

**Natural Resources GP**

**Recent Technology and Policy  
Developments in Critical Materials  
CRM, with REE emphasis**

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**The 18th International Workshop, TACEC Milan,  
Nov 19-21, '13 *as presented***

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## ... Definitions – Critical vs Essential...

### Fundamental Distinction

- Security of supply + Importance of applications
- Critical: medical, defense, aerospace, high-tech, green-energy; also: political risk in supply, 'blood minerals'
- Essential: day-to-day life [agriculture, construction, basic industries] but w/ no visible political risk in the supply; however, if access becomes restricted [permit delays?] → essential can become critical

## ...Definitions – Critical vs Essential...

### Critical [EC]

- Antimony
- Indium
- Beryllium
- Magnesium
- Cobalt
- Niobium
- Fluorspar
- PGMs
- Gallium
- Rare earths
- Germanium
- Tantalum
- Graphite [→ Graphene]
- Tungsten

### Essential

- Salt
- Potash
- Bauxite and Aluminium
- Iron ore
- Ferroalloys
- Magnesite
- Gypsum
- Many industrial minerals,...

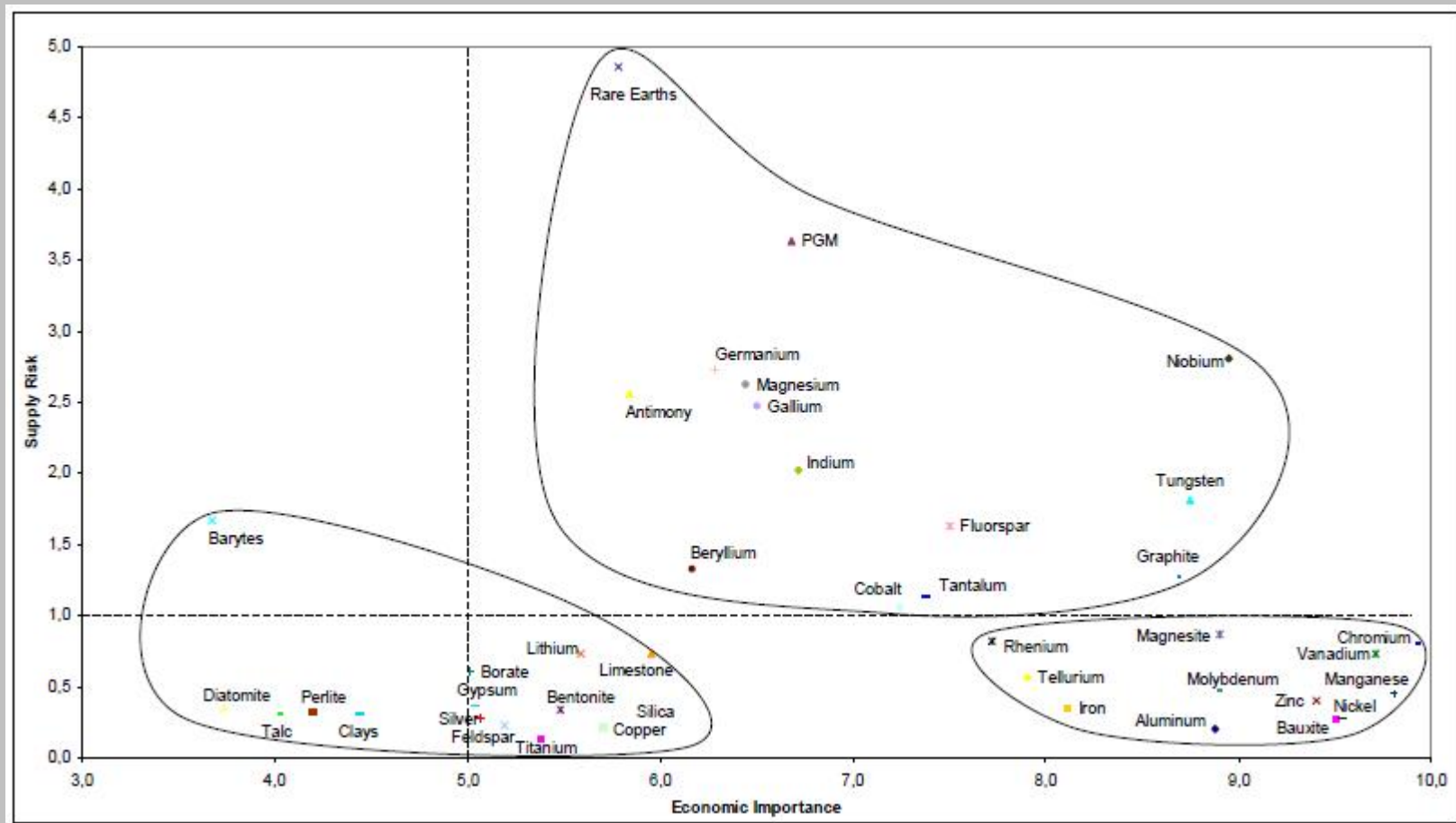
## ... Definitions – Critical vs Essential...

