Deutsche Bank
Markets Research

F.I.T.T.

Rating
Sell

Company
Lynas Corporation Ltd

Reuters	Bloomberg	Exchange	Ticker
LYC.AX	LYC AU	ASX	LYC

Date
15 July 2013

Australasia
Australia
M&M - Other Metals

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F.I.T.T. for investors

Pulling apart the rare earth market

'Bottom-up' analysis suggests most rare earths are oversupplied until 2016

With ex-China rare earth supply making a step change in 2013, we have reviewed the market balance to determine whether demand growth is strong enough to support a 30% increase in available supply. China dominates the global market (90% of supply, 70% of demand) and its rare earth policies have re-shaped the industry through vertical integration and supply constraints that have forced product substitution in many applications. 2011 prices have evaporated with global economic uncertainty, and we see current prices as the new reality. We believe Lynas is in a tough position with sales uncertainty and possible capital issues while it waits for a market recovery; rating cut to SELL.

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FITT Research

Price at 11 Jul 2013	0.47
Price target - 12mth	0.30
52 week range (AUD)	0.90 - 0.36
ALL ORDINARIES	4,885

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Chinese policy the largest swing factor in rare earth supply

After 20 years of global supply domination, Chinese policies are restricting rare earth production beyond domestic requirements and applying export duty rates and quotas to create a two-tiered price environment. Lynas and Molycorp (MCP.N, not covered) are preparing to bring ex-China supply into the market, just as global economic activity slows. The companies expect to have available capacity of c.40ktpa by 2014, greatly increasing supply in a global market that is currently c.110ktpa. A key risk to pricing forecasts is Chinese production quotas, particularly from 2016 when internal consumption looks likely to exceed the current 93.8kt production quota. If China meets domestic demand above current quotas, we see up to 17% downside to our 2018 prices.

Green technologies and developing economies to drive rare earth demand

Over 10 industry growth forecasts have been sourced from DB's global research teams to determine the key sectors that will drive rare earth demand over the coming decade. We expect the rare earth magnet industry to grow at 9-11% per annum on the back of growth markets such as wind turbines (DBe 26% CAGR) and the hybrid/electric vehicle industry (DBe 24% CAGR). The glass industry and polishing powders (5-6% CAGR) should benefit from exposure to developing markets and strong forecasts in global consumer electronics.

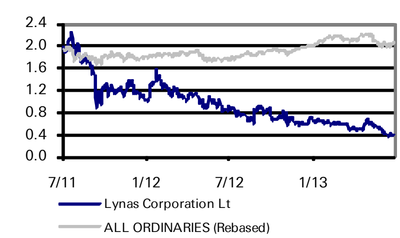
Rare earth 'basket price' concept doesn't tell the real story

With each deposit in the world having a different composition, and rare earth consumption unique to each demand market, we separate the rare earth elements into individual supply/demand forecasts. We see neodymium (Nd), praseodymium (Pr) & yttrium (Y) in strong demand with prices to increase over 40% by 2018. Conversely, lanthanum and cerium will likely be oversupplied.

LYC $0.30/sh PT (previously $0.58/sh); downgrade to SELL

Our PT is based on our DCF (13% nominal WACC). We updated our pricing and volume expectations and incorporated discounts for some intermediate product sales. We have lowered our EPS c.150% from FY14-FY16 and we do not expect LYC to have positive EPS until FY17. We also see significant funding risk, DBe net debt of $375m in FY14 and +40% gearing. Upside risks: movements in forex, the rare earth price and lower input costs.

Price/price relative



Performance (%)	1m	3m	12m
Absolute	-8.8	-9.7	-48.3
ALL ORDINARIES	2.9	-2.5	18.1

Model updated:08 July 2013

Running the numbers

Australasia

Australia

M&M - Other Metals

Lynas Corporation Ltd

Reuters: LYC.AX — Bloomberg: LYC AU

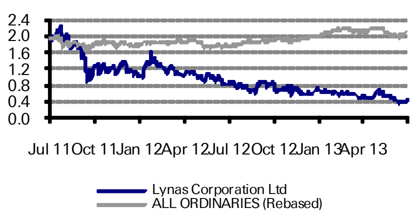
Sell

Price (11 Jul 13)	AUD 0.47
Target Price	AUD 0.30
52 Week range	AUD 0.36 - 0.90
Market Cap (m)	AUDm 875
	USDm 797

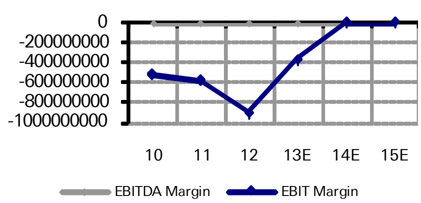
Company Profile

Lynas Corporation owns the Mt. Weld rare earth mining operation in Western Australia and a rare earths processing facility on the east coast of Malaysia.

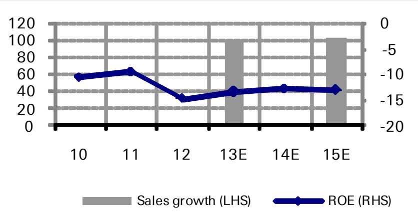
Price Performance



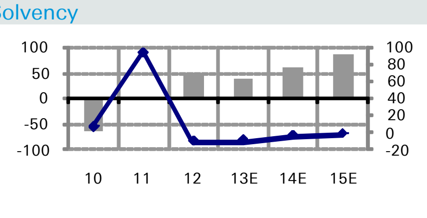
Margin Trends



Growth & Profitability



Solvency



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Fiscal year end 30-Jun	2010	2011	2012	2013E	2014E	2015E
Financial Summary						
DB EPS (AUD)	-0.03	-0.04	-0.05	-0.04	-0.04	-0.04
Reported EPS (AUD)	-0.03	-0.04	-0.05	-0.04	-0.04	-0.04
DPS (AUD)	0.00	0.00	0.00	0.00	0.00	0.00
BVPS (AUD)	0.37	0.37	0.33	0.35	0.31	0.27
Valuation Metrics						
Price/Sales (x)	nm	nm	nm	nm	5.5	2.7
P/E (DB) (x)	nm	nm	nm	nm	nm	nm
P/E (Reported) (x)	nm	nm	nm	nm	nm	nm
P/BV (x)	1.5	5.4	2.6	1.3	1.5	1.7
FCF yield (%)	nm	nm	nm	nm	nm	nm
Dividend yield (%)	0.0	0.0	0.0	0.0	0.0	0.0
EV/Sales	6.4	2.6	2.4	5.7	7.5	4.0
EV/EBITDA	-12.5	-44.3	-26.3	-15.7	-23.9	-75.6
EV/EBIT	-12.2	-44.3	-26.3	-15.5	-17.8	-24.5
Income Statement (AUDm)						
Sales	0	0	0	0	159	324
EBITDA	-51	-58	-90	-73	-50	-17
EBIT	-52	-58	-90	-74	-67	-53
Pre-tax profit	-43	-57	-98	-81	-83	-74
Net income	-43	-59	-88	-83	-83	-74
Cash Flow (AUDm)						
Cash flow from operations	-9	-34	-93	-85	-66	-38
Net Capex	-30	-194	-339	-164	-32	-40
Free cash flow	-39	-228	-433	-250	-98	-78
Equity raised/(bought back)	450	102	1	175	0	0
Dividends paid	0	0	0	0	0	0
Net inc/(dec) in borrowings	0	212	211	0	0	75
Other investing/financing cash flows	-22	-293	146	71	0	0
Net cash flow	387	-156	-76	-2	-98	-3
Change in working capital	*0*	*0*	*0*	*0*	*0*	*0*
Balance Sheet (AUDm)						
Cash and cash equivalents	405	198	124	121	24	21
Property, plant & equipment	179	361	707	882	897	901
Goodwill	0	0	0	0	0	0
Other assets	57	315	193	122	122	122
Total assets	641	874	1,024	1,125	1,043	1,044
Debt	0	212	403	399	399	474
Other liabilities	22	35	57	43	43	43
Total liabilities	22	247	460	442	442	517
Total shareholders' equity	619	627	563	684	601	527
Net debt	*-405*	*14*	*279*	*278*	*375*	*454*
Key Company Metrics						
Sales growth (%)	0.0	0.0	0.0	100.0	nm	103.2
DB EPS growth (%)	42.3	-35.8	-45.0	12.6	5.7	10.8
Payout ratio (%)	nm	nm	nm	nm	nm	nm
EBITDA Margin (%)	nm	nm	nm	nm	-31.5	-5.3
EBIT Margin (%)	-	-	-	-	-42.3	-16.3
ROE (%)	-10.5	-9.5	-14.7	-13.4	-12.9	-13.1
Net debt/equity (%)	-65.5	2.2	49.5	40.6	62.5	86.0
Net interest cover (x)	5.7	93.7	-11.5	-10.9	-4.4	-2.5
DuPont Analysis						
EBIT margin (%)	-	-	-	-	-42.3	-16.3
x Asset turnover (x)	0.0	0.0	0.0	0.0	0.1	0.3
x Financial cost ratio (x)	0.8	1.0	1.1	1.1	1.2	1.4
x Tax and other effects (x)	1.0	1.0	0.9	1.0	1.0	1.0
= ROA (post tax) (%)	-10.0	-7.8	-9.3	-7.8	-7.6	-7.1
x Financial leverage (x)	1.1	1.2	1.6	1.7	1.7	1.8
= ROE (%)	-10.5	-9.5	-14.7	-13.4	-12.9	-13.1
annual growth (%)	*24.6*	*10.0*	*-55.5*	*9.4*	*3.6*	*-1.6*
x NTA/share (avg) (x)	0.2	0.4	0.3	0.3	0.3	0.3
= Reported EPS	-0.03	-0.04	-0.05	-0.04	-0.04	-0.04
annual growth (%)	*42.3*	*-35.8*	*-45.0*	*12.6*	*5.7*	*10.8*

Source: Company data, Deutsche Bank estimates

LYNAS CORPORATION AND FINANCIAL SUMMARY DATA

		2012A		2013F		2014F		2015F		2016F		2017F		2018F		2019F		2020F
REO and AUDUSD																		
AUDUSD		1.03		1.03		0.95		0.93		0.90		0.87		0.83		0.80		0.80
Mt Weld REO (US$/kg)	**$**	**56.4**	**$**	**25.5**	**$**	**22.3**	**$**	**21.9**	**$**	**21.4**	**$**	**22.9**	**$**	**27.0**	**$**	**29.4**	**$**	**29.4**
Realised Price (US$/kg)	**$**	**-**	**$**	**-**	**$**	**19.4**	**$**	**19.9**	**$**	**19.5**	**$**	**21.1**	**$**	**25.1**	**$**	**27.4**	**$**	**27.4**
Lanthanum	$	19	$	9	$	7	$	7	$	6	$	6	$	6	$	6	$	6
Cerium	$	19	$	9	$	7	$	6	$	5	$	5	$	6	$	6	$	6
Cerium/Lanthanum	$	21	$	9	$	7	$	6	$	6	$	5	$	6	$	6	$	6
Neodymium	$	129	$	59	$	56	$	58	$	59	$	65	$	79	$	88	$	88
Praseodymium	$	109	$	59	$	54	$	52	$	57	$	69	$	86	$	96	$	96
Neodymium/Praseodymium	$	79	$	53	$	50	$	51	$	53	$	59	$	73	$	81	$	81
Samarium	$	15	$	7	$	5	$	4	$	4	$	5	$	5	$	6	$	6
Dysprosium	$	1,147	$	439	$	340	$	295	$	274	$	306	$	346	$	368	$	368
Europium	$	2,261	$	876	$	681	$	621	$	557	$	549	$	574	$	585	$	585
Gadolinium	$	24	$	22	$	20	$	21	$	22	$	23	$	25	$	25	$	25
Terbium	$	1,706	$	721	$	642	$	672	$	708	$	746	$	788	$	807	$	807
Yttrium	$	33	$	18	$	17	$	20	$	22	$	23	$	24	$	25	$	25
SEG	$	117	$	70	$	55	$	51	$	47	$	47	$	50	$	51	$	51

	2012A	2013F	2014F	2015F	2016F	2017F	2018F	2019F	2020F
PRODUCTION: REO (kt)									
Cerium carbonate	-	0.15	1.68	3.51	4.57	5.14	5.18	5.18	5.18
Lanthanum carbonate	-	0.08	0.87	1.82	2.37	2.67	2.69	2.69	2.69
Cerium/Lanthanum carbonate	-	0.23	2.34	4.05	5.28	5.94	5.98	5.98	5.98
Neodymium/Praseodymium oxide	-	0.16	1.42	1.82	2.37	2.67	2.69	2.69	2.69
SEG + Heavy Rare Earths	-	0.03	0.31	0.65	0.84	0.95	0.96	0.96	0.96
Cerium/Lanthanum/Pras carbonate	-	-	0.25	1.35	1.76	1.98	1.99	1.99	1.99
Neodymium oxide	-	-	0.17	0.91	1.19	1.34	1.35	1.35	1.35
Praseodymium oxide	-	-	0.17	0.91	1.19	1.34	1.35	1.35	1.35
Total	**-**	**0.6**	**7.2**	**15.0**	**19.6**	**22.0**	**22.2**	**22.2**	**22.2**
SALES: REO (kt)									
Mount Weld	-	-	7.8	15.1	19.6	22.0	22.2	22.2	22.2
Total	**-**	**-**	**7.8**	**15.1**	**19.6**	**22.0**	**22.2**	**22.2**	**22.2**
CASH COST (US$/kg)									
Mount Weld/LAMP	-	33.3	23.4	18.4	16.0	15.8	15.5	15.3	15.3
Average	**-**	**33.3**	**23.4**	**18.4**	**16.0**	**15.8**	**15.5**	**15.3**	**15.3**
CAPEX (A$m)									
Mount Weld/LAMP	341	167	32	40	44	44	44	38	38
Total	**341**	**167**	**32**	**40**	**44**	**44**	**44**	**38**	**38**
SALES REVENUE - Consolidated (A$m)									
Mount Weld/LAMP	0	0	159	324	423	535	668	755	759
Total	**0**	**0**	**159**	**324**	**423**	**535**	**668**	**755**	**759**
OPERATING PROFIT BY MINE (A$m)									
Mount Weld/LAMP	(90)	(74)	(67)	(53)	(18)	34	150	226	239
Total	**(90)**	**(74)**	**(67)**	**(53)**	**(18)**	**34**	**150**	**226**	**239**

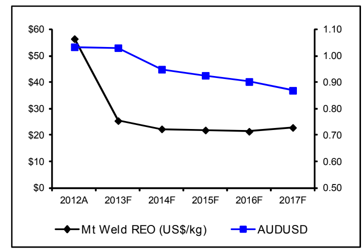
RESERVES & RESOURCES

	Resources			Reserves		
	Kt	% REO	REO (Kt)	Kt	% TLnO	TLnO (Kt)
Mount Weld- CLD	14,949	9.7%	1,454	9,700	11.7%	1,138.0
Mount Weld- Duncan	8,993	4.8%	435.0			
Crown Polymetallic	37,700	1.2%	437.4			
Kangankunde- Malawi	2,500	4.2%	105.0			
Total	**64,142**	**3.8%**	**2,431.8**	**9,700**	**11.7%**	**1,138**

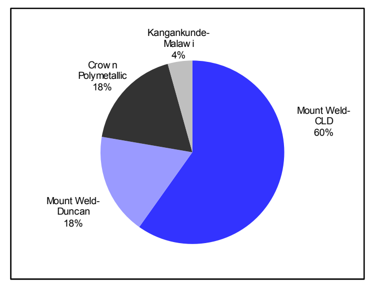
NPV (FY14)

	A$m	A$ps	(%)
Mt Weld & LAMP	**1,141**	**0.58**	**191%**
Crown Polymetallic	10	0.01	2%
Kangankunde- Malawi	-	-	0%
Exploration (incl. Duncan deposit)	10	0.01	2%
Corporate	(189) -	0.10	-32%
		-	
Gross Asset Value	**972**	**0.50**	**163%**
Net Debt	375	0.19	63%
Valuation	**597**	**0.30**	**100%**
Shares on issue	**1,961**	M	
NPV discounting rate:	**13%**		

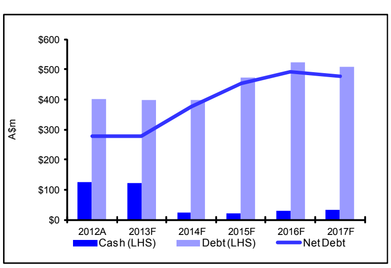
REO & AUDUSD



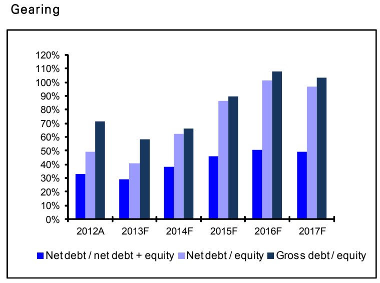
Resources - REO Content



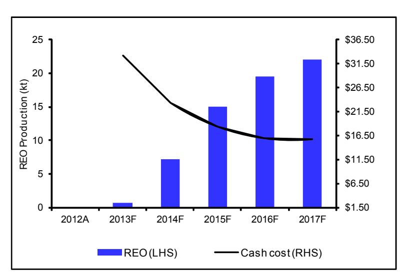
Cash and debt



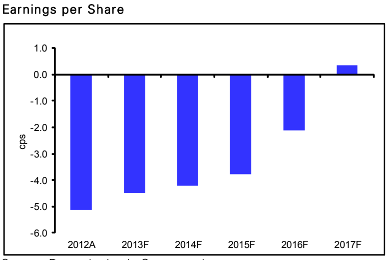
Gearing



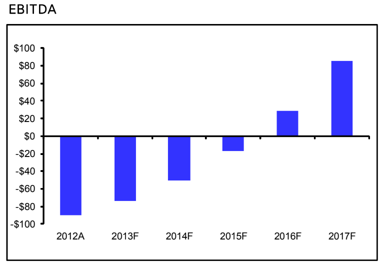
Production vs Cash Costs



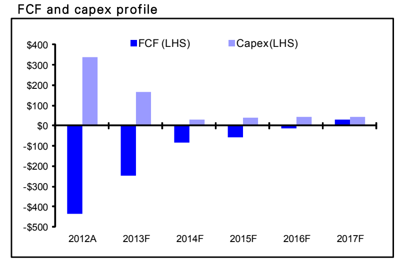
Earnings per Share



EBITDA



FCF and capex profile



Source: Deutsche bank, Company data

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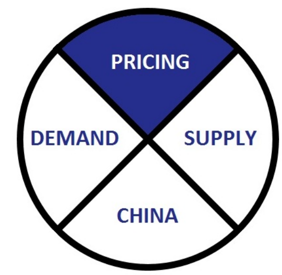
Executive summary

Re-basing price expectations for the new reality



After a rollercoaster ride over the last three years, global economic uncertainty, demand destruction and de-stocking have brought rare earth element (REE) prices in 2013 back to levels many thought would not be seen again. To identify key pricing drivers and the new reality for a balanced market, we have undertaken a deep-dive supply and demand analysis into the highly dynamic, technology-driven rare earth industry, incorporating:

- Chinese rare earth policy and domestic supply sensitivities, along with imminent ex-China production from Lynas Corporation and US-based Molycorp (MCP.N, not covered), to understand global supply over the medium-long term.
- Rare earth demand from the major consumption markets, applying industry growth rates from DB's global research teams to identify which markets will drive demand over the next six years and which rare earth elements will be in the greatest shortage.
- A review of Lynas Corporation's balance sheet and position in the market:
  - Examining how LYC's rare earth saleable products will be valued relative to spot pricing and the reported 'basket price'.
  - Implications for the market from the company's expansion plans.
  - Forecasts on earnings, free cash flow and debt repayment profile.

