ANNEXES TO THE REPORT ON CRITICAL RAW MATERIALS FOR THE EU

REPORT OF THE AD HOC WORKING GROUP ON DEFINING CRITICAL RAW MATERIALS

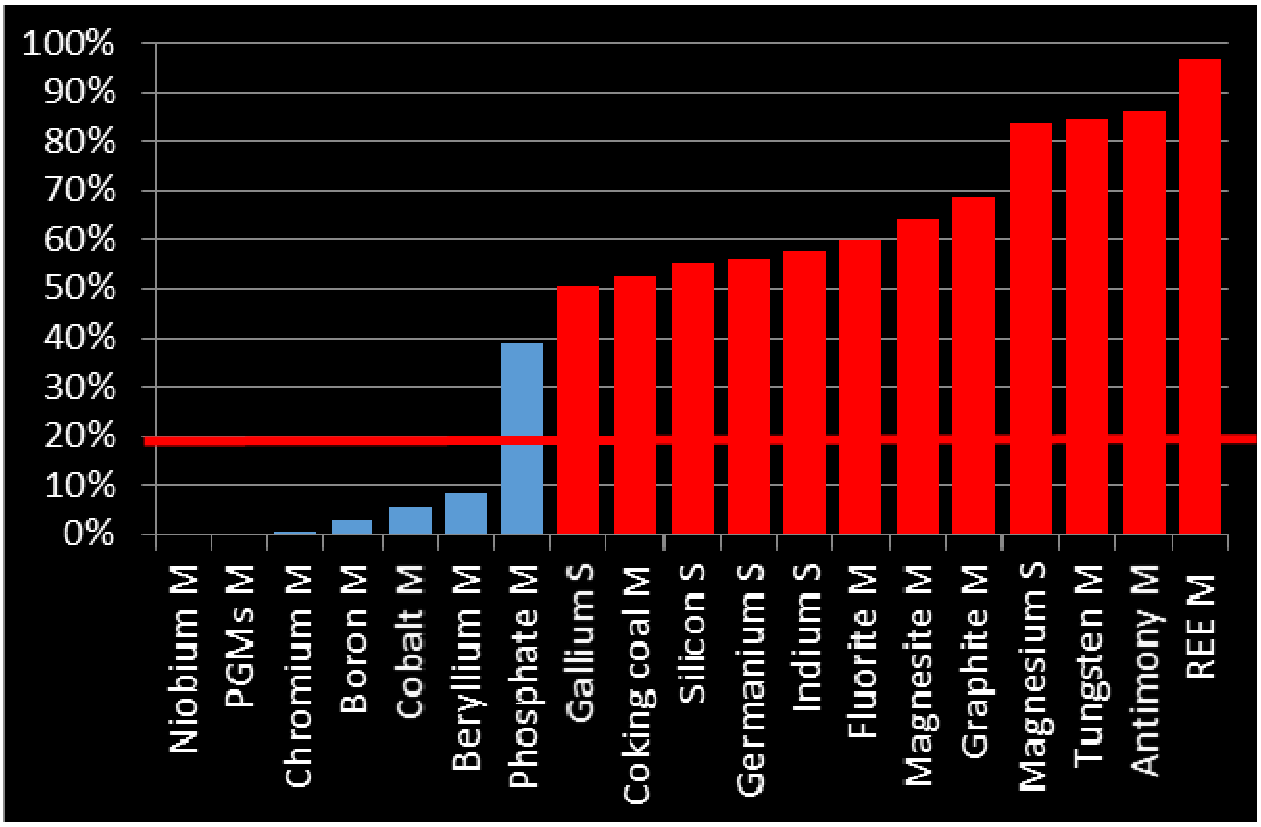
Date: 25/05/2014

DG ENTR

Table of Contents

ANNEX A: EU CRITICAL RAW MATERIALS LIST (2014) AND CHINA'S SHARE OF THE WORLD MINING

EU Critical Raw Materials list (2014) and China's share of the world mining (M) or smelter (S) production – In red: raw materials of which China is the first global producer – Data sources: World Mining Data, USGS, BGS



ANNEX B – STATISTICAL INFORMATION FOR CRITICALITY ASSESSMENT

This Annex contains the following information, used in the criticality assessment; Megasector assignments and values, WGI (scaled), End use data sources and locality, and Production data sources.

1.1. Megasector values and assignments

Megasector	2010		2006		Change (2006 to 2010)		
	VA (€M)	%	VA (€M)	%	VA (€M)	% VA	%
Construction Material	104,441	5.72%	98,452	5.75%	5,989	6%	-0.03%
Metals	164,623	9.01%	189,013	11.04%	-24,390	-13%	-2.03%
Mechanical Equipment	182,406	9.98%	181,548	10.61%	858	0%	-0.63%
Electronics & ICT	104,855	5.74%	123,098	7.19%	-18,243	-15%	-1.45%
Electrical Equipment & Dom. Appliances	88,139	4.82%	83,746	4.89%	4,393	5%	-0.07%
Road Transport	147,442	8.07%	156,252	9.13%	-8,810	-6%	-1.06%
Aircraft, Shipbuilding, Trains	51,222	2.80%	48,242	2.82%	2,980	6%	-0.02%
Other Final Consumer Goods	63,280	3.46%	69,479	4.06%	-6,199	-9%	-0.60%
Food	164,978	9.03%	154,417	9.02%	10,561	7%	0.01%
Beverages	37,000	2.02%	34,000	1.99%	3,000	9%	0.03%
Paper	41,276	2.26%	41,065	2.40%	211	1%	-0.14%
Wood	46,493	2.54%	37,148	2.17%	9,345	25%	0.37%
Pharmaceuticals	85,872	4.70%	70,500	4.12%	15,372	22%	0.58%
Chemicals	108,804	5.95%	116,377	6.80%	-7,573	-7%	-0.85%
Rubber, Plastic & Glass	98,135	5.37%	100,382	5.86%	-2,247	-2%	-0.49%
Refining	29,239	1.60%	33,463	1.95%	-4,224	-13%	-0.35%
Total	1,518,205	83.08 %	1,532,493	89.80%	-14,288	-1%	-6.72%
Non-manufacturing megasectors included							
Oil & Gas Extraction	50,010	2.74%	59,223	3.46%	-9,213	-0.16	-0.72%
Mining of Metal Ores	4,483	0.25%	4,993	0.29%	-510	-0.1	-0.04%
Total Manufacturing VA in Europe (Adjusted for 2010 Due to Change in NACE Classification)	1,827,427	100%	1,711,786	100%			
Not Included							
Textiles & Clothes	53,207	3.00%	64,430	3.76 %			
Publishing & Printing	82,714	4.67%	96,331	5.63 %			
Tobacco	6,949	0.39%	8,250	0.48 %			

Sum used in analysis	1,715,567	94.0%	1,701,504	99.7 %			

Due to a change in Eurostat's NACE classification to Rev2 from Rev1.1, it has been necessary to replicate the mega sectors constructed in 2010 using Rev1.1 NACE classes using NACE Rev2 classes. This allows the use of the most recent GVA for 2010 . This change in NACE classification can be considered more than a simple change of labelling of the NACE categories. Several categories have been split up to gain precision while others where combined. Eurostat characterizes the change in classification as follows:

"In order to have an idea of the impact of changes on official statistics due to the implementation of NACE Rev. 2, it is useful to distinguish the following types of correspondences between NACE Rev. 1.1 and NACE Rev. 2:

- 1-to-1 correspondences: 195 classes in NACE Rev. 1.1 correspond exactly to one class in NACE Rev. 2 and *vice versa*
- n-to-1 correspondences: 86 cases, where two or more classes in NACE Rev 1.1 correspond to one class in NACE Rev. 2
- 1-to-m correspondences: 18 cases, where one NACE Rev. 1.1 class is split into two or more classes in NACE Rev 2
- n-to-m correspondences: 215 cases, where two or more classes in NACE Rev. 1.1 correspond to two or more classes in NACE Rev. 2."

As a result there are now more NACE groups and classes than previously, with some not included in manufacturing. Therefore to calculate the percentage shares of each megasector overall manufacturing GVA it had been necessary to determine an adjusted "Total Manufacturing VA in Europe". However, this is only relevant to the several NACE classes that have been moved from Manufacturing in 2010 compared with previously, for instance Publishing and Printing. The reassignments used in this study are outlined below, this does not represent a one-to-one mapping.

