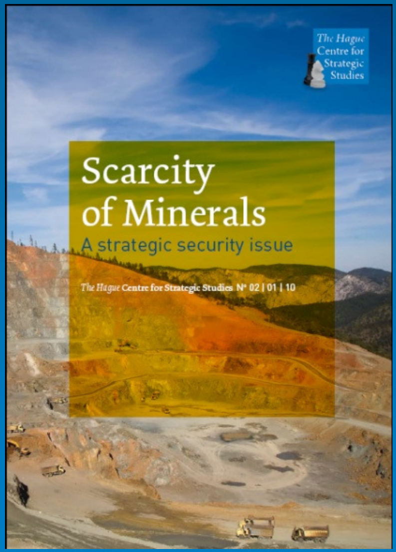

METAL SCARCITY, POLITICS & POWER

RARE EARTHS, MINOR & SPECIALTY METALS INVESTMENT SUMMIT
LONDON, MARCH 18, 2010.

JAAKKO KOOROSHY

The Hague Centre for Strategic Studies

INTRODUCTION

The Hague Centre for Strategic Studies works on strategic minerals for a variety of clients:

- Various Dutch government organizations including the Dutch Ministry of Interior & Kingdom Relations
- The Dutch Think-tank on National Security
- The EU Policy on Natural Resources (POLINARES)
- TNO Research Organisation

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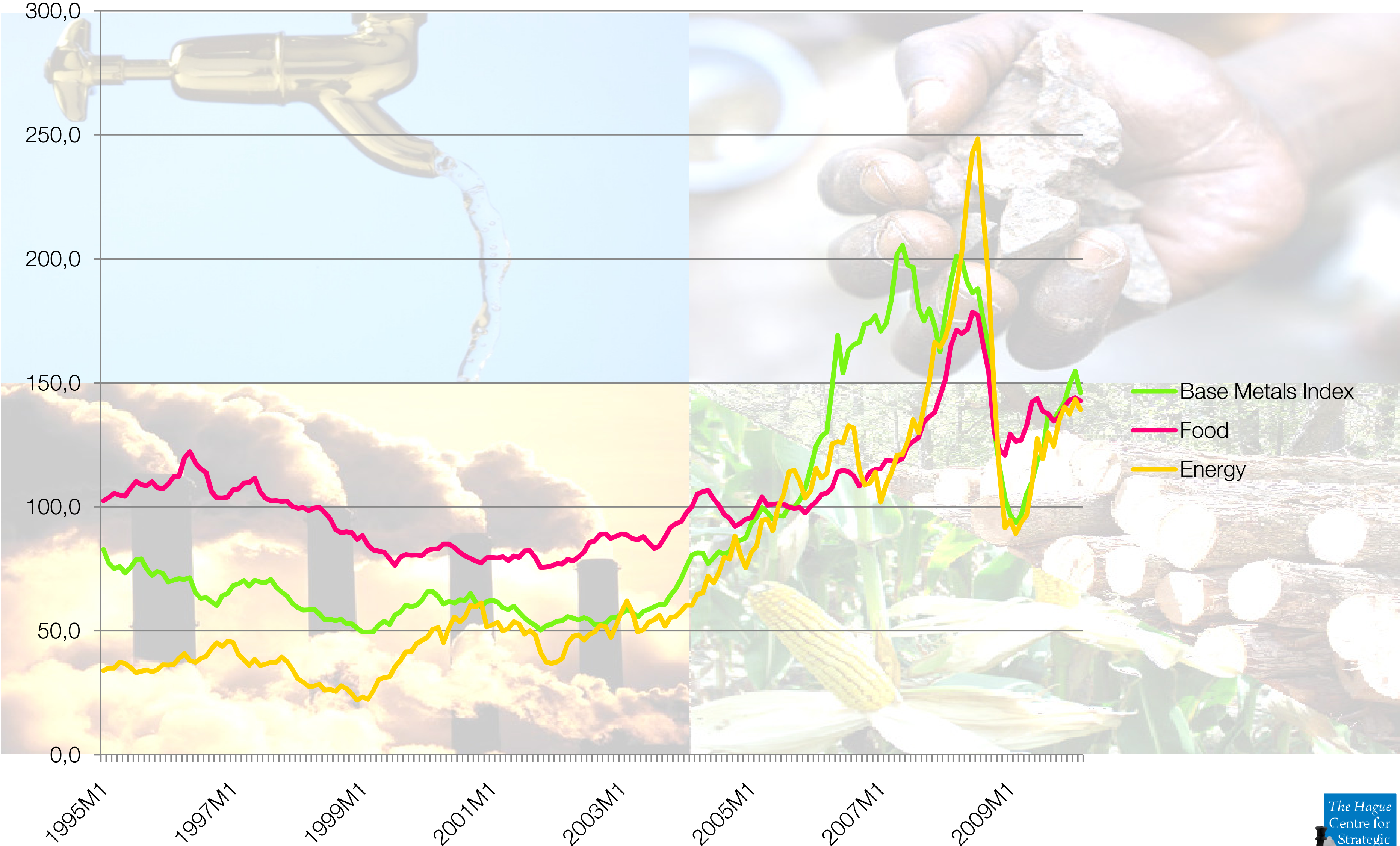
WHY MINOR METALS MATTER TO GOVERNMENTS