Rocketing prices driven by the perfect 'supply/demand' storm in 2011

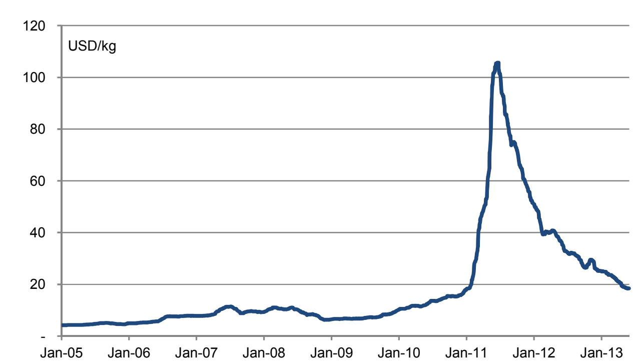
Increasing global demand coincided with Chinese export restrictions to drive prices up 650% in 2011

In 2010, China contributed 95% of global rare earth production and was the major supplier to global markets. Chinese rare earth export quotas were cut 40% to 30ktpa (from 50ktpa in 2009), inducing a global scramble to secure supply. Chinese export duty rates and taxation were also increased to incentivize internal consumption and increase vertical integration, in an effort to capture a greater share of the value chain.

We expect prices to find a floor over the next six months

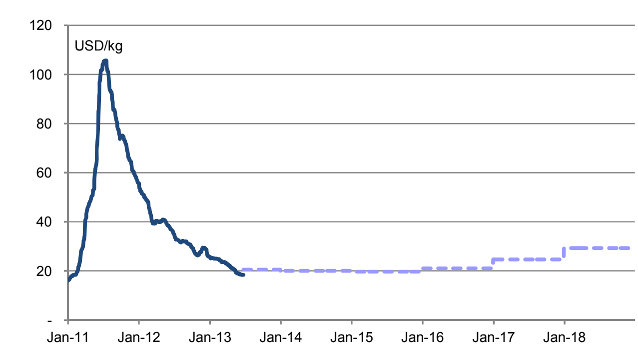
After rising up to 650% in the first seven months of 2011, rare earth prices have continued to slide to return to pre-crisis levels (see Figure 1). Global economic uncertainty has curtailed demand and stockpiles are being worked down. A Chinese production response occurred in late 2012, with Baotou (600111.CH, not covered) temporarily ceasing production activities at the world's largest REE mine, Bayan Obo.

Figure 1: Historical pricing for light rare earth ore (US$/kg)



Source: Deutsche Bank, Asian Metals

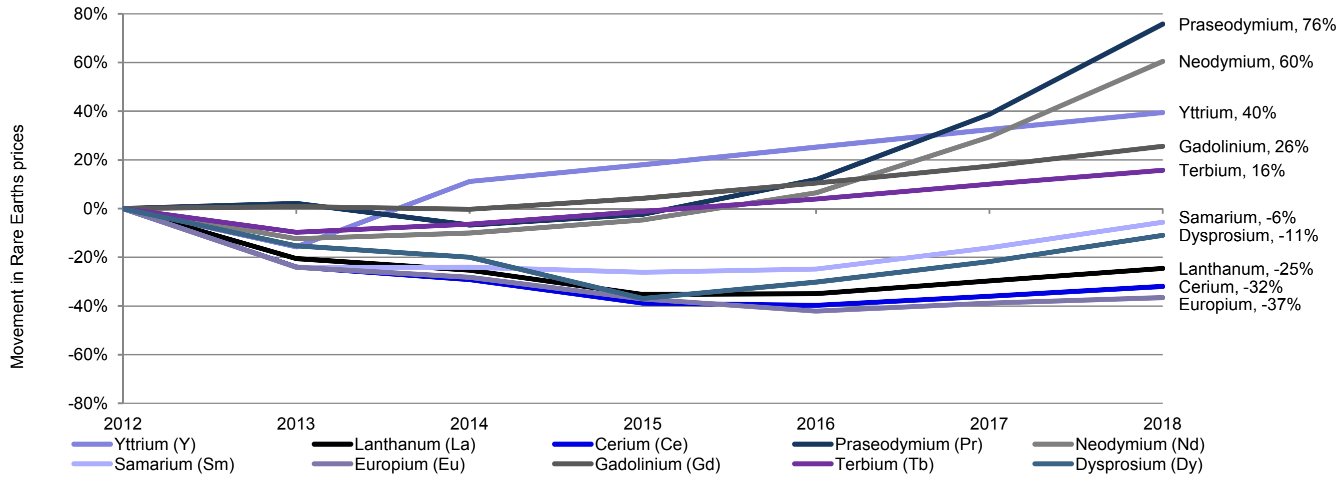
Figure 2: Historical pricing and DB forecast price (US$/kg)



Source: Deutsche Bank, Asian Metals

Rare earth pricing a function of individual supply/demand drivers

Figure 3: DBe price movements dependent on end applications; those linked to magnets (Nd,Pr) in greatest undersupply



Source: Deutsche Bank

Product replacement and substitution driving a structural change in demand

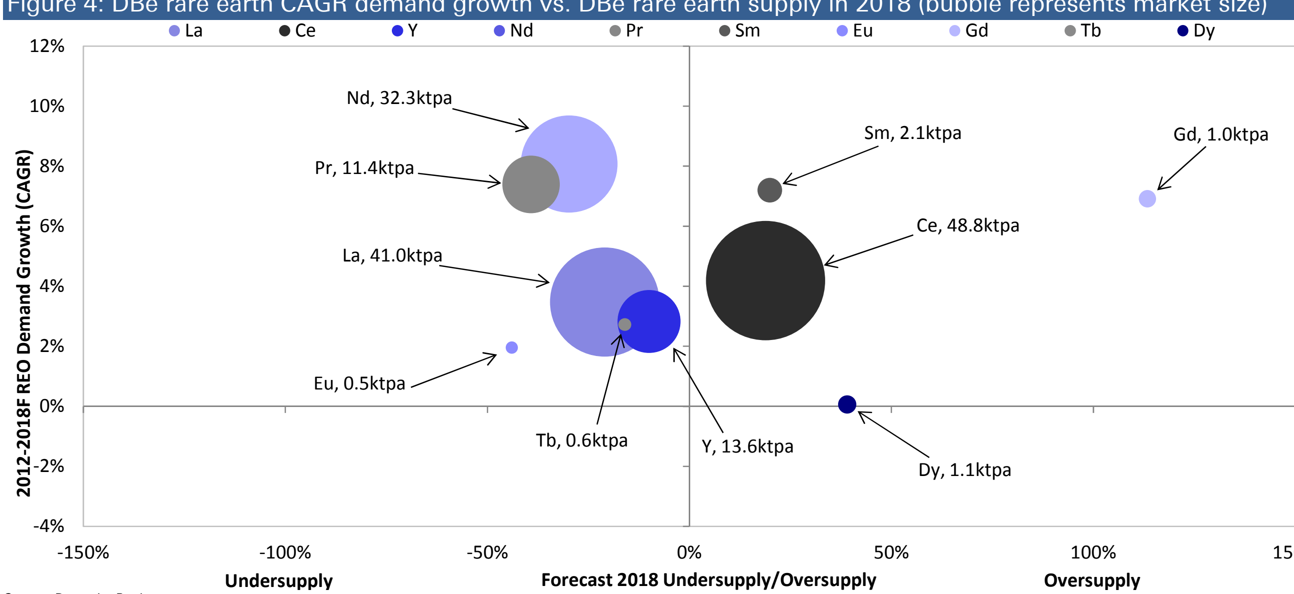
Rare earth elements provide productivity efficiencies in many applications than cannot be reproduced by lower quality alternatives, but price increases in 2011 forced end-users to investigate ways to decrease rare earth intensity in a number of products. In more price-elastic applications, structural changes in rare earth use occurred, including:

Price elasticity is a factor in rare earth demand; lower-quality alternatives can be used if prices get too high

- La oxide content in fluid catalytic cracking units (3% w/w to 2% w/w in 2011).
- Increased recycling in polishing powders and automotive catalysts (La, Ce, Pr).
- Improvements in LED technology threatening rare earth phosphors (Y, Eu, Tb).
- R&D to decrease dysprosium consumption in rare earth magnets.

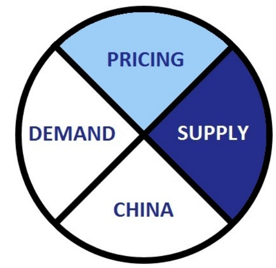
By 2018, rare earths with exposure to magnets and glass (neodymium, praseodymium and yttrium) will be in undersupply and have strong price support, in our view:

Figure 4: DBe rare earth CAGR demand growth vs. DBe rare earth supply in 2018 (bubble represents market size)



Source: Deutsche Bank

Supply – Chinese control but LYC and MCP ramping up in 2014



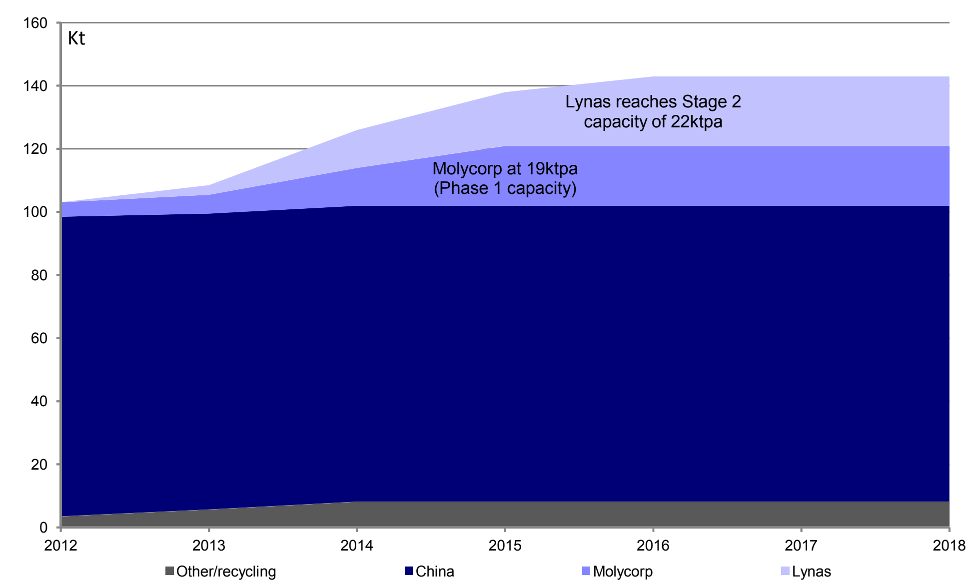
After dominating rare earth supply since the early 1990s, vertical integration and investment in Chinese industries has driven the rest of the world to look for alternate supply sources.

The most prominent developments are **Lynas** and **Molycorp** which are both aiming to ramp-up in the coming 12 months, despite entering a weak price environment.

- In early June, **Lynas** announced that its Malaysian plant had reached nameplate rates for Phase 1 (11ktpa). However, as a result of weak market conditions, the company indicated that the Phase 2 expansion will be delayed until further improvements in the market were seen.
- In Phase 1 of production, **Molycorp** aims to produce 19kt. The company has a longer term aspiration target of 40ktpa through a Phase 2 expansion. Our base case is predicated on the standard market assumption that Phase 2 does not occur at that stage. In the March Q production update in May, Molycorp indicated that it was producing at a run rate of c.7ktpa, and on track to ramp up towards the 19kt annualized run rate towards the middle of 2013.

Lynas and Molycorp will increase global supply by c.30% once ramped up to Stage 1 capacities (11ktpa for Lynas and 19kt for Molycorp)

Figure 5: DBe global supply assumptions (2012 – 2018)



Source: Deutsche Bank, US Geological Society, company data

Recycling could become a larger part of supply

The ability to recycle rare earths depends primarily on the product that the rare earths are used in and also the cost of extraction and refining. We assume that 5kt per year continues in forward years; however, we note that recycling could become more prevalent if it becomes mandated in particular regions, if or rare earth prices rise beyond our current expectations. The fact that there is very little recycling currently suggests that the value extracted from the recapture is not sufficient to cover the costs. However, particular regions of the world, including Japan (through Hitachi Ltd.) are exploring more innovative ways to recover materials.

The next wave of projects not required until 2018

We expect our supply assumptions will meet demand over the medium term, with price support not expected until closer to 2018. In our view, the next wave of projects is longer dated and obtaining funding in the current environment will be challenging.

There are a number of new projects being developed but we assume delays occur

Chinese production quotas the biggest risk to DB supply assumptions

The Chinese government released the first rare earth 'white paper' in June 2012, affirming the government's public stance that rare earth production will not compromise the conservation of China's natural resources and the surrounding environment. This rhetoric has led the global market to a widely-held view that Chinese rare earth production will remain at current quota rates (93.8ktpa) into the future.

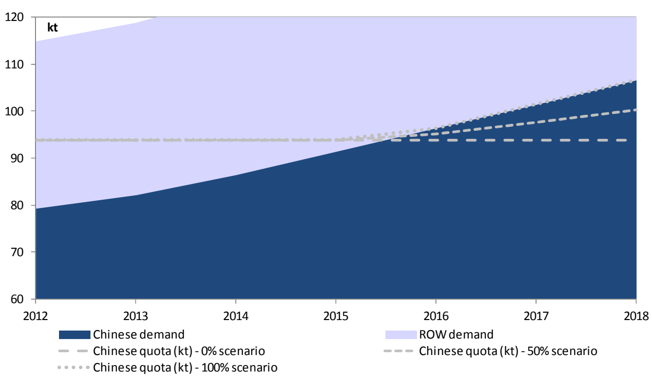
If China meets its own demand, we expect rare earth prices to be c.17% below our base case assumptions in 2018

To reflect current market expectations, we have held Chinese rare earth production flat at 93.8ktpa in our supply/demand analysis. However, we expect Chinese rare earth consumption to exceed the current 93.8kt production quota (2012) from 2016.

We recognize that there is significant downside risk to rare earth pricing if China's production quota policies adjust to domestic demand. We have considered three possible production responses, where 0%, 50% and 100% of Chinese demand over 93.8ktpa is met by increased production.

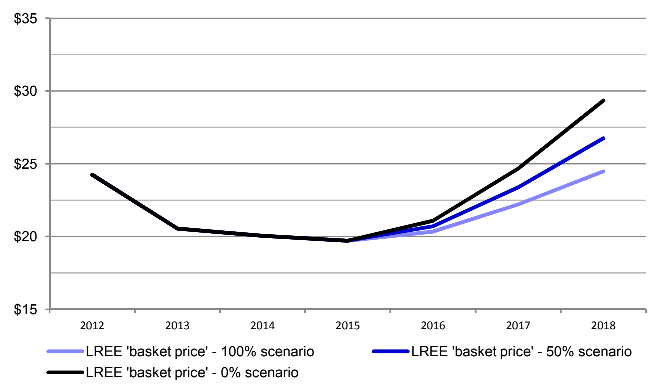
- If the Chinese production quotas increase to 50% of demand above 93.8ktpa, rare earth pricing is c.9% lower in 2018. If Chinese supply is set at internal demand, rare earth prices could be c.17% below our base case assumptions.

Figure 6: 0%, 50% and 100% Chinese quota scenarios



Source: Deutsche Bank, US Geological Survey

Figure 7: 'Basket price' sensitivity to Chinese quota



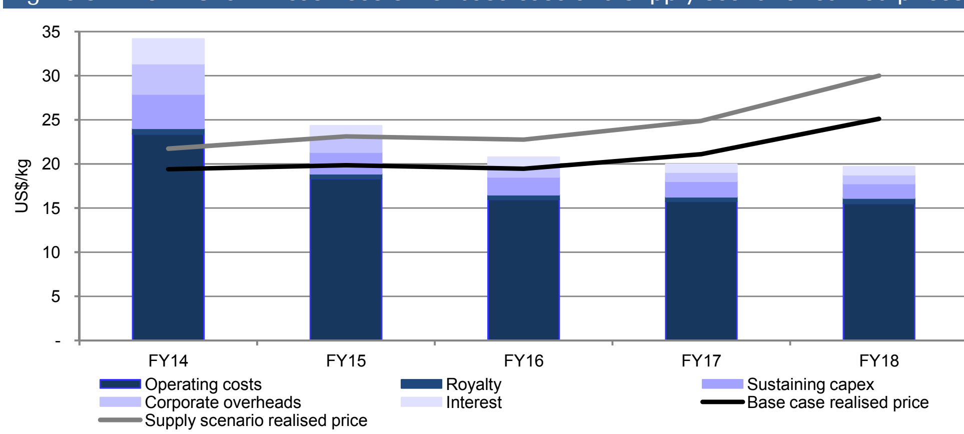
Source: Deutsche Bank, US Geological Survey, Asian Metals

Significant supply restrictions required to push realized price above US$30/kg

To run an upside pricing scenario, we assume a 10% restriction in Chinese production quotas; LYC would be FCF positive in FY16 and 2018 realized price would be US$30/kg.

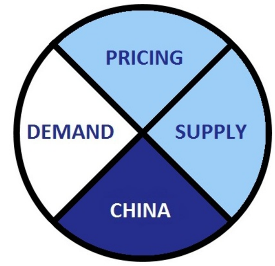
There could be large pricing adjustments to our forecasts depending on Chinese policy

Figure 8: DBe LYC 'all-in cash costs' vs. base case and supply scenario realized prices



Source: Deutsche Bank, company data

China – Government policy and regulation the largest variable



Production/export quota systems the issue in 2011 and the risk in forward years

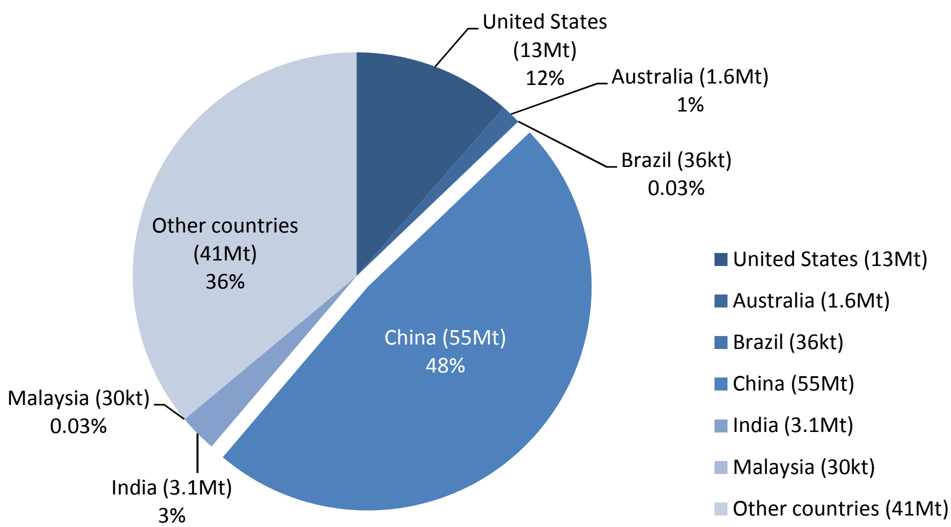
Despite the advances in domestic industries, Chinese rare earth production has historically run ahead of internal consumption, making China the key provider to the seaborne REE market over the last 20 years.

In 2004, the Chinese government introduced an export quota and export duty rates to rare earth commodities and refined metals. In 2006, production quotas were also introduced. These ongoing quota systems are aimed at:

Chinese export and production quotas aim to increase consolidation, protect the environment and promote vertical integration in our view

- **Industry regulation:** the Chinese Government is driving structural changes to curb illegal mining (see decrease in production above quotas in Figure 10) and move towards a consolidated industry, dominated by a few large companies.
- **Conservation of resources:** despite internal demand for rare earths increasing, rare earths have been identified as strategically important and the Chinese government has stated that slowing the exhaustion of reserves is a priority.

