Study on the review of the list of Critical Raw Materials

Executive summary

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EXECUTIVE SUMMARY

Context

Raw materials are not only essential for the production of a broad range of goods and services used in everyday life, but also for the development of emerging innovations in the EU, which are notably necessary for the development of more eco-efficient and globally competitive technologies. The accelerating technological innovation cycles and the rapid growth of emerging economies have led to increasing global demand for highly sought after metals and minerals. Securing access to a stable supply of many raw materials has become a major challenge for national and regional economies with limited production, such as the EU economy, which relies on imports of many minerals and metals needed by industry, including many critical raw materials.

To address the growing concern of securing valuable raw materials for the EU economy, the European Commission (EC) launched the European Raw Materials Initiative[1] in 2008. It is an integrated strategy that establishes targeted measures to secure and improve access to raw materials for the EU:

- Securing a fair and sustainable supply of raw materials from international markets;
- Fostering sustainable supply within the EU; and
- Boosting resource efficiency and promoting recycling.

One of the priority actions of the Initiative was to establish a list of critical non-energy raw materials at EU level. The first list was established in 2011 and it is updated every three years.

The present study addresses the third assessment of critical raw materials for the EU. The purpose of these exercises is to regularly assess the criticality of raw materials for the EU based on the methodology[2] developed by the European Commission, in cooperation with the Ad hoc Working Group on Defining Critical Raw Materials (AHWG)[3], and to update the list of critical raw materials for the EU. The first assessment, conducted in 2011, identified 14 critical raw materials out of the 41 non-energy, non-agricultural candidate raw materials assessed. In the 2014 exercise, 20 raw materials were identified as critical out of 54 non-energy, non-agricultural candidate materials. The same EC criticality methodology was used in both of the previous assessments, based on two parameters: Economic Importance (EI) and Supply Risk (SR).

Novelties of the 2017 assessment

Firstly, the 2017 assessment covers a larger number of materials (78 individual materials or 61 raw materials comprising 58 individual and 3 grouped materials) compared to the previous assessments (41 materials in 2011 and 54 materials in 2014). Nine new materials (six abiotic materials[4] and three biotic materials[5]) are assessed. Fifteen individual rare earth elements (REEs) were analysed separately, as were five platinum-group metals (PGMs), excluding osmium.

Secondly, criticality assessment results are available for the first time at both the individual material level and the group level for the rare earth elements and platinum group metals, whereas in the 2011 and 2014 assessments, the results of these material groups were presented at the group level only. The 15 rare earth elements (REEs) are split into two sub-categories based on their chemical and physical properties - ‘heavy’ rare earth elements (HREEs), consisting of ten individual materials[6] and ‘light’ rare earth elements (LREEs), comprising five individual materials[7]. The five platinum group metals

[1] https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy_en
[2] Methodology for establishing the EU List of Critical Raw Materials, 2017, ISBN 978-92-79-68051-9
[3] The AHWG on Defining Critical Raw Materials is a sub-group of the Raw Materials Supply Group expert group.
[4] New abiotic materials assessed: aggregates, bismuth, helium, lead, phosphorus, sulphur
[5] New biotic materials assessed: natural cork, natural teak wood and sapele wood
[6] HREEs: dysprosium, erbium, europium, gadolinium, holmium, lutetium, terbium, thulium, ytterbium, yttrium
[7] LREEs: cerium, lanthanum, neodymium, praseodymium, samarium

(excluding osmium)[8] (PGMs) are grouped under one group[9]. The results presented for the grouped materials (HREEs, LREEs and PGMs) are the arithmetic averages of the results of the individual materials included in these groups. It should be noted that the 2011 assessment grouped all rare earth elements, including scandium, under the rare earth elements group, while the 2014 and 2017 assessments examine scandium separately.