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WHY MINOR METALS MATTER TO GOVERNMENTS

Element	Market Share of China	Announced 2010 Quota	2009 Export Duty
Dysprosium (Dy)	99%	Full export ban	-
Lanthanum (La)	95%	ca. 9.000 t	-
Neodymium (Nd)	95%	ca. 5.000 t	-
Gallium (Ga)	83%	-	-
Germanium (Ge)	79%	-	-
Indium (In)	60%	233 t	-
Antimony	87%	57,500 t	-
Tungsten (W)	84%	14,300 t	20%
Magnesium (Mg)	48%	1,330,000 t	10%
Vanadium (V)	38%	-	30%
Molybdenum (Mo)	23%	25.500 t	-

WHY MINOR METALS MATTER TO GOVERNMENTS

Element	Main Applications
Dysprosium (Dy)	Permanent magnets: electrical vehicles; wind turbines
Lanthanum (La)	Nickel-metal hybrid batteries: electrical vehicles
Neodymium (Nd)	Permanent magnets: electrical vehicles; wind turbines
Gallium (Ga)	Semiconductors; solar energy cells; LEDs; defense applications
Germanium (Ge)	Semiconductors; solar energy cells; LEDs; fiber-optics; infra-red
Indium (In)	liquid crystal displays (LCD); semiconductor; solar energy cells; LEDs
Antimony (Sb)	Solder, Semiconductors
Tungsten (W)	High-performance steel (strength, heat resistance); e.g. industrial cutting tools
Magnesium (Mg)	High-performance steel (light-weight, malleability); e.g. car-bodies, airplanes
Vanadium (V)	High-performance steel (anticorrosion, heat/shock resistance); e.g. jet engines
Molybdenum (Mo)	High-performance steel (anticorrosion, heat/wear resistance); e.g. rocket engines

Table 3. Number of WWS power plants or devices needed to power the world's and the U.S.'s total energy demand in 2030 (11.5 TW and 1.8 TW, respectively, from Table 1) assuming a given partitioning of the demand among plants or devices.

Energy Technology	Rated power of one plant or device (MW)	Percent of 2030 power demand met by plant/device	Number of plants or devices needed World	Number of plants or devices needed U.S.
Wind turbine	5	50	3.8 million	590,000
Wave device	0.75	1	720,000	110,000
Geothermal plant	100	4	5350	830
Hydroelectric plant	1300	4	900	140
Tidal turbine	1	1	490,000	7600
Roof PV system	0.003	6	1.7 billion	265 million
Solar PV plant	300	14	40,000	6200
CSP plant	300	20	49,000	000046

Source: Scientific American, November 2009.