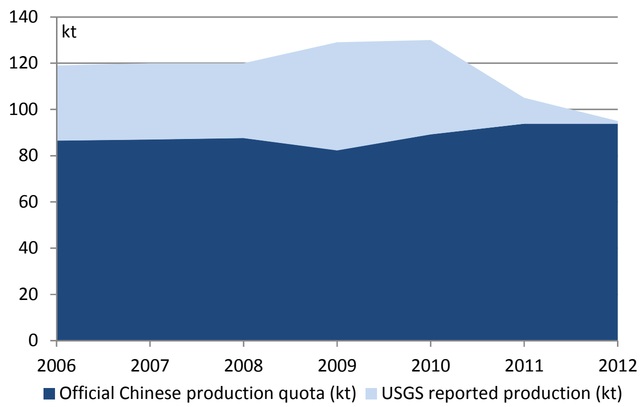
Figure 9: Global rare earth reserves dominated by China (48%)



Source: US Geological Survey, "Mineral Commodity Summaries", January 2013

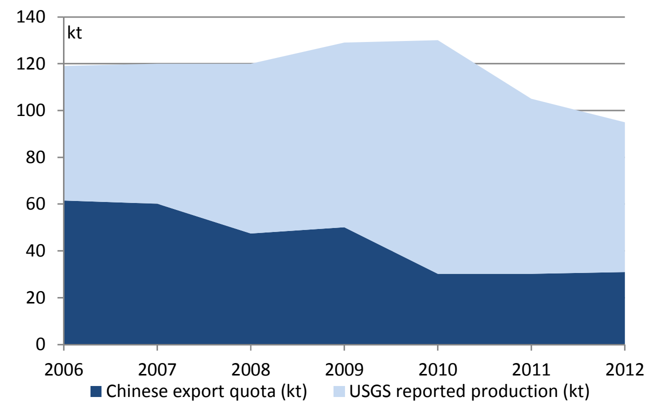
- **Environmental conservation:** the mining and refining of rare earths can have serious environmental impacts due to the extractive processes, smelting requirements and potential storage issues of associated radioactive minerals.
- **Domestic consumption and vertical integration:** the introduction of export restrictions and export duty rates (see Figure 11) resulted in a two-tier pricing regime, with ex-China rare earth consumers paying more than their Chinese domestic competitors for the same product, largely due to export duty rates which are typically either 0%, 15% or 25% depending on individual elements.
  - This has incentivized internal consumption of rare earth oxides, leading to an increase in vertical integration and production of higher-value products such as magnets, phosphors, ceramics and batteries inside China.
  - The export quotas have also led to some global companies that require rare earths in their products to move operations to China, where pricing is more competitive and there is greater confidence in supply.

Figure 10: Chinese REE production vs production quota



Source: China Ministry of Land and Resources, US Geological Survey, Ministry of Commerce of China

Figure 11: Chinese REE production vs. export quota

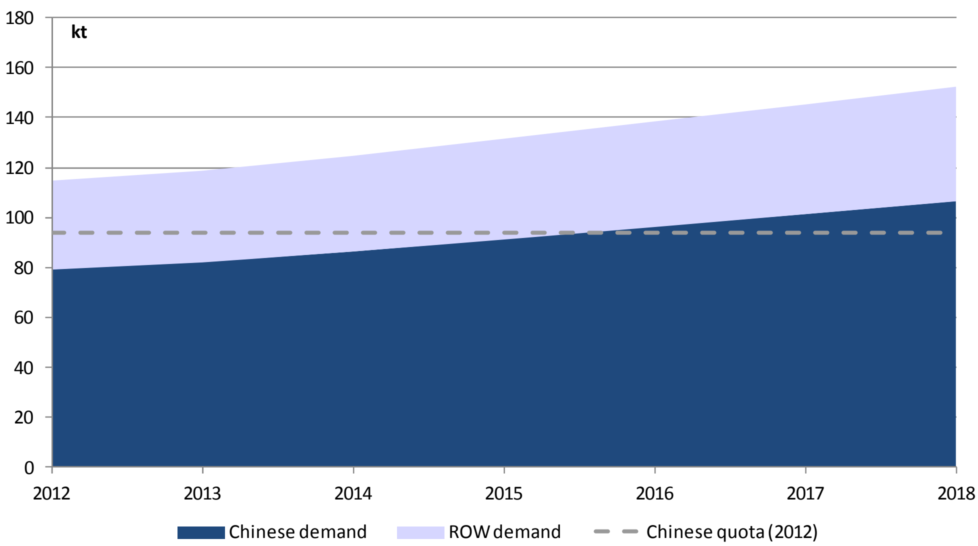


Source: China Ministry of Land and Resources, US Geological Survey, Ministry of Commerce of China

Will China protect its own downstream industries?

On our demand assumptions, we expect Chinese rare earth consumption to exceed the current 93.8kt production quota (2012) from 2016:

Figure 12: DBe Chinese and rest of world (ROW) demand vs. 2012 production quota



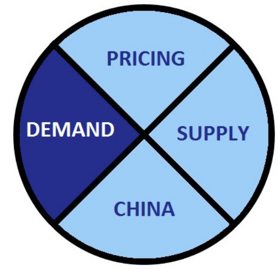
Source: Deutsche Bank, China Ministry of Land and Resources, US Geological Survey, Ministry of Commerce of China

If the rare earth market does tighten, a key risk to expansion aspirations by Lynas,Molycorp and other RE companies is the potential for Chinese production to increase.

2016 looms as a key year where we forecast Chinese demand will reach the current production quota of 93.8kt. There is a risk that production quotas are increased at this point in our view

- Current production quotas are set above internal consumption rates; as demand increases, we see risk that China meets this with its own supply.
- Illegal mining is being phased out in China, bringing total Chinese production closer to the official production quotas. We do not believe that in an undersupply scenario, the first rare earth production brought back online in China is the environmentally-destructive, illegal mining operations.
- With 48% of global reserves, it is possible that legal Chinese operations (currently operating at the production quotas) are expanded or new sustainable, long life mines are brought online, in our view.

Demand – Magnets and global urbanization driving growth



Magnets, the glass industry and polishing powders are key demand drivers for rare earth element growth in our view

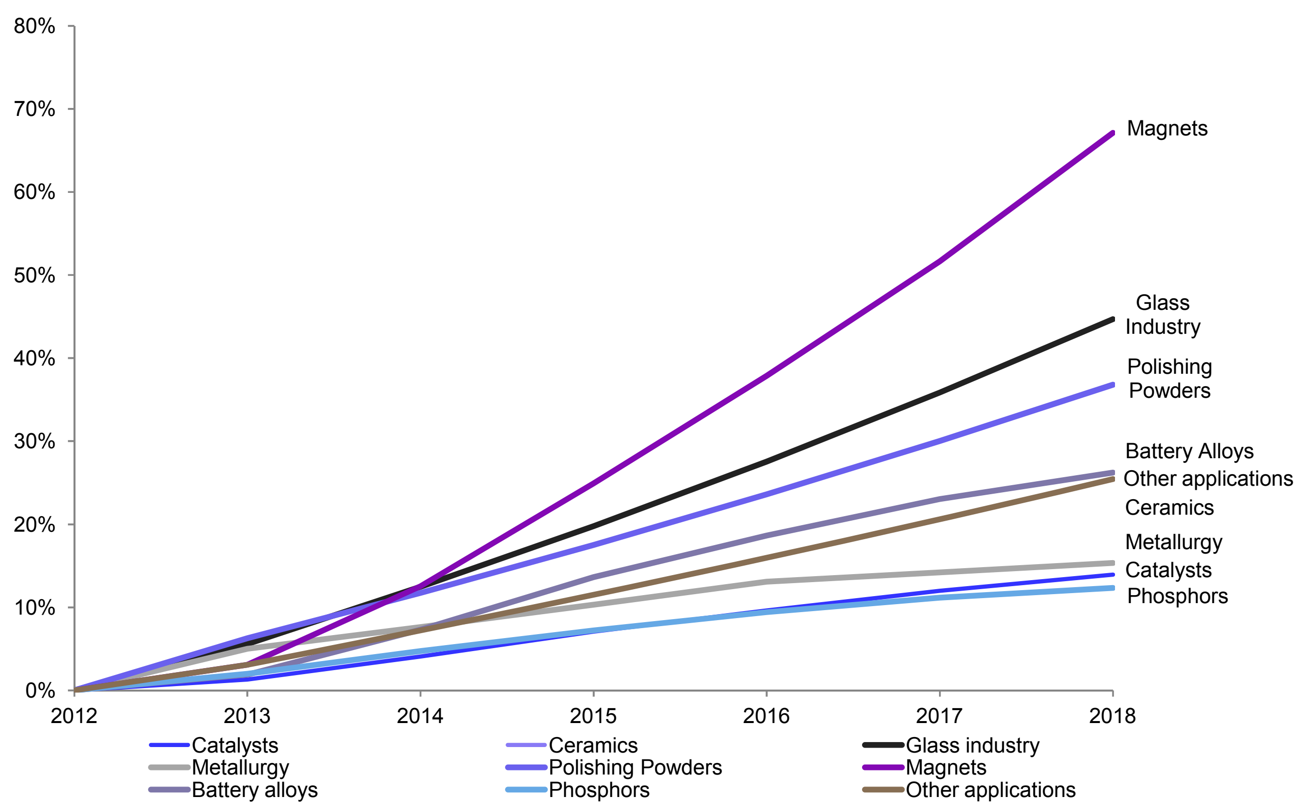
Magnet applications the standout driver for demand growth

With neodymium-based magnets used in strong-growing markets such as wind turbines (DBe 26% CAGR) and the hybrid/electric car industry (DBe 24% CAGR), rare earth magnet demand is a key growth driver in the near-term. We expect the overall rare-earth magnet industry to grow at 9-11% per annum between 2014 and 2018.

Glass industry and polishing powders soaking up the light rare earth supply

Driven by a strong exposure to developing markets and underlying economic growth, we expect rare-earth consumption in the global glass industry to be a healthy market for light rare earths in forward years. With strong forecasts in global consumer electronics, polishing powders will likely outperform most rare earth markets. Providing support for these demand assumptions is the excess lanthanum and cerium (the largest light rare earth elements produced by volume) supply generated as global production tries to meet demand for the higher value elements such as neodymium.

Figure 13: DBe cumulative demand growth for major rare earth consuming markets (2012 – 2018)



Source: Deutsche Bank

Structural industry changes to strengthen some markets and weaken others

Rare earth demand will continue to be a function of technological change

With the implementation of rare earth intensive direct-drive technology in wind turbines, rare-earth consumption in this sector will grow at a higher rate each year, in our view. Conversely, the energy efficiency and lower costs offered by LED technology in lighting and electronics is expected to put pressure on the rare-earth intensive phosphor industry. This highlights that rare-earth demand will largely be a factor of technological change and will remain a dynamic industry.

Green technologies and government support a demand catalyst

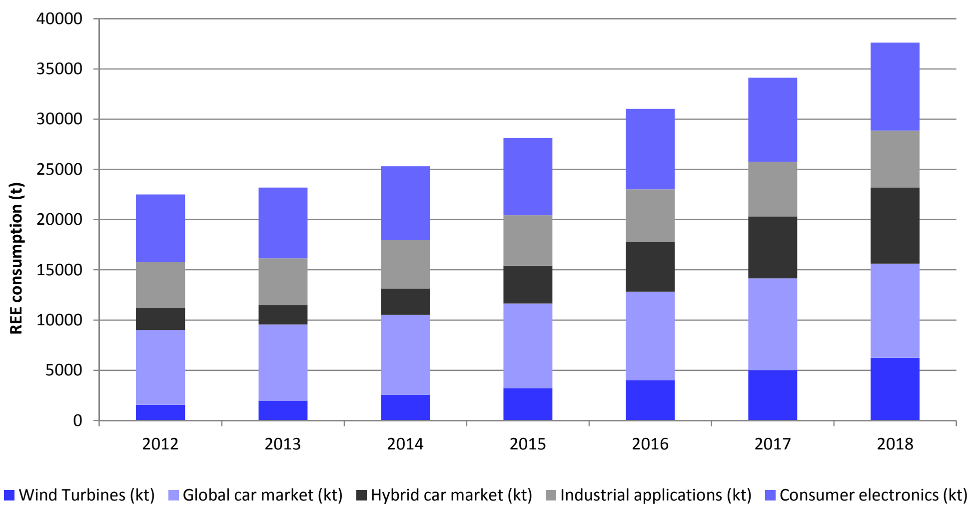
The momentum in greener technologies generated in the last five years is currently being challenged by economic uncertainty and a curbing of capital funding and investment. Growth rates for green technologies such as wind technology and hybrid and electric vehicles have not met expectations in recent years, with lower cost incumbent technologies being preferred to higher-cost alternatives.

Green technology take up will continue to be a function of economics and government policies

DB has a positive view on these markets, but we note that government subsidies are important in the uptake of wind turbines as a power source and a) cost efficiencies and b) infrastructure development are the drivers of hybrid/electric vehicles being accepted by the mass market.

The world's largest offshore wind farm, the 'London Array', was inaugurated by David Cameron on 4th July, 2013. The field hosts 175 3.6MW direct-drive wind turbines by Siemens.

Figure 14: DBe rare earth magnet demand by key growth market 2012 - 2018



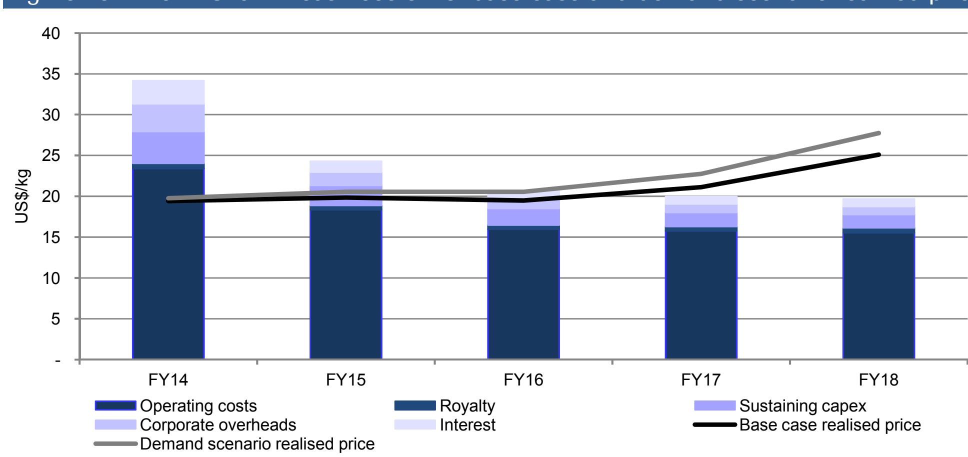
Source: Deutsche Bank

Industry growth rate sensitivity highlights pricing pressure out to 2016

To consider an upside scenario on pricing we have applied a 10% premium on our industry growth assumptions from 2013 out to 2018. The impact on LYC's realized prices is shown in Figure 15. Increasing demand growth by 10% does not alter our view that rare earth prices will remain subdued over the next 3 years, and reiterates that global rare earth supply is the biggest risk (and swing factor) on the rare earth market.

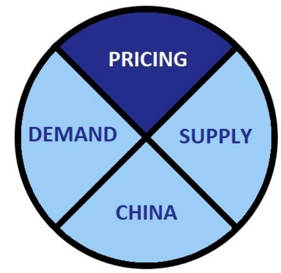
10% higher demand growth than we expect presents additional upward pressure on prices

Figure 15: DBe LYC 'all-in cash costs' vs. base case and demand scenario realized price



Source: Deutsche Bank

Pricing – Basket price doesn't translate to realized price



Efforts to understand the current pricing environment and possible margins for multi-element rare earth deposits have led to the "**basket price**" approach as a reference price. This definition takes current refined oxide prices and the percentage composition of rare earths in a particular mineral resource to determine a weighted average price.

The "basket price" does not reflect supply and demand for individual elements, so the elements that are driving price support can't be easily identified.

This approach to price referencing has two main issues. 1) The "basket price" shows the weighted average price of a refined rare earth product (>99% REO); these prices can be realized only on projects designed to mine, process and refine rare earth elements to a near-pure product, 2) Comparisons between two assets cannot be made because the "basket price" refers to the average price for a kilogram of rare earths as per the ratio of rare earth elements present, but not the overall deposit grade.

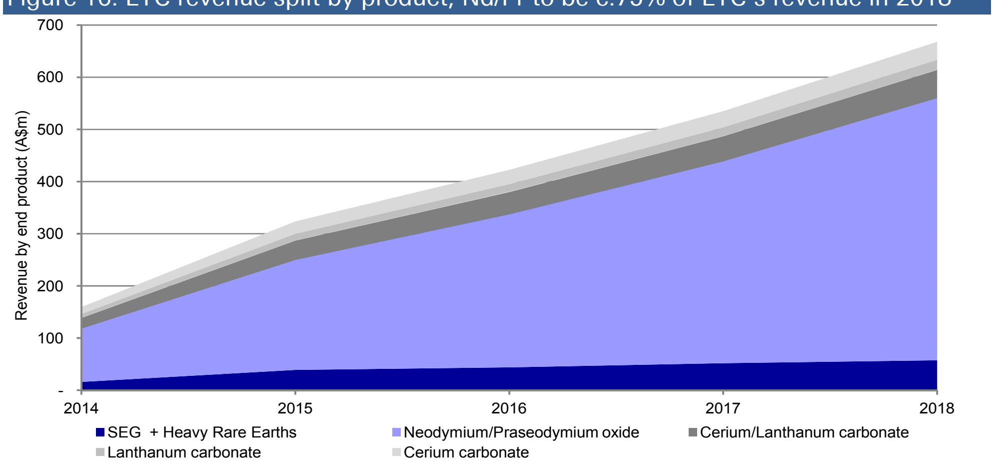
A number of products are not sold in the pure form and therefore attract a discount price, not captured by the theoretical basket price

Another consideration is the Chinese domestic price against ex-China FOB pricing. The difference is a function of duty rates (0%, 15% or 25% depending on the element) and also the supply and demand dynamics outside China, with a larger premium achieved when ex-China demand for products is high. In our realized price forecasts, we assume a 15% premium will be achieved for lanthanum, cerium and neodymium products until 2016 when we believe Chinese consumption equals Chinese production.

We expect the ex-China FOB price premium over domestic pricing to close to zero by 2016 with a 15% premium for Lanthanum, Cerium and Neodymium until this time

We now model LYC revenue on an individual product basis, taking into account the discounts to spot pricing generated by intermediate rare earth products (see next page).

Figure 16: LYC revenue split by product; Nd/Pr to be c.75% of LYC's revenue in 2018



Source: Deutsche Bank Future data are estimates

Figure 16 shows the key market for Lynas is Nd/Pr oxide, which is most leveraged to magnet demand. Despite c.70% of LYC's production being La and Ce products, the low-value of these products results in only c.20% of revenue. The heavy rare earth 'SEG' is composed of more valuable rare earths, but incurs a large pricing discount to the weighted average price due to it being an intermediate, unrefined product.

Nd/Pr oxide makes up c.75% of revenues by 2018 on our forecasts

Figure 17: DBe LYC realized pricing deck (adjusted for intermediate product discounts)

	FY12	FY13	FY14	FY15	FY16	FY17	FY18	LT
Cerium (US$/kg)	19.4	8.8	7.1	6.4	5.5	5.2	5.6	5.7
Lanthanum (US$/kg)	18.5	8.7	7.2	6.6	5.7	5.5	6.0	6.2
Cerium/Lanthanum (US$/kg)	20.6	8.7	7.2	6.5	5.6	5.3	5.7	5.9
Neodymium/Praseodymium (US$/kg)	79.4	53.2	49.9	51.3	52.9	59.0	72.8	80.8
SEG (US$/kg)	117.3	69.8	54.8	50.6	46.7	47.2	50.0	51.3

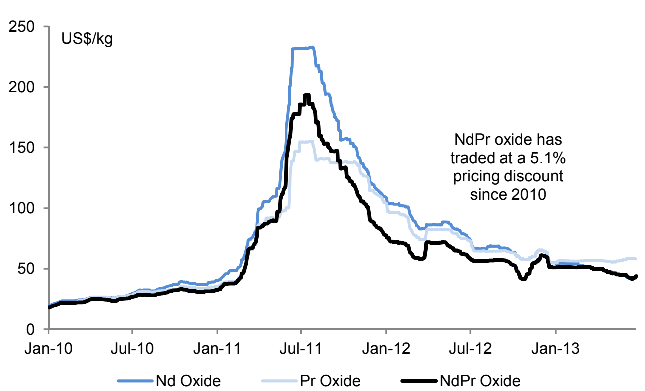
Source: Deutsche Bank

Breakdown of LYC's products and realized pricing dynamics

Lynas will produce five main products from Phase 1 operations at the Malaysian LAMP processing plant (all tonnages are presented on a rare-earth oxide equivalent basis):

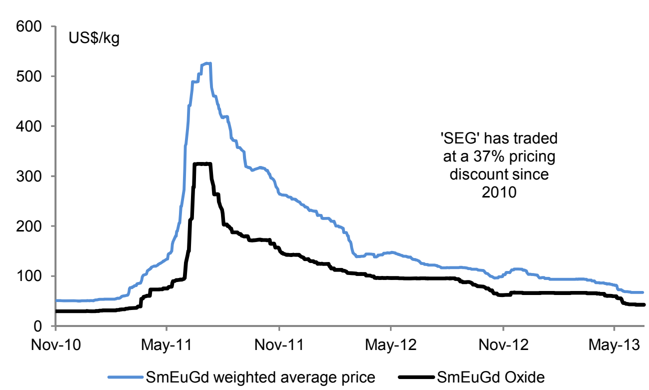
- **Cerium (Ce) carbonate (2,600tpa in Phase 1):** A light rare earth carbonate is easier to separate than a higher-quality oxide, but does attract a pricing discount. Lynas reports carbonate production on an oxide-equivalent basis, so more than 2,600t of Ce carbonate will be produced, but revenue will be a function of oxide-equivalent production (2,600t REO equivalent).
- **Lanthanum (La) carbonate (1,350tpa):** Similar to Ce carbonate, the lanthanum product is relatively easy to liberate, however due to the natural abundance of these elements, it is a somewhat saturated market. Spot domestic Chinese prices for Ce and La oxides are currently c.US$5/kg.
- **Cerium/lanthanum carbonate (4,000tpa):** A mixed carbonate product, Ce/La carbonate is a marketable product because cerium and lanthanum are both used in many applications and separation is not required. We expect that pricing for Ce/La carbonate should stay broadly in line with Ce and La prices (currently US$5/kg); note that the 4,000tpa is also an a oxide-equivalent basis, but a pricing discount for a mixed product could impact realized price.
- **Neodymium/praseodymium (Nd/Pr) oxide (2,700tpa):** The rare earth elements in greatest demand, neodymium and praseodymium are both used in magnets (and other applications), so a mixed oxide product is a common commodity on the market. The Nd/Pr oxide has a higher rare-earth purity (>99% REO) than the carbonate products, but has historically traded at a discount to Nd and Pr oxide prices (see Figure 18). A pricing discount of c.10% has been realized since 2005, and 5% since 2010. We assume a 10% discount on average in forecasts.
- **SEG + Heavy Rare Earths (480tpa):** The residual product that is produced once the lighter rare earths have been separated. 'SEGH' (Samarium, Europium, Gadolinium, heavy rare earths) is a lower-quality (albeit heavy rare earth dominant) product that requires significant refining to separate the constituent elements. Spot SEG prices since 2010 have been c.63% of the constituent oxide prices, on average; we expect a c.40% discount to continue. At present, further refining of the SEG product only occurs inside China. We believe LYC is still determining an off take partner for this product.