Finally, the 2017 assessment applies a revised version of the EC criticality methodology while ensuring comparability with the previous methodology used in 2011 and 2014. The revised methodology is based on the same two parameters – Supply Risk (SR) and Economic Importance (EI) – as the initial methodology. There are however several significant updates in the revised methodology that should be carefully considered when analysing the criticality results[10]:

- Systematic screening of the most critical points of the raw material production stages in the supply chain (mining/extracting and processing/refining).
- Inclusion of substitution in the Economic Importance calculations, while the previous assessments only addressed substitution in the SR calculations.
- More specific allocation of raw materials to the relevant end-use applications and corresponding manufacturing sectors, instead of mega sectors; moreover, the allocation is based on official statistical sectoral or product classifications.
- Refined methodology for calculating Supply Risk:
  - Inclusion of Import Reliance (IR) parameter;
  - Considering the shares of the global supply and the actual sourcing of the material to the EU (domestic production plus imports);
  - Inclusion of trade-related parameter based on export restrictions and the EU trade agreements;
  - Guidance to improve End-of-Life Recycling Input Rate (EOL-RIR) results using higher quality EU based data.
- Compared to the previous assessments, the criticality threshold in the 2017 assessment for the SR remains at 1; however, the criticality threshold for EI was moved to 2.8 due to the implementation of the revised methodology.

Results

Of the 61 candidate raw materials assessed (58 individual and 3 grouped materials), the following 26 raw materials and groups of raw materials were identified as critical:

2017 Critical Raw Materials (26)			
Antimony	Gallium	Magnesium	Scandium
Baryte	Germanium	Natural graphite	Silicon metal
Beryllium	Hafnium	Natural Rubber	Tantalum
Bismuth	Helium	Niobium	Tungsten
Borate	HREEs	PGMs	Vanadium
Cobalt	Indium	Phosphate rock	
Fluorspar	LREEs	Phosphorus	

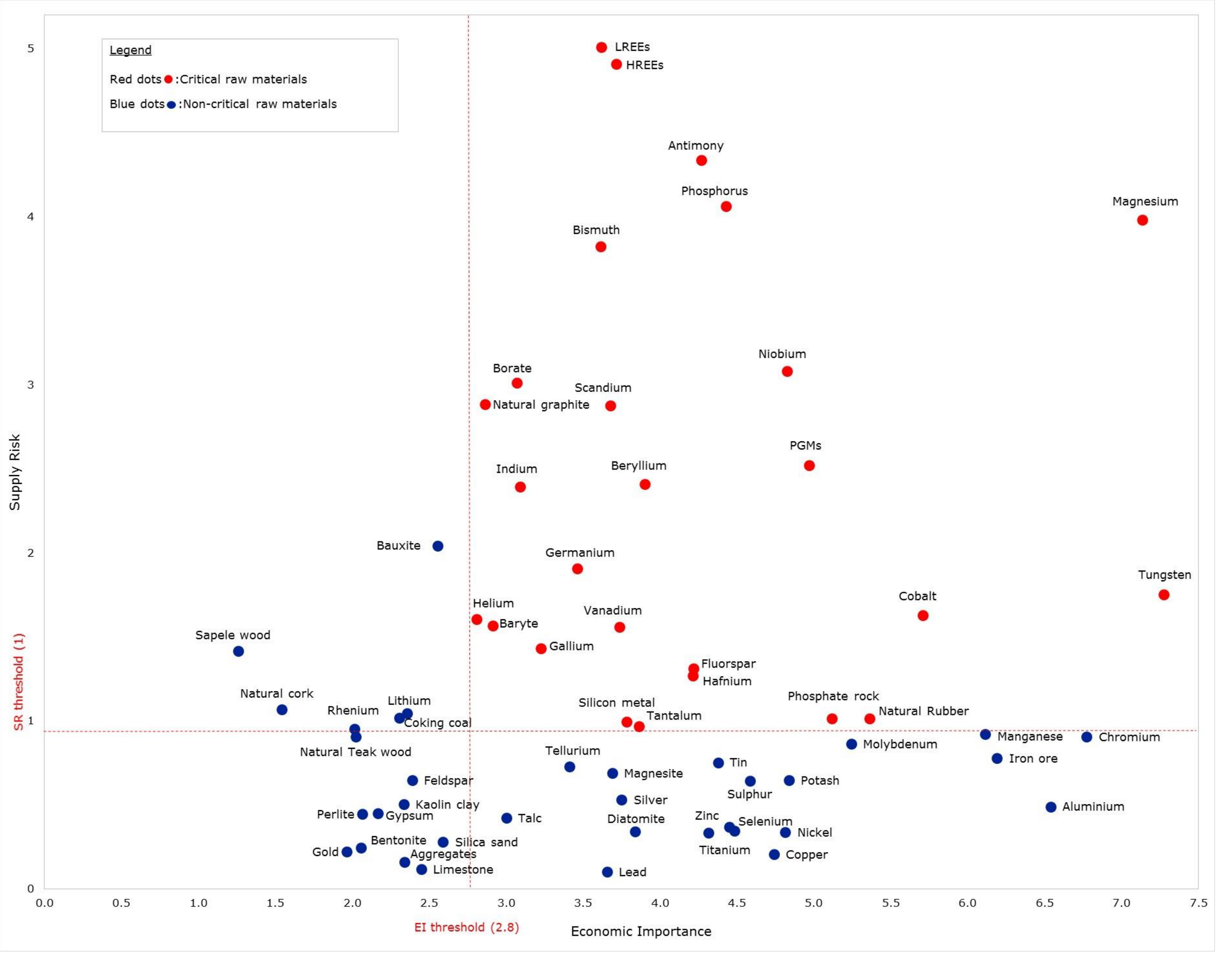
The overall results of the 2017 criticality assessment are shown in the following figure A. Critical raw materials (CRMs) are highlighted by red dots and are located within the criticality zone (SR ≥ 1 and EI ≥ 2.8) of the graph. Blue dots represent the non-critical raw materials.