### **Criticality Criteria: Technical, commercial and political factors**

- Entire cycle: Extraction > Processing > Components > End-Use Technologies > Recycling and Reuse
- Economic Importance
- Import Dependence
- Supply Risk, Country Risk
- Recycling
- Substitutability
- Environmental issues
- Policies: Emerging economies pursue industrial devt strategies [trade, taxation, investment instruments] to reserve resource base for exclusive use
- Hence: shortages for the EU [and the 'West' in general]

# ... Definitions – Critical vs Essential

## The EU 14 critical raw materials



## Examples: CRM production to application...

### Raw materials

- Lifeblood of EU industry
- 30 million jobs in the EU
- Increasing demand for unprocessed minerals and metals
- Strong challenges to the supply of certain raw materials, including price volatility and market distortions
- Green energy applications: silicon, rare earths, lithium, graphite made renewable energy applications possible [wind, solar power], considered viable alternatives to conventional power options → green battery options, applications for solar cells, flexible batteries

# ...Examples: CRM production to application...

## REE

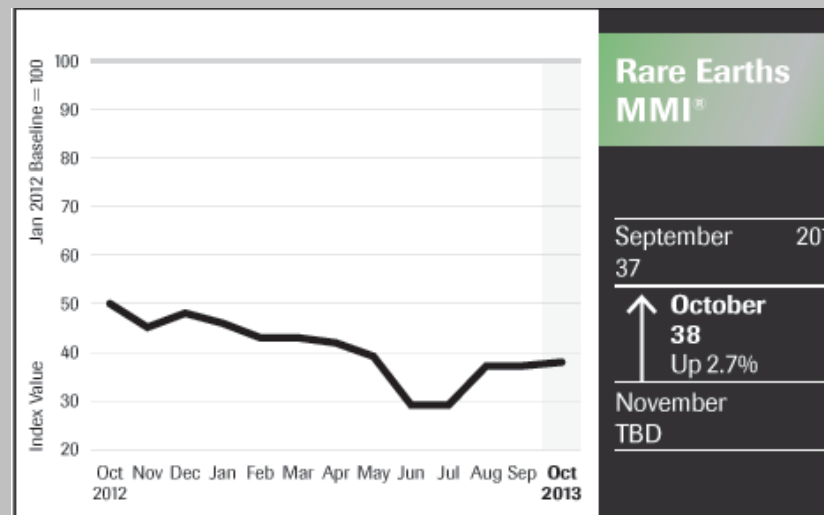
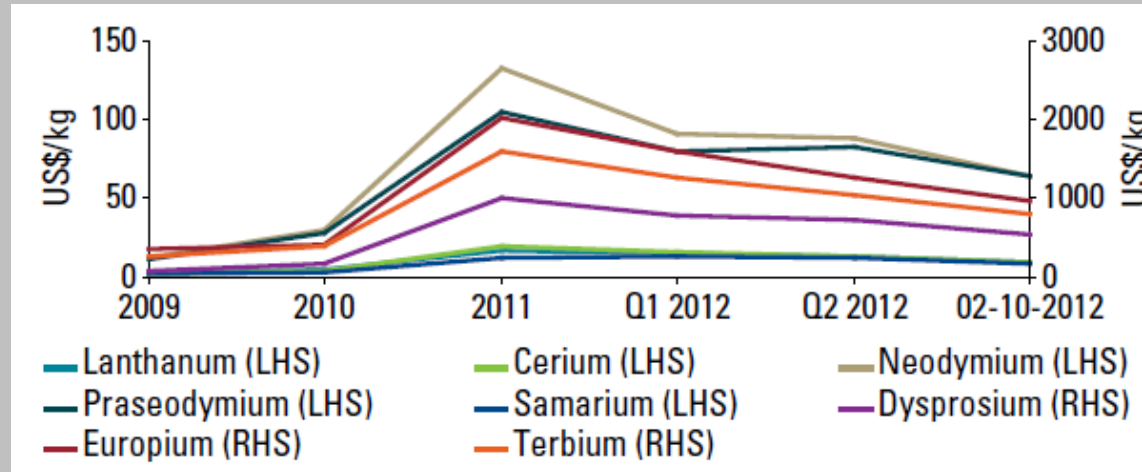
- Naturally occurring non-toxic materials, unique properties essential for emerging technologies and environmental, energy efficiency, health solutions
- 16 elements: 15 lanthanide-series elements + yttrium
- Similar chemical properties, ability to readily discharge & accept electrons, indispensable & not-easily-replaceable in electronic, optical, magnetic, catalytic applications