Figure 18: NdPr oxide price vs. Nd oxide and Pr oxide



Source: Deutsche Bank, Asian Metals

Figure 19: SEG oxide price vs. constituent REO prices



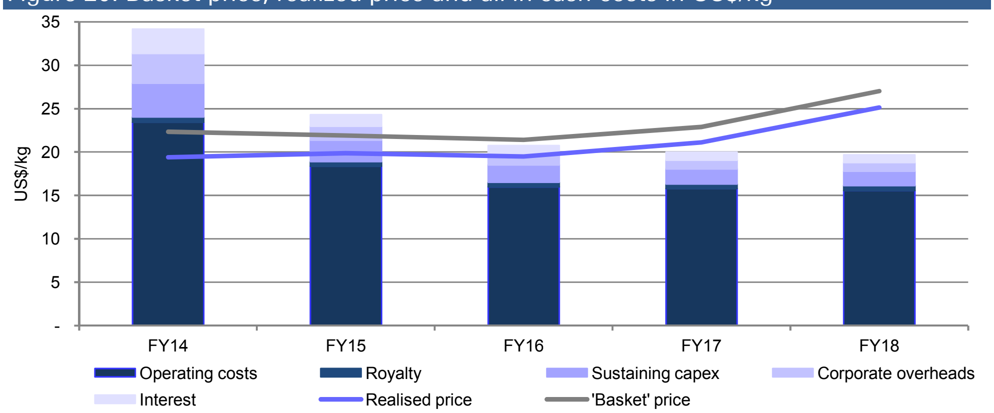
Source: Deutsche Bank, Asian Metals

Impact on Lynas Corporation

In this section of the report we outline the impact of our market analysis on LYC and we explain our investment thesis which underpins our move to a Sell (PT now $0.30/sh from $0.58/sh). While we believe LYC is well placed longer term, we believe there are a number of shorter term risks largely relating to profitability and the balance sheet.

Figure 20 shows the theoretical "basket price" derived from our forecasts as well as the realized price we believe Lynas will receive. The figure shows our expectation for operating costs (US$16/kg by FY16 and US$15/kg by FY18). In our cost analysis, we also assume c.A$25m/year in corporate and marketing costs, A$30-40m/year in sustaining capex (Mount Weld and Malaysia combined) and c.A$20m/year in interest payments on its two facilities. We do not believe Lynas will produce free cash flow until FY16 which will see pressure on its cash position (DBe $121m at the end of FY13).

Figure 20: Basket price, realized price and all in cash costs in US$/kg



Source: Deutsche Bank Future data are estimates

Production – ramping up to 22ktpa in FY17 in our view

In early June, Lynas announced that its LAMP (Lynas Advanced Material Plant) in Malaysia had reached the nameplate rate for Phase 1 (11ktpa). However as a result of weak market conditions, the company indicated that ongoing production will depend on market demand. At the same time, Lynas announced that construction and pre-commissioning of the Phase 2 LAMP was essentially complete. Phase 2 commissioning will likely be delayed until market conditions warrant, it in our view.

Figure 21: DBe LYC production forecasts per product

Production REO (kt)	FY12	FY13	FY14	FY15	FY16	FY17
Cerium carbonate	-	0.15	1.68	3.51	4.57	5.14
Lanthanum carbonate	-	0.08	0.87	1.82	2.37	2.67
Cerium/lanthanum carbonate	-	0.23	2.34	4.05	5.28	5.94
Neodymium/praseodymium oxide	-	0.16	1.42	1.82	2.37	2.67
SEG = Heavy Rare Earths	-	0.03	0.31	0.65	0.84	0.95
Ce/La/Pr carbonate	-	-	0.25	1.35	1.76	1.98
Neodymium oxide	-	-	0.17	0.91	1.19	1.34
Praseodymium oxide	-	-	0.17	0.91	1.19	1.34
Total	**-**	**0.6**	**7.2**	**15.0**	**19.6**	**22.0**
Cash costs (US$/kg)	-	33.3	23.4	18.4	16.0	15.8

Source: Deutsche Bank

Figure 22 shows the change to our Lynas earnings estimates.

Figure 22: EPS changes post pricing and volume adjustments

	FY13E	FY14E	FY15E	FY16E
Previous estimates (cps)	-4.4	-1.8	3.2	-6.9
Revised estimates (cps)	-4.5	-4.2	-3.8	-2.1
% change	-2%	-130%	-286%	-211%
Consensus (cps)	-6.7	-3.7	.05	6.9

Source: Deutsche Bank, Bloomberg Finance LP

Balance Sheet – a key focus with debt refinancing possibly needed in our view

We expect Lynas to have $121m cash at the end of June, 2013 and a net debt position of $278m. We expect the net debt position to increase to $375m by the end of June, 2014. The company currently has two debt sources:

We forecast net debt to be $278m at the end of FY13, we expect this to increase to $375m by the end of FY14

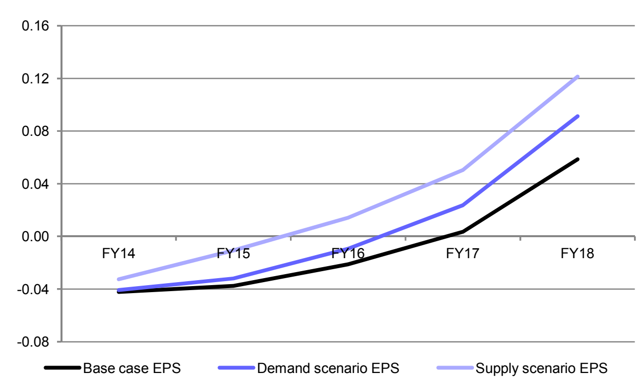
1) US$225m facility with Sojitz (Japanese trading firm supplying rare earths into Japan). The facility is only associated with Phase 2. Repayments are currently due to start on the 31st of March, 2015, finishing on the 31st of March, 2017 over 5 installments. The Sojitz facility has a number of covenants relating to debt service, loan life coverage and gross debt. The interest rate increased from LIBOR + 2.75% to LIBOR + 5.25% after covenants were recently checked. We believe that there is a restriction of further debt at the company level of US$80m. At the end of December, 2012, there was still A$37m (converted to A$ at the prevailing exchange rate) of the US$225m undrawn.

2) US$225m facility with Mount Kellett. It has an interest rate of 2.75% with a conversion price of A$1.15/sh (initially $1.25/sh but reset with equity raising at the end of 2012). The conversion date is on July 25th, 2016.

As a result of the current falling rare earth prices and weak selling conditions, we are concerned that repayments for the Sojitz facility will be challenging and the conversion price for the Mount Kellett facility is currently well out of the money. We therefore see risk that Lynas will need to restructure its balance sheet over the coming 12-24 months. Figure 23 and Figure 24 show our base case and scenario EPS and gearing (based on assumed refinancing) expectations. The demand scenario is 10% above our base case and the supply scenario is a 10% restriction in Chinese production quotas (93.8ktpa base assumption), both show upside to our base case.

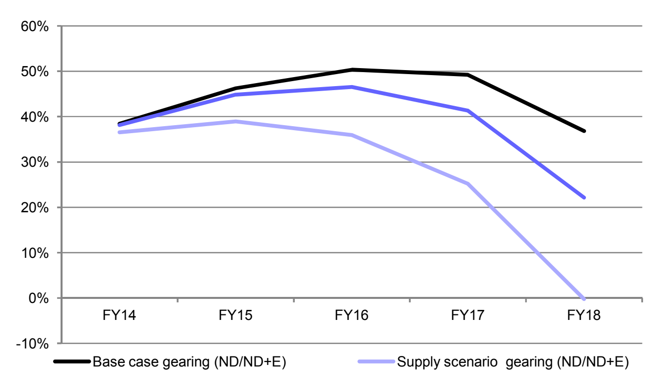
On our pricing assumptions, gearing increases to c.50% (ND/(ND+E)) by FY16

Figure 23: DBe EPS using base case and scenario prices



Source: Deutsche Bank

Figure 24: DBe gearing at base case and scenario prices



Source: Deutsche Bank

Implications on global equities

Supply/demand analysis and pricing outcomes has read-through for other listed stocks

This market analysis, and our subsequent rare earth pricing forecasts, will have read-through implications on a number of listed rare earth companies with producing assets and/or development projects. The following companies have been referred to and included in our market analysis:

Figure 25: Companies mentioned list – Listed companies

Listed companies mentioned	Ticker	Exchange	Price Target
Lynas Corporation	LYC	ASX	Sell, $0.30/sh
Molycorp Minerals LLC	MCP	NYSE	not covered
Inner Mongolia Baotou Steel Rare-Earth Hi-Tech Company (Baotou)	600111.CH	SSE	not covered
Alkane Resources	ALK	ASX	not covered
Greenland Minerals	GGG	ASX	not covered
Arafura Resources	ARU	ASX	not covered
Northern Minerals	NTU	ASX	not covered
Peak Resources	PEK	ASX	not covered
Avalon Rare Metals	AVL	TSX	not covered
Great Western Minerals	GWG	TSX	not covered
Rare Element Resources	RES/REE	TSX/NYSE	not covered

Source: Deutsche Bank, Bloomberg Finance LP

Deutsche Bank research teams with contributions to analysis

We have incorporated a number of Deutsche Bank views, forecasts and analyses from various global research teams. The teams who have contributed data and/or information to this market analysis are listed below:

Global teams

- Global Commodities research team
- Global Economics research team

Australia

- Australian Environmental, Social & Governance research team
- Australian Oil, Gas & Utilities research team

United States

- US Autos & Auto Parts research team

United Kingdom

- European Chemicals research team

Hong Kong

- HK Utilities & Alternative Energy research team

South Korea

- South Korean Technology & Electrical Equipment research team

Rare earth elements

History of global rare earth production

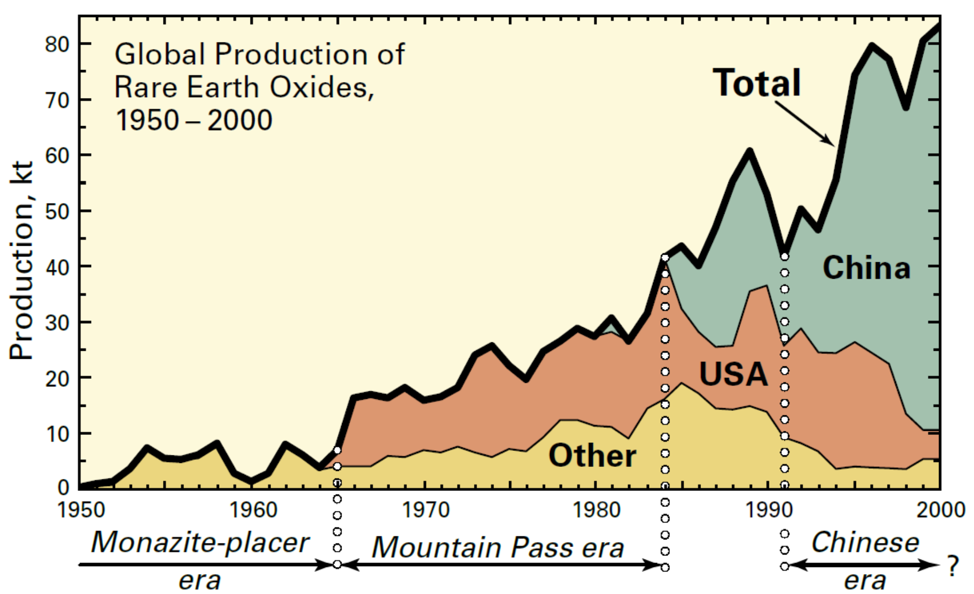
Rare earth elements (REE) were first discovered in 1787 after a previously unknown mineral was discovered near the village of Ytterby, Sweden and a new oxide called 'yttria' was isolated. Seven years later, another rare earth mineral was identified in the Bastnäs region in Sweden, from which 'ceria' was liberated and named.

Over the next 30 years, researchers were able to separate a number of other elements from these original ore sources, but conventional methods of separation were limited by the similarities in geochemical properties exhibited by the various oxides. The development of spectroscopy in the late 1800s allowed more rare-earth elements to be identified, with lutetium the final discovery in 1907.

Early industrial applications for rare earth elements were restricted by the expensive separation costs. However, technological advances such as ion exchange and fractional crystallization led to an increase in availability (and investigation into applications) in the late 1950s and early 1960s.

Up until this point, rare earth production was mainly from placer sand deposits in India and Brazil, while monazite ores had started to be developed in South Africa from the 1950s.

Figure 26: Global rare earth element (REE) production 1950 - 2000



Source: US Geological Survey, "Rare Earth Elements – Critical Resources for High Technology", 2002

Mountain Pass era (1965 – 1985)

The Mountain Pass mine in California, USA, owned by the Molybdenum Corporation of America (Molycorp, MCP.N, not covered), commenced small-scale mining in 1952, before dominating global rare earth production from the 1960s through to the 1990s.

The Mountain Pass ore body is a carbonatite-hosted, bastnäsite deposit that is rich in cerium (49%), lanthanum (33%), neodymium (12%) and praseodymium (5%). Other rare earth elements are present in trace amounts. At the time of project development, bastnäsite ores were preferred over the other main type of ore, monazite, due to the lower thorium content; interest in thorium as a potential nuclear fuel had declined in the 1960s, and concerns over the safe disposal of radioactive thorium persisted.

Figure 27: Mountain Pass mining operation today

Source: Molycorp website

Mining of ore was halted in 2002 for economic and environmental reasons, however processing of stockpiles continued. Mining operations recommenced in 2012 in response to increased rare earth demand, with plans to increase current rare earth oxide (REO) production rates to 19ktpa in the second half of 2013. There is also a Stage 2 expansion towards 40ktpa planned pending appropriate market conditions.

The rise of Chinese production (1985 - present)

Chinese scientists discovered rare earth resources in Bayan Obo, Inner Mongolia in 1927 and production of rare earth concentrates commenced from 1957. Rare earth mining increased throughout the 1990s, largely as a by-product of iron ore mining.

Between 1990 and 2000, Chinese rare-earth production increased 450% to 73ktpa (from c.16ktpa). This increase coincided with a substantial decline of rare earth production from other countries (mainly USA) to 16ktpa, taking global production to c.90ktpa at the beginning of the 21st century.

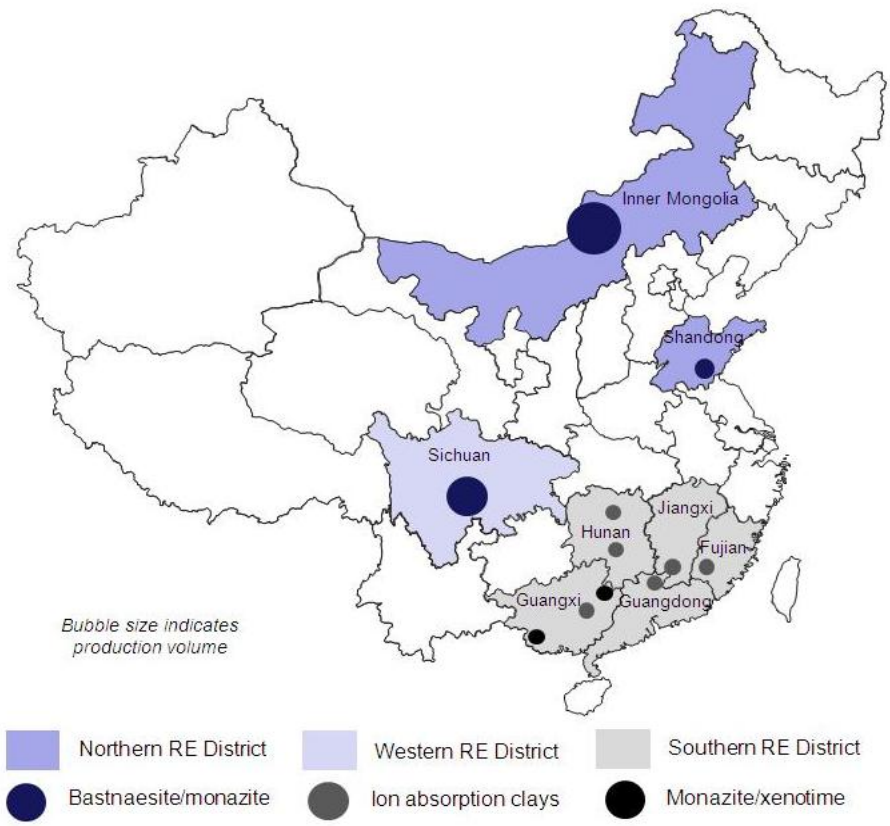
By 2005, China accounted for over 95% of global rare earth production (including 99.8% of heavy rare earth oxide (HREO) production). Production quotas were introduced in 2006 to control illegal mining, encourage industry consolidation and to preserve Chinese rare earth reserves. The Chinese rare earth production quota was 93.8kt in 2011 and 2012; and for the first half of 2013, it has been set at 46.9kt.

Chinese rare earth production

The Bayan Obo mine in Inner Mongolia commenced production in the early 1950s and today is the world's largest rare earth operation, with annual production capacity of c.50ktpa rare earth oxides (REO) when including surrounding operations. This production hub is owned and operated by the Inner Mongolia Baotou Steel Rare-Earth Hi-Tech Company (Baotou)(600111.CH, not covered), a subsidiary of Baotou Steel.

Despite the scale of the Bayan Obo operation, most other rare earth production in China comes from smaller operations focusing on a wide range of rare earth deposits (see rare earth deposit section, page 27).

Figure 28: Key regions of rare earth production in China



Source: Deutsche Bank

Rare earth production in China can be divided into three main areas, the northern, western and southern districts:

Northern District

Region: Inner Mongolia (Baotou), Shandong

Main ore type: Bastnäsite

Production quota in 2012: 51.5kt of rare earth oxide (REO)

Rare earth operations in this region focus predominately on bastnäsite ores and consequently production is light rare earth element (LREE) dominant (see page 81). These operations are largely owned by major companies and are well regulated.

Rare earths have been mined in Inner Mongolia since the 1950s, with current production above 50ktpa (c.60% of Chinese production). However, we note that as a result of weak demand in 2012, mining activities at the Bayan Obo operation were suspended for approximately three months to contain excess supply during a de-stocking phase.