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GOVERNMENTS STUDY MINERALS…

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…DETERMINE ELEMENTS OF CRTICAL STRATEGIC IMPORTANCE…

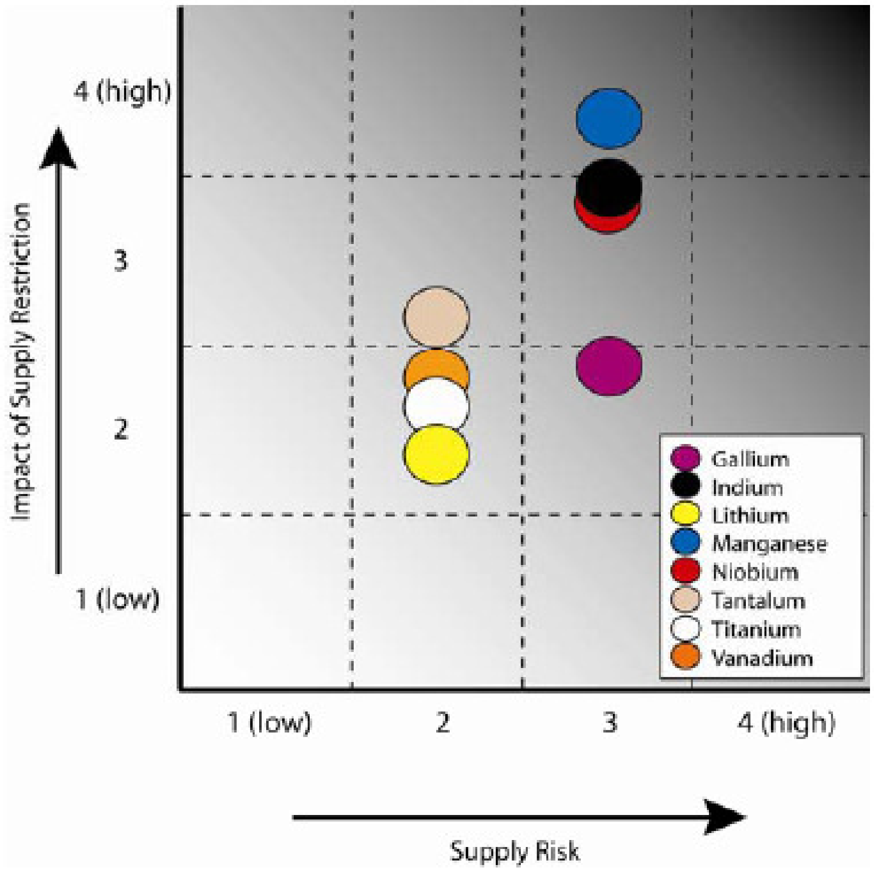


FIGURE 4.6 The criticality matrix for the eight candidate materials discussed above. Of the eight, niobium, indium, manganese, and potentially gallium stand out as materials of potential concern to the U.S. economy.

Source: National Research Council, *Minerals, Critical Minerals, and the U.S. Economy.* Washington: National Academies Press, 2007.