	NACE Rev 1.1	NACE Rev 2
Construction Material	DI262 - Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products	234 - Manufacture of other porcelain and ceramic products
	DI263 - Manufacture of ceramic tiles and flags	232 - Manufacture of refractory ceramic products
	DI264 - Manufacture of bricks, tiles and construction products, in baked clay	233 - Manufacture of clay building materials
	DI265 - Manufacture of cement, lime and plaster	235 - Manufacture of cement, lime and plaster
	DI266 - Manufacture of articles of concrete, plaster and cement	236 - Manufacture of articles of concrete, plaster and cement
	DI267 - Cutting, shaping and finishing of ornamental and building stone	237 - Cutting, shaping and finishing of ornamental and building stone
	DJ281 - Manufacture of structural metal products	251 - Manufacture of structural metal products
		2433 - Cold forming or folding
		4332 - Joinery installation
	NACE Rev 1.1	NACE Rev 2

Metals	DJ271 - Manufacture of basic iron and steel and of ferro-alloys	241 - Manufacture of basic iron and steel and of ferro-alloys
	DJ272 - Manufacture of tubes	242 - Manufacture of tubes, pipes, hollow profiles and related fittings, of steel
	DJ273 - Other first processing of iron and steel	243 - Manufacture of other products of first processing of steel
	DJ274 - Manufacture of basic precious and non-ferrous metals	245 - Casting of metals
	DJ275 - Casting of metals	253 - Manufacture of steam generators, except central heating hot water boilers
	DJ282 - Manufacture of tanks, reservoirs and containers of metal; manufacture of central heating radiators and boilers	255 - Forging, pressing, stamping and roll-forming of metal; powder metallurgy
	DJ283 - Manufacture of steam generators, except central heating hot water boilers	256 - Treatment and coating of metals; machining
	DJ284 - Forging, pressing, stamping and roll forming of metal; powder metallurgy	259 - Manufacture of other fabricated metal products
	DJ285 - Treatment and coating of metals; general mechanical engineering	383 - Materials recovery
	DJ287 - Manufacture of other fabricated metal products	2441 - Precious metals production
		2442 - Aluminium production
		2443 - Lead, zinc and tin production
		2444 - Copper production
		2445 - Other non-ferrous metal production
		2521 - Manufacture of central heating radiators and boilers
		2529 - Manufacture of other tanks, reservoirs and containers of metal
		3299 - Other manufacturing n.e.c.
		3311 - Repair of fabricated metal products
	NACE Rev 1.1	NACE Rev 2
Mechanical Equipment	DK291 - Manufacture of machinery for the production and use of mechanical power, except aircraft, vehicle and cycle engines	281 - Manufacture of general-purpose machinery
	DK292 - Manufacture of other general purpose machinery	289 - Manufacture of other special-purpose machinery
	DK293 - Manufacture of agricultural and forestry machinery	283 - Manufacture of agricultural and forestry machinery
	DK294 - Manufacture of machine-tools	2821 - Manufacture of ovens, furnaces and furnace burners
	DK295 - Manufacture of other special purpose machinery	2822 - Manufacture of lifting and handling equipment
		2824 - Manufacture of power-driven hand tools
		2825 - Manufacture of non-domestic cooling and ventilation equipment
		2829 - Manufacture of other general-purpose machinery n.e.c.
		2841 - Manufacture of metal forming machinery
		2849 - Manufacture of other machine tools

		3312 - Repair of machinery
		9522 - Repair of household appliances and home and garden equipment
	NACE Rev 1.1	NACE Rev 2
Electronics & ICT	DL300 - Manufacture of office machinery and computers	261 - Manufacture of electronic components and boards
	DL321 - Manufacture of electronic valves and tubes and other electronic components	262 - Manufacture of computers and peripheral equipment
	DL322 - Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy	263 - Manufacture of communication equipment
	DL323 - Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods	264 - Manufacture of consumer electronics
	DL331 - Manufacture of medical and surgical equipment and orthopaedic appliances	265 - Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks
	DL332 - Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment	266 - Manufacture of irradiation, electro-medical and electrotherapeutic equipment
	DL333 - Manufacture of industrial process control equipment	267 - Manufacture of optical instruments and photographic equipment
	DL334 - Manufacture of optical instruments and photographic equipment	325 - Manufacture of medical and dental instruments and supplies
	DL335 - Manufacture of watches and clocks	332 - Installation of industrial machinery and equipment
		2823 - Manufacture of office machinery and equipment (except computers and peripheral equipment)
		3313 - Repair of electronic and optical equipment
		9512 - Repair of communication equipment
	NACE Rev 1.1	NACE Rev 2
Electrical Equipment + Domestic Appliances	DL311 - Manufacture of electric motors, generators and transformers	271 - Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus
	DL312 - Manufacture of electricity distribution and control apparatus	272 - Manufacture of batteries and accumulators
	DL313 - Manufacture of insulated wire and cable	273 - Manufacture of wiring and wiring devices
	DL314 - Manufacture of accumulators, primary cells and primary batteries	274 - Manufacture of electric lighting equipment
	DL315 - Manufacture of lighting equipment and electric lamps	275 - Manufacture of domestic appliances
	DL316 - Manufacture of electrical equipment n.e.c.	279 - Manufacture of other electrical equipment
	DK297 - Manufacture of domestic appliances n.e.c.	3314 - Repair of electrical equipment
	NACE Rev 1.1	NACE Rev 2

Road Transport	DM341 - Manufacture of motor vehicles	291 - Manufacture of motor vehicles
	DM342 - Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	292 - Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers
	DM343 - Manufacture of parts and accessories for motor vehicles and their engines	293 - Manufacture of parts and accessories for motor vehicles
	DM354 - Manufacture of motorcycles and bicycles	309 - Manufacture of transport equipment n.e.c.
		3317 - Repair and maintenance of other transport equipment
	NACE Rev 1.1	NACE Rev 2
Aircraft, Shipbuilding, Trains	DM351 - Building and repairing of ships and boats	301 - Building of ships and boats
	DM352 - Manufacture of railway and tramway locomotives and rolling stock	302 - Manufacture of railway locomotives and rolling stock
	DM353 - Manufacture of aircraft and spacecraft	303 - Manufacture of air and spacecraft and related machinery
		3315 - Repair and maintenance of ships and boats
		3316 - Repair and maintenance of aircraft and spacecraft
	NACE Rev 1.1	NACE Rev 2
Other Final Consumer Goods	DN361 - Manufacture of furniture	310 - Manufacture of furniture
	DN362 - Manufacture of jewellery and related articles	321 - Manufacture of jewellery, bijouterie and related articles
	DN363 - Manufacture of musical instruments	322 - Manufacture of musical instruments
	DN364 - Manufacture of sports goods	323 - Manufacture of sports goods
	DN365 - Manufacture of games and toys	324 - Manufacture of games and toys
	DN366 - Miscellaneous manufacturing n.e.c.	257 - Manufacture of cutlery, tools and general hardware
	DJ286 - Manufacture of cutlery, tools and general hardware	264 - Manufacture of consumer electronics
		3291 - Manufacture of brooms and brushes
		3319 - Repair of other equipment
		9524 - Repair of furniture and home furnishings
		9529 - Repair of other personal and household goods
	NACE Rev 1.1	NACE Rev 2

Food	DA151 - Production, processing, preserving of meat and meat products	101 - Processing and preserving of meat and production of meat products
	DA152 - Processing and preserving of fish and fish products	102 - Processing and preserving of fish, crustaceans and molluscs
	DA153 - Processing and preserving of fruit and vegetables	103 - Processing and preserving of fruit and vegetables
	DA154 - Manufacture of vegetable and animal oils and fats	104 - Manufacture of vegetable and animal oils and fats
	DA155 - Manufacture of dairy products	105 - Manufacture of dairy products
	DA156 - Manufacture of grain mill products, starches and starch products	106 - Manufacture of grain mill products, starches and starch products
	DA157 - Manufacture of prepared animal feeds	107 - Manufacture of bakery and farinaceous products
	DA158 - Manufacture of other food products	108 - Manufacture of other food products
		109 - Manufacture of prepared animal feeds
	NACE Rev 1.1	NACE Rev 2
Beverages	DA159 - Manufacture of beverages	110 - Manufacture of beverages
	NACE Rev 1.1	NACE Rev 2
Tobacco	DA160 - Manufacture of tobacco products	120 - Manufacture of tobacco products
	NACE Rev 1.1	NACE Rev 2
Textiles & Clothes	DB171 - Preparation and spinning of textile fibres	131 - Preparation and spinning of textile fibres
	DB172 - Textile weaving	132 - Weaving of textiles
	DB173 - Finishing of textiles	133 - Finishing of textiles
	DB174 - Manufacture of made-up textile articles, except apparel	139 - Manufacture of other textiles
	DB175 - Manufacture of other textiles	141 - Manufacture of wearing apparel, except fur apparel
	DB176 - Manufacture of knitted and crocheted fabrics	142 - Manufacture of articles of fur
	DB177 - Manufacture of knitted and crocheted articles	143 - Manufacture of knitted and crocheted apparel
	DB182 - Manufacture of other wearing apparel and accessories	151 - Tanning and dressing of leather; manufacture of luggage, handbags, saddlery and harness; dressing and dyeing of fur
	DB183 - Dressing and dyeing of fur; manufacture of articles of fur	152 - Manufacture of footwear
	DC191 - Tanning and dressing of leather	
	DC192 - Manufacture of luggage, handbags and the like, saddler	
	DC193 - Manufacture of footwear	
	DB181 - Manufacture of leather clothes	