Western District

Region: Sichuan province (multiple mining licences)

Main ore type: Monazite

Production quota (2012): 24.0kt REO

Rare earth production from Western China is c.25% of Chinese total production, and sourced mainly from LREE-dominant monazite ores. Mining activities are mainly within the Sichuan Province, with seven main mining licences currently approved. The largest producer in this region is Sichuan Jiangxi Copper Rare Earths Company.

Southern District

Region: Jiangxi, Guandong, Fujian, Hunan, Guangxi and Yunnan provinces

Key ore type: Ion-adsorption clay, monazite and xenotime

Production quota (2012): 17.9kt REO

Rare earth production in the southern region of China is a complex network of smaller operations exploiting different rare earth deposits with varying compositions. One key thematic through the region is that the weathered laterite and clay deposits have higher heavy rare earth element (HREE) content, resulting in the southern district producing more than 90% of global HREE production in 2012.

The southern district contributes c.20% of Chinese production, but due to the softer style of rare earth ores, smaller-scale operations can be set up relatively easily, and illegal mining is an issue. The lateritic and clay deposits are leached with chemicals to extract the rare earths, but the disposal of the tailings is a key environmental concern and a driver for stronger policing of licensing and official quotas in the area.

Chinese production and export quotas

Rare earths have been traded in a variety of forms over the last fifty years; firstly as Chinese production increased and then as vertical integration was embraced by Chinese companies:

1970s

Chinese rare earth exports were predominately in the form of mineral concentrates that could be easily extracted and refined by the purchaser.

1980s

Mixed rare earth chemicals such as carbonates and chlorides were developed and exported throughout the 1980s, allowing higher grade products and higher yields for Chinese producers.

1990s

Isolated rare earth oxides and metals were in greater demand, leading to an increase in rare earth refining. Over the course of the decade, rare earth products such as magnets, phosphors and polishing powders were developed in China and exported globally.

2000s

As the Chinese economy grew, vertical integration by Chinese companies and investment in China to secure rare earth supply were key themes. China aimed to increase manufacturing activity, and the consumption of rare earths increased in China following significant investment in domestic industries, securing a greater part of the value chain. Key exports from China are now mainly components and rare earth-consuming products such as magnets, computer hard drives, electric motors and liquid crystal displays (LCDs).

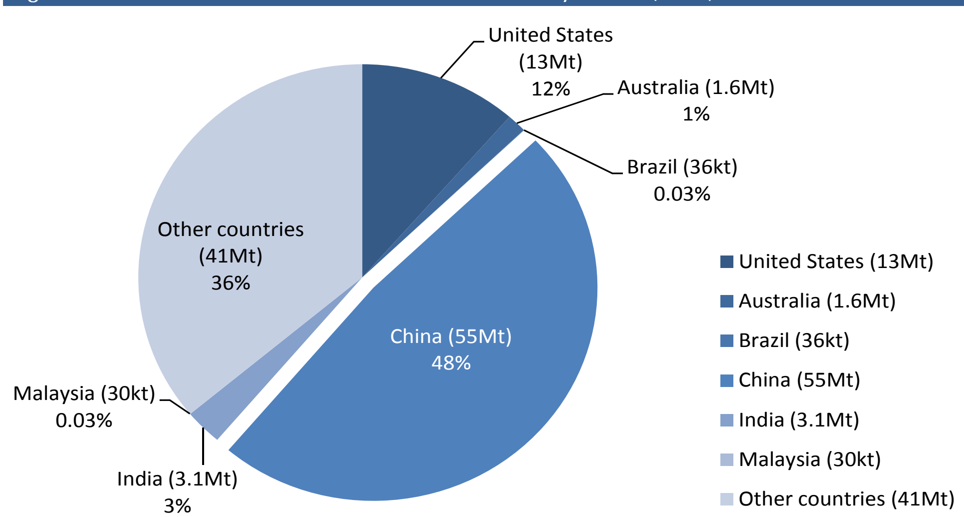
2004: Introduction of export quota system and production quotas two years later

Despite the advances in domestic industries, Chinese rare earth production has historically run ahead of internal consumption, making China the key provider to the seaborne rare earth market over the last 20 years.

In 2004, export quotas and export duty rates were introduced. In 2006, domestic production quotas commenced. These industry quotas were applied to drive a shift in the rare earth industry around four main pillars:

- **Industry regulation:** a large proportion of the rare earth industry in China has been from illegal mining, with annual Chinese production estimated to be up to 30% above official production quotas in recent years. A part of this is illegal, small scale operations as well as private companies operating beyond their production quotas. The Central Government is driving structural changes towards a consolidated industry, dominated by a few large scale, state-owned entities (SOE's).
- **Conservation of resources:** Chinese rare earth production has greatly exceeded domestic consumption over the last 20 years. Internal demand for rare earths is increasing, however with these metals becoming of greater strategic importance, the Chinese government has stated that slowing the exhaustion of rare earth reserves is a priority.

Figure 29: Global rare earth reserves dominated by China (48%)

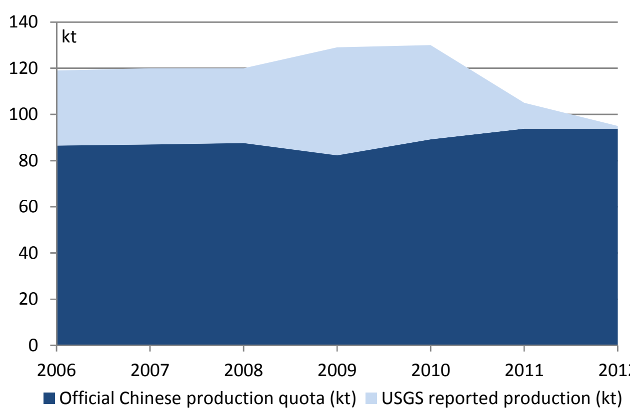


Source: US Geological Survey, "Mineral Commodity Summaries", January 2013

- **Environmental considerations:** the mining and refining of rare earths can have serious environmental impacts due to the extractive processes, smelting requirements and potential storage issues of associated radioactive minerals contained in rare earth deposits. The rare earth industry, particularly the illegal activities, has been poorly regulated in terms of environmental standards and this caught the attention of the international press and conservation agencies.
- **Domestic consumption and vertical integration:** the introduction of export restrictions and export duty rates introduced a two-tier pricing regime, with ex-China rare earth consumers paying more than their Chinese domestic competitors for the same product.
  - This has incentivized internal consumption of rare earths, leading to an increase in vertical integration and production of higher-value products like magnets, phosphors, ceramics and batteries inside China.
  - The export quotas have also led to some global companies that require rare earths in their products to move operations to China, where pricing is more competitive and there is a greater confidence in supply.

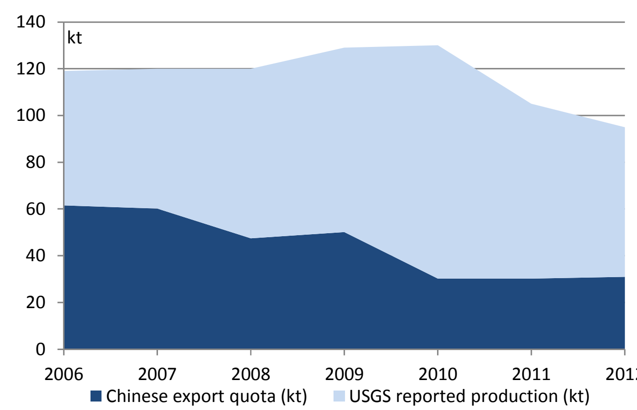
Figure 30 shows that illegal mining (above official production quotas) has reduced since 2010.

Figure 30: Chinese rare earth production vs official quota



Source: China Ministry of Land and Resources, US Geological Survey, Ministry of Commerce of China

Figure 31: Chinese rare earth production vs. export quota



Source: China Ministry of Land and Resources, US Geological Survey, Ministry of Commerce of China

Figure 32: China's Rare Earth Production and Exports, 2006 - 2012

	2006	2007	2008	2009	2010	2011	2012
Official Chinese production quota (kt)	86.5	87.0	87.6	82.3	89.2	93.8	93.8
US Geological Survey reported production (kt)	119.0	120.0	120.0	129.0	130.0	105.0	95.0
Chinese export quota (kt)	61.6	60.2	47.5	50.2	30.3	30.3	31.0

Source: China Ministry of Land and Resources, US Geological Survey, Ministry of Commerce of China

2012: WTO claim over export restrictions

In 2012, the United States, Japan and the European Union put forward a World Trade Organisation (WTO) joint-dispute resolution case against China. The grounds for the case were the restrictive policies put in place by the Chinese government over rare earth export quotas and export duty rates.

Around 90% of global rare earth production comes from China. Japan imports about 60% of Chinese exports.

The Chinese government has stated that the export limits were put in place to protect natural resources and the environment. This dialogue was then reaffirmed in China's first 'white paper' on the rare earth industry, released on July 20th, 2012.

The WTO's dispute settlement review of the case is continuing; a review panel was composed in September 2012.

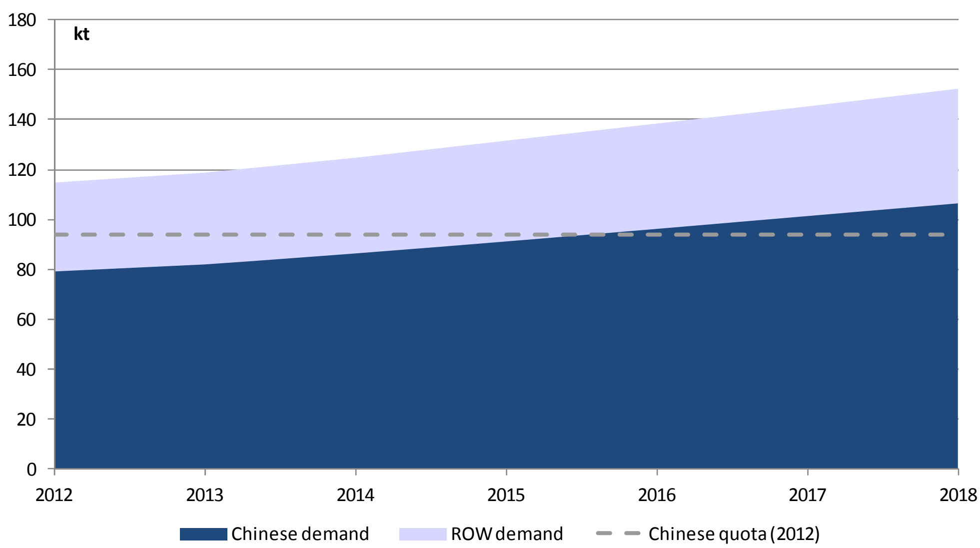
The future of rare earth production/export quotas

With the outcomes of the WTO claim yet to be determined, we assume the existing production quotas, export quotas and export duty rates stay in place and remain largely unchanged in the short-medium term.

Future legislation around Chinese rare earth production is the single biggest unknown when generating a rare earth supply/demand model. There is evidence that the increased industry regulation is curbing illegal mining, and we believe environmental standards will be enforced.

However, with nearly 50% of global rare earth reserves and a number of large scale, legal operating mines in production, we believe that a more sustainable, regulated rare earth industry in China can increase production rates whilst maintaining the new industry standards.

Figure 33: DBe Chinese and rest of world (ROW) demand vs. 2012 production quota



Source: Deutsche Bank, China Ministry of Land and Resources, US Geological Survey, Ministry of Commerce of China

On our estimates, Chinese rare earth demand will exceed the current 93.8kt production quota (2012) in 2016 (see Figure 33). In this scenario, China has the option of increasing domestic production rates or sourcing rare earth materials from the seaborne market. We discuss impacts to rare earth pricing from Chinese production quota sensitivities on page 36.

Historical Chinese export duty rates for rare earth ores, powders and metals

Figure 34 shows the export duty rates for various rare earth products that are currently exported from China. Export duty rates are now 0%, 15% or 25% depending on the element and its strategic importance.

Figure 34: China's rare earth export duty rates (2007-2011)

	Export duty rate (%)				
Commodity	**2007**	**2008**	**2009**	**2010**	**2011**
Yttrium oxide	10	25	25	25	25
Lanthanum oxide	10	15	15	15	15
Cerium oxide, hydroxide, carbonate and others	10	15	15	15	15
Praseodymium	-	-	-	-	-
Neodymium	10	15	15	15	15
Europium and its oxide	10	25	25	25	25
Gadolinium	-	-	-	-	-
Terbium and its oxide, chloride and carbonate	10	25	25	25	25
Dysprosium oxide, chloride and carbonate	10	25	25	25	25
Holmium	-	-	-	-	-
Erbium	-	-	-	-	-
Thulium	-	-	-	-	-
Ytterbium	-	-	-	-	-
Lutetium	-	-	-	-	-
Other rare-earth oxide	10	15	15	15	15
Mixed rare-earth chlorides and fluorides	10	15	15	15	15
Mixed rare-earth carbonates	10	15	15	15	15
Mixed rare-earth, yttrium and scandium compounds and metals (including battery grade)	10	25	25	25	25
Non-mixed rare-earth carbonates	10	15	15	15	15
Rare-earth ore	10	15	15	15	15
Metals:					
Lanthanum	-	-	-	-	-
Cerium	-	-	-	-	25
Neodymium	10	15	15	15	15
Dysprosium	-	-	-	25	25
Other mixed metals	-	-	-	25	25

Source: US Geological Survey, "China's Rare-Earth Industry, 2011

Value Added Tax (VAT) rebates likely to fluctuate with the economy

China applies a VAT on the transfer of taxable goods and services at each point in the production process. The VAT is generally 17%, however this can be as low as 6% for some products.

Since 1985, China has offered some VAT rebates for product exports. The level of rebate tends to vary depending on economic activity. We assume that as global growth weakens the government will likely increase the rebates and decrease the effective VAT paid.

Due to the fluctuations in the VAT rebates over time, we have not factored in a VAT rebate assumption in forward years in our analysis. We assume that outside China production will not be impacted by the tax or the rebate.

Key characteristics of major REE deposit types

Common rare earth deposits can be grouped into two broad divisions:

Primary deposits

Primary deposits are generally formed through magmatic processes or via late-stage hydrothermal fluid movement. As the magmatic flows cool and solidify, rare earth minerals like **bastnäsite** are formed. These igneous deposits are generally associated with carbonates and alkali minerals.

Secondary deposits

Secondary deposits form through sedimentary or metamorphic processes in much lower-energy environments. Rare earth sands can accumulate in both marine and terrestrial settings, producing placer-style deposits. Over time, metamorphic conditions can lead to re-crystallization, producing **monazite** and **xenotime** ores. Weathering can further concentrate rare earths in the form of **lateritic clays**.

Figure 35: Key characteristics and examples of the major REE deposit types

Deposit type	Brief Description	Known Deposits*	Typical grades and tonnage	Major examples
PRIMARY DEPOSITS				
Carbonatite-associated	Deposits associated with carbonate-rich igneous rocks, present in alkaline igneous provinces and zones of major faulting	107	10kt to +500Mt, 0.1-10% REO grade e.g. Bayan Obo: 750Mt at 4.1% REO	**Mountain Pass, USA; Bayan Obo, China**; Okoursu, Namibia; Amba Dongar, India; Barra do Itapirapuã, Brazil; Iron Hill, USA
Associated with alkaline igneous rocks	Deposits associated with igneous rocks characterised by abundant alkali minerals and enrichment in HFSE	122	Typically <100Mt, grade variable, typically <5% REO grade e.g. Thor Lake: 64.2Mt at 1.96% REO	**Ilimaussaq (Kvanefjeld), Greenland**; Khibina and Lovozero, Russia; **Thor Lake and Strange Lake, Canada**; Weishan, China; Brockman, Australia; Pajarito Mountain, USA
Iron-REE deposits (iron oxide-copper-gold deposits)	Copper-gold deposits rich in iron oxide and diverse in character and form	4	Variable, can be large e.g. Olympic Dam, 2000Mt at 0.33% REO	**Olympic Dam, Australia**; Pea Ridge, USA
Hydrothermal deposits (unrelated to alkaline igneous rocks)	Typically quartz, fluorite, polymetallic veins and pegmatites of diverse origin	63	Typically <1Mt, rarely above 50Mt, 0.5-4.0% REO grade e.g. Lemhi Pass 39Mt at 0.51% REO	Karonge, Burundi; Naboomspruit and **Steenkampskraal, South Africa**; Lemhi Pass and Snowboard and Bear Lodge, USA; **Hoidas Lake, Canada**
SECONDARY DEPOSITS				
Marine placers (including coastal dune deposits formed by aeolian processes)	Accumulations of resistant, heavy minerals, concentrated by coastal processes and found along or close to existing coastlines	264	Highly variable tonnage, up to 300Mt, generally <0.1% monazite e.g. Jangardup 30Mt at 0.05% monazite	**Eneabba**, Jangarup, Capel, WIM 150, North Stradbroke Island, Australia; Green Cove Springs, USA; Richards Bay, South Africa; Chavara, India
Alluvial placers	Concentrations of resistant, heavy minerals in river channels	78	Up to 200Mt, typically <0.1% monazite e.g. Horse Creek 19Mt at 0.04% monazite	Perak, Malaysia; Chavara, India; Carolina monazite belt and Horse Creek, USA; **Guangdong, China**
Paleoplacers	Ancient placer deposits typically forming consolidated, cemented rocks	13	10Mt to 100Mt, typically <0.1% REO grade	Elliot Lake, Canada; Bald Mountain, USA
Lateritic deposits	Residual surface deposits formed from intense chemical weathering of REE-enriched igneous rocks	42	10kt to +100Mt, 0.1-10% REO grade e.g. Mount Weld; 12.24Mt at 9.7% REO	**Mount Weld, Australia**; Araxá, Brazil; Kangankunde, Malawi
Ion-adsorption clays	Residual clay deposits formed from the weathering of REE-enriched granites	>100	Generally <10kt, low grade 0.03-0.35% REO grade	**Longnan, Xunwu, China**

*Source: British Geological Society, "Rare Earth Elements", November 2011; *numbers of documented occurrences compiled from Orris and Grauch*

Rare earth ore types

Bastnäsite (REE)CO_3F

The leading ore source of rare earths globally, bastnäsite is commercially extracted throughout China (including the world's largest rare earth mine, Bayan Obo), as well as many other regions around the world.

Bastnäsite is a carbonate-fluoride mineral that forms with varying compositions of cerium, lanthanum, yttrium and small quantities of other rare earths. It is found in carbonatite-rich, igneous deposits and also associated with alkaline minerals in igneous provinces.

Bastnäsite can contain high overall rare earth grades, but is generally dominated by light rare earth elements (LREEs). All rare earth minerals are produced in commercial quantities through the mining of bastnäsite ores, but to increase production of heavy rare earth element (HREE) minerals, significant increases in mining rates would be required. In our view, this would dilute the markets for the more abundant LREEs (like cerium, lanthanum and yttrium).

Global operations/projects extracting bastnäsite ores include:

- Bayan Obo, Inner Mongolia, China
- Mountain Pass, California, USA
- Karonge, Burundi, India
- Mianning, Sichuan, China
- Weishan, Shandong, China
- Ryddarhyttan and Finbo, Sweden

Monazite (REE)PO_4

Monazite is a reddish-brown phosphate mineral, associated with the chemical weathering of carbonatite ores; because of the supergene processes, monazite deposits are relatively large, near surface, laterite deposits that can vary in composition and hardness, from competent rock to loose gravel and sands. Monazite is commonly associated with the radioactive element, thorium.

Monazite can also be found in hydrothermal "placer" deposits (coastal, waterways etc), where the depositional environments concentrate the heavier rare earth sands. To date, none of these deposits have been economically developed.

Monazite has a broad geochemical range, with four main compositions used to define types:

- Monazite-Ce (Ce, La, Pr, Nd, Th, Y)PO_4
- Monazite-La (La, Ce, Nd, Pr)PO_4
- Monazite-Nd (Nd, La, Ce, Pr)PO_4 and;
- Monazite-Sm (Sm, Gd, Ce, Th)PO_4

The range of monazite ores can vary greatly in composition, both regionally (in the same geological setting) and globally, as a result of the wide spectrum of potentially dominant rare earths that can make up the mineral structure. Monazite ores can also have elevated levels of the radioactive element thorium, which can make processing and tailings storage more complex.