[8] Osmium was assessed in the previous assessments; however it is excluded from the 2017 exercise due to the lack of robust quantitative figures on osmium. In the 2014 criticality assessment, osmium was assessed using the data available for ruthenium and iridium. In the 2017 assessment, complementary information on osmium is provided in the PGMs factsheet, where relevant.

[9] PGMs: iridium, platinum, palladium, rhodium, ruthenium

[10] Further details in Methodology for establishing the EU List of Critical Raw Materials, 2017, ISBN 978-92-79-68051-9

Figure A: Economic importance and supply risk results of 2017 criticality assessment



The 2017 CRMs list includes 17 out of the 20 CRMs identified in 2014. The three CRMs from 2014 that are not included in the 2017 CRMs list are: chromium, coking coal and magnesite. Compared to the 2014 CRMs list, nine additional raw materials have been identified as critical and enter the 2017 CRMs list: baryte, natural rubber, scandium, tantalum, vanadium, hafnium, bismuth, helium and phosphorus. The first six materials listed were considered non-critical in 2014, whereas the latter three materials are entirely new to the 2017 CRMs list since they were not assessed in either of the previous assessments. Contrary to 2011 and 2014, natural rubber, one of the biotic materials, is classified as critical in 2017. The following table summarises the key changes in the 2017 CRMs list compared to the 2014 CRMs list.

2017 CRMs vs. 2014 CRMs			
Antimony	LREEs	Bismuth	~~*Chromium*~~
Beryllium	Magnesium	Helium	~~*Coking coal*~~
Borate	Natural graphite	Phosphorus	~~*Magnesite*~~
Cobalt	Niobium	Baryte	
Fluorspar	PGMs	Hafnium	
Gallium	Phosphate rock	Natural Rubber	
Germanium	Silicon metal	Scandium	
HREEs	Tungsten	Tantalum	
Indium		Vanadium	

Legend:

Black: CRMs in 2017 and 2014
Red: CRMs in 2017, non-CRMs in 2014
Green: CRMs assessed in 2017, not assessed in 2014
~~*Strike:*~~ Non-CRMs in 2017 (critical in 2014)

The 2017 assessment identifies all 14 of the 2011 CRMs as critical. Compared to the 2011 CRMs list, the 2017 CRMs list includes ten additional critical raw materials: baryte, borate, vanadium, bismuth, hafnium, helium, natural rubber, phosphate rock, phosphorus and silicon metal. The first three materials listed previously were considered non-critical in 2011 and the last seven materials listed were not assessed in 2011. The table below summarises the key changes in the 2017 CRMs list compared to the 2011 CRMs list.