														3	IIIB
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														88.906	
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	
138.91	140.12	140.91	144.24	(145)	150.36	151.96	157.25	158.93	162.50	164.93	167.26	168.93	173.04	174.97	
LREE								HREE							



# ...Examples: CRM production to application...

## REE Prices



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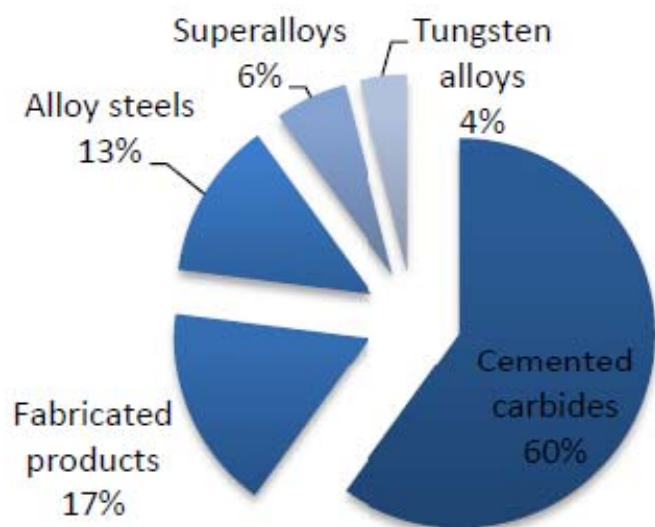
## ...Examples: CRM production to application...

### Magnesium Mg

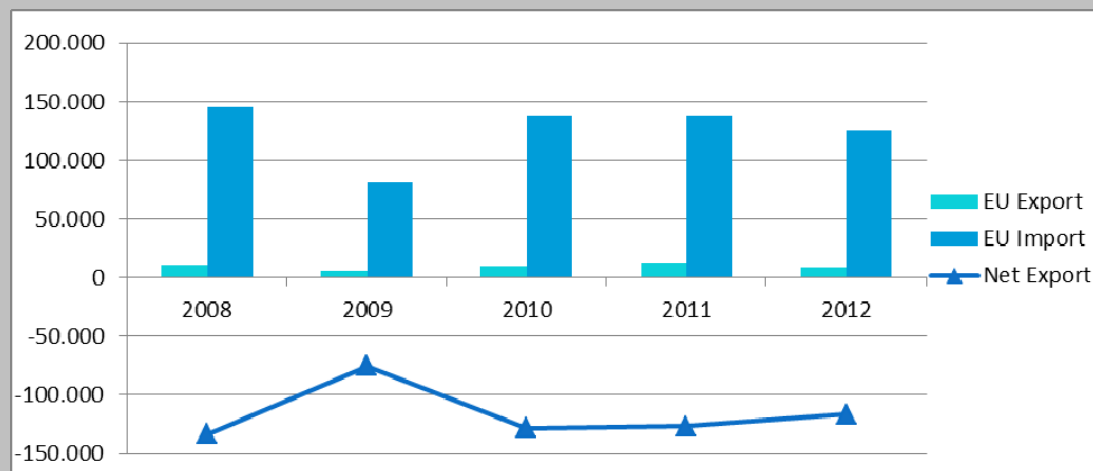
- In over 60 different minerals
- Most important sources: dolomite, seawater/ brine magnesite...and magnesite in China [dbm earlier in France]
- EU imports 90% fm China.
- Non-EU: High purity mostly exported to Norway 34%, USA 18, Turkey 17; low purity to USA 32, Switzerland 29.
- Major uses: Al-Mg alloys, in aerospace & automobile industry, production of [food] packaging products mainly beverage cans, wide range of consumer products: tennis rackets, fishing gear, computer printers, bakery racks.