Global operations/projects extracting monazite ores include:

- Mount Weld, Western Australia
- Araxá, Minas Gerais, Brazil
- Catalão, Goiás, Brazil
- Mrima, Kenya
- Mabounié, Gabon

Xenotime (Y, HREE)PO_4

Xenotime is a rare earth phosphate mineral similar in composition to monazite, but with a different rare earth content due to higher pressure/temperature conditions during formation. The two phosphate minerals are often both found in singular rare earth deposits in granitic, pegmatitic and gneissic rocks as well as marine placers.

Xenotime is the third-most exploited rare-earth mineral, and its high yttrium and heavy rare earth content makes it an important ore type for some of the smaller rare earth markets. Xenotime is the major HREE source in China, which produces >95% of heavy rare earths globally.

Lateritic/ion adsorption deposits

Lateritic deposits are generated by intense near-surficial and chemical weathering that allows for concentration of rare earths through fluid migration and precipitation. Ion adsorption clays are very similar, with the mineral source being a rare earth-bearing granite that has been exposed to oxidation and weathering effects, allowing the rare earth-rich precipitates to migrate and concentrate via fluid movement.

Despite mining of ion-adsorbed clays in South China being a significant contribution to the global HREE market, similar styles of deposits in other countries may not be economical due to a) higher labour and consumables costs and b) the environmental impacts of sulfuric acid (H_2SO_4) and/or ammonium sulfate $(NH_4)SO_4$ leaching used to treat the clay ores.

Other minor rare earth ores

Some rare earth production comes from other ore sources, but this is generally as a by-product when producing other materials. Rare earths are currently being produced in Russia through the processing of stockpiles from previous mining operations that extracted loparite (REE,Na,Ca)(Ti,Nb,Ta)O_3.

Rare earths are also found in fergusonite, eudialyte and allanite; however, these ore types have not been economically developed to date.

Rare earth supply

Global supply growing but Chinese shadow over market remains

Supply growing from 105kt today to 143kt in 2018 on our estimates

In 2011, Chinese mines produced 97% of the world's supply of rare earths. It is likely China will dominate global supply until at least 2020, particularly given it holds 48% of the world's current reserves. Chinese production quotas, first introduced in 2006, will continue to be an important part of the market dynamics. In our base case, we assume that China continues to supply 93.8ktpa.

The interesting dynamic will be when the domestic consumption (c.80kt in 2012) grows to a level that exceeds the current production quota (93.8ktpa). Despite China's efforts to curb illegal mining and consolidate operations (as outlined in its 'white paper' in June, 2012 titled "Situation and Policies in China's Rare Earth Industry"), we believe that this stoic approach to future production rates may begin to change if domestic consumption exceeds current production levels.

In our analysis we assume that out until 2018, the only players in the market are China (production held flat at the current production quota), Lynas production up to 22kt and Molycorp up to 19kt in Phase 1 (we do not assume Phase 2 to 40kt at this stage). We also assume up to 3kt from other countries such as India (Chavara), Brazil (INB Buena) and Malaysia (Ipoh) and an additional 5kt of rare earth recycling.

Figure 36: DBe global rare earth supply by producer/company 2012 - 2018

Supply Model (kt)	2012	2013	2014	2015	2016	2017	2018
Mountain Pass	4.6	6.0	12.0	19.0	19.0	19.0	19.0
Mt Weld	0.0	3.0	12.0	17.0	22.0	22.0	22.0
China	95.0	93.8	93.8	93.8	93.8	93.8	93.8
India	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Malaysia	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Brazil	0.3	0.0	0.0	0.0	0.0	0.0	0.0
REE recycling	0.0	2.5	5.0	5.0	5.0	5.0	5.0
Total global supply	**103**	**108**	**126**	**138**	**143**	**143**	**143**

Source: Deutsche Bank, US Geological Survey

Chinese has the reserves to continue to dominate the market, policy is the swing factor

On the 20th of June, 2012, the Chinese 'white paper' (produced by The Information Office of the State Council) highlighted the following key points:

1) China recognizes that rare earths have an increasing number of applications with unique properties required in new energy and material applications.

2) As the world's largest producer, China recognizes that the environment was becoming increasingly damaged as a result of some practices. It took steps to protect resources and the environment.

3) Radioactive elements such as thorium are a key consideration for health of individuals and the environment.

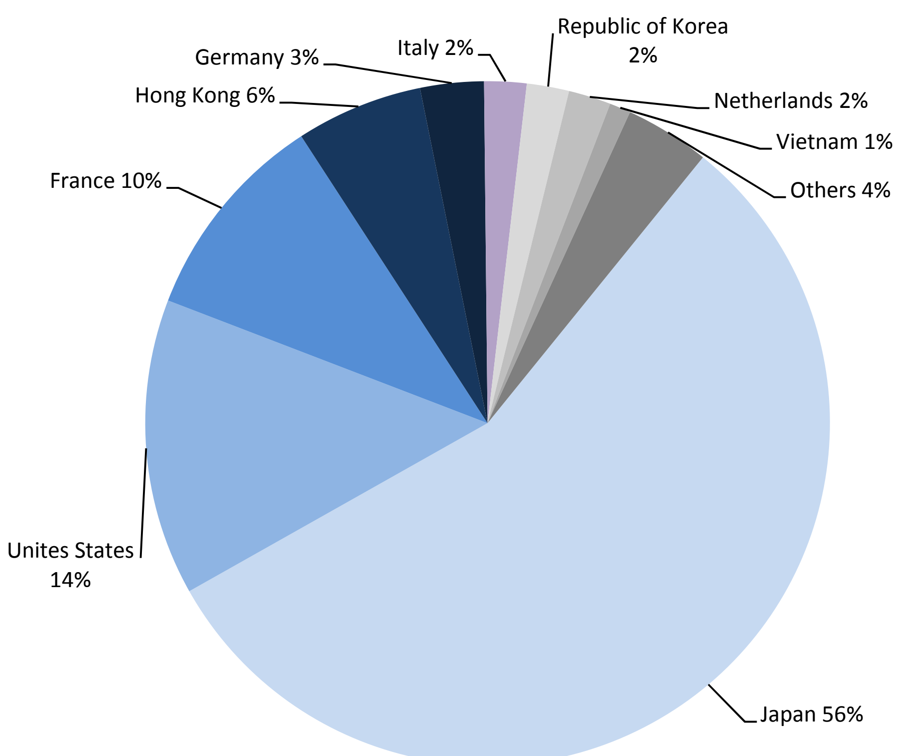
4) China plans on decreasing small, disorderly mining activities and promoting a consolidated approach. Mining has been ongoing for more than 50 years and has largely been unregulated with a high level of illegal mining. In 2006 – 2008, tonnes sold were thought to be greater than 30% above the official export rates (supported by Figure 30, page 24).

5) China continues to see room for growth in vertical integration to increase downstream manufacturing within China.

6) In April, 2012, the Association of China Rare Earth Industry was founded with the aim to increase environmental protection and conserve the resource base. It also planned to increase recycling rates.

7) In the paper, China also highlights that it plans to promote fair trade and international cooperation.

Figure 37: Market for China's rare earth exports in 2011



Source: Chinese white paper, June, 2012

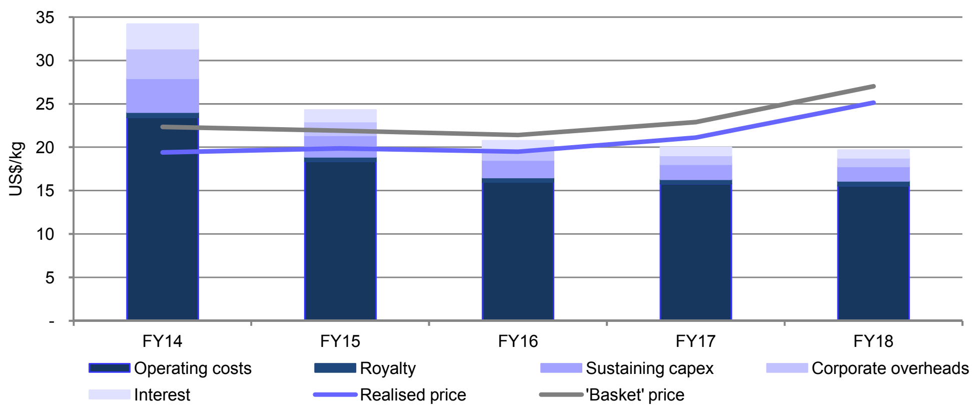
Ex-China supply sources

Lynas – now in production but waiting on demand to improve

Below, we have summarized Lynas' production, cash costs, mine life and balance sheet. While we believe LYC is well placed longer term, we believe there are a number of shorter term risks largely relating to profitability and the balance sheet.

Figure 38 shows the theoretical "basket price" derived from our forecasts as well as the realized price we believe Lynas will receive. The figure shows our expectation for operating costs (US$16/kg by FY16 and US$15/kg by FY18). In our cost analysis, we also assume c.A$25m/year in corporate and marketing costs, A$30-40m/year in sustaining capex (Mount Weld and Malaysia combined) and c.A$20m/year in interest payments on its two facilities. We do not believe Lynas will produce free cash flow until FY16 which will see pressure on its cash position (DBe $121m at the end of FY13).

Figure 38: Basket price, realized price and all in cash costs in US$/kg



Source: Deutsche Bank Future data are estimates

Production – ramping up to 22ktpa in FY17 in our view

In early June, Lynas announced that its LAMP (Lynas Advanced Material Plant) in Malaysia had reached the nameplate rate for Phase 1 (11ktpa). However as a result of weak market conditions, the company indicated that ongoing production will depend on market demand. At the same time, Lynas announced that construction and pre-commissioning of the Phase 2 LAMP was essentially complete. Phase 2 commissioning will likely be delayed until market conditions warrant it, in our view.

Figure 39: DBe LYC production forecasts per product

Production REO (kt)	FY12	FY13	FY14	FY15	FY16	FY17
Cerium carbonate	-	0.15	1.68	3.51	4.57	5.14
Lanthanum carbonate	-	0.08	0.87	1.82	2.37	2.67
Cerium/lanthanum carbonate	-	0.23	2.34	4.05	5.28	5.94
Neodymium/praseodymium oxide	-	0.16	1.42	1.82	2.37	2.67
SEG = Heavy Rare Earths	-	0.03	0.31	0.65	0.84	0.95
Ce/La/Pr carbonate	-	-	0.25	1.35	1.76	1.98
Neodymium oxide	-	-	0.17	0.91	1.19	1.34
Praseodymium oxide	-	-	0.17	0.91	1.19	1.34
Total	**-**	**0.6**	**7.2**	**15.0**	**19.6**	**22.0**
Cash costs (US$/kg)	-	33.3	23.4	18.4	16.0	15.8

Source: Deutsche Bank

We assume production of 7.2kt in FY14, 15kt in FY15, 20kt in FY16 and 22kt (full run rate) in FY17. The ramp up profile is largely a result of our expectation of market requirements rather than technical restrictions.

Post hitting the 22ktpa run rate, we expect a mine out until 2045 as a minimum based on current reserves (after recoveries).

Balance Sheet – a key focus with debt refinancing possibly needed in our view

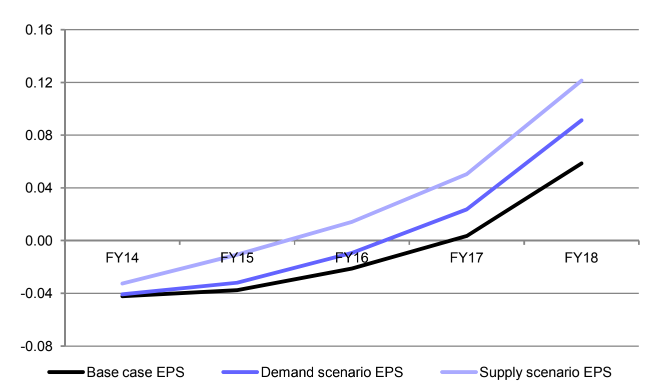
We expect Lynas to have $121m cash at the end of June, 2013 and a net debt position of $278m. We expect the net debt position to increase to $375m by the end of June, 2014. The company currently has two debt sources:

1) US$225m facility with Sojitz (Japanese trading firm supplying rare earths into Japan). The facility is only associated with Phase 2. Repayments are currently due to start on the 31st of March, 2015, finishing on the 31st of March, 2017 over 5 installments. The Sojitz facility has a number of covenants relating to debt service, loan life coverage and gross debt. The interest rate increased from LIBOR + 2.75% to LIBOR + 5.25% after covenants were recently checked. We believe that there is a restriction of further debt at the company level of US$80m. At the end of December, 2012, there was still A$37m (converted to A$ at the prevailing exchange rate) of the US$225m undrawn.

2) US$225m facility with Mount Kellett. It has an interest rate of 2.75% with a conversion price of A$1.15/sh (initially $1.25/sh but reset with equity raising at the end of 2012). The conversion date is on July 25th, 2016.

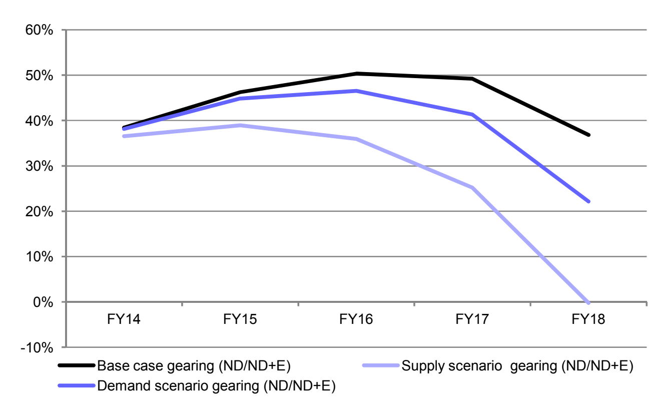
As a result of the current falling rare earth prices and weak selling conditions, we are concerned that repayments for the Sojitz facility will be challenging and the conversion price for the Mount Kellett facility is currently well out of the money. We therefore see risk that Lynas will need to restructure its balance sheet over the coming 12-24 months. Figure 40 and Figure 41 show our base case and scenario EPS and gearing (based on assumed refinancing) expectations. The demand scenario is 10% above our base case and the supply scenario is a 10% restriction in Chinese production quotas (93.8ktpa base assumption), both show upside to our base case.

Figure 40: DBe EPS using base case and scenario prices



Source: Deutsche Bank

Figure 41: DBe gearing at base case and scenario prices



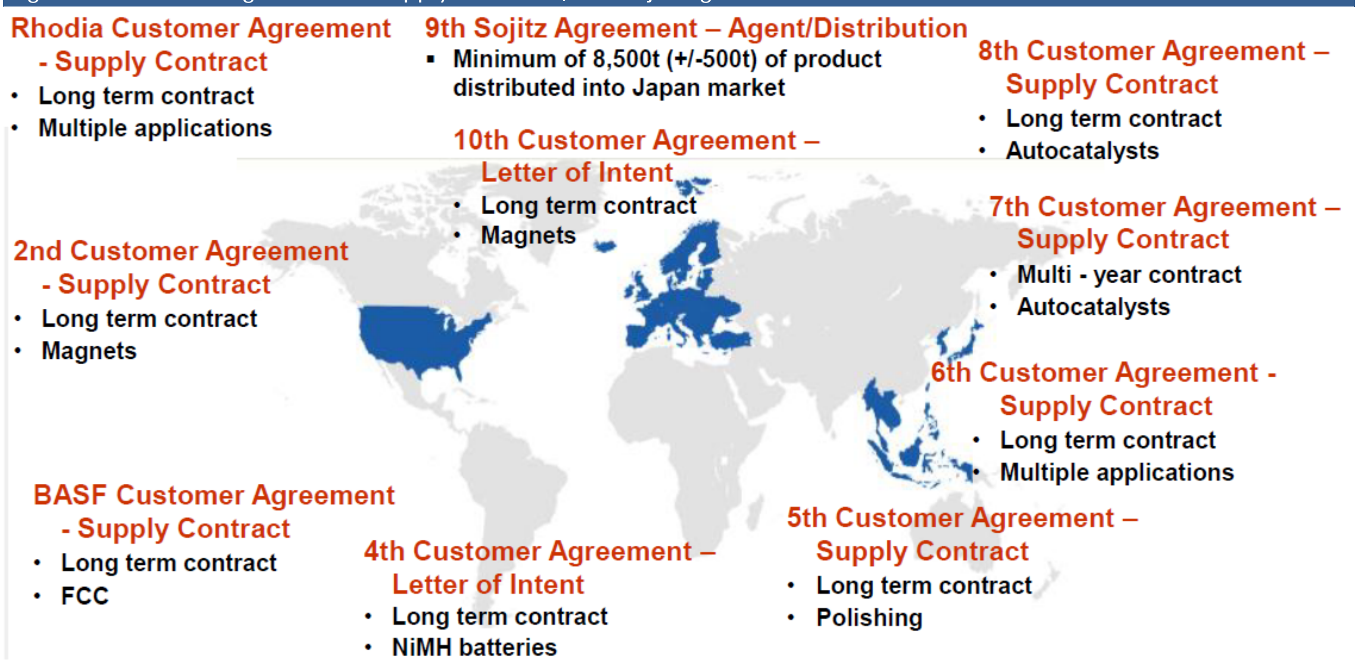
Source: Deutsche Bank

Strategic alliances may help support Lynas volumes

Prior to commissioning and commercial production, it is our understanding that Lynas has seven rare earth supply contracts, an agreement with Sojitz (a minimum 8,500t (+/- 500t) per year over a 10 year period, the alliance also involved a US$225m facility) and two Letters of Intent. Lynas and Siemens also have a JV for magnet production for long term supply and development. Details on the volumes and pricing agreements associated with any of these contracts are not publicly available.

The exact impact of the legacy contracts on Lynas' realized prices for its rare earth products is difficult to tell. Although many of these contracts were negotiated before or during the 2011 supply crisis, we do not believe any of these contracts were based on 2011 spot prices.

Figure 42: LYC has signed seven supply contracts, the Sojitz agreement and two letters of intent



Source: LYC presentation 30/11/2011

Molycorp – the other major player in the market

The Mountain Pass mine in California, USA, owned by the Molybdenum Corporation of America (Molycorp, MCP.N, not covered), commenced small-scale mining in 1952, before dominating global rare earth production from the 1960s through to the 1990s. The deposit it is a carbonatite-hosted, bastnäsite that contains c.30Mt at c.8% rare earth elements (REE) and is rich in cerium (49%), lanthanum (33%), neodymium (12%) and praseodymium (5%). Other rare earth elements are present in trace amounts.

Mining of ore was halted in 2002 for economic, regulatory and environmental reasons, however processing of stockpiles continued at c.4ktpa. A new plan was established in 2008 with a focus on low cost production and vertical integration in an attempt to capture more value through the supply chain. Mining operations recommenced in 2012 in response to increased rare earth demand, with plans to increase current rare earth oxide (REO) production rates to 19ktpa in the second half of 2013. There is also a Stage 2 expansion towards 40ktpa planned pending appropriate market conditions. We do not assume the expansion to 40ktpa in our base case.

In the first quarter production update in May, Molycorp indicated that it was producing at a run rate of c.7kt per year and was still on track to ramp up towards the 19kt annualized run rate in the second half of 2013. Although similar to Lynas, it has indicated that its ramp up schedule will likely vary depending on market conditions.

Molycorp has links inside and outside of China; outside China it has metal and alloy production facilities in Arizona and Estonia and magnetic material capabilities in Thailand and Japan. Inside China, it has a LREE separation facility, a HREE separation facility and magnetic material production.

Molycorp has suggested that it still aims to have longer term costs of US$6-7/kg which would make it the lowest cost producer in the world. Lowering costs will require production improvements. It highlights that it should be low cost given it has a natural gas power plant (combined heat and power) and it is also looking at improving wastewater management and reagent usage (utilizing a Chlor-Alkali facility due later in 2013).