2017 CRMs vs. 2011 CRMs			
Antimony	*LREEs*	Baryte	Bismuth
Beryllium	Magnesium	Borate	Hafnium
Cobalt	Natural graphite	Vanadium	Helium
Fluorspar	Niobium		Natural Rubber
Gallium	PGMs		Phosphate rock
Germanium	Tungsten		Phosphorus
HREEs	*Scandium*		Silicon metal
Indium	Tantalum		

Legend

Black: CRMs in 2017 and 2011

Italics: Materials grouped under the REEs group in 2011

Red: CRMs in 2017, non-CRMs in 2011

Green: CRMs assessed in 2017, not assessed in 2011

The results of the analysis of the global primary supply of the critical raw materials are presented in the two following tables. Table A presents the results for 43 raw materials, out of which 23 are individual critical raw materials and 20 belong to the three critical raw material groups: HREEs (10), LREEs (5) and PGMs (5). Table A includes the individual results of the grouped materials to allow for a more in-depth look into the global supply of the material groups. The second table B presents the averaged figures on global primary supply for the 3 material groups: HREEs, LREEs, and PGMs. It should be noted however, that in this table, calculating the average for the largest global supplier for all the PGMs is not possible because the major producing country is not the same for each of the five PGMs. For iridium, platinum, rhodium and ruthenium, the major global supplier is South Africa, whereas for palladium the major global supplier is Russia. Finally, figure B presents a world map representing the main producers of critical raw materials for the EU.

Table A: Global supply of the CRMs – individual materials

Material		Stage[11]	Main global supplier	Share	Material		Stage	Main global supplier	Share
1	Antimony	P	China	87%	23	Natural graphite	E	China	69%
2	Baryte	E	China	44%	24	Natural Rubber	E	Thailand	32%
3	Beryllium	E	USA	90%	25	*Neodymium*	E	China	95%
4	Bismuth	P	China	82%	26	Niobium	P	Brazil	90%
5	Borate	E	Turkey	38%	27	*Palladium*	P	Russia	46%
6	*Cerium*	E	China	95%	28	Phosphate rock	E	China	44%
7	Cobalt	E	DRC	64%	29	Phosphorus	P	China	58%
8	*Dysprosium*	E	China	95%	30	*Platinum*	P	S. Africa	70%
9	*Erbium*	E	China	95%	31	*Praseodymium*	E	China	95%
10	*Europium*	E	China	95%	32	*Rhodium*	P	S. Africa	83%
11	Fluorspar	E	China	64%	33	*Ruthenium*	P	S. Africa	93%
12	*Gadolinium*	E	China	95%	34	*Samarium*	E	China	95%
13	Gallium*	P	China	73%	35	Scandium	P	China	66%
14	Germanium	P	China	67%	36	Silicon metal	P	China	61%
15	Hafnium	P	France	43%	37	Tantalum	E	Rwanda	31%
16	Helium	P	USA	73%	38	*Terbium*	E	China	95%
17	*Holmium*	E	China	95%	39	*Thulium*	E	China	95%
18	Indium	P	China	56%	40	Tungsten	E	China	84%
19	*Iridium*	P	S. Africa	85%	41	Vanadium	P	China	53%
20	*Lanthanum*	E	China	95%	42	*Ytterbium*	E	China	95%
21	*Lutetium*	E	China	95%	43	*Yttrium*	E	China	95%
22	Magnesium	P	China	87%					
Legend									
Stage		E = Extraction stage P = Processing stage							
HREEs		Dysprosium, erbium, europium, gadolinium, holmium, lutetium, terbium, thulium, ytterbium, yttrium							
LREEs		Cerium, lanthanum, neodymium, praseodymium and samarium							
PGMs		Iridium, palladium, platinum, rhodium, ruthenium							

