 2008.
[2] National Research Council (2008): *Minerals, critical minerals, and the US economy*". National Academic Press, Washington DC.

- technical considerations (such as capacity to extract)
- environmentally and socially responsible production
- political factors (e.g. political and social stability of producing countries)
- economic factors.

However, the detailed criteria to be taken into account differ, depending on the time horizon taken into consideration and whether primary or secondary raw materials are being considered.

Over the short to medium term, the availability and reliability of supply is measured in terms of the following variables:
- significant increases in demand (leading to higher prices or unavailability)
- a thin market (in a small market with a limited number of applications for a mineral, it may be difficult to significantly increase production if new applications are discovered)
- high concentration of production (company, mine or country level)
- proportion of raw material produced as a by-product of another mineral
- low production from domestic scrap (recycling).

Of the 11 raw materials that were analysed on the basis of this methodology, 5 have been assessed as ‘highly critical’: indium, manganese, niobium, rare earths and the platinum group metals. It is important to note that this is not a definitive list of critical minerals, as the NRC did not have the time or the resources to assess all possible critical minerals.

Whereas the study was co-funded by the US Department of the interior/US Geological Survey, the resulting list does not have official, formal status. The purpose of the study was rather to present the proposed methodology as an aid to decision makers in taking appropriate steps to mitigate restrictions in the nonfuel mineral supply.

It is also important to note that the report only addressed in a limited way the mineral needs that are specific to the needs of the defence industry. Since 1939, the US Department of Defence has maintained a stockpile of strategic materials[3] to supply the needs of the US national defence. In the 1990s, the Congress authorised its disposal, but as a result of reported shortages of certain raw materials, such as titanium, it recently directed the Department of Defence to review its current stockpile disposal policy.

Japan

In 2004, the Japanese government created the Japanese Oil, Gas and Metals National Cooperation (JOGMEC). Among JOGMEC’s important activities are providing financial assistance to Japanese companies for mineral exploration and deposit development, gathering and analysing information on mineral and metal markets to better understand supply risk, and managing Japan’s economic stockpile for rare metals. JOGMEC defines rare metals as those that (a) are essential to Japanese industry, sectors such as iron and steel, automobiles, information technology, and home appliances and (b) are subject to significant supply instability. JOGMEC manages rare-metal stockpiles in cooperation with private companies, with the goal of having stocks equivalent to 60 days of Japanese industrial consumption.

[3] based on Strategic and Critical Materials Stock Piling Act of 1946 and National Security Act of 1949

Stocks exist for seven materials: chromium, cobalt, manganese, molybdenum, nickel, tungsten, and vanadium. JOGMEC is closely observing 7 other raw materials.

Germany

In 2006, RWI Essen published a study[4], commissioned by the Federal Ministry of Economy into the criticality of long-term supply of non-energy raw materials to the German economy. The study developed a methodology to assess criticality and analyses criticality for specific commodities.

The assessment is based on a two-stage process. In the first stage, a quantitative approach involving three sub-stages is used to identify 'potentially critical' commodities. It is based on 3 criteria:

- value of net imports of the raw material into Germany *(> € 0)*
- country production concentration *(Herfindahl Index >=0.15)*
- political and economic risk in producing countries *(weighted average of 5 World Bank indicators for each mineral<059).*

In a second stage, the 'real criticality' of the selected materials was assessed by means of a detailed qualitative analysis. The study considered in particular: aluminium (bauxite), zinc, platinum, chromium, copper, germanium, fluorite, magnesite, vanadium, iron ore, tantalum and graphite.

In the detailed case-by-case analysis, the study considered these 12 minerals against criteria such as:

- mining concentration by company
- recycling rate
- resource scarcity
- future demand
- substitutability
- alternative sources of raw material (potential for domestic production increase, synthetic manufacture…).

The study revealed that of the 12 commodities, only platinum was considered to be "not uncritical". It is also worth noting that the study differentiates between three main perspectives for assessing criticality: absolute scarcity (exhaustion of deposits), relative scarcity (short – medium term bottlenecks) and reliability (short term disruptions).

UK

A number of recent studies have been undertaken in the UK, which include some form of consideration of criticality, such as the strategic report[5] published in 2008 by the Resource

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[4] RWI Essen, BGR, ISI (2007): *Trends der Angebots- und Nachfragesituation bei der mineralischen Rohstoffen*. www.rwiessen.de

[5] Morely and Eatherley (2008): *Material security – Ensuring resource availability for the UK economy*. www.oakdenehollins.co.uk

Efficiency Knowledge Transfer Network, which is funded by the UK Government, Regional Development Agencies and Research Councils.

A two-dimensional approach is used, similar to the NRC model, which is complemented by a more quantitative approach of constructing a composite material insecurity index (MMI) and ranking materials according to their degree of criticality. The MMI includes 8 criteria that reflect ‘material risk’ and ‘supply risk’.