	NACE Rev 1.1	NACE Rev 2
Wood	DD201 - Sawmilling and planing of wood; impregnation of wood	161 - Sawmilling and planing of wood
	DD202 - Manufacture of veneer sheets; manufacture of plywood, laminboard, particle board, fibre board and other panels and boards	162 - Manufacture of products of wood, cork, straw and plaiting materials
	DD203 - Manufacture of builders"carpentry and joinery	
	DD204 - Manufacture of wooden containers	4391 - Roofing activities
	DD205 - Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials	
	NACE Rev 1.1	NACE Rev 2
Paper	DE211 - Manufacture of pulp, paper and paperboard	171 - Manufacture of pulp, paper and paperboard
	DE212 - Manufacture of articles of paper and paperboard	172 - Manufacture of articles of paper and paperboard
	NACE Rev 1.1	NACE Rev 2
Publishing Printing	DE221 - Publishing	581 - Publishing of books, periodicals and other publishing activities
	DE222 - Printing and service activities related to printing	181 - Printing and service activities related to printing
	DE223 - Reproduction of recorded media	182 - Reproduction of recorded media
		592 - Sound recording and music publishing activities
	NACE Rev 1.1	NACE Rev 2
Pharmaceuticals	DG244 - Manufacture of pharmaceuticals, medicinal chemicals and botanical products	211 - Manufacture of basic pharmaceutical products
		212 - Manufacture of pharmaceutical preparations
	NACE Rev 1.1	NACE Rev 2
Chemicals	DG241 - Manufacture of basic chemicals	201 - Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms
	DG242 - Manufacture of pesticides and other agro-chemical products	202 - Manufacture of pesticides and other agrochemical products
	DG243 - Manufacture of paints, varnishes and similar coatings, printing ink and mastics	203 - Manufacture of paints, varnishes and similar coatings, printing ink and mastics
	DG245 - Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	204 - Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations
	DG246 - Manufacture of other chemical products	205 - Manufacture of other chemical products
	DG247 - Manufacture of man-made fibres	206 - Manufacture of man-made fibres
		268 - Manufacture of magnetic and optical media

	NACE Rev 1.1	NACE Rev 2
Rubber, Plastic & Glass	DH251 - Manufacture of rubber products	221 - Manufacture of rubber products
	DH252 - Manufacture of plastic products	222 - Manufacture of plastics products
	DI261 - Manufacture of glass and glass products	231 - Manufacture of glass and glass products
	DI268 - Manufacture of other non-metallic mineral products	239 - Manufacture of abrasive products and non-metallic mineral products n.e.c.
	NACE Rev 1.1	NACE Rev 2
Refining	DF231 - Manufacture of coke oven products	191 - Manufacture of coke oven products
	DF232 - Manufacture of refined petroleum products	192 - Manufacture of refined petroleum products
	DF233 - Processing of nuclear fuel	2446 - Processing of nuclear fuel
		3812 - Collection of hazardous waste
		3822 - Treatment & disposal of hazardous waste

1.2. WGI values (Scaled)

Country	WGI	WGI (scaled)
Afghanistan	-1.75	8.50
Albania	-0.20	5.40
Algeria	-0.93	6.86
Argentina	-0.22	5.43
Armenia	-0.27	5.55
Australia	1.63	1.74
Austria	1.49	2.03
Azerbaijan	-0.85	6.69
Bahrain	0.04	4.93
Bangladesh	-0.87	6.73
Belarus	-1.01	7.01
Belgium	1.37	2.26
Bhutan	0.12	4.77
Bolivia, Plurinational State of	-0.54	6.07
Bosnia and Herzegovina	-0.42	5.83
Botswana	0.69	3.62
Brazil	0.13	4.73
Bulgaria	0.18	4.64
Burkina Faso	-0.38	5.76
Burundi	-1.19	7.38
Cambodia	-0.78	6.56
Cameroon	-0.89	6.78
Canada	1.62	1.76
Chile	1.21	2.58
China	-0.59	6.18
Colombia	-0.23	5.46
Congo, the Democratic Republic of the	-1.64	8.28
Costa Rica	0.58	3.84
Côte d'Ivoire	-1.16	7.32
Croatia	0.38	4.24
Cuba	-0.53	6.06
Cyprus	1.06	2.87
Czech Republic	0.95	3.10
Denmark	1.86	1.28
Dominican Republic	-0.36	5.73
Ecuador	-0.76	6.52
Egypt	-0.74	6.48
Eritrea	-1.40	7.81
Estonia	1.06	2.88
Ethiopia	-0.96	6.92
Fiji	-0.60	6.19
Finland	1.85	1.31
France	1.21	2.57

Country	WGI	WGI (scaled)
French Guiana	1.00	2.99
Gabon	-0.55	6.10
Georgia	0.02	4.97
Germany	1.42	2.16
Ghana	0.14	4.72
Greece	0.36	4.28
Greenland	1.41	2.18
Guatemala	-0.57	6.15
Guinea	-1.19	7.38
Guyana	-0.38	5.75
Honduras	-0.55	6.11
Hungary	0.74	3.51
Iceland	1.48	2.04
India	-0.30	5.60
Indonesia	-0.47	5.93
Iran, Islamic Republic of	-1.16	7.32
Iraq	-1.34	7.69
Ireland	1.44	2.11
Israel	0.59	3.81
Italy	0.52	3.96
Jamaica	0.01	4.98
Japan	1.17	2.66
Jordan	-0.13	5.25
Kazakhstan	-0.59	6.18
Kenya	-0.69	6.39
Korea, Democratic People's Republic of[†]	-1.61	8.22
Korea, Republic of	0.76	3.47
Kyrgyzstan	-0.83	6.67
Lao People's Democratic Republic	-0.91	6.82
Latvia	0.61	3.77
Liberia	-0.73	6.46
Macedonia, the former Yugoslav Republic of	-0.08	5.16
Madagascar	-0.71	6.42
Malawi	-0.34	5.68
Malaysia	0.32	4.37
Mali	-0.49	5.97
Mauritania	-0.88	6.76
Mexico	-0.13	5.26
Mongolia	-0.22	5.44
Montenegro	0.10	4.79
Morocco	-0.33	5.65
Mozambique	-0.30	5.60
Myanmar	-1.65	8.30
Namibia	0.30	4.41

Country	WGI	WGI (scaled)
Nauru	0.13	4.74
Nepal	-0.89	6.78
Netherlands	1.71	1.58
New Caledonia	-0.17	5.35
New Zealand	1.83	1.34
Nicaragua	-0.61	6.22
Niger	-0.58	6.16
Nigeria	-1.15	7.30
Norway	1.70	1.59
Oman	0.19	4.62
Pakistan	-1.14	7.29
Panama	0.08	4.84
Papua New Guinea	-0.69	6.37
Paraguay	-0.60	6.20
Peru	-0.18	5.37
Philippines	-0.49	5.99
Poland	0.83	3.33
Portugal	0.93	3.15
Qatar	0.55	3.89
Romania	0.15	4.71
Russian Federation	-0.74	6.48
Rwanda	-0.21	5.42
Saudi Arabia	-0.47	5.93
Senegal	-0.39	5.78
Serbia	-0.12	5.24
Sierra Leone	-0.65	6.30
Slovakia	0.79	3.42
Slovenia	0.92	3.17
Solomon Islands	-0.43	5.86
South Africa	0.25	4.49
Spain	0.94	3.13
Sri Lanka	-0.29	5.58
Sudan	-1.60	8.19
Suriname	-0.10	5.21
Sweden	1.80	1.39
Syrian Arab Republic	-1.10	7.21
Taiwan, Province of China	1.01	2.98
Tajikistan	-1.10	7.20
Tanzania, United Republic of	-0.36	5.71
Thailand	-0.29	5.58
Togo	-0.89	6.78
Tunisia	-0.18	5.36
Turkey	-0.01	5.03
Turkmenistan	-1.41	7.81
Uganda	-0.60	6.19
Ukraine	-0.58	6.16
United Arab Emirates	0.48	4.04

Country	WGI	WGI (scaled)
United Kingdom	1.34	2.33
United States	1.23	2.53
Uruguay	0.84	3.32
Uzbekistan	-1.29	7.57
Venezuela, Bolivarian Republic of	-1.28	7.55
Viet Nam	-0.55	6.10
Zambia	-0.30	5.60
Zimbabwe	-1.48	7.95

1.3. End use data sources and locality

Material	Location	Year	Source
Aluminium	Europe	2010	European Aluminium Association
Antimony	Europe	2011	Roskill
Barytes	US	2012	U.S. Geological Survey
Bauxite	US	2012	U.S. Geological Survey
Bentonite	Europe	2011	IMA-Europe
Beryllium	Europe	2012	BeST2013
Borate	Europe	2012	IMA-Europe
Chromium	US	2012	U.S. Geological Survey
Clays	Europe	2010	CRM2010
Cobalt	Worldwide	2011	Cobalt Facts, CDI 2012
Coking coal	Worldwide	2007	intertechpira
Copper	Europe	2011	ICA
Diatomite	US	2012	U.S. Geological Survey
Feldspar	US	2012	U.S. Geological Survey
Fluorspar	Worldwide	2010	CRM2010
Gallium	Worldwide	2010	Indium Corp
Germanium	Worldwide	2012	U.S. Geological Survey
Gold	Worldwide	2012	World Gold Council
Gypsum	US	2012	U.S. Geological Survey
Hafnium	Worldwide	2011	Lipmann, Walton & Co
Heavy Rare Earth Elements	Worldwide	2012	Roskill & USGS
Indium	Worldwide	2011	Indium Corp
Iron	Europe	2010	CRM 2010
Light Rare Earth Elements	Worldwide	201	Roskill & USGS