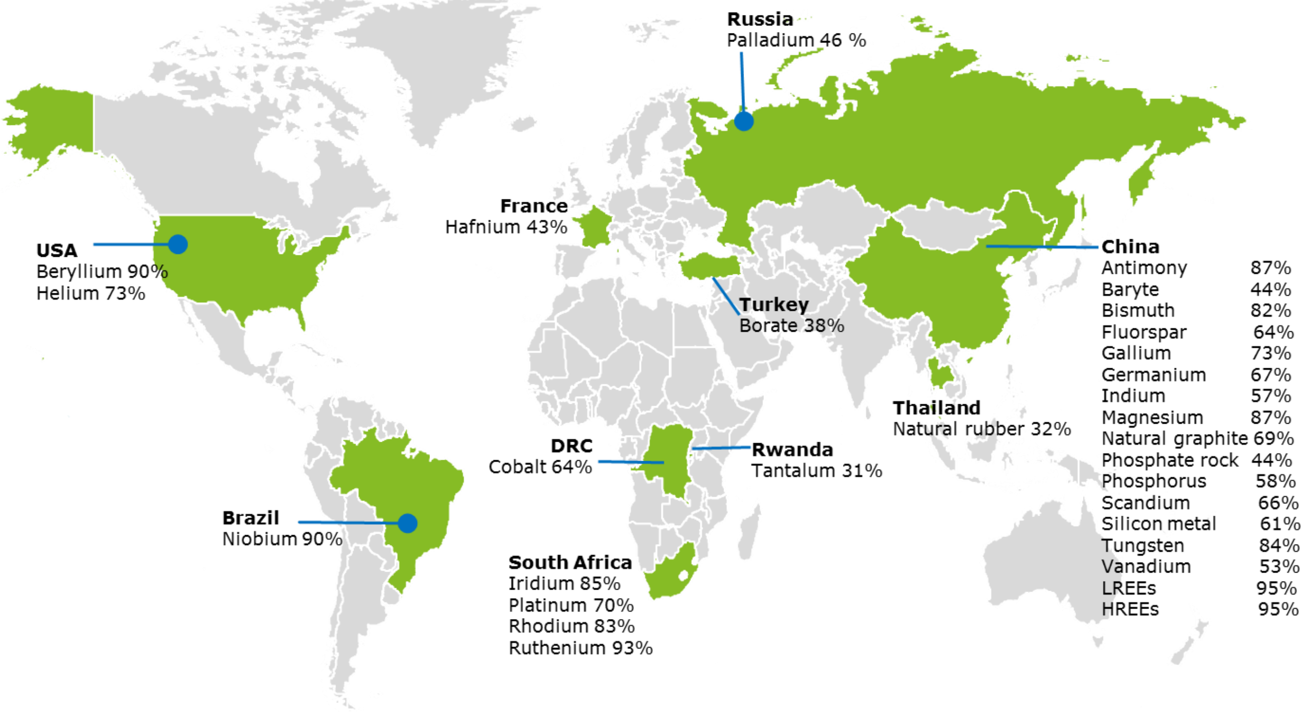
*Global supply calculation based on production capacity.

Table B: Global supply of the CRMs – grouped materials (average)

Material	Stage[1] 1	Main global supplier	Share
HREEs	E	China	95%
LREEs	E	China	95%
PGMs (iridium, platinum, rhodium, ruthenium)	P	South Africa	83%
PGMs (palladium)	P	Russia	46%

[11] Stage refers to the life-cycle stage of the material that the criticality assessment was carried out on: extraction (E) or processing (P).

Figure B: Countries accounting for largest share of global supply of CRMs



The analysis of the global supply results indicates that China is the largest global supplier of the identified critical raw materials. Several other countries are also important global suppliers of specific materials. For instance, Russia and South Africa are the largest global suppliers for platinum group metals, the USA for beryllium and helium and Brazil for niobium (see map in figure B).