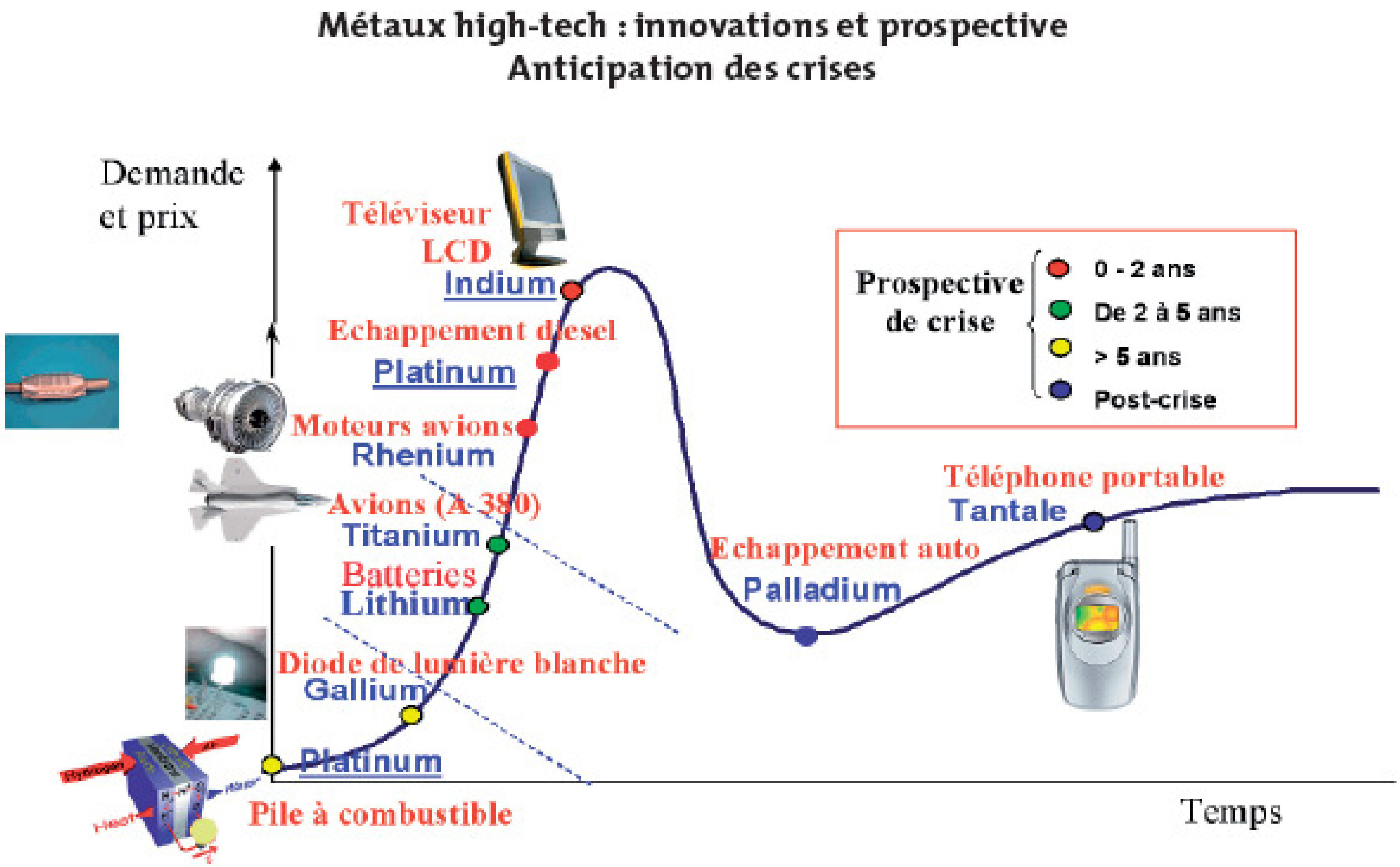
Tabelle 3.3: Für Deutschland potentiell risikoreiche Importrohstoffe

	Risikoindikator		Risikoindikator
Kupfer	0,56	Magnesit	0,02
Germanium	0,46	Vanadium	0,01
Zink	0,46	Magnesium	-0,02
Blei	0,46	Industriediamanten	-0,10
Aluminium (Bauxit)	0,35	Flussspat	-0,15
Silizium	0,33	Chrom	-0,23
Niob	0,12	Sillimanit	-0,35
Palladium	0,04	Zinn	-0,46

Quelle: BGR (2005) und eigene Berechnungen

Source: M. Frondel, G. Angerer et al, *Trends der Angebots - und Nachfragesituation bei mineralischen Rohstoffen*. RWI Essen, ISI, BGR, 2007.

…DETERMINE ELEMENTS OF CRTICAL STRATEGIC IMPORTANCE…



Source: C. Hocquard, "Les nouveaux matériaux stratégiques, métaux high tech, métaux verts, vers une convergence," *Mag'Mat*, No. 26, 2008.