‘Material risk’ indicators:
- global consumption levels
- lack of substitutability
- global warming potential
- total mineral requirement.

‘Supply risk’ indicators:
- scarcity *(exceeding reserves by 2050)*
- concentration of production by country
- political instability in key supplying regions
- vulnerability to effects of climate change in key supplying regions.

The report analyses 69 minerals and concludes that the 8 most critical minerals in order of most to least are: gold, rhodium, mercury, platinum, strontium, silver, antimony and tin.

France

Criticality assessments are carried out on an irregular basis by the Ministry of Economy, Industry and Employment. Following an ad-hoc request by industry, a working group is established to conduct an in-depth analysis of the mineral’s criticality. Criteria which may be considered are:

- scarcity
- lack of domestic production
- consumer needs
- substitutability
- recycling.

The outcome of this work consists of a comprehensive analysis of the relevant mineral and expert advice to industry on the evolution of the market for the mineral for next 5 years. However, this advice is not publicly available, and only used for internal purposes of industry.

Besides the assessments carried out by the French Ministry, work has also been carried out by the French geological service BRGM, which focused particularly on the high degree of criticality of high tech metals, based on three criteria: possibility (or not) of substitution, essential role and potential supply risks. It is interesting to note that the conclusions of their analyses are not limited to the French situation, but seem to have a broader European scope. They identify short to medium term supply risks for a number of materials, in particular antimony, chromite, cobalt, germanium, gallium, indium, lithium, magnesium, molybdenum, platinum, palladium, rhodium, rare earths, rhenium, titanium and tungsten.

Austria

The Ministry of Economy and Labour conducts a regular criticality assessment that is based on 6 criteria:

- import dependence
- annual domestic demand
- potential for substitution
- sensitivity *(disruption of supply of a small quantity of minerals may disrupt a whole manufacturing chain)*
- multiplication effect *(i.e. impact on downstream industries)*
- political stability of source countries.

There is an additional requirement that a raw material can qualify as critical only if the interruption of its supply has a potential to impact on a share of Austrian production that is larger than one percent of the country's GDP.

The following minerals are presently classified as critical for Austria: iron ore, chromium, manganese, molybdenum, nickel, ferrotitanium, ferroniobium, ferrotantalium, ferrovanadium, cobalt, copper, magnesium, fluorspar, carbon, aluminium and tungsten.

The analysis is based on a qualitative assessment conducted by an independent group of experts (including representatives from government, industry, chamber of commerce and academia).

The assessment is carried out every 5 years and the data input is based on average values for the preceding 5 years. The results feed into decisions made by the Austrian government on changes to the country's minerals policy, such as stimulating domestic extraction or supporting R&D.

The brief (non-exhaustive) overview of the above approaches allows us to make some important observations.

- Different criticality assessments use varying criteria and adopt varying time perspectives. The data sources and means of aggregating information to determine criticality also vary. As a result, the different methodologies may deliver different ratings as to the criticality of a particular non-energy raw material.

- The approaches do have in common that they consider a whole range of factors in relation to the importance of raw materials for the economy and in relation to the availability and reliability of supply. Several of the criteria used are common to most of the models, such as concentration of production at company or country level, political stability of producing countries, degree of import dependence, and substitutability (see also an overview in Annex I).

- It is important to note that the various criticality approaches focus exclusively on extracted materials (minerals & metals). Many of the materials that are defined as being (highly) critical in various approaches (see overview in Annex II) consist of so-called high tech metals.

- Whatever the methodology used, it is acknowledged that a criticality assessment only captures a raw material's degree of criticality at a specific point in time and is very likely to evolve over time, which implies that regular monitoring/updating of a list would be appropriate.

3. Towards an EU methodology

The Communication on the Raw Materials Initiative outlined the three main reasons behind the criticality of some raw materials: (1) significant economic importance for key sectors, (2) high supply risks (e.g. very high import dependence, high level of concentration in particular countries) and (3) lack of substitution.

In 2008 RPA was tasked by the Commission to carry out a study[6], whereby one of the aims was to assess the relevance of the various tools used to identify critical minerals for their potential application to the supply of non-energy raw materials to the EU. As to the issue of upgrading a country-based model to the level of the EU, the study has not identified specific issues. However, there may be interesting differences in conclusions, when applying some of the criteria at EU level compared to national level. These differences will arise from national differences in the importance of manufacturing industries reliant on specific materials, in the technologies in place which may affect substitutability and national recycling rates. Hence, it is very likely that a mineral which is not considered to be critical at EU level, is considered critical to a particular Member State. Furthermore, there may be important differences between the availability of data and information at the level of Member States and the EU.