Chinese production quota assumption

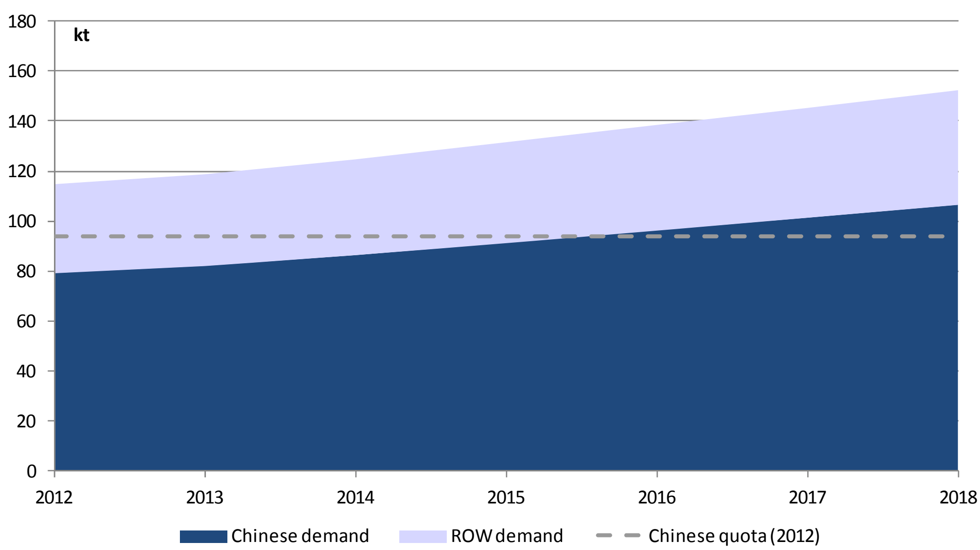
As the dominant global producer and consumer of rare earths, Chinese production rates over time is a key assumption in any rare earth supply/demand model, particularly how future legislation dictates China's ability to meet its own internal demand requirements.

The Chinese government has enforced domestic production quotas in the last 12-18 months, restricting legal mines to their allotted capacities and phasing out illegal mines operating without a license.

The Chinese government's rare earth 'white paper' has reiterated China's public stance that rare earth production will not compromise the conservation of China's natural resources and the surrounding environment. This rhetoric has led the global market to a widely-held view that Chinese rare earth production will remain at current rates (93.8ktpa) into the future.

On our demand assumptions, we expect Chinese rare earth consumption to exceed the current 93.8kt production quota (2012) from 2016:

Figure 43: DBe Chinese and rest of world (ROW) demand vs. 2012 production quota



Source: Deutsche Bank, China Ministry of Land and Resources, US Geological Survey, Ministry of Commerce of China

We see three possible options for the Chinese government to employ in response to the growing rare earth market:

- **No production increase:** China maintains a strong position on rare earth production and holds the production quota at 93.8ktpa. In this scenario, Chinese requirements beyond 93.8ktpa will need to be sourced from ex-China production sources at seaborne market rates.
- **Partial response to domestic demand:** Chinese quotas are eased to allow some increase in production, but some rare earth imports will be required to meet internal demand.
- **Setting production quotas in line with domestic demand:** Chinese quotas are dependent on internal rare earth consumption, with production rates increasing in line with demand.

We do not believe increasing Chinese production quotas necessarily assumes illegal or environmentally-destructive mining is brought back into the supply chain. China has 48% of global REE reserves and a number of large scale, legally operating mines:

- We believe the consolidation occurring in the industry today should lead to a well-controlled supply market that can respond to changing legislation.
- In our view, surviving companies should be large enough to develop new deposits that are more sustainable than the peripheral mining operations that are currently being phased out.

Pricing sensitivities to Chinese production quotas

To reflect current market expectations, we have held Chinese rare earth production flat at 93.8ktpa in our supply/demand analysis. We do recognize that there is significant downside risk to rare earth pricing if China's production quota policies adjust to market demand.

We have considered the three possible production responses in our supply/demand model, running scenarios where:

a) 0% of Chinese demand over 93.8ktpa is met by increased production

b) 50% of Chinese demand over 93.8ktpa is met by increased production

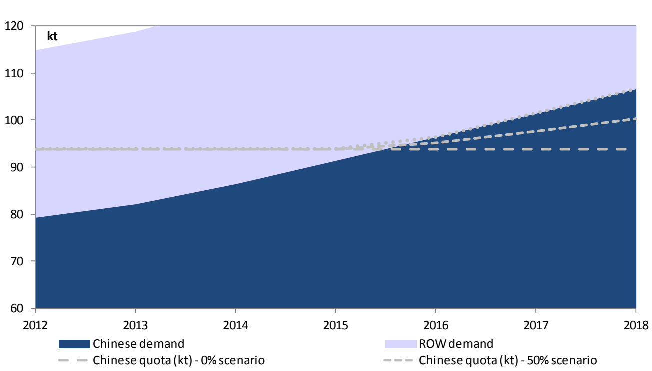
c) 100% of Chinese demand over 93.8ktpa is met by increased production

Figure 44: DBe Chinese rare earth demand vs. production quota scenarios

	2012	2013	2014	2015	2016	2017	2018
Chinese demand (kt)	**79.3**	**82.2**	**86.5**	**91.4**	**96.4**	**101.4**	**106.6**
a) Chinese quota (kt) - 0% scenario	93.8	93.8	93.8	93.8	93.8	93.8	93.8
b) Chinese quota (kt) - 50% scenario	93.8	93.8	93.8	93.8	95.1	97.6	100.2
c) Chinese quota (kt) - 100% scenario	93.8	93.8	93.8	93.8	96.4	101.4	106.6

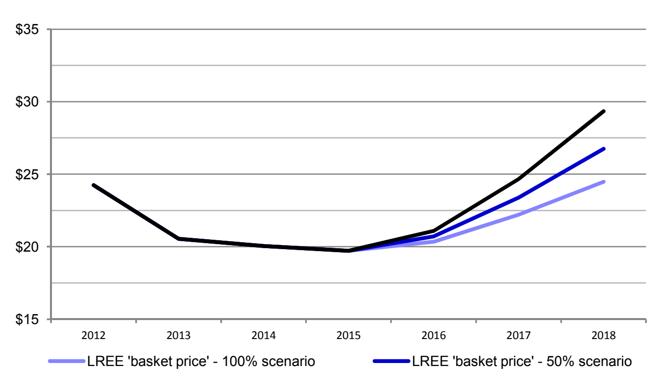
Source: Deutsche Bank, China Ministry of Land and Resources, US Geological Survey, Ministry of Commerce of China

Figure 45: 0%, 50% and 100% Chinese quota scenarios



Source: Deutsche Bank, China Ministry of Land and Resources, US Geological Survey, Ministry of Commerce of China

Figure 46: LREE 'basket price' sensitivity to Chinese quota



Source: Deutsche Bank, China Ministry of Land and Resources, US Geological Survey, Ministry of Commerce of China

Significant downside risk to pricing if Chinese production exceeds current levels

- If the Chinese government increases production quotas to 50% of demand above 93ktpa, we believe this would have a -2% impact on pricing in 2016, 5% lower in 2017 and 9% lower in 2018.

- If Chinese production quotas are set in line with internal rare earth demand, REO prices would be 4% lower in 2016, 10% lower in 2017 and 17% lower in 2018.

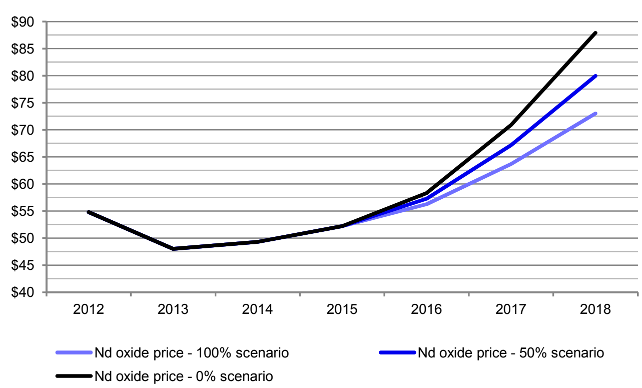
Figure 47: DBe standard LREE 'basket price' sensitivity to Chinese production quota

	2012	2013	2014	2015	2016	2017	2018
a) LREE 'basket price' - 0% scenario	$24.25	$23.86	$20.05	$19.71	$21.08	$24.66	$29.34
b) LREE 'basket price' - 50% scenario	$24.25	$23.86	$20.05	$19.71	$20.71	$23.38	$26.75
% difference	-	-	-	-	*-2%*	*-5%*	*-9%*
d) LREE 'basket price' - 100% scenario	$24.25	$23.86	$20.05	$19.71	$20.34	$22.20	$24.48
% difference	-	-	-	-	*-4%*	*-10%*	*-17%*

Source: Deutsche Bank

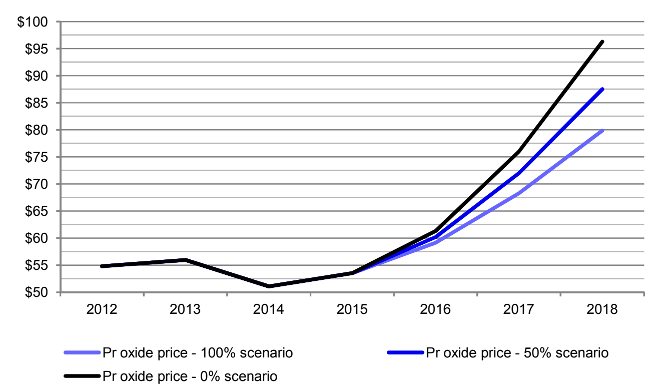
The pricing impact on the two rare earth elements we believe to be in the greatest under-supply, neodymium and praseodymium, is shown below:

Figure 48: Nd oxide price sensitivity to Chinese quota



Source: Deutsche Bank, China Ministry of Land and Resources, US Geological Survey, Ministry of Commerce of China Future data are forecasts

Figure 49: Pr oxide price sensitivity to Chinese quota



Source: Deutsche Bank, China Ministry of Land and Resources, US Geological Survey, Ministry of Commerce of China Future data are forecasts

Recycling could become a larger part of supply

We estimate recycling is in the order of 5kt per year. The ability to recycle rare earths depends primarily on the product that the rare earths are used in and also rare earth prices. We assume that 5kt per year continues in forward years, however we note that recycling could become more prevalent if it becomes mandated in particular regions or if higher prices encourage it.

The fact that there is very little recycling currently suggests that the value extracted from the recapture is not sufficient to cover the costs. However, particular regions of the world, including Japan (through Hitachi Ltd.) are exploring more innovative ways to recover materials.

If there are periods of shortages going forward, it is likely this will cause prices to go up which would result in more favourable economics for recycling. In the mean time, some research into reclaiming material will likely continue. Permanent magnet recycling will likely have the highest amount of physical tonnes recycled going forward. Lithium-ion battery growth over nickel-metal-hydride batteries would also take the pressure off some of the critical rare earths.

In the below section we have summarized the potential for recycling in various applications.

- **Catalysts** – Used catalysts are generally considered hazardous, with the normal practice to use lined landfills for disposal and no recycling is undertaken.
- **Glass** – Coloured glass containing rare earths is often partially recycled through the manufacturing of further products such as tiles and fibers. The remaining glass is generally disposed of in landfills. Polishing powders can be regenerated however the process is generally costly and therefore is not widely used.
- **Metallurgy** – Rare earths are generally in very low concentrations in the slag and is therefore difficult to recycle. Used material is normally sent to landfills.
- **Phosphors** – Lighting and lamps are possible areas where recycling could become more dominant. Rhodia and some other groups continue to explore the possibilities of developing this industry.
- **Ceramics** – It is possible to recycle some of the rare earth material however currently it is not completed as the cost is higher than the value of the new products.
- **Neodymium-Iron-Boron Magnets** – Potential for recycling, re-manufacturing and re-use. Magnets can be separated back out from the applications they are used in. One setback is the fact that magnets often corrode with use, making it more difficult to recover the rare earths. Also, magnets with plating such as nickel are difficult to recycle. Hitachi is a leader currently and has successfully recycled some magnets from hard disk drives.
- **Battery Alloys** – Nickel-metal-hydride (NiMH) batteries can be recycled. This is already occurring. In general a used battery contains 50% nickel and 33% rare earths by weight. Recycling can be completed through pyrometallurgical processes; waste that can't be separated is sent to landfill.

DB global supply assumptions

Figure 50 shows our global supply assumptions on an elemental basis. Figures are calculated by taking the compositions for each of the rare earth projects modeled and the production rates we expect from each operation each year:

Figure 50: DBe global rare earth supply market 2012 - 2018

REO supply (t)	2012	2013	2014	2015	2016	2017	2018
Yttrium	12.2	12.2	12.2	12.3	12.3	12.3	12.3
% growth	*0%*	*0%*	*1%*	*0%*	*0%*	*0%*	*0%*
Lanthanum	21.5	22.7	27.6	31.2	32.4	32.4	32.4
% growth	*0%*	*6%*	*21%*	*13%*	*4%*	*0%*	*0%*
Cerium	38.7	41.7	49.9	55.7	58.0	58.0	58.0
% growth	*0%*	*8%*	*20%*	*12%*	*4%*	*0%*	*0%*
Praseodymium	5.0	5.2	6.1	6.6	6.9	6.9	6.9
% growth	*0%*	*4%*	*16%*	*9%*	*4%*	*0%*	*0%*
Neodymium	16.4	17.2	20.0	21.7	22.7	22.7	22.7
% growth	*0%*	*4%*	*16%*	*9%*	*4%*	*0%*	*0%*
Samarium	1.8	1.9	2.2	2.4	2.5	2.5	2.5
% growth	*0%*	*6%*	*17%*	*8%*	*5%*	*0%*	*0%*
Europium	0.2	0.2	0.2	0.3	0.3	0.3	0.3
% growth	*0%*	*6%*	*25%*	*12%*	*8%*	*0%*	*0%*
Gadolinium	2.1	2.1	2.2	2.2	2.2	2.2	2.2
% growth	*0%*	*1%*	*3%*	*1%*	*0%*	*0%*	*0%*
Terbium	0.4	0.4	0.5	0.5	0.5	0.5	0.5
% growth	*0%*	*4%*	*5%*	*1%*	*1%*	*0%*	*0%*
Dysprosium	1.5	1.5	1.6	1.6	1.6	1.6	1.6
% growth	*0%*	*1%*	*2%*	*0%*	*0%*	*0%*	*0%*
TOTAL	100	105	122	134	139	139	139

Source: Deutsche Bank, US Geological Survey, note these figures reflect the 10 rare earth elements included in this supply/demand analysis

The next wave

We expect current rare earth supply to be sufficient to meet global demand until 2016, and therefore we do not see any pressure on pricing in the medium term. Molycorp and Lynas production growth is significant in the context of the current market size. We therefore believe that it will be difficult for the next wave of projects to obtain funding until pricing support reappears. We also believe that beyond funding, the construction process will be lengthy.

- **Rather than differentiate between the quality of potential projects, we assume no further production beyond Lynas, Molycorp and China until 2018.**

Figure 51 shows the resource and grade along with a target production date for a number of global companies with rare earth deposits. Key considerations for likely projects that may be approved include the following:

- Environment approval
- Funding requirements
- Grade of deposit
- Scalability
- Political risk of country where the project is located
- The composition of the deposit, i.e. the weighting of the deposit towards the elements that are likely to be in shortage in outer years such as neodymium, praseodymium and dysprosium.

Figure 51: Current and future potential rare earth projects

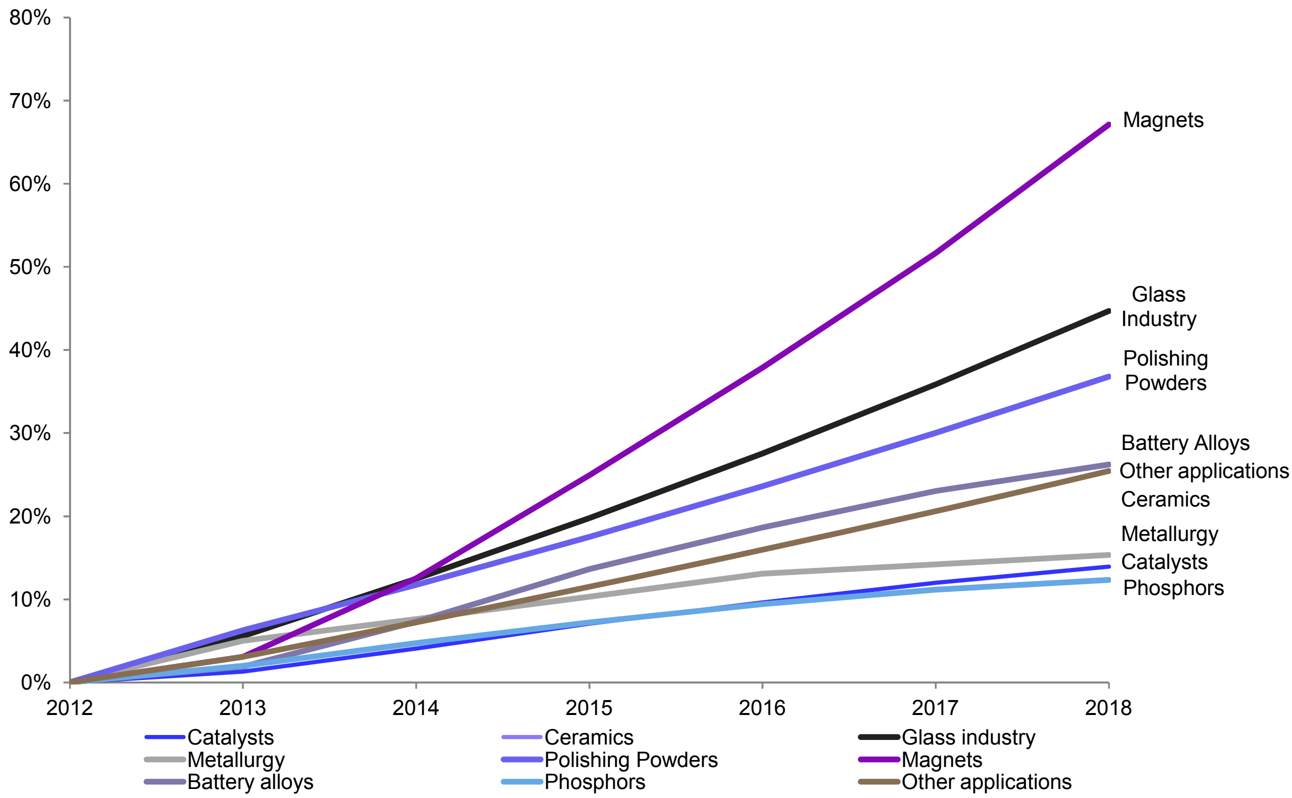
Project	Company	Resource (Mt)	Grade (%)	Company production target	Comments
Mount Weld	Lynas	14.9	9.80%	Producing	Now in production
Mountain Pass	Molycorp Minerals LLC	34.8	6.57%	Producing	Production is ramping up
Bayan Obo	Baotou	800	6.00%	Producing	
Dubbo Zirconia	Alkane Resources	73.2	0.75%	2015	Contains zirconia (1.96%), niobium
Kvanefjeld	Greenland Minerals	956	1.08%	2017	Also contains uranium at 273ppm
Nolan's Bore	Arafura Resources	47.0	2.60%	2017	Also contains phosphate at 11.0%
Browns Range	Northern Minerals	1.44	0.73%	2016	
Ngualla	Peak Resources	21.6	4.54%	Q1 2016	
Nechalacor/Thor Lake	Avalon Rare Metals	304	1.37%	2017	Also contains zirconia at 2.43%
Steenkampskraal	Great Western Minerals	0.5	16.36%	2014	
Ulba Tailings	Kazatomprom			2015	
Bear Lodge	Rare Element Resources	57	2.75%	2016	
Hoidas Lake	Great Western Minerals	1.4	2.60%	PFS stage	

Source: Company data

Rare earth demand

Growth markets the key to understanding rare earth demand

Figure 52: DBe cumulative demand growth for major rare earth consuming markets (2012 – 2018)



Source: Deutsche Bank

Magnet applications the standout driver for demand growth

With neodymium magnets used in strong-growing markets like wind turbines (DBe 26% CAGR) and the hybrid and electric car industry (DBe 24% CAGR), rare earth magnet demand is a key growth driver in the near-term. We expect the overall rare earth magnet industry to grow at 9-11% per annum between 2014 and 2018.

Glass industry and polishing powders soaking up the light rare earth supply

Driven by strong exposure to developing markets and primary economic growth, we expect rare earth consumption in the global glass industry to be a strong market for light rare earths in forward years. With DB's positive view on consumer electronics, polishing powders are also likely to outperform other markets. Supporting these demand assumptions is the excess lanthanum and cerium supply being generated as global production tries to meet demand for the higher value elements like neodymium.