		2	
Limestone	Europe	2007	CRM2010
Lithium	Worldwide	2011	Roskill 2012 in mineral info 2012
Magnesite	Europe	2010	CRM2010
Magnesium	Europe	2012	Roskill
Manganese	Europe	2012	Euro Alliages 2013
Molybdenum	Worldwide	2010	SMR GmbH, Steel & Metals Market Research 2011
Natural Graphite	Worldwide	2012	Roskill 2013 in 37th ECGA General Assembly
Natural rubber	Europe	2012	ETRMA
Nickel	Europe	2010	Nickel Institute
Niobium	Worldwide	2010	Heraeus 2010 (taken from CBMM)
Perlite	US	2011	U.S. Geological Survey
Phosphate Rock	US	2012	U.S. Geological Survey
Platinum Group Metals	Worldwide	2012	Johnson Matthey Interim Review 2012
Potash	Worldwide	2011	U.S. Geological Survey
Pulpwood	Europe	2012	Confederation of European Paper Industry
Rhenium	Worldwide	2011	Lipmann, Walton & Co
Sawn Softwood	Europe	2011	European Organisation of the Sawmill Industry
Scandium	Worldwide	2011	INSG
Selenium	Worldwide	2011	U.S. Geological Survey
Silica sand	Europe	2010	CRM2010
Silicon	Europe	2010	Euroalliages
Silver	Worldwide	2011	Silver Institute
Talc	Europe	---	IMA-Europe
Tantalum	Worldwide	2011	Roskill 2013 in Minor Metals Conf
Tellurium	Worldwide	2010	STDA
Tin	Worldwide	2011	ITRI

Titanium	US	2012	U.S. Geological Survey
Tungsten	Worldwide	2010	CRM2010
Vanadium	Worldwide	2012	Roskill 2013 in Titantium Europe Conf
Zinc	Worldwide	---	ILZSG

1.4. Production data sources

Material	Year	Source
Aluminium	2010	World Mining Data
Antimony	2011	World Mining Data
Barytes	2010	World Mining Data
Bauxite	2011	Raw Materials Data
Bentonite	2010	World Mining Data
Beryllium	2011	U.S. Geological Survey
Borate	2010	World Mining Data
Chromium	2010	World Mining Data
Clays	2010	World Mining Data
Cobalt	2010	U.S. Geological Survey
Coking coal	2010	World Mining Data
Copper	2010	U.S. Geological Survey
Diatomite	2010	World Mining Data
Feldspar	2010	U.S. Geological Survey
Fluorspar	2010	World Mining Data
Gallium	2011	U.S. Geological Survey
Germanium	2011	Germanium Corporation
Gold	2011	Raw Materials Data
Gypsum	2010	World Mining Data and U.S. Geological Survey
Hafnium	2012	Lipmann, Walton & Co
Heavy Rare Earth Elements	2012	Roskill, IMCOA, U.S. Geological Survey
Indium	2012	U.S. Geological Survey
Iron	2010	World Mining Data
Light Rare Earth Elements	2012	World Mining Data and U.S. Geological Survey
Limestone	2012	Roskill
Lithium	2011	World Mining Data
Magnesite	2010	World Mining Data
Magnesium	2011	U.S. Geological Survey
Manganese	2010	World Mining Data
Molybdenum	2010	World Mining Data
Natural Graphite	2012	U.S. Geological Survey
Natural rubber	2012	International Rubber Study Group
Nickel	2011	Raw Materials Data
Niobium	2010	U.S. Geological Survey
Perlite	2011	U.S. Geological Survey
Phosphate Rock	2010	World Mining Data
Platinum Group Metals	2012	Johnson Matthey and U.S. Geological Survey
Potash	2012	U.S. Geological Survey
Pulpwood	2011	FAOstat
Rhenium	2011	Lipmann, Walton & Co
Sawn Softwood	2011	European Organisation of the Sawmill Industry
Scandium	2011	INSG

Selenium	2011	ILZSG
Silica sand	2012	U.S. Geological Survey
Silicon	2011	BGS
Silver	2012	Raw Materials Data
Talc	2010	World Mining Data
Tantalum	2011	Raw Materials Data
Tellurium	2011	ILZSG
Tin	2012	World Bureau of Metal Statistics, ITRI, Direccao Geral de Energia e Geologia (Portugal), compiled by BGR
Titanium	2010	World Mining Data
Tungsten	2010	World Mining Data
Vanadium	2010	World Mining Data
Zinc	2010	U.S. Geological Survey

NB: Data from these sources was used in the analysis. Data presented the material profiles differs in some cases due to data confidentiality

ANNEX C – FURTHER DATA AND DETAILED RESULTS OF CRITICALITY ASSESSMENT

This Annex contains the following information: end uses, megasector assignment and substitution values, a summary of economic importance and supply risk calculations, a comparison of results for 2013 and 2010, and large format results charts.

1.5. End uses, megasector assignment and substitution values

Material	Application	Share	Megasector	Value (GVA)	Substitutability
Aluminium	Transport	37%	Transport-Road	147.4	0.7
Aluminium	Building	26%	Construction	104.4	0.5
Aluminium	Packaging	16%	Metals	164.6	0.7
Aluminium	Engineering	14%	MechEquip	182.4	0.7
Aluminium	Others	7%	Other	63.3	0.5
Antimony	Flame Retardants	52%	Chemicals	108.8	0.7
Antimony	Lead-acid batteries (automotive)	20%	Transport-Road	147.4	0.7
Antimony	Lead Alloys	11%	Metals	164.6	0.3
Antimony	Lead Alloys	11%	Metals	164.6	0.7
Antimony	Lead-acid batteries (other)	7%	Electrical	88.1	0.7
Barytes	Weighting agent in gas- and oil-well drilling fluids	95%	Oil	50.0	1.0
Barytes	Others (paints, plastics, rubber, automobile brake and clutch pads, automobile paint)	5%	Other	63.3	0.5
Bauxite	Aluminium production	86%	Metals	164.6	1.0
Bauxite	Nonmetallurgical uses	10%	Chemicals	108.8	0.5
Bauxite	Others	4%	Other	63.3	0.5
Bentonite	Pet litter	29%	Other	63.3	0.3
Bentonite	Foundry molding sands	24%	Metals	164.6	0.7
Bentonite	Pelletizing of iron ore	21%	Mining	4.5	0.7
Bentonite	Civil engineering	11%	Construction	104.4	0.5
Bentonite	Specialties	4%	Chemicals	108.8	0.7
Bentonite	Paper	4%	Paper	41.3	0.5
Bentonite	Food & wine	4%	Food	165.0	0.7

Material	Application	Share	Megasector	Value (GVA)	Substitutability
	production				
Bentonite	Drilling fluids	2%	Oil	50.0	0.7
Beryllium	Mechanical equipment	25%	MechEquip	182.4	0.9
Beryllium	Electrical equipment and domestic appliances	20%	Electrical	88.1	0.9
Beryllium	Electronics & IT	20%	Electronics	104.9	0.7
Beryllium	Road transport	15%	Transport-Road	147.4	0.9
Beryllium	Aircraft, shipbuilding and trains	10%	Transport-Other	51.2	1.0
Beryllium	Others	4%	Other	63.3	0.5
Beryllium	Rubber, plastics and glass	3%	Plastic	98.1	0.7
Beryllium	Metals	3%	Metals	164.6	1.0
Borate	Glass	51%	Plastic	98.1	1.0
Borate	Frits & ceramics	14%	Construction	104.4	0.7
Borate	Agriculture	13%	Chemicals	108.8	1.0
Borate	Chemicals	8%	Chemicals	108.8	0.5
Borate	Metallurgy	5%	Metals	164.6	1.0
Borate	Construction materials	4%	Construction	104.4	0.7
Borate	Industrial fluids	2%	Chemicals	108.8	0.5
Borate	Other	2%	Other	63.3	0.5
Borate	Detergents	1%	Chemicals	108.8	0.7
Borate	Flame retardants	1%	Chemicals	108.8	0.3
Chromium	Stainless steel	88%	Metals	164.6	1.0
Chromium	Steel	9%	Metals	164.6	0.7
Chromium	Superalloys	2%	Metals	164.6	1.0
Chromium	Other	1%	Other	63.3	0.5
Clays	Ceramics	61%	Construction	104.4	1.0
Clays	Others	18%	Other	63.3	0.5
Clays	Paper	17%	Paper	41.3	0.3
Clays	Fiberglass	5%	Plastic	98.1	0.7
Cobalt	Batteries	30%	Electronics	104.9	0.8
Cobalt	Superalloys	19%	Metals	164.6	0.7
Cobalt	Hard Materials - Carbides, Diamond Tooling	13%	Metals	164.6	0.7
Cobalt	Pigments	9%	Chemicals	108.8	0.5
Cobalt	Catalysts	9%	Chemicals	108.8	0.7
Cobalt	Magnets	7%	Electrical	88.1	0.7
Cobalt	Hardfacing/HSS	5%	Metals	164.6	0.7

