

“The Challenges of Meeting Rare Earths Demand in 2015”

by

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Summary of Presentation

- The rare earths industry today
- China
- Present and future demand and supply
- Rare earths project essentials
- Potential new suppliers
- Lithium – threat or necessity?
- Sustainability through diversity

The Rare Earths Market Today

- Estimated demand in 2008/10: 124,000t REO
- Average price: US\$11-13/kg REO;
- Total value: US\$1½ billion pa
- Constraints on Chinese exports are creating opportunities for non-Chinese projects
- Several non-Chinese rare earths projects being evaluated
- 2010: Prices have started to recover with the improving global economy, particularly 'magnetic' rare earths.

Rare Earths – Commercial Concepts

- Rare earths are not commodities – customer specific
- Western rare earths enterprises are single project companies (debt has to be non-recourse project funded)
- Capital intensive (>US\$40/kg annual capacity)
- Long start-up; limited expertise outside China
- Supply and demand for individual REOs is not in balance
- Used in small quantities:
 - REO price has negligible impact on final product price
 - Limited recycling

Rare Earths – Technical Concepts

- Rare earths have unique chemical, magnetic and luminescent properties
- Each orebody is different; so the process route is project specific
- Pilot plant studies required to:
 - Generate samples for customer approval as basis for sales contracts
 - Demonstrate technical viability
 - Provide data for bankable feasibility study
 - Generate data for environmental impact statement
- Chemically similar so difficult to separate

China: Industry Constraints

- Production quotas – reserves limited
- Export quotas
- Export taxes: 15-25%
- VAT rebate on exports withdrawn
- No new rare earth mining licences
- Environmental legislation enforced
- Potential shortage of Nd, Tb and Dy

China: Export Quota History

Chinese Export Quota History 2004-2009 (Tonnes REO)

<u>Year</u>	<u>Rare Earth Quotas</u>				<u>ROW</u>
	<u>Domestic Companies</u>	<u>Foreign Companies</u>	<u>Total</u>	<u>Change</u>	<u>Demand</u>
2005	48,040t	17,659t	65,609t	0%	46,000t
2006	45,752t	16,069t	61,821t	-6%	50,000t
2007	43,574t	16,069t	59,643t	-4%	50,000t
2008	Actual: 34,156t Adjusted: 40,987t*	Actual: 13,293t Adjusted: 15,834t*	Actual: 47,449t Adjusted: 56,939t*	-5½%*	50,000t
2009	33,300t	16,845t	50,145t	-12%	25,000t
2010	Quota for 1H2010 is 16,304t compared with 15,043t for 1H2009	Quota for 1H2010 is 5,978t compared with 6,685t for 1H2009	n/a	n/a	48,000t

Note: * Quotas adjusted to an equivalent 12 month quota as there was a change in the dates for which they were issued; so that now they are for a calendar year

Chinese Rare Earths Production

Chinese Production of Rare Earth Chemical Concentrates 2004-15 (tpa REO $\pm 15\%$)

<u>Year</u>	<u>Bayan Obo Bastnasite</u>	<u>Sichuan Bastnasite</u>	<u>Ion Adsorption Clays</u>	<u>Monazite</u>	<u>Total (incl. illegal mining)</u>
2004	42-48,000	20-24,000	28-32,000	-	90-100,000
2006	45-55,000	23-28,000	40-50,000	8-12,000	125-140,000
2008	60-70,000	10-15,000	45-55,000	8-12,000	125-140,000
<i>2010f</i>	<i>70-80,000</i>	<i>10-15,000</i>	<i>30-40,000</i>	<i>4-8,000</i>	<i>110-130,000</i>
<i>2015f</i>	<i>80-100,000</i>	<i>20-40,000</i>	<i>40-50,000</i>	<i>8-12,000</i>	<i>170-185,000</i>

Global RE Consumption 2008

Estimated Global Rare Earths Demand in 2008 (t REO $\pm 10\%$)

(Source: Roskill, IMCOA, CREIC and Rare Earths Industry Stakeholders)

Application	China	Japan & NE Asia	USA	Others	Total
Catalysts	9,000	3,000	9,500	3,500	25,000
Glass	7,500	2,000	1,000	1,500	12,000
Polishing	8,000	4,500	1,000	1,500	15,000
Metal Alloys	15,500	4,500	1,250	1,000	22,250
Magnets	21,000	3,500	750	1,000	26,250
Phosphors	5,500	2,500	500	500	9,000
Ceramics	2,500	2,500	1,250	750	7,000
Other	5,000	2,000	250	250	7,500
Total	74,000	24,500	15,500	10,000	124,000