…DETERMINE ELEMENTS OF CRTICAL STRATEGIC IMPORTANCE…

Material	Symbol	Overal Material Insecurity	Material Risk				Supply Risk			
			A - Global Consumption	B - Substitutability	C - GWP	D - TMR	E - Scarcity	F - Monopoly Supply	G - Political Stability	H - CC Vulnerability
Gold	Au	21	2	2	3	3	3	2	3	3
Rhodium	Rh	20	1	3	3	3	2	3	2	3
Mercury	Hg	20	2	2	3	2	2	3	3	3
Platinum	Pt	20	1	2	3	3	3	3	2	3
Strontium	Sr	19	2	3	2	2	2	2	3	3
Silver	Ag	19	2	2	3	2	3	1	3	3
Antimony	Sb	19	2	2	2	1	3	3	3	3
Tin	Sn	19	2	3	2	2	3	1	3	3
Magnesium	Mg	18	2	3	2	1	2	2	3	3
Tungsten	W	18	2	2	2	2	2	2	3	3
Baryte	$BaSO_4$	18	2	2	2	2	2	2	3	3
Talc	$H_2Mg_3(SiO_3)_4$	18	2	2	2	2	2	2	3	3
Bismuth	Bi	18	2	2	2	2	2	2	3	3
Palladium	Pd	18	1	2	3	3	3	2	3	1
Nickel	Ni	18	3	2	2	2	3	2	3	1
Boron	B	18	3	2	2	1	2	3	3	2
Andalusite	Al_2SiO_5	18	2	2	2	2	2	3	2	3
Molybdenum	Mo	17	2	3	2	2	2	2	2	2
Zinc	Zn	17	3	2	1	1	3	1	3	3
Holmium	Ho	17	1	2	2	2	2	2	3	3
Terbium	Tb	17	1	2	2	2	2	2	3	3
Fluorspar	CaF_2	17	2	2	1	2	2	2	3	3
Arsenic	As	17	2	2	2	1	2	2	3	3
Graphite	C	17	2	2	1	2	2	2	3	3
Ammonia	NH3	17	2	2	2	2	2	1	3	3
Cobalt	Co	17	2	2	2	2	2	2	3	2
Europium	Eu	17	1	2	2	2	2	2	3	3
Gadolinium	Gd	17	1	2	2	2	2	2	3	3
Osmium	Os	17	1	2	2	3	2	2	3	2
Borate	$B(OR)_3$	17	3	2	2	2	2	1	3	2
Niobium	Nb	17	2	2	2	2	2	2	2	3
Kyanite	Var	17	2	2	2	2	2	3	2	2

Source: Resource Efficiency Knowledge Transfer Network, *Material Security. Ensuring Resource Availability for the UK Economy*. Chester: C-Tech Innovation Ltd, 2008.

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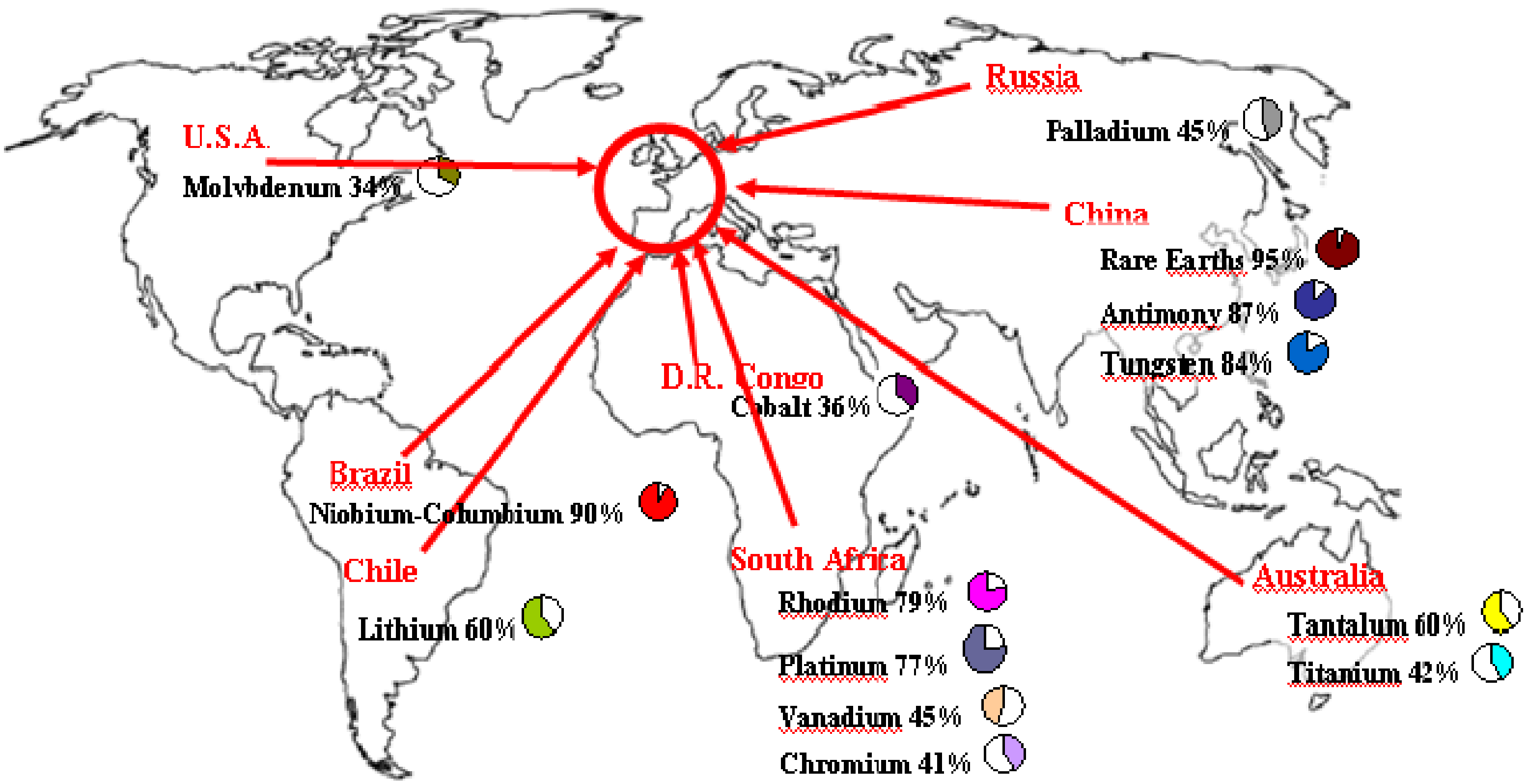
…DETERMINE ELEMENTS OF CRTICAL STRATEGIC IMPORTANCE…