# ...Examples: CRM production to application...

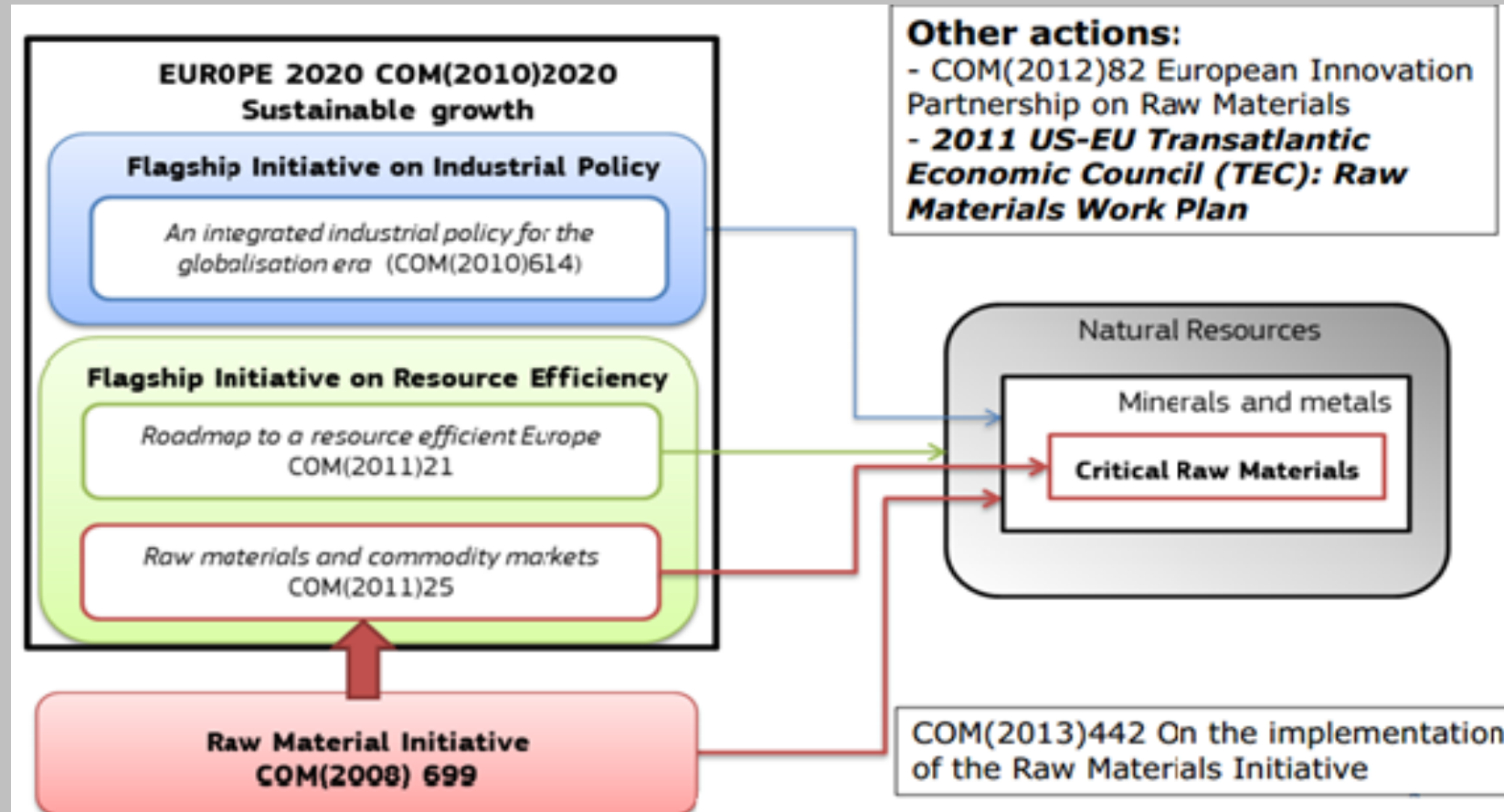
## Main Mg uses



## Real magnesia prices *deflated, 2011 = 100*



## Established CRM policies...



## ...Established CRM policies...

### EU

EU Raw Materials Initiative RMI- to contribute to 2020 EU Industrial Policy [increase industry share to 20% of GDP] and to the Resource Efficiency Policy ensuring raw materials sustainable supply

Greenland: *June 2012*: EC signed a Letter of Intent on co-operation on raw materials

**w/ Africa:** Bilateral AUC-EC co-operation on raw materials & devt based on the EU RMI & the African Union policy on mining and minerals, the 2009 'African Mining Vision'

**w/ LatAm** '11 RM co-operation w/ Chile, Uruguay, joint press release w/ Argentina. '12 LOIs w/ Columbia, Mexico. '12: w/ Uruguay on geological knowledge, green economy, energy efficiency, recycling, training, sustainability, innovation, etc. Uruguay offered observer status in EIP

## ...Established CRM policies...

### US

Legislative initiatives -- but DoD/DoE dichotomy on REE  
RAND study, Critical Materials: Present Danger to U.S.  
Manufacturing, '13

Multilateral w/ EU, Japan – see below, but also WTO on REE

### China

7/12: ~6bi RNB Stockpile strategic reserves, incl 10kpt  
M,HREE. 7/12: Cuts REE mining permits 41%. 8/12: 1st REE  
export increase in 3 years, no new mining licenses to '15.  
Consolidate number of companies. Shut illegal mines.  
Increase taxation for Chinese producers. 9/12: Tougher EHS,  
Co-ordinated pricing, withdrawal of VAT rebate on exports,  
Emphasis on HRE, Assistance in R&D

## ...Established CRM policies...

### Japan

10/11 workshops in Washington, Tokyo. 3/12 to research the substitution of raw materials. 5/13 Brussels, trilateral EU/US/Japan w/ govt representatives, the EC and industry, on efficient CRM mgmt

### Russia

*10/12:* St Petersburg industrial policy dialogue sub-group Russian govt & EC, w/ industry delegations →EC's overview of the latest developments in raw materials policy & update on industrial policy