The study also concluded that the US methodology would provide a good framework for examining criticality issues, allowing to expand or delete criteria considered based on material specific considerations. For some indicators and for some materials there may be a lack of available data at EU level which will require further consideration. The latter also supports the study's recommendation to complement a quantitative assessment by a qualitative assessment, which may be accompanied by discussions in a group or committee (similar to the approaches in the US, France, and Austria).

The analysis of both "importance in use" and "supply risk" could be developed within a two-dimensional approach, which will have the advantage that it would allow to determine a specific degree of criticality for selected materials.

Whereas during the phase of application of the methodology, data gaps would prevent a clear positioning on the grid, an additional qualitative assessment could complete the information. As the study carried out by RPA has shown, it is possible (even with these constraints) to produce meaningful analyses for different materials. Unavailability of data may also lead to policy recommendations being formulated in order to improve data collection.

Once the methodology has been established, it will need to be applied to a range of materials to check to what degree they can be considered as critical or not. In order to keep the work manageable a limited number of materials need to be selected. In the Staff Working Document the following materials have been identified as displaying short to medium supply

[6] RPA (2008): *Study in the field of non-energy raw materials.*

risks: **antimony, chromite, cobalt, germanium, gallium, indium, lithium, magnesium, manganese, molybdenum, niobium, platinum, palladium, rhodium, rare earths, rhenium, tantalum, titanium, tungsten, and vanadium.** These raw materials have to be analysed as a matter of priority.

In line with the various approaches undertaken by Member States and other countries, it is proposed to start the assessment of criticality with non-energy minerals. Bearing in mind that the Communication on the Raw Materials Initiative also focused on non-energy minerals, although the underlying analysis and proposed measures also apply to a high degree to other non-energy raw materials, consideration could be given to the potential applicability of the methodology to other non-energy materials.

Paul Anciaux – 21/04/2009

ANNEX I

Table 4.1: Criteria Used for Criticality Assessments

	UK	DE	USA	KR	AT	FR
Criteria relating to supply risk						
Geological availability (scarcity)	Y	*y*	Y	Y		Y
Proportion of production of mineral as by-product			Y			
Availability of secondary resource			*y*			
Level of investment in extraction			*y*			
Safer sources of supply (such as synthetic manufacture, etc.)		*y*				
Concentration of production by country of origin	Y	Y	*y*	Y		
Concentration of production by company		*y*	*y*			
Concentration of production by mine of extraction			*y*			
Political instability in countries of origin	Y	Y	*y*	Y	Y	
Vulnerability to the effects of climate change	Y					
Global Warming Potential (to measure environmental impact)	Y					
Material mined to extract mineral (environmental impact)	Y					
Environmental and social acceptability of production			*y*			
Technical factors affecting production of mineral			*y*			
Economic factors affecting production (such as electric. price)		*y*	*y*			
Criteria relating to the mineral or impact of supply disruption						
Global Demand	Y					
Domestic demand			Y		Y	Y
Small (thin) markets			*y*			
Demand side factors incl. tech. develop. (emerging uses)		*y*	Y	Y	Y	
Substitutability	Y	*y*	Y		Y	Y
Import Dependence		Y	Y		Y	Y
Recycling rate or similar indicators		*y*	Y			Y
Importance of mineral for the (national) economy (such as input-output analysis/sensitivity to supply disruption/potential to affect a certain proportion of economy)			Y	Y	Y	
Price-related criteria						
Price developments over the long term		*y*		Y		
Price volatility				Y		

Note:
Please note that the distinction between mineral risk, supply risk, and price-related criteria has been made for the purposes of this table and may not correspond to distinctions made by some of the criticality assessments included here. UK denotes Morely and Eatherley (2008), DE denotes RWI Essen *et al* (2006), USA denotes NRC (2008), KR refers to South Korea, AT to Austria and FR to France. 'Y' denotes that criterion is used for criticality assessment. Some methodologies may not use all criteria in a systematic manner (for instance certain criteria may be used for several materials only or for materials that have been pre-selected on the basis of other criteria) - such criteria are signalled with a '*y*'.

Source: RPA (2008): *Study in the field of non-energy raw materials*.

ANNEX II

MINERAL RAW MATERIALS	US Report	Japan	RWI study	UK study	BRGM	Austria
antimony				*	*	
bauxite						*
chromite		**				*
cobalt		**			*	*
copper						*
fluorspar						*
gallium	*				*	
germanium					*	
gold				*		
indium	**				*	
iron						*
lithium	*				*	
magnesium					*	*
manganese	**	**				*
mercury				*		
molybdenum		**			*	*
nickel		**				*
niobium	**					*
palladium	**				*	
platinum	**		*	*	*	
rare earths	**				*	
rhenium					*	
rhodium	**			*	*	
silver				*		
strontium				*		
tantalum	*					*
tin				*		
titanium	*				*	*
tungsten		**			*	*
vanadium	*	**				*

Note: in the case of Japan, "**" refers to stockpiled materials

Note2: magnesite is an ore for magnesium production