Data source : World Mining Data (2008) **=USGS (2008)
The figures and pie graphs indicate the proportion of world production

Source: Commission of the European Communities, "Commission Staff Working Document accompanying the Communication from The Commission to the European Parliament and the Council: 'The Raw Materials Initiative – Meeting our Critical Needs for Growth and Jobs in Europe'." Brussels, 2008.

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...AND MOVE TOWARDS LEGISLATION!

USMMA
UNITED STATES MAGNETIC MATERIALS ASSOCIATION

FOR IMMEDIATE RELEASE
February 4, 2010

Magnet Materials Supply Chain Players Propose Six-Point Plan to Address Impending Rare Earths Crisis
USMMA Offers Path Forward to Federal Government Leaders

Washington, DC – The United States Magnet Materials Association ("USMMA"), a coalition of companies representing domestic high performance magnet producers and suppliers, today submitted a proposal to the U.S. Departments of Commerce, Energy, State, and Defense, Office of the U.S. Trade Representative, and Office of Science and Technology Policy within the Executive Office of the President to create a "whole-of-government" approach to resolving the Rare Earth Elements (REE) supply crisis, a serious threat to the United States' economic and national security.

Today, the United States is totally dependent on foreign sources for rare earth materials. These elements are essential to numerous renewable energy and defense systems including wind turbines, hybrid-electric batteries, computer hard drives and precision-guided munitions. Currently, China provides over 97% of the world's rare earth raw materials and dominates the world's rare earth refining, alloying and manufacturing.

USMMA proposes the creation of an interagency working group, with high-level principals identified and empowered by the Secretaries of Commerce, Defense, Energy, State, the U.S. Trade Representative and the Executive Office of the President, charged with implementing a six-point plan to restore a domestic rare earth supply chain to meet economic and national security needs:

1. *Establish a baseline - Studies by affected agencies to establish a baseline of rare earth usage and dependence and any economic or national security issues that result, as well as an action plan to restore specific holes in the domestic supply-chain, to include mining, refining, alloying and manufacturing [Note: many of these are ongoing]*
2. *Obtain raw material necessary to resume defense critical rare earth manufacturing in the face of a pending worldwide shortage - A program whereby the Defense National Stockpile purchases existing rare earth supply to support the US Government's critical needs while the domestic supply chain is rebuilt over the next 5 years*

COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels,
COM(2008) 699

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL

THE RAW MATERIALS INITIATIVE — MEETING OUR CRITICAL NEEDS FOR GROWTH AND JOBS IN EUROPE

{SEC(2008) 2741}

EN EN

国土资源部关于下达2010年钨矿锑矿和稀土矿开采总量控制指标的通知 Page 1 of 2

中华人民共和国国土资源部
Ministry of Land and Resources of the People's Republic of China

http://www.mlr.gov.cn/zwgk/zytz/201003/t20100315_141382.htm 17-3-2010

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MINERAL POLICY BENCHMARK

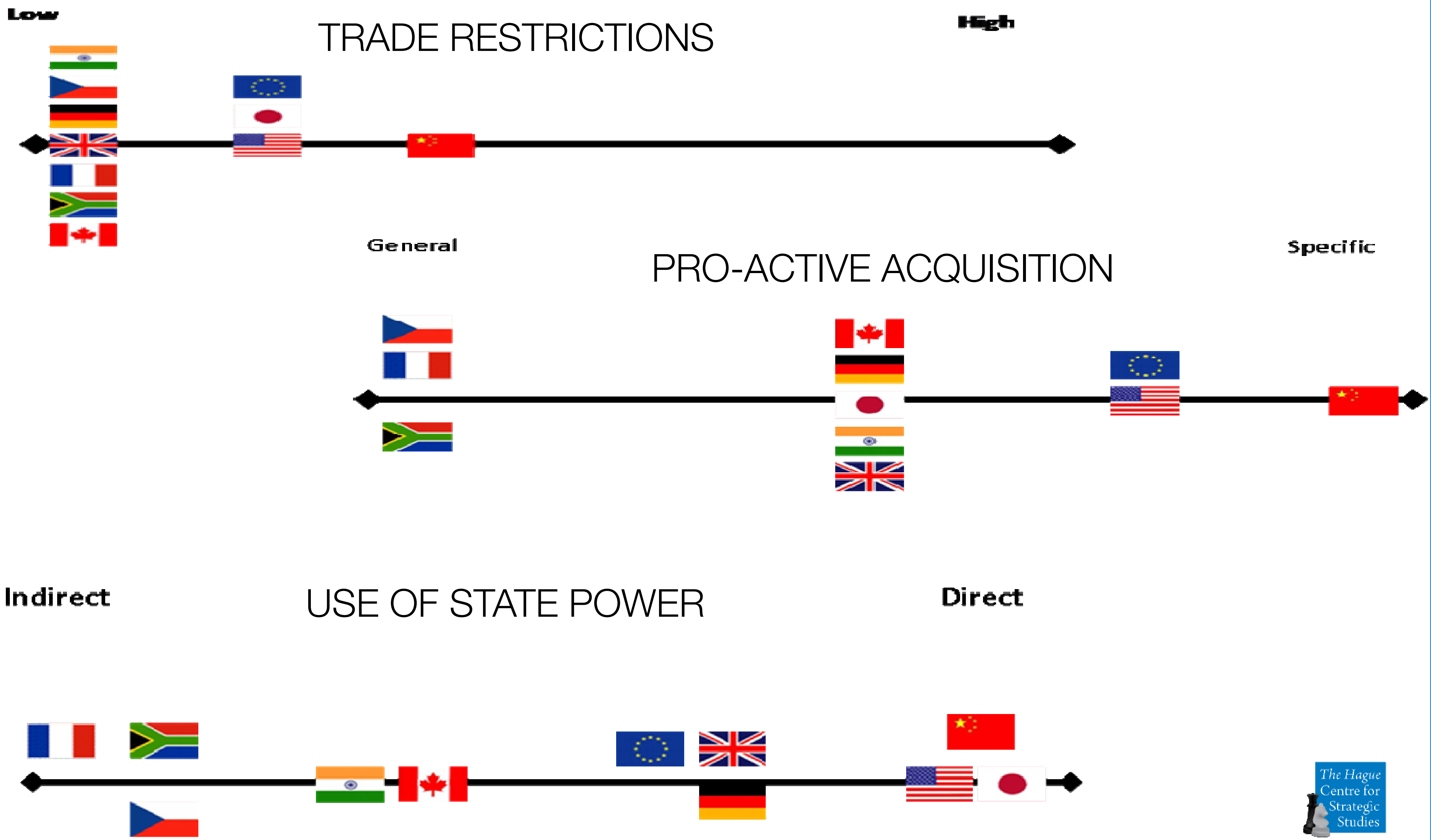
Policy Features	US	UK	FR	GE	CZ	IN	CN	CA	SA	JP	EU
National Geo. Survey	X	X	X	X		X	X	X	X	X	X
Local Policy (bottom-up)		X				X					
Nat. Policy (top-down)	X			X	X		X	X	X	X	X
Nationalised Companies						X	X			X	