The Last 18-24 Months

- Global financial crisis
- China declares 'heavy' rare earths resources are finite (approx. 15 years)
- Chinese export quotas steady in 2010
- Chinese export taxes maintained
- Stockpiles of rare earths to be established in Baotou and Southern China
- Consolidation of rare earths industry started in Baotou & Southern China

Forecast Demand in 2015

Global Rare Earths Demand in 2008/10 & 2015 (tpa REO) ± 15%

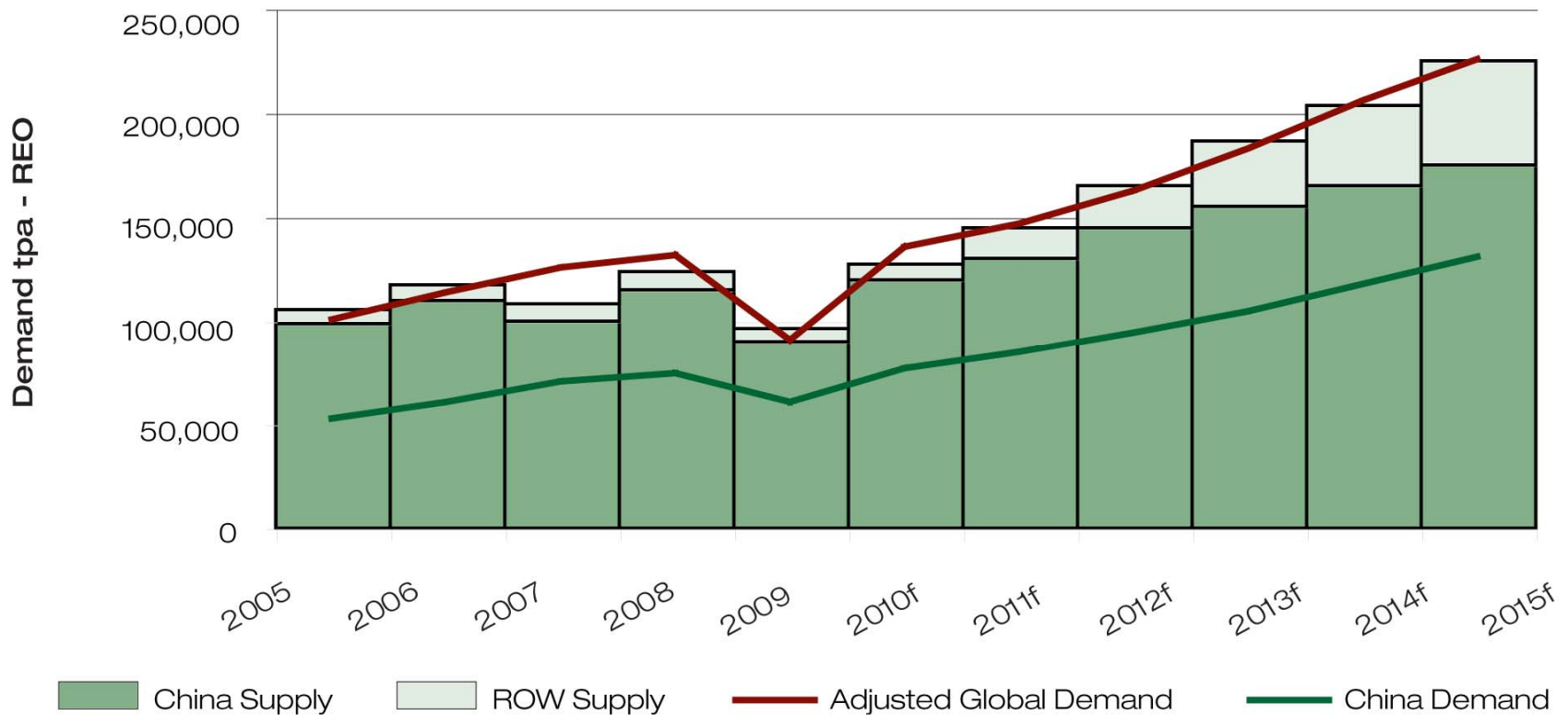
<u>Application</u>	<u>Consumption tpa REO</u>		<u>Market Share</u> <u>2015</u>
	<u>2008/10^f</u>	<u>2015^f</u>	
Catalysts	25,000	30-34,000	16%
Glass	12,000	13,000	6½%
Polishing	15,000	20-22,000	11%
Metal Alloys	22,250	50-55,000	26%
Magnets	26,250	45-50,000	23%
Phosphors & Pigments	9,000	12-14,000	6½%
Ceramics	7,000	8-10,000	5%
Other	7,500	10-12,000	6%
Totals	124,000	190-210,000	100%