Material	Application	Share	Megasector	Value (GVA)	Substitutability
	& Other Alloys				
Cobalt	Tyre Adhesives, Soaps, Driers (paint/ink)	5%	Other	63.3	0.7
Cobalt	Feedstuffs, Biotech, Anodising, Recording Media, Electrolysis	3%	Other	63.3	0.7
Coking coal	Steel production	90%	Metals	164.6	0.7
Coking coal	Other metallurgy & niche markets	10%	Metals	164.6	0.5
Copper	Electrical infrastructure and equipment	41%	Electrical	88.1	0.7
Copper	Construction	13%	Construction	104.4	0.3
Copper	Mechanical equipment	12%	MechEquip	182.4	0.7
Copper	Other	12%	Other	63.3	0.5
Copper	Automotive	10%	Transport-Road	147.4	0.7
Copper	Electronics & ICT	6%	Electronics	104.9	0.7
Copper	Transport, other	4%	Transport-Other	51.2	0.7
Diatomite	Filter aids	75%	Beverages	37.0	0.3
Diatomite	Absorbents	12%	Chemicals	108.8	0.5
Diatomite	Fillers	12%	Construction	104.4	0.3
Diatomite	Others	1%	Other	63.3	0.5
Feldspar	Glass	70%	Plastic	98.1	0.7
Feldspar	Pottery and other uses	30%	Other	63.3	0.3
Fluorspar	Hydrofluoric acid	52%	Chemicals	108.8	1.0
Fluorspar	Steel	25%	Metals	164.6	0.3
Fluorspar	Aluminium	18%	Metals	164.6	1.0
Fluorspar	Other	5%	Other	63.3	0.5
Gallium	Integrated circuits	41%	Electronics	104.9	0.7
Gallium	LED	25%	Electronics	104.9	0.7
Gallium	Alloys, Batteries and Magnets	17%	Metals	164.6	0.5
Gallium	Solar	17%	Electronics	104.9	0.3
Germanium	Fibre optic	30%	Electronics	104.9	1.0
Germanium	Catalysts (polymers)	25%	Plastic	98.1	0.7
Germanium	Infrared optic	25%	Electronics	104.9	1.0

Material	Application	Share	Megasector	Value (GVA)	Substitutability
Germanium	Parts for electrical and solar equipment	15%	Electronics	104.9	0.7
Germanium	Others	5%	Other	63.3	0.5
Gold	Jewelry	82%	Other	63.3	0.7
Gold	Electronics	13%	Electronics	104.9	1.0
Gold	Other	4%	Other	63.3	0.5
Gold	Dental	2%	Pharma	85.9	0.3
Gypsum	Wallboard and plaster products	90%	Construction	104.4	0.7
Gypsum	Cement production and agricultural applications	6%	Other	63.3	0.9
Gypsum	Others	4%	Other	63.3	0.5
Hafnium	Super Alloys	45%	Metals	164.6	0.3
Hafnium	Nuclear Control Rods	13%	Electrical	88.1	0.3
Hafnium	Plasma Cutting Tips	13%	MechEquip	182.4	0.5
Hafnium	Optical Coatings	11%	Electronics	104.9	0.5
Hafnium	Catalysts	7%	Chemicals	108.8	0.5
Hafnium	CVD/Targets	7%	Chemicals	108.8	0.5
Hafnium	Special Steels	3%	Metals	164.6	0.5
Hafnium	Electronics	1%	Electronics	104.9	0.5
Indium	Flat panel displays	56%	Electronics	104.9	1.0
Indium	Solders	10%	Electrical	88.1	0.7
Indium	Photovoltaics	8%	Electronics	104.9	0.7
Indium	Others	8%	Other	63.3	0.5
Indium	Thermal interface materials	6%	Electronics	104.9	0.7
Indium	Batteries (alkaline)	5%	Electronics	104.9	0.3
Indium	Alloys/compounds	4%	Metals	164.6	0.3
Indium	Compound semiconductors & LEDs	3%	Electronics	104.9	0.7
Iron ore	Steel: Construction	26%	Construction	104.4	1.0
Iron ore	Steel: Automotive	16%	Transport-Road	147.4	0.7
Iron ore	Steel: Mechanical engineering	14%	MechEquip	182.4	0.7
Iron ore	Steel: Tubes	12%	Metals	164.6	0.7
Iron ore	Steel: Metal	12%	Metals	164.6	1.0

Material	Application	Share	Megasector	Value (GVA)	Substitutability
	goods				
Iron ore	Steel: Structural	11%	Construction	104.4	1.0
Iron ore	Steel: Domestic applicances	4%	Electrical	88.1	0.7
Iron ore	Steel: Misc	3%	Metals	164.6	0.5
Iron ore	Other	2%	Other	63.3	0.5
Iron ore	Steel: Shipyard	1%	Transport-Other	51.2	1.0
Limestone	Paper (bleaching)	22%	Paper	41.3	0.3
Limestone	Iron & steel	21%	Metals	164.6	1.0
Limestone	Building materials (incl. Sealants and plasters)	19%	Construction	104.4	1.0
Limestone	Environmental protection (flue gas, drinking water, sewage treatment)	9%	Construction	104.4	1.0
Limestone	Paints & coatings	8%	Chemicals	108.8	0.3
Limestone	Agriculture (fertilisers)	8%	Chemicals	108.8	1.0
Limestone	Plastics and rubber	5%	Plastic	98.1	0.3
Limestone	Chemical	5%	Chemicals	108.8	1.0
Limestone	Non-ferrous	2%	Metals	164.6	1.0
Limestone	Others	1%	Other	63.3	0.5
Lithium	Ceramics and glass	30%	Plastic	98.1	1.0
Lithium	Batteries	22%	Electronics	104.9	1.0
Lithium	Other	22%	Other	63.3	0.5
Lithium	Lubricating grease	11%	Chemicals	108.8	0.7
Lithium	Continuous casting	4%	Metals	164.6	0.7
Lithium	Gas and air treatment	4%	MechEquip	182.4	0.3
Lithium	Synthetic rubbers and plastics	3%	Plastic	98.1	0.7
Lithium	Aluminium smelting	2%	Metals	164.6	0.3
Lithium	Pharmaceuticals	2%	Pharma	85.9	0.3
Magnesite	Refractory others	83%	Metals	164.6	0.7
Magnesite	Environmental	6%	Other	63.3	0.7
Magnesite	Agricultural (animal feed &	5%	Chemicals	108.8	1.0

Material	Application	Share	Megasector	Value (GVA)	Substitutability
	fertilizers)				
Magnesite	Others	5%	Other	63.3	0.8
Magnesite	Cement-industry	1%	Construction	104.4	0.7
Magnesium	aluminum-based alloys (packaging, transportation, other applications)	40%	Beverages	37.0	0.7
Magnesium	Magnesium die-casting	39%	Transport-Road	147.4	0.7
Magnesium	Steel desulphurisation	12%	Metals	164.6	0.3
Magnesium	Others	7%	Other	63.3	0.5
Magnesium	Nodular cast iron	1%	Metals	164.6	0.7
Manganese	Construction	25%	Construction	104.4	1.0
Manganese	Automotive	14%	Transport-Road	147.4	1.0
Manganese	Mechanical Engineering	13%	MechEquip	182.4	1.0
Manganese	Structural steelworks	11%	MechEquip	182.4	1.0
Manganese	Tubes	10%	MechEquip	182.4	1.0
Manganese	Metalware	10%	Metals	164.6	1.0
Manganese	Non-steel alloys	6%	Metals	164.6	0.7
Manganese	Other	5%	Other	63.3	0.5
Manganese	Domestic appliances	4%	Electrical	88.1	1.0
Manganese	Batteries (cathodes)	2%	Electronics	104.9	0.0
Manganese	Shipyards	1%	Transport-Other	51.2	1.0
Molybdenum	Oil and Gas	18%	Oil	50.0	1.0
Molybdenum	Chemical/Petrochemical	15%	Chemicals	108.8	1.0
Molybdenum	Automotive	14%	Transport-Road	147.4	1.0
Molybdenum	Mechanical Engineering	12%	MechEquip	182.4	1.0
Molybdenum	Power Generation	8%	Electrical	88.1	1.0
Molybdenum	Process Industry	8%	MechEquip	182.4	1.0
Molybdenum	Other Transportation	7%	Transport-Other	51.2	1.0
Molybdenum	Others	7%	Other	63.3	0.5
Molybdenum	Building / Construction	6%	Construction	104.4	0.3
Molybdenum	Aerospace &	3%	Transport-	51.2	1.0