9/13 investment announcement US\$1b in REE production, Russian billionaire to produce REE from thorium-bearing concentrate discarded fm Russian '40s atomic bomb devt

## Recent CRM technical and commercial developments...

- 7/13 **Brazil** Public & private sectors to develop REE industry
- 9/13 **Philippines** surveys old mines for Scandium, Yttrium
- 10/13 **Australia**: Lynas started commercial production of REE, but Malaysian plant operational problems
- /13 **Jamaica** RRE fm alumina red mud project
- 10/13 **Norway** undersea mining research gathers pace
- 10/13 **India**: Protests against [!] ban on REE mining

### Japan

- 6/13 Honda to reuse REE metal fm hybrid vehicle batteries



## **. . . Recent CRM technical and commercial developments...**

- ...11/13 REE Conf, HK: Japanese REE demand to increase 6% in '13, led by surge in polishing of high-quality glass surfaces: mirrors, television & monitors, cathode ray tubes, panel display, glass platters in hard disks...
- 11/13 Samsung R&D to reduce dependence on China REE for electronic products, incl optical materials to improve luminous efficiency w/o REE

### **Canada**

- 8/13 Avalon's Nechalacho REE Project at Thor Lake, NW Territories
- 10/13 REE Symposium: REE sector w/ goal of producing 20 pct of world demand for separated critical REE products by '18

## . . . Recent CRM technical and commercial developments...

- 11/13 Companies to get assistance fm Canadian govt w/ formation of new association 'Canadian REE Network CREEN'
- 11/13 Quest Rare Minerals Quebec REE project 'scares investors', total mine & processing plant \$2.57 bi construction Capex
- 1/13 US DOE research lab averting supply crunch of REE & other economically important raw materials, called the Critical Materials Hub
- 7/13 Apple's patent application submitted by a REE magnet coating
- 10/13 Nautilus Minerals to open 2<sup>nd</sup> seafloor mine by '17