The Issue of 'Balance' in 2015

Forecast Supply and Demand for Selected Rare Earths in 2015

<u>Rare Earth Oxide</u>	<u>Demand @</u> <u>190-210,000tpa REO</u>	<u>Supply @</u> <u>210-230,000tpa REO</u>
Cerium	65-70,000t REO	85-90,000t REO
Lanthanum	55-60,000t REO	55-60,000t REO
Neodymium	36-38,000t REO	35-37,000t REO
Terbium	450-500t REO	350-400t REO
Dysprosium	2,200-2,600t REO	1,800-2,000t REO

Rare Earths Supply & Demand



(Assuming current trends continue, new projects are developed and there is a 'balance' in supply and demand for individual rare earths through extra supply.

Source: Roskill, IMCOA, CREIC & Rare Earths Industry Stakeholders.)

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Rare Earths Project Essentials

- Compliant resource/reserve
- Rare earth minerals amenable to concentration
- Continuous pilot plant to demonstrate/provide:
 - Ability to produce products to customer specifications
 - Data for bankable feasibility study
 - Data for environmental impact statement, including radioactive waste management
 - Viability of project for investors and banks
- Access to labour, power, water and chemicals
- Realistic marketing strategy
- Adequate funding including working capital
- Realistic construction and start-up schedule

Potential North American Suppliers

<u>Factor</u>	<u>Mountain Pass</u> (USA) RCF, Goldman Sachs & Traxys	<u>Hoidas Lake</u> (Canada) Great Western Minerals Group	<u>Nechalacho</u> (Canada) Avalon Ventures Ltd	<u>Bear Lodge</u> (USA) Rare Element Resources Ltd
Status	Re-commissioned separation plant. Feasibility study of re-commencing mining and processing underway.	Advanced exploration. Some preliminary test work completed. Could be supplemented by Steenkampskraal Project in South Africa	Pre-feasibility study underway. Some preliminary test work completed.	Resource engineering study underway. Process development commenced
Resource	20Mt @9.2% REO 1.8Mt REO contained (a proven reserve)	2½Mt @ 2.4% REO 0.06Mt REO (inferred)	69Mt @2.0%REO 1.3Mt REO (inferred)	9 Mt @ 4.1% REO 0.4 Mt REO (inferred)
Potential Production	Target: 18,000t pa REO; start-up in 2012. Phase #2 : +100%	Hoidas : 3-5,000 tpa REO Start-up post 2014. Steenkampskraal maybe in 2013/14	3-5,000 tpa REO Start-up post 2014	Unknown
Critical Issues	■ New owners ■ Completing DFS ■ Re starting an 'old' plant.	■ Define ore reserve ■ Develop process ■ Complete DFS ■ Approvals ■ Customer support	■ Define ore reserve ■ Develop process ■ Complete DFS ■ Approvals ■ Customer support	■ Define ore reserve ■ Develop process ■ Complete DFS ■ Approvals ■ Customer support

Other Potential Suppliers

<u>Factor</u>	<u>Mt Weld</u> (Australia/Malaysia) Lynas Corporation Ltd	<u>Dubbo Zirconia</u> (Australia) Alkane Resources Ltd	<u>Nolans</u> (Australia) Arafura Resources Ltd	<u>Kvanefield</u> (Greenland) Greenland Minerals & Energy Ltd
Status	Start-up in late 2010. Project approvals in place. Construction well advanced but suspended	3 rd generation pilot plant in 'production' for customer samples. Approvals process well advanced	Pre-feasibility study complete. Pilot plant well advanced. Approvals process started.	Advanced exploration. Some preliminary test work.
Resource	12Mt @ 9.7% REO 1.2Mt REO contained (a proven reserve)	73Mt @ 0.9% REO 0.65Mt REO contained (a proven reserve)	30Mt @ 2.8% REO 0.85Mt REO contained	215Mt @ 1.0% REO 2.6Mt REO contained
Potential Production	10,500t REO pa in 2011. Several sales contracts in place. Increase to 21,000t REO in 2012/13	2,500tpa REO in 2013/14. REOs (rich in M&HREEs) will be by-products to zirconium chemical and niobium production.	20,000 tpa REO in 2014(?). Phosphate, calcium chloride & uranium co-products.	TBA. Potential for rare earths carbonate output to exceed 20,000 tpa REO as a co-product to uranium post 2014
Critical Issues	■Funding issues now resolved - no debt. ■Separation of mining and processing	■Complete DFS ■Approvals (started) ■Customer support	■Define ore reserve ■Confirm process ■Complete DFS ■Approvals (started) ■Customer support	■Define ore reserve ■Develop process ■Complete DFS ■Approvals ■Customer support.