Material	Application	Share	Megasector	Value (GVA)	Substitutability
	Defence		Other		
Molybdenum	Electronics & Medical	2%	Electronics	104.9	1.0
Natural Graphite	Electrodes	34%	Metals	164.6	1.0
Natural Graphite	Others	24%	Other	63.3	0.5
Natural Graphite	Refractories	20%	Metals	164.6	0.7
Natural Graphite	Lubricants	6%	Chemicals	108.8	0.3
Natural Graphite	Foundries	5%	Metals	164.6	0.7
Natural Graphite	Batteries	4%	Electronics	104.9	0.3
Natural Graphite	Graphite Shapes	4%	MechEquip	182.4	1.0
Natural Graphite	Friction Products	2%	Transport-Road	147.4	0.7
Natural Graphite	Recarburising	1%	Metals	164.6	0.3
Natural rubber	Tyres (land vehicles) & other automotive	87%	Transport-Road	147.4	0.9
Natural rubber	General (non-automotive)	12%	Plastic	98.1	0.3
Natural rubber	Tyres (aircraft)	1%	Transport-Other	51.2	1.0
Nickel	Stainless steel	61%	Metals	164.6	0.7
Nickel	Nickel base alloys	12%	Metals	164.6	0.7
Nickel	Alloy steel	9%	Metals	164.6	0.7
Nickel	Plating	7%	Metals	164.6	1.0
Nickel	Other	5%	Other	63.3	0.5
Nickel	Copper base alloys	2%	Metals	164.6	1.0
Niobium	Steel: Structural	31%	Construction	104.4	0.7
Niobium	Steel: Automotive	28%	Transport-Road	147.4	0.7
Niobium	Steel: Pipeline	24%	Oil	50.0	0.7
Niobium	Superalloys	8%	Metals	164.6	0.7
Niobium	Others	6%	Other	63.3	0.5
Niobium	Steel: Chemical industry	3%	MechEquip	182.4	0.7
Perlite	Formed products	53%	Other	63.3	0.5
Perlite	Fillers	15%	Construction	104.4	0.3
Perlite	Horticultural aggregate	14%	Food	165.0	0.3

Material	Application	Share	Megasector	Value (GVA)	Substitutability
Perlite	Filter aid	10%	Beverages	37.0	0.3
Perlite	Others	5%	Other	63.3	0.5
Perlite	Plaster aggregate	1%	Construction	104.4	0.3
Perlite	High-temperature insulation	1%	Construction	104.4	0.3
Perlite	Concrete aggregate	1%	Construction	104.4	0.3
Phosphate Rock	Wet-process phosphoric acid and superphosphoric acid (used as intermediate feedstocks in the manufacture of granular and liquid ammonium phosphate fertilizers and animal feed supplements)	95%	Chemicals	108.8	1.0
Phosphate Rock	Others	5%	Other	63.3	0.5
PGMs	Autocatalyst	55%	Transport-Road	147.4	1.0
PGMs	Jewellery	17%	Other	63.3	0.3
PGMs	Electronics	10%	Electronics	104.9	1.0
PGMs	Chemical & Electrochemical	7%	Chemicals	108.8	1.0
PGMs	Others	6%	Other	63.3	0.5
PGMs	Medical alloys	3%	Metals	164.6	0.3
PGMs	Glass	1%	Plastic	98.1	1.0
PGMs	Petroleum Production	1%	Refining	29.2	1.0
Potash	Fertilisers	92%	Food	165.0	0.3
Potash	Others	8%	Other	63.3	0.5
Pulpwood	Graphic paper	44%	Paper	41.3	0.7
Pulpwood	Packaging papers	43%	Paper	41.3	0.7
Pulpwood	Household & sanitary	8%	Paper	41.3	0.7
Pulpwood	Other papers	5%	Paper	41.3	0.7
REE (Heavy)	Phosphors: lighting	45%	Electrical	88.1	0.7
REE (Heavy)	Phosphors: displays	14%	Electronics	104.9	0.7
REE (Heavy)	Magnets	12%	Electrical	88.1	0.7

Material	Application	Share	Megasector	Value (GVA)	Substitutability
REE (Heavy)	Chemical (other)	10%	Chemicals	108.8	1.0
REE (Heavy)	Ceramics: electronics	7%	Electronics	104.9	1.0
REE (Heavy)	Phosphors: other	5%	Chemicals	108.8	1.0
REE (Heavy)	Glass	4%	Plastic	98.1	1.0
REE (Heavy)	Metallurgy	3%	Metals	164.6	0.3
REE (Light)	Magnets	21%	Electrical	88.1	0.7
REE (Light)	Glass Polishing	17%	Plastic	98.1	0.7
REE (Light)	FCCs	14%	Refining	29.2	1.0
REE (Light)	Metallurgy	12%	Metals	164.6	0.3
REE (Light)	Batteries (NiMH)	9%	Electrical	88.1	0.3
REE (Light)	Autocatalyst	7%	Transport-Road	147.4	0.7
REE (Light)	Glass	7%	Plastic	98.1	1.0
REE (Light)	Others	7%	Other	63.3	0.5
REE (Light)	Phosphors	3%	Electronics	104.9	0.7
REE (Light)	Ceramics	2%	Construction	104.4	1.0
REE (Light)	Catalyst	1%	Chemicals	108.8	1.0
Rhenium	Super alloys (aerospace)	63%	Transport-Other	51.2	1.0
Rhenium	Super alloys (gas turbines)	13%	MechEquip	182.4	1.0
Rhenium	Catalysts	9%	Chemicals	108.8	0.7
Rhenium	Others	6%	Other	63.3	0.5
Rhenium	Automotive Parts	5%	Transport-Road	147.4	1.0
Rhenium	Petroleum Production	2%	Refining	29.2	1.0
Rhenium	Tools	2%	MechEquip	182.4	1.0
Sawn Softwood	Construction	80%	Construction	104.4	0.7
Sawn Softwood	Furniture	20%	Other	63.3	0.7
Scandium	Al-alloys: Sport	85%	Other	63.3	0.3
Scandium	Lighting	10%	Electronics	104.9	0.7
Scandium	Fuel cells	5%	Electronics	104.9	0.3
Selenium	Metallurgy	40%	Metals	164.6	0.3
Selenium	Glass	25%	Plastic	98.1	0.7
Selenium	Chemicals and Pigments	10%	Chemicals	108.8	0.3
Selenium	Agriculture	10%	Chemicals	108.8	1.0
Selenium	Electronics	10%	Electronics	104.9	0.3
Selenium	Others	5%	Other	63.3	0.5
Silica sand	Glass (flat & container glass)	38%	Plastic	98.1	1.0
Silica sand	Building	30%	Construction	104.4	1.0

Material	Application	Share	Megasector	Value (GVA)	Substitutability
	materials (cement, concrete blocks, glues for tiles, etc.)				
Silica sand	Foundry	17%	Metals	164.6	1.0
Silica sand	Others (fibreglass, chemicals, abrasives, leasure, filtration)	15%	Other	63.3	0.5
Silicon metal	Chemicals and Pigments	54%	Chemicals	108.8	0.7
Silicon metal	Metallurgy	38%	Metals	164.6	1.0
Silicon metal	Electronics	8%	Electronics	104.9	0.7
Silver	Jewellery, Silverware, Coins and Medals	37%	Other	63.3	0.7
Silver	Electronics	22%	Electronics	104.9	1.0
Silver	Others	17%	Other	63.3	0.5
Silver	Photography	8%	Chemicals	108.8	0.3
Silver	Brazing Alloys & Solders	7%	Metals	164.6	0.7
Silver	Photovoltaics	6%	Electronics	104.9	1.0
Silver	Ethylene Oxide industry	3%	Chemicals	108.8	0.7
Talc	Plastics	31%	Plastic	98.1	0.3
Talc	Paint	21%	Chemicals	108.8	0.3
Talc	Paper	15%	Paper	41.3	0.3
Talc	Agriculture	12%	Chemicals	108.8	0.7
Talc	Ceramics	9%	Construction	104.4	0.3
Talc	Rubber	4%	Plastic	98.1	0.7
Talc	Others	4%	Other	63.3	0.5
Talc	Cosmetics & pharmaceuticals	3%	Pharma	85.9	0.7
Talc	Food	1%	Food	165.0	0.7
Tantalum	Capacitors	40%	Electronics	104.9	0.3
Tantalum	Superalloys	21%	Metals	164.6	0.7
Tantalum	Sputtering targets	12%	Electronics	104.9	1.0
Tantalum	Mill products	11%	MechEquip	182.4	0.7
Tantalum	Carbides	10%	MechEquip	182.4	0.3
Tantalum	Chemicals	6%	Chemicals	108.8	1.0
Tellurium	Photovoltaics	40%	Electronics	104.9	0.3
Tellurium	Thermoelectrics	30%	Electronics	104.9	0.7

Material	Application	Share	Megasector	Value (GVA)	Substitutability
Tellurium	Metallurgy	15%	Metals	164.6	0.3
Tellurium	Others	10%	Other	63.3	0.5
Tellurium	Rubber Formulation	5%	Plastic	98.1	0.3
Tin	Solder (eletronics)	45%	Electronics	104.9	0.7
Tin	Tinplate (packaging)	16%	Metals	164.6	0.3
Tin	Chemicals and Pigments	15%	Chemicals	108.8	0.7
Tin	Solder (industrial)	9%	MechEquip	182.4	0.7
Tin	Others	8%	Other	63.3	0.5
Tin	Brass and Bronze	5%	Metals	164.6	0.3
Tin	Float Glass	2%	Plastic	98.1	0.7
Titanium	Paint	56%	Chemicals	108.8	0.3
Titanium	Plastic	27%	Plastic	98.1	0.3
Titanium	Paper	9%	Paper	41.3	0.3
Titanium	Welding rod coatings and manufacturing carbides, chemicals and metal	5%	Metals	164.6	0.7
Titanium	Others	3%	Other	63.3	0.7
Tungsten	Cemented carbides	60%	MechEquip	182.4	0.7
Tungsten	Fabricated products	17%	Electrical	88.1	0.7
Tungsten	Alloy steels (mainly tool steel, >80%)	13%	MechEquip	182.4	0.7
Tungsten	Superalloys	6%	Metals	164.6	0.7
Tungsten	Tungsten alloys	4%	MechEquip	182.4	0.7
Vanadium	Full alloy incl tool steel	32%	MechEquip	182.4	0.5
Vanadium	HSLA steel long products	25%	Metals	164.6	0.3
Vanadium	HSLA steel plate	18%	Metals	164.6	0.3
Vanadium	Carbon steel	13%	Metals	164.6	0.7
Vanadium	Titanium alloys	5%	Metals	164.6	1.0
Vanadium	Chemicals	4%	Chemicals	108.8	0.3
Vanadium	Other iron & steel	2%	Metals	164.6	0.5
Vanadium	Other (mainly batteries)	1%	Other	63.3	0.5
Zinc	Galvanizing	50%	Metals	164.6	0.7
Zinc	Brass and	17%	Metals	164.6	0.5