## ... Recent CRM technical and commercial developments

- 10/13 US Rare Earths secures \$4 mi financing
- 11/13 Method to recycle REE fm industrial wastewater fm high-tech applications like cell phones & green technologies. Pilot-scale experiment uses flower-like nano-Mg(OH)<sub>2</sub>
- 11/13 EcoATM project: machine to be installed in shopping malls or large stores, shoppers and cell phone owners can recycle their old phones for cash
- RARE3 project: recycling processes based on non-aqueous technology for permanent magnets & lamp phosphors; by recycling REEs fm phosphors & magnets one specifically targets 5 most critical REE: Nd, Eu, Tb, Dy and Y

## Recent CRM policy developments...

### EU level:

- 4/12 report on EU Trade Policy for Raw Materials, info on RMI implementation in trade policy.
- 9/13 EC Vice-President Antonio Tajani: Innovation in raw materials – be it in mining, processing, recycling, or substitution –the key to future growth and jobs -- SIP implementation to start Dec '13, Monitoring & evaluation, late '14
- EC's European REE Competency Network ERECON addressing supply security guided by a Steering Committee to set the agenda of the Working Group meetings of REE experts
- EC to issue report to EC-Council on CRM list review by '14.

## ... Recent CRM policy developments...

- 9/13 European Federation of Refractories Producers PRE fm a RM perspective, outlined how some refractory raw materials, eg graphite, can be considered critical when taking into account supply risk & economic importance. Magnesite and bauxite also identified as potentially critical.
- 10/13 Greenland Opens Up Rare Earth Mining Opportunities, parliament ends decades-long prohibition on mining radioactive materials including uranium and REE
- 11/13 EC report on Norra Karr 'Critical Metals in the Path towards the Decarbonization of the EU Energy Sector: Tasman Metals' Norra Kärr in Sweden 'is the only advanced REE project within the EU'
- 12/13? Commission to publish in the coming weeks the outcome of its 2<sup>nd</sup> review of CRM

## **. . . Recent CRM policy developments...**

**Russia:** Govt to spend \$1bn to expand REE production by '18 to cut dependence on China as Russia's stocks almost depleted

**Japan** to subsidize underwater REE venture,

**Norway** 11/13: scientists receive EU funding to develop REE fm e-waste

**US** 5/13 House Resources Committee approves REE/critical minerals bills

### **China**

- Baotou REE Products Exchange trial run: China's 1<sup>st</sup> internal trading platform -- to regulate prices & deals in the REE industry

- 7/13 Ministry of Commerce announced 2<sup>nd</sup> batch of REE export quota: 24 companies selected

- 10/13 China drafting REE rules on mining, Association

- 11/13 China opposes release of WTO report on REE

## ... Recent CRM policy developments

### Co-operation agreements

- 5/13 Japanese ministry agreement w/ EC & US DOE, to continue trilateral cooperation on efficient CRM mgmt. NEDO and Ames Laboratory, U.S., MoU to establish cooperation.
- EC committed in its RMI to continue to assess [w/ African countries] feasibility of further co-operation between Geo Surveys and in multilateral fora eg UNESCO Geosciences Programme
- 6/13 Report from the Commission to the EP, the Council, the European Economic & Social Committee and the Committee of the Regions On the implementation of the Raw Materials Initiative
- 12/13 Trilateral US-Japan-EU workshop on CRM, part of the European Raw Materials Diplomacy Events

## **Conclusions. Recommendations**

- **Supply-demand fundamentals are very important...**
- **...but also in CRM the market mechanism is not enough: China a major player, environmental issues etc**
- **Peoples' participation – 'social license'**
- **Recycling, substitution: partially working**
- **REE: Chinese export quotas never fully used up**
- **Molycorp, Lynas: technical, environmental, market and financial problems**
- **Policy measures 'to ensure extractive industries become foundation for local economic development': talk, no teeth so far**
- **Need for increased international efforts: offensive [devt] as well as defensive [WTO] – China might lift LREE quota**
- **Do not forget Essential Materials, too**



**Thank you very much!**  
**Vasili Nicoletopoulos**

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