The Ten Steps to Rare Earths Commercial Production

STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	STEP 6	STEP 7	STEP 8	STEP 9	STEP 10
Prove Resource	Process Defined	Pre-Feasibility Study	PILOT PLANT(S)			EIS Approval	Letters of Intent (LOI)	BFS & Funding	Construction & Start-up
			Beneficiation	Extraction	Separation				
Mt Weld (Lynas)									
Mountain Pass (Molycorp Expansion)									
Nolans (Arafura)									
Dubbo (Alkane)									
Nechalacho (Avalon)									
Hoidas Lake (GWMG)									
Bear Lodge (Rare Element Resources)									
Kvanefjeld (Greenlands Minerals & Energy)									

Lithium – Threat or Necessity?

- Lanthanum supply will probably not be able to meet total HEV demand beyond 2015/16.
- The ‘conversion’ to Li-ion batteries from LaNiH is likely to be slower than many commentators currently believe – but it will happen.
- In other words the successful development of a mass-production lithium battery technology is essential if the 2020 goals for HEVs and EVs is to be met.

Suggested Sustainability Policy

Department of Defence adopts a purchasing compliance policy that demands that all included imported 'strategic minerals' in the total supply chain are sourced so that:

- No more than 40/50% of imported 'strategic minerals' originate in the first country (unless a bilateral trade agreement in place).
- One Agency to be given stewardship for monitoring the ongoing situation.
- Independent verification of supply chain.
- Grants to develop production technology.
- Other entities may adopt code/compliance order.

The Outlook for 2015

- Supply will be tight.
- 'Balance' will still be an issue; so prices for Nd, Tb, and Dy will remain strong.
- Potential large surplus of Ce.
- China will not 'starve' the ROW of rare earths.
- First of new and potential projects should be on-stream.
- Demand: 190-210,000tpa REO – **will be met.**

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Sources of Reference

- Data from Roskill's 13th Edition “The Economics of Rare Earths” (November 2007).
- China Rare Earths Information Centre and other Chinese rare earths associations
 - Prices from *metal pages*©
 - Company web sites
- Private discussions with producers and consumers

Rare Earths Prices 2005 - 10

Comparison of Selected Rare Earths Prices US\$/kg REO 2005-10

(Notes: 1.Source is *metal pages*© 2. Prices have been rounded 3. US\$1.00 = C¥6.85)

<u>Rare Earths Product</u>	<u>Rare Earths Price FOB China</u>				<u>Rare Earths Price in China Jan/Feb 2010</u>
	<u>2005</u>	<u>2007</u>	<u>2009</u>	<u>Jan/Feb 2010</u>	
Lanthanum Oxide	US\$1.60	US\$3.10	US\$5.90	US\$5.55	US\$4.10
Cerium Oxide	US\$1.40	US\$2.50	US\$4.20	US\$4.15	US\$2.90
Praseodymium Oxide	US\$8.30	US\$28.00	US\$14.75	US\$24.75	US\$21.20
Neodymium Oxide	US\$7.40	US\$29.00	US\$14.85	US\$25.40	US\$21.90
Europium Oxide	US\$280	US\$300	US\$465	US\$480	US\$375
Dysprosium Oxide	US\$50	US\$85	US\$105	US\$125	US\$110
Terbium Oxide	US\$325	US\$555	US\$350	US\$355	US\$320
Yttrium Oxide	n/a	US\$6.85	US\$13.50	US\$10.25	US\$6.50
Rare Earth Carbonate	US\$1.40	US\$5.60	US\$8.10	US\$8.25	US\$4.55

China: RE Export Transition

- 1970s: Rare earth mineral concentrates.
- 1980s: Mixed rare earth chemical concentrates.
- Early 1990s: Separated rare earth oxides and metals.
- Late 1990s: Magnets, phosphors, polishing powders.
- 2000s: Electric motors, computers, batteries, LCDs, mobile phones.