Material	Application	Share	Megasector	Value (GVA)	Substitutability
	Bronze				
Zinc	Zinc Alloying	17%	Metals	164.6	0.7
Zinc	Chemicals	6%	Chemicals	108.8	1.0
Zinc	Zinc semi-manufactures	6%	Metals	164.6	0.5
Zinc	Miscellaneous	4%	Other	63.3	0.5

1.6. Economic importance and supply risk calculations

Material	Economic Importance (Raw)	Economic Importance (Scaled)	HHI	HHI-WGI (scaled)	Substitutability Index	Recycling Input Rate (EoL %)	Supply Risk (WGI)
Aluminium	138	7.57	1781	1.0512	0.63	35%	0.43
Antimony	129	7.07	7458	4.6108	0.62	11%	2.5
Barytes	51	2.8	2941	1.7755	0.98	0%	1.74
Bauxite	156	8.55	1886	0.6179	0.93	0%	0.57
Bentonite	84	4.61	1620	0.6703	0.55	0%	0.37
Beryllium	123	6.74	8242	2.113	0.85	19%	1.45
Borate	103	5.65	2624	1.0752	0.88	0%	0.95
Chromium	163	8.94	2503	1.2132	0.96	13%	1.01
Clays	87	4.77	1046	0.3403	0.78	0%	0.27
Cobalt	122	6.69	3361	2.7261	0.71	16%	1.63
Coking coal	164	8.99	3049	1.73	0.68	0%	1.18
Copper	105	5.76	1452	0.4407	0.62	20%	0.22
Diatomite	55	3.02	2108	0.7333	0.33	0%	0.24
Feldspar	88	4.82	1315	0.6083	0.58	0%	0.35
Fluorspar	131	7.18	3535	2.1484	0.8	0%	1.72
Gallium	115	6.3	4985	3.0361	0.6	0%	1.82
Germanium	101	5.54	4009	2.2513	0.86	0%	1.94
Gold	69	3.78	606	0.2812	0.72	25%	0.15
Gypsum	101	5.54	1144	0.6735	0.7	1%	0.47
Hafnium	143	7.84	4414	1.1334	0.38	0%	0.43
Indium	102	5.59	3757	2.1962	0.82	0%	1.8
Iron	135	7.4	1655	0.7653	0.84	22%	0.5
Limestone	105	5.76	1080	0.5076	0.75	0%	0.38
Lithium	100	5.48	3073	0.8342	0.78	0%	0.65
Magnesite	151	8.28	4872	2.9927	0.72	0%	2.15
Magnesium	100	5.48	7439	4.5963	0.64	14%	2.53
Manganese	142	7.78	1297	0.5707	0.94	19%	0.43
Molybdenum	108	5.92	2270	1.1276	0.92	17%	0.86
Natural Graphite	135	7.4	4979	3.0597	0.72	0%	2.2
Natural Rubber	141	7.73	1909	1.0899	0.83	0%	0.9
Nickel	161	8.83	1069	0.5215	0.68	32%	0.24
Niobium	107	5.87	8504	4.008	0.69	11%	2.46
Perlite	83	4.55	1882	0.6764	0.42	0%	0.28
Phosphate Rock	106	5.81	1995	1.1147	0.98	0%	1.09
PGMs	120	6.58	4542	2.1929	0.83	35%	1.18
Potash	157	8.61	1576	0.6599	0.32	0%	0.21
Pulpwood	41	2.25	1160	0.352	0.7	51%	0.12
REE (Heavy)	98	5.37	9807	6.0644	0.77	0%	4.67

Material	Economic Importance (Raw)	Economic Importance (Scaled)	HHI	HHI-WGI (scaled)	Substitutability Index	Recycling Input Rate (EoL %)	Supply Risk (WGI)
REE (Light)	95	5.21	7598	4.6753	0.67	0%	3.13
Rhenium	82	4.5	4092	1.0931	0.94	13%	0.89
Sawn Softwood	97	5.32	763	0.2412	0.70	9%	0.15
Scandium	69	3.78	5350	3.3144	0.34	1%	1.12
Selenium	126	6.91	1001	0.4144	0.48	5%	0.19
Silica sand	105	5.76	1608	0.4606	0.92	24%	0.32
Silicon	130	7.13	3397	2.0139	0.81	0%	1.63
Silver	87	4.77	2137	1.335	0.72	24%	0.73
Talc	93	5.1	1260	0.6592	0.39	0%	0.26
Tantalum	135	7.40	2486	1.1751	0.55	4%	0.62
Tellurium	109	5.98	1061	0.441	0.44	0%	0.19
Tin	123	6.74	2536	1.5399	0.60	11%	0.82
Titanium	101	5.54	1355	0.4307	0.33	6%	0.13
Tungsten	165	9.05	7300	4.5132	0.70	37%	1.99
Vanadium	166	9.1	3230	1.7854	0.46	0%	0.82
Zinc	158	8.66	1390	0.7457	0.66	8%	0.45

1.7. Comparison of 2010 and 2013 studies

Raw Material	2010			2013		
	EI	SR (WGI)	Classification	EI	SR (WGI)	Classification
Aluminium	8.88	0.20	non-critical	7.57	0.43	non-critical
Antimony	5.84	2.56	critical	7.07	2.54	critical
Barytes	3.68	1.67	non-critical	2.80	1.74	non-critical
Bauxite	9.51	0.26	non-critical	8.55	0.57	non-critical
Bentonite	5.48	0.34	non-critical	4.61	0.37	non-critical
Beryllium	6.17	1.32	critical	6.74	1.45	critical
Borate	5.01	0.60	non-critical	5.65	0.95	critical
Chromium	9.92	0.80	non-critical	8.94	1.01	critical
Clays	4.44	0.30	non-critical	4.77	0.27	non-critical
Cobalt	7.24	1.06	critical	6.69	1.63	critical
Coking coal				8.99	1.18	critical
Copper	5.71	0.21	non-critical	5.76	0.22	non-critical
Diatomite	3.73	0.34	non-critical	3.02	0.24	non-critical
Feldspar	5.19	0.23	non-critical	4.82	0.35	non-critical
Fluorspar	7.50	1.63	critical	7.18	1.72	critical
Gallium	6.50	2.47	critical	6.30	1.82	critical
Germanium	6.28	2.73	critical	5.54	1.94	critical
Gold				3.78	0.15	non-critical
Gypsum	5.04	0.36	non-critical	5.54	0.47	non-critical
Hafnium				7.84	0.43	non-critical
Indium	6.71	2.02	critical	5.59	1.80	critical
Iron Ore	8.11	0.35	non-critical	7.40	0.50	non-critical
Limestone	5.95	0.73	non-critical	5.76	0.38	non-critical
Lithium	5.59	0.73	non-critical	5.48	0.63	non-critical
Magnesite	8.90	0.86	non-critical	8.28	2.15	critical
Magnesium	6.45	2.62	critical	5.48	2.53	critical
Manganese	9.80	0.45	non-critical	7.78	0.43	non-critical
Molybdenum	8.89	0.47	non-critical	5.92	0.86	non-critical
Natural Graphite	8.68	1.27	critical	7.40	2.20	critical
Natural rubber				7.73	0.90	non-critical
Nickel	9.54	0.27	non-critical	8.83	0.24	non-critical
Niobium	8.95	2.80	critical	5.87	2.46	critical
Perlite	4.20	0.31	non-critical	4.55	0.28	non-critical
Phosphate Rock				5.81	1.09	critical
PGMs	6.68	3.63	critical	6.58	1.18	critical
Potash				8.61	0.21	non-critical
Pulpwood				2.25	0.12	non-critical
REE (Heavy)*	5.78	4.86	critical	5.37	4.67	critical
REEs (Light)*	5.78	4.86	critical	5.21	3.13	critical
Rhenium	7.72	0.82	non-critical	4.50	0.89	non-critical
Sawn Softwood			non-critical	5.32	0.15	non-critical
Scandium*	5.78	4.86	critical	3.78	1.12	non-critical

Raw Material	2010			2013		
	EI	SR (WGI)	Classification	EI	SR (WGI)	Classification
Selenium				6.91	0.19	non-critical
Silica sand	5.83	0.18	non-critical	5.76	0.32	non-critical
Silicon metal				7.13	1.63	critical
Silver	5.07	0.27	non-critical	4.77	0.73	non-critical
Talc	4.02	0.30	non-critical	5.10	0.26	non-critical
Tantalum	7.38	1.13	critical	7.40	0.62	non-critical
Tellurium	7.90	0.56	non-critical	5.98	0.19	non-critical
Tin				6.74	0.89	non-critical
Titanium	5.38	0.13	non-critical	5.54	0.13	non-critical
Tungsten	8.75	1.81	critical	9.05	1.99	critical
Vanadium	9.71	0.73	non-critical	9.10	0.82	non-critical
Zinc	9.40	0.40	non-critical	8.66	0.45	non-critical

*Heavy Rare Earth Elements, Light Rare Earth Elements, and Scandium were considered together (as Rare Earth Elements) in the 2010 exercise.