In terms of the total number of CRMs, China is the major global supplier of 30 out of the 43 individual critical raw materials or 70% (see the following figure C[12]). This includes all of the REEs and other critical raw materials such as magnesium, tungsten, antimony, gallium and germanium among others. It is important to note as well that China is also a major consumer of several of these critical raw materials e.g. antimony, HREEs, LREEs, PGMs, magnesium, natural graphite, tungsten, etc. and, therefore, Europe competes with China and other emerging economies for supplies.

Furthermore, despite China being the largest global supplier for the majority of the critical raw materials, the analysis of the primary EU sourcing (i.e. domestic production plus imports) paints a different picture (see the figure D below[13]). The analysis of the EU sourcing includes only 37 out of the 43 individual critical raw materials since the five PGMs and beryllium are excluded from the analysis due to little or no EU sourcing activity. Although China is the major EU supplier for 15 out of 38 individual materials (or 39%), several other countries represent main shares of the EU supply for specific critical raw materials, such as the USA (beryllium and helium), Russia (tungsten and scandium) and Mexico (fluorspar).

[12] The figure should not be interpreted in terms of tonnage of CRM that originate from these countries, but in terms of the number of CRMs, for which the country is the main global supplier or producer of the CRM.
[13] The figure should not be interpreted in terms of tonnage of CRM that originate from the countries, but in terms of the number of CRMs, for which the country is the main supplier for the EU.

Figure C: Main global suppliers of CRMs (based on number of CRMs supplied out of 43), average from 2010-2014