POLICY CATERGORISATION AND VARIABLES

Type of Policy	Policy Instrument
National Governance	Domestic Supplier, Preference, Direct State Involvement, National Coherent Government Policy, National Transparency, National Good Governance, Public-Private Partnerships, National Enterprise Preference, Private Enterprise Preference
Trade Restrictions	Tariffs, Import Restrictions, Export Restrictions, Direct Subsidies, Export Subsidies, Layered Exchange Rates, Administrative Barriers, (Anti-) Dumping Policies
Technology Advancement	Renewable Energy, Recycling, Substitutes, Research & Development, Domestic Capacity Improvement, Knowledge Base Improvement
Pro-active Acquisition	Identification Critical Minerals, Stockpiling Minerals, International Strategic Partnerships, Foreign Direct Investment
Development Cooperation	Development Aid, Transparency, Good Governance
Global Governance	Liberalisation World Market, Collaborative Governance

Variables	Cat.	US	CA	CN	JP	GB	FR	GE	CZ	EU	IN	SA
Domestic supplier preference	NG	X		X		X						
Direct state involvement	NG	X		X	X							X
Coherent government policy	NG	X	X		X	X	X	X		X	X	
National good governance	NG		X	X							X	X
National Transparency	NG		X	X							X	X
Public-Private partnerships	NG	X			X	X		X			X	X
Nationalised enterprises	NG		X									X
Privatised enterprises	NG								X		X	
Tariffs	TR											
Import restrictions	TR									X		
Export restrictions	TR											
Direct subsidies	TR			X	X							
Export subsidies	TR											
Exchange rates	TR											
Administrative barriers	TR	X		X								
Anti-dumping measures	TR											
Renewable energy	TA		X	X		X	X	X	X	X		
Recycling	TA		X	X		X		X	X	X		X
Substitutes	TA	X				X	X	X		X		
Research & Development	TA	X	X	X		X	X	X	X	X	X	X
Dom. capacity improvement	TA	X		X				X	X	X	X	
Knowledge base improvement	TA	X						X	X	X	X	
Identification critical minerals	PA	X		X		X						
Stockpiling critical minerals	PA	X		X		X						
Int. strategic partnerships	PA	X	X	X	X			X		X		
Foreign direct investments	PA			X	X			X		X	X	
Development aid	DC		X		X	X		X		X		
Transparency	DC		X			X		X		X		
Good governance	DC		X			X		X		X		
Liberalisation world market	GG		X		X	X		X	X	X		X
Global governance	GG		X	X	X	X	X	X	X	X		X

BENCHMARK RESULTS



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CONCLUSIONS

•Governments around the world are beginning to pay **increased attention** to REEs and minor and specialty metals. This is due to:

- Recent upward trajectory of commodity prices
- Increasing appreciation of their role in emerging technologies
- Concerns about supply choke-points, particularly China
- Their strategic role in enabling the energy transition

•In **response** governments have began to:

- Designate critical or strategic metals,
- Monitor supply and demand
- And move towards regulating supply, trade, and consumption

•Authorities are **motivated by** interests to:

- Secure access to key materials for their economies
- Increase profits from their natural resources
- Gain influence on valuable downstream industries
- Attain strategic bargaining chips (?)

CONCLUSIONS

•If the role and prices of REEs and minor and specialty-metals keep increasing, this will certainly cause more attention and intervention in markets, both by supplier and consumer countries.

•This is likely to have consequences across the entire value chain:

- •Minerals might not necessarily be mined were most profitable
- •Countries might regulate trade
- •Countries might create stockpiles
- •Countries might ration consumption
- •Countries might introduce domestic supplier preference

All this matters to your business!

Questions?

Our Report is available for download at the HCSS website:

www.hcss.nl

For remarks: jaakko@hcss.nl