ANNEX D – SECTOR SPECIFIC DISCUSSIONS

1.8. Raw Materials and their criticality in the European defence sector

Some initial conclusions from the European Defence Agency's Analysis
On the grounds of internal work and a set of studies for the defence sector, an initial, non-exhaustive view on raw materials for defence supply chains and their criticality is described below. These studies cover criticalities in supply chains of a variety of defence technologies, products and capabilities.

The effort is made to get a view on the gaps for military capabilities and to be able to mitigate, reduce or eliminate reliance on outside (non-EU) suppliers for critical technologies in the security and defence environment. This has been thoroughly done for the ammunitions, for electronic components and to a certain extent for the defence aerospace sector - all key sectors as they affect the operational capabilities of the Armed Forces in Europe.

Those studies consider all forms of non-EU dependencies with a focus on those that are critical and leading to ever-increasing dependencies if not addressed: market-oriented dependencies, raw materials, specific components not available in EU, regulation, and the loss of engineering know-how.

Guaranteed access to raw materials and security of supply is important for all industries in Europe, but has a particular importance for the defence sector as it affects security and operational autonomy.

This resulted in the following, albeit incomplete picture for defence in Europe:

1. **Copper, Tungsten and Molybdenum**
   a) Domain of dependency: ammunitions: material for ballast, fragments generators and shape charges, nozzle throats and jet vanes (jet engine components).
   b) Related equipment: Thermal Vapor Compression systems, Long duration motors, anti-armour warheads, aircraft interception warhead and kinetic penetrator.
   c) Cause of dependency: European suppliers (Austria, France and Finland) get the raw material from outside of Europe.
   d) Risk: dependence of the supply for high quality and high performance products.

2. **Rare Earths**. Most used in the defence industry are; dysprosium, erbium, europium, gadolinium, neodymium, yttrium and praseodymium
   a) Domain of dependency: in ammunitions, aerospace, military surveillance systems, and military motors for catalytic converters, permanent magnets, battery cells, nuclear batteries, lasers and X-ray tubes.
   b) Related equipment: Motors, actuators.
   c) Cause of dependency: European producers are fully dependent on China for the raw material.
   d) Risk: unavailability of the materials.

3. Gallium

a) Domain of dependency: electronic components, integrated circuits, printed circuit boards (PCB); high power switching.
b) Related equipment: semiconductor components (in form of GaAs & GaN) for high power electronics in Radars, Communication and Electronic Warfare (Phased Array) Antennas; power conversion for increase of power integration density and efficiency (transversal use for defence systems and platforms), LED (Light Emitting Diodes).
c) Cause of dependency: production predominantly outside of Europe; demand most likely increasing.
d) Risk: limited availability, increase in demand and price.

4. Titanium

a) Domain of dependency: aerospace applications for fixed-wing aircrafts and helicopters; missile systems; naval vessels.
b) Related equipment: used on frames to reduce weight and increase durability in extreme conditions.
c) Causes of dependency: existing range of suppliers but Russia and China dominant with over 40% of global production.
d) Risk: currently no substitute for titanium in most military and aerospace applications, risk of increase in demand and price.

Other raw materials used in jet engine components and missile parts are *Niobium, Beryllium* (also for radars), *Tantalum* as well as *Cobalt*. The *Platinum Group Metals* are used for electronic devices, Germanium for infrared detectors, thermal imaging cameras, optical fibres, and magnesium for warheads. Although not critical in wider economic terms, the use of the following raw materials are of importance to defence aerospace applications: Titanium (see above), *Rhenium* for military jet engines, and *Molybdenum, Vanadium and Chromium* are extensively used in aircraft components and jet engines in particular.

References:

2009 EDA study ' Discotech European Roadmap in electronic and photonic components for Defence'
2011 EDA study 'Ammunition non-EU dependencies'
2012 EDA study 'How to ensure Tomorrow's Military Aerospace Supply Chain'

1.9. Critical raw materials in the energy technologies

Background
In order to tackle climate change, to increase energy supply security and to foster the sustainability and competitiveness of the European economy, the EU has made the transition to a low-carbon economy a central policy priority. To ensure this, the EU created the Strategic Energy Technology Plan (SET-Plan) with the aim to accelerate the development of low-carbon energy technologies throughout the EU in

support of their subsequent large-scale deployment by 2020[1,2]. The SET-Plan prioritised six technologies: nuclear fission, solar photovoltaics (PV) and concentrated solar power (CSP), wind, bioenergy, carbon capture and storage (CCS) and the electricity grids. The EU also committed itself to reducing greenhouse gas emissions to 80-95% below 1990 levels by 2050. The Commission has since analysed the pathway towards the 2050 targets and their implications within its EU Energy Roadmap 2050[3,4].

Critical metals in low-carbon energy technologies

In a first study conducted by the JRC in 2011 (Critical Metals in Strategic Energy Technologies), critical metals were identified, which could become a bottleneck to the supply-chain of the low-carbon energy technologies addressed by the SET-Plan.[5] Sixty metals (i.e. metallic elements, metallic minerals and metalloids) are considered; only iron, aluminium and radioactive elements (used as fuel in nuclear plants) were specifically excluded. Graphite was also included, reflecting its status as one of the critical raw materials identified by the EU Raw Materials Initiative. Fourteen metals were identified to be a cause for concern. After taking into account market and geopolitical parameters, five metals were labelled "critical", namely tellurium, indium, gallium, neodymium and dysprosium. The potential supply chain constraints for these materials were most applicable to the deployment of wind and PV energy technologies.

In a follow-up study, other energy and low-carbon technologies are investigated that not only play an important role in the EU's path towards decarbonisation but also may compete for the same metals as identified in the six SET-Plan technologies.[6] Eleven technologies were analysed including fuel cells, electricity storage, electric vehicles and lighting. Where possible, the study modelled the implications for materials demand as a result of the scenarios described in the EU Energy Roadmap 2050. Consequently, the results obtained in the first study were updated to reflect the data that has become available in the roadmap.

The study found that eight metals have a high criticality rating and are therefore classified as "critical". These are the six rare earth elements (dysprosium, europium, terbium, yttrium, praseodymium and neodymium), and the two metals gallium and tellurium. Four metals (graphite, rhenium, indium and platinum) are found to have a medium-to-high rating, suggesting that the market conditions for these metals should be monitored in case the markets for these metals deteriorate thereby increasing the risk of supply chain bottlenecks. The applications, i.e. technologies, of particular concern are electric vehicles, wind and solar energy, and lighting. Ways of mitigating the supply-chain risks for the critical metals were considered. These fall into three categories: increasing primary supply, re-use/recycling and substitution.

[1] European Council conclusions adopted on the basis of the Commission's Energy Package, e.g. the Communications: An Energy Policy for Europe COM(2007)1, Limiting Global Climate Change to 2 degrees Celsius—The way ahead for 2020 and beyond, COM(2007)2, Brussels.

[2] A European Strategic Energy Technology Plan (SET-Plan), Towards a low carbon future, COM(2007)723, Brussels.

[3] A roadmap for moving to a competitive low carbon economy in 2050,COM(2011)112, Brussels.

[4] Energy Roadmap 2050, COM(2011)885/2, Brussels.

[5] EU JRC (2011), Assessing metals as Supply Chain Bottlenecks in Priority Energy Technologies

[6] EC JRC (2013) Critical Metals in the Path towards the decarbonisation of the EU Energy Sector

Further research
A number of topics were identified as possibly meriting further research. These include:

- conducting further studies to look at raw materials requirements for hybrid and electric vehicles for a wider range of technology uptake and penetration scenarios
- developing new and more detailed scenarios for the uptake and technology mix of options for stationary energy storage
- undertaking similar studies in defence and aerospace
- improving statistics on the contribution of recycling to world production for a number of metals
- investigating the contribution of greater traceability and transparency to reducing raw materials supply risk.

1.10. Materials of concern to the ICT sector

Technologies in the ICT are increasing reliant on a growing number of different materials. Many of the materials that are now used have historically been low production volume, speciality metals, with only niche uses. Whilst often small in terms of volume of materials used, they play an irreplaceable role in a product's function. Therefore a developing ICT sector places growing pressure on the access to these materials. This has led to concerns over supply of certain metals which are linked to the ICT sector, those particularly highlighted by DG Connect include:

- rare earth elements, specifically dysprosium, erbium, europium, neodymium, terbium and yttrium
- indium
- hafnium
- gallium
- germanium.

Projects arising from DG Research have sought to address these concerns through the development of alternative technologies that are not reliant on these materials, or through enabling recovery of these materials through recycling and related actions.