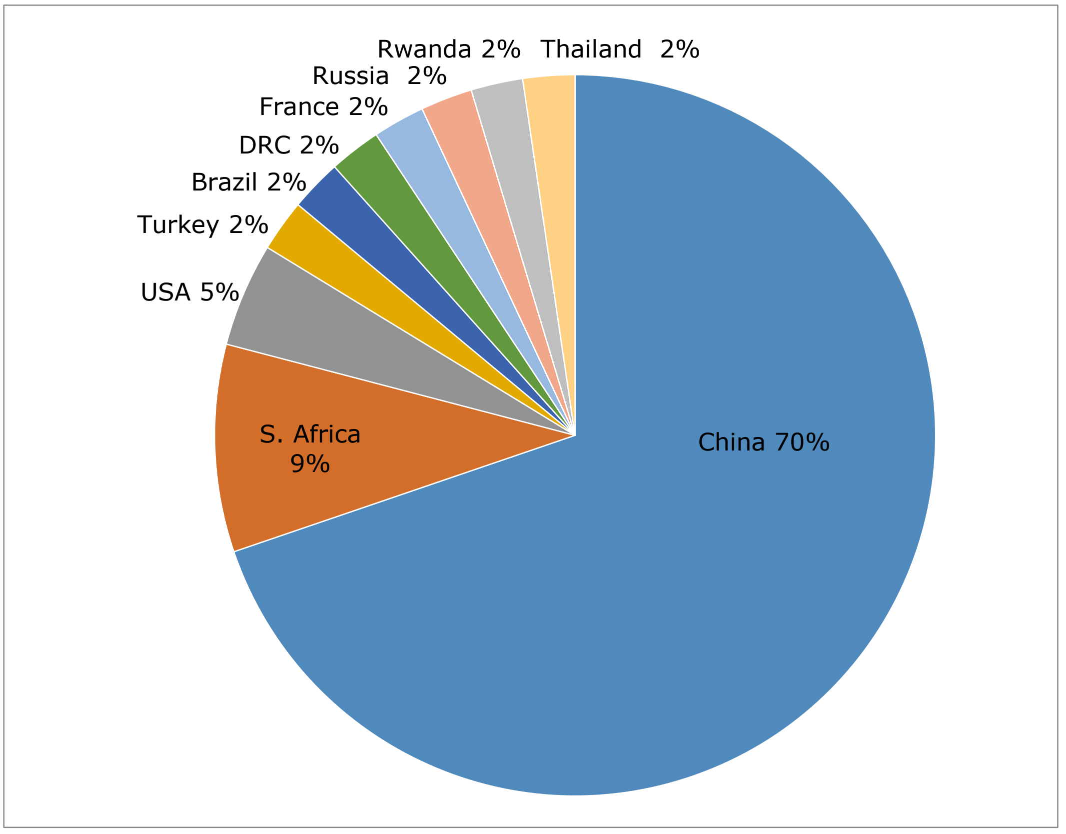
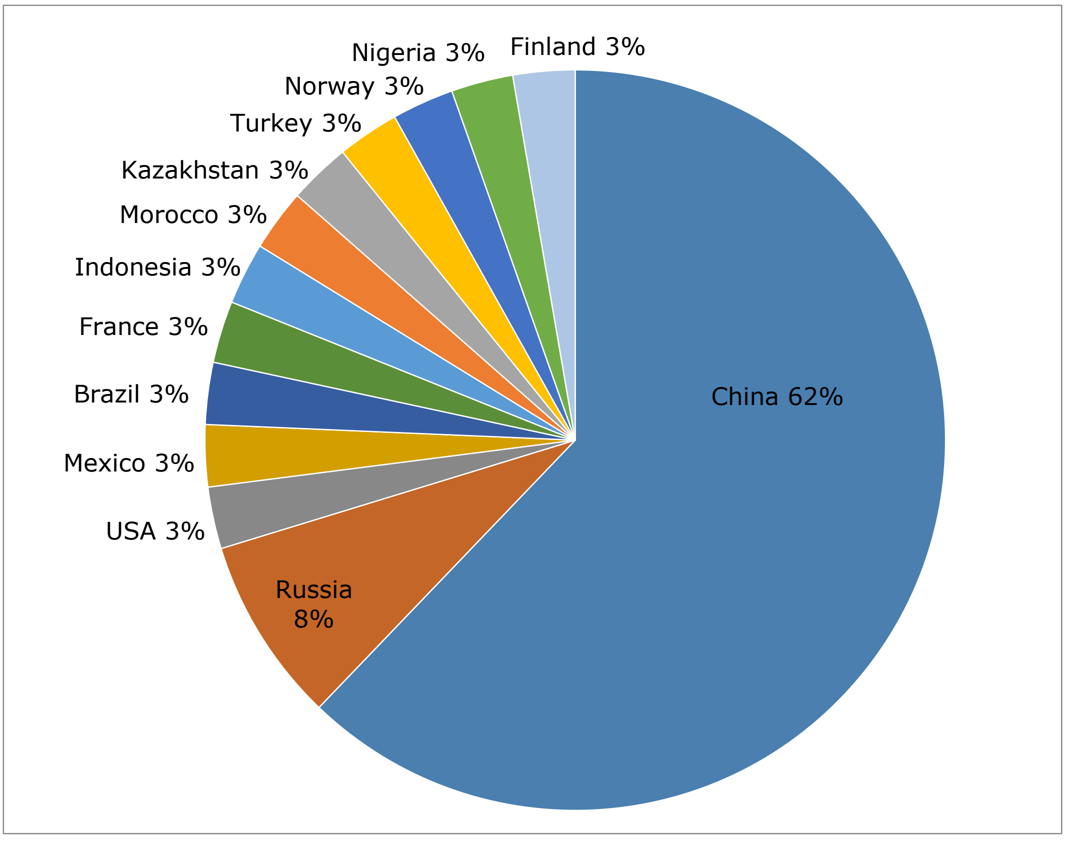


Figure D: Main EU suppliers of CRMs (based on number of CRMs supplied out of 37), average from 2010-2014



Finally, another significant finding is that for certain CRMs, despite China being the largest global supplier, other countries represent the main share in EU sourcing and not China (see following table C). The revised methodology incorporates actual sourcing to the EU, therefore allows for a more realistic picture of Europe's supply of the raw materials assessed.

Table C: CRMs with China as the largest global supplier but not as largest EU supplier

CRM	Main EU supplier	Share of EU sourcing
Fluorspar	Mexico	27%
Phosphate rock	Morocco	27%
Phosphorus	Kazakhstan	77%
Scandium	Russia	67%
Silicon metal	Norway	23%
Tungsten	Russia	50%
Vanadium	Russia	60%