Structural industry changes to strengthen some markets and weaken others

With the implementation of REE-intensive direct-drive technology in wind turbines, rare earth consumption in this sector will grow at a higher rate each year, in our view. Conversely, the energy efficiency and lower costs offered by light emitting diode (LED) technology in lighting and electronics is expected to put pressure on incumbent technologies, like the rare-earth intensive phosphor industry.

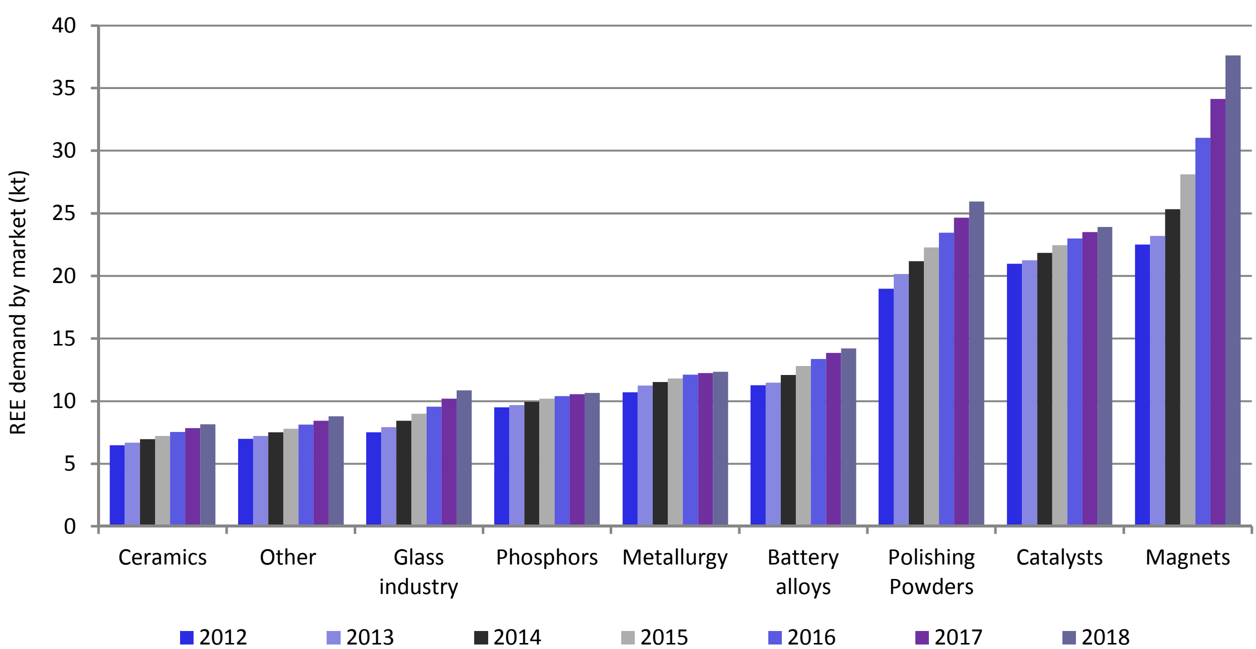
DBe rare earth demand (2012 – 2018)

Figure 53: DBe rare earth demand by key market (2012 – 2018)

Demand (kt)	2012	2013	2014	2015	2016	2017	2018
Mature markets							
Catalysts	21.0	21.3	21.8	22.5	23.0	23.5	23.9
% growth	-	*1%*	*3%*	*3%*	*2%*	*2%*	*2%*
Glass industry	7.5	7.9	8.4	9.0	9.6	10.2	10.9
% growth	-	*6%*	*6%*	*6%*	*6%*	*6%*	*6%*
Metallurgy	10.7	11.2	11.5	11.8	12.1	12.2	12.4
% growth	-	*5%*	*2%*	*2%*	*2%*	*1%*	*1%*
Ceramics	6.5	6.7	7.0	7.2	7.5	7.8	8.1
% growth	-	*3%*	*4%*	*4%*	*4%*	*4%*	*4%*
Emerging markets							
Magnets	22.5	23.2	25.3	28.1	31.0	34.1	37.6
% growth	-	*3%*	*9%*	*11%*	*10%*	*10%*	*10%*
Battery alloys	11.3	11.5	12.1	12.8	13.4	13.9	14.2
% growth	-	*2%*	*5%*	*6%*	*4%*	*4%*	*3%*
Polishing Powders	19.0	20.2	21.2	22.3	23.4	24.7	26.0
% growth	-	*6%*	*5%*	*5%*	*5%*	*5%*	*5%*
Phosphors	9.5	9.7	9.9	10.2	10.4	10.6	10.7
% growth	-	*2%*	*3%*	*2%*	*2%*	*2%*	*1%*
Other	7.0	7.2	7.5	7.8	8.1	8.4	8.8
% growth	-	*3%*	*4%*	*4%*	*4%*	*4%*	*4%*
TOTAL	**114.9**	**118.9**	**124.8**	**131.7**	**138.6**	**145.4**	**152.5**
% growth	-	*3%*	*5%*	*6%*	*5%*	*5%*	*5%*

Source: Deutsche Bank

Figure 54: DBe rare earth market demand (2012 – 2018)

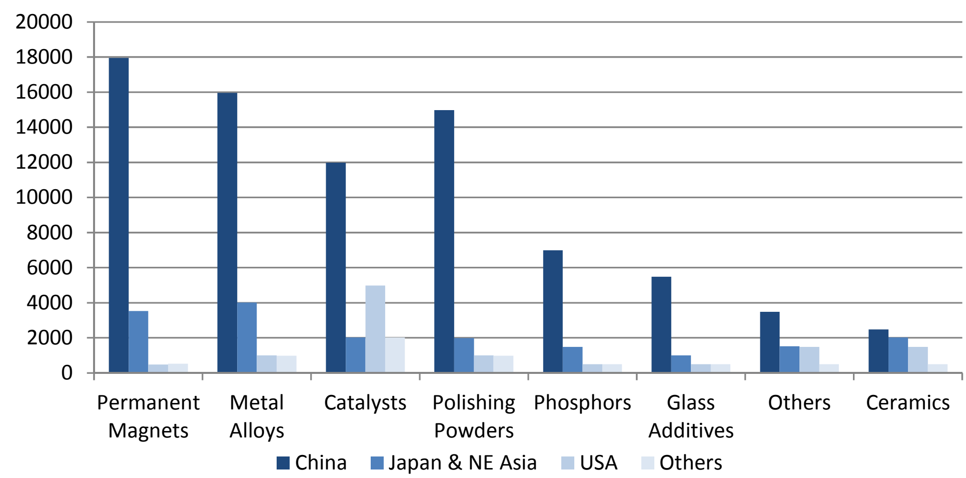


Source: Deutsche Bank, US Geological Survey

China should continue to dominate rare earth demand

Despite slowing in recent times, Chinese GDP continues to grow at c.8% per annum; twice the rate of the rest of the world. With significant investment in domestic industries and vertical integration, we believe Chinese rare earth demand will remain at c.70% of global demand over the next few years.

Figure 55: Rare earth market demand by region (2012)



Source: Technology Metals Research

Figure 56: Chinese rare earth market demand (2012)

Industry	Chinese demand (t)	Total demand (t)	%
Catalysts	11,974	20,987	57%
Ceramics	2,478	6,491	38%
Glass industry	5,482	7,500	73%
Metallurgy	8,699	10,710	81%
Polishing Powders	14,978	18,969	79%
Magnets	17,961	22,500	80%
Battery alloys	7,265	11,264	64%
Phosphors	6,996	9,496	74%
Other	3,487	6,996	50%

Source: Technology Metals Research

Price elasticity a factor in demand

Rare earth elements are used in a broad spectrum of products, from industrial applications to consumer markets driven by discretionary spending. Some rare earth consuming products have demand exposure solely from developed countries, whereas others are integral to economic development in emerging markets.

In the last two years, a severe restriction on Chinese supply and soaring rare earth prices led to industry initiatives in product substitution, replacement, and recycling. It is important to note that despite alternatives being available in many applications, they are generally less effective than rare earths. In saying that, pricing will have an impact on consumption:

- **Price elastic applications:** polishing powders, NiMH batteries, direct-drive wind turbine technology, and phosphors.
- **Price inelastic applications:** fluid catalytic cracking (FCCs), high temperature ceramics, magnets in traditional car market (power steering, weight savings).

DB demand market growth assumptions

Figure 57: Market growth forecasts (2013 – 2018) used in this demand analysis

Industry	Implied market growth rate	Source	2013	2014	2015	2016	2017	2018
Catalysts								
FCC's	Global oil production	Deutsche Bank	1.0%	1.4%	1.3%	1.3%	1.3%	1.3%
Auto catalysts	Global car production	Deutsche Bank	1.9%	5.3%	5.9%	4.4%	3.7%	2.6%
Ceramics	Global GDP forecast	Deutsche Bank	3.1%	4.0%	4.0%	4.0%	4.0%	4.0%
Glass industry	Global GDP forecast + 2.5% premium	Deutsche Bank, Nippon Sheet Glass Co. Ltd.	5.6%	6.5%	6.5%	6.5%	6.5%	6.5%
Metallurgy	Chinese steel production	Deutsche Bank	5.0%	2.5%	2.5%	2.5%	1.0%	1.0%
Polishing Powders	- Global TV production	Deutsche Bank	1.3%	2.9%	3.7%	3.7%	3.7%	3.7%
	- Global mobile phone prod'n	Deutsche Bank	7.1%	5.0%	5.0%	5.0%	5.0%	5.0%
	- Global PC production	Deutsche Bank	6.0%	6.5%	6.5%	6.5%	6.5%	6.5%
Magnets								
Wind turbines	Global installed wind capacity	International Energy Agency	13.7%	14.7%	12.2%	11.2%	10.8%	10.0%
	Direct-drive market share	Deutsche Bank	13.4%	15.4%	17.9%	20.6%	23.9%	27.6%
Global car market	Global car production	Deutsche Bank	1.9%	5.3%	5.9%	4.4%	3.7%	2.6%
Hybrid car market	Global HEV production	Deutsche Bank	-13.1%	34.2%	43.5%	31.8%	24.3%	23.0%
Industrial applications	Global GDP forecast	Deutsche Bank	3.1%	4.0%	4.0%	4.0%	4.0%	4.0%
Consumer electronics	- Global TV production	Deutsche Bank	1.3%	2.9%	3.7%	3.7%	3.7%	3.7%
	- Global HDD production	Deutsche Bank	-3.8%	0.7%	0.7%	0.7%	0.7%	0.7%
	- Global mobile phone prod'n	Deutsche Bank	7.1%	5.0%	5.0%	5.0%	5.0%	5.0%
	- Global PC production	Deutsche Bank	6.0%	6.5%	6.5%	6.5%	6.5%	6.5%
Battery alloys	Global HEV production	Deutsche Bank	-13.1%	34.2%	43.5%	31.8%	24.3%	23.0%
	NiMH battery market share	Deutsche Bank	59%	50%	45%	35%	25%	20%
Phosphors	Global GDP forecast	Deutsche Bank	3.1%	4.0%	4.0%	4.0%	4.0%	4.0%
	LED market share	Deutsche Bank	6.0%	7.2%	8.6%	10.4%	12.4%	14.9%
Other applications	Global GDP forecast	Deutsche Bank	3.1%	4.0%	4.0%	4.0%	4.0%	4.0%

Source: Deutsche Bank

Figure 58: DBe global GDP forecasts (2011 – 2014)

GDP growth (%)	2011	2012	2013e	2014e
US	1.8	2.2	2.2	3.2
Eurozone	1.5	-0.5	-0.6	1.0
Germany	3.0	0.7	0.1	1.5
Japan	-0.5	1.9	2.0	0.6
UK	1.0	0.3	1.1	1.8
China	9.3	7.8	7.9	8.8
India	7.5	4.1	6.3	6.4
EM (Asia)	7.5	6.1	6.3	7.3
EM (Lat Am)	4.3	2.8	2.8	3.6
EM (CEEMEA)	4.9	2.8	2.7	3.6
Emerging Markets	6.4	4.8	4.9	5.8
Developed Markets	1.4	1.2	1.2	2.1
Global GDP growth	**3.8**	**2.9**	**3.1**	**4.0**

Source: Deutsche Bank

Rare earth mature markets

Catalysts

Figure 59: Key rare earth elements

La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Y
66%	32%	0.6%	0.8%						

Source: Deutsche Bank, US Geological Survey

There are two main markets for rare earths in catalysts: Fluid catalytic cracking (FCC) and automotive catalytic converters:

Fluid catalytic cracking (FCC)

Fluid catalytic cracking is the process used in petroleum refineries to separate a heavy hydrocarbon product into lighter hydrocarbon fractions. FCC is applied to a portion of the crude oil that has a boiling point above 340°C and an average molecular weight of 200 or higher; this portion is often referred to as Heavy Gas Oil.

Fluid cracking is dependent on the control of temperature and pressure conditions and the presence of an appropriate catalyst to provide physical sites for the reaction to take place.

The catalyst is based on a rock known as zeolite, used for its porous characteristics. To achieve the optimal silicon-to-aluminum ratio needed for fluid cracking, without weakening the structure of the rock, the zeolite undergoes a process to replace aluminum with rare earth elements within the rock matrix.

Automotive catalytic converters

Rare earth oxides are used in automotive catalytic converters as a protective coating for other, more expensive catalysts. Platinum group metals (like palladium, platinum etc.) are used more extensively as primary catalysts in this process, but the use of REOs provides longevity of the product and generates higher temperature conditions where some efficiencies can be gained.

Catalytic converters were made mandatory in American car production in 1975 due to EPA regulations on toxic emissions. Around 90% of cars globally are fitted with auto-catalytic converters, with the expectation that that figure will move to 100% as older cars are phased out and global emission standards are applied to the car industry.

Industry feedback from the U.S. suggests c.US$80 worth of REEs can be recovered from recycling an old car

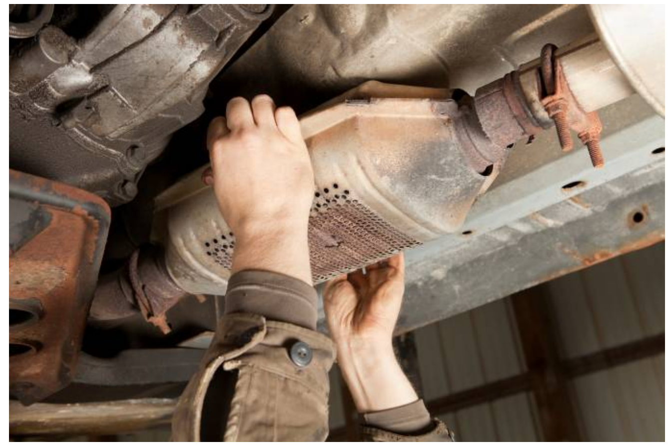
As with scrap steel recycling, some rare earths can be extracted from recycled cars. Deutsche Bank's US Automotive Industry team recently met with LKQ (LKQ.N, Hold, US$26.00/sh PT), the largest supplier of recycled and re-furbished car and truck parts in the United States. LKQ feedback was that "the average U.S. vehicle has 1.5 catalytic converters and they estimate recovery of US$80 worth of precious/rare earth elements from each vehicle".

- We allow for this recycling of rare earths in our supply model by assuming 5kt of rare earths are recycled each year across all rare earth consuming industries.

Figure 60: Oil refinery with cracking columns

Source: iStockphoto

Figure 61: Automotive catalytic converter



Source: iStockphoto

DB growth assumptions

We have applied Deutsche Bank forecasts for global oil production growth and global car production growth to assume the increase in REE consumption in FCCs and automotive catalytic converters respectively.

Figure 62: DBe global oil production forecasts 2012-2018

	2012	2013	2014	2015	2016	2017	2018
DBe global oil demand (mbbl/day)	89.8	90.7	92.0	93.2	94.4	95.6	96.8
% growth	**-**	**1.0%**	**1.4%**	**1.3%**	**1.3%**	**1.3%**	**1.3%**

Source: Deutsche Bank, forecast out to 2016, projected at constant growth rate to 2018

Figure 63: DBe global car production forecasts 2012-2018

Production (millions)	2012	2013	2014	2015	2016	2017	2018
Europe	19.3	18.7	19.4	20.2	21.1	22.1	22.9
Greater China	18.6	20.4	22.6	24.8	26.6	28.1	29.2
Japan/Korea	13.9	12.9	12.6	12.6	12.1	12.2	12.3
Middle East/Africa	1.7	1.8	2.1	2.2	2.4	2.5	2.5
North America	15.4	16.1	16.3	17.0	17.6	17.7	17.8
South America	4.3	4.5	4.8	5.3	5.5	5.8	6.0
South Asia	8.2	8.6	9.7	10.6	11.4	12.0	12.4
Total	**81.5**	**83.1**	**87.5**	**92.6**	**96.7**	**100.3**	**102.9**
% growth	**6.0%**	**1.9%**	**5.3%**	**5.9%**	**4.4%**	**3.7%**	**2.6%**

Source: Deutsche Bank

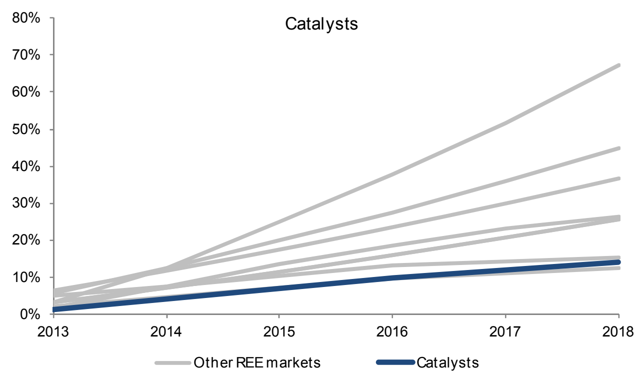
We believe c.33% of rare earth demand from catalysts in 2012 was driven by automotive catalytic converters, with c.67% consumed by the other main market; FCC production. There are other catalyst applications that use rare earths in small amounts, however we have pooled this consumption with FCCs and applied the DB oil production growth rate (1.0-1.4% CAGR).

Figure 64: DBe demand growth rate for catalysts 2012-2018

	2012	2013	2014	2015	2016	2017	2018
Fluid catalytic converters (t)	13,991	14,132	14,334	14,521	14,708	14,895	15,082
% growth	-	1.0%	1.4%	1.3%	1.3%	1.3%	1.3%
Automotive catalytic converters (t)	6,996	7,129	7,506	7,949	8,299	8,606	8,830
% growth	-	1.9%	5.3%	5.9%	4.4%	3.7%	2.6%
Catalysts (REE t)	**20,987**	**21,260**	**21,841**	**22,470**	**23,007**	**23,501**	**23,912**
% growth	**-**	**1.3%**	**2.7%**	**2.9%**	**2.4%**	**2.1%**	**1.7%**

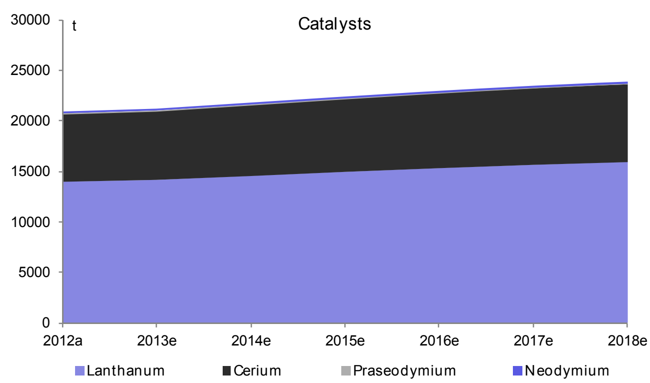
Source: Deutsche Bank

Figure 65: Cumulative demand growth for catalysts



Source: Deutsche Bank Future data are forecasts

Figure 66: Rare earth demand in catalysts (2012-18)



Source: Deutsche Bank

Glass industry

Figure 67: Key rare earth elements

La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Y
25%	69%	1%	3.1%						2.1%

Source: Deutsche Bank, US Geological Survey

Colouring agents

Rare earths are added to various glass products to perform a variety of practical and aesthetic functions, including i) colourising or de-colourising of the glass, ii) altering the refractive index and iii) absorbing ultraviolet light.

Although there is a strong market for recycled glass, clear glass is unlikely to contain rare earth elements. Coloured glass, which may have REEs present, is also recycled but more likely to end up in coloured tiles, construction aggregate or landfill than in an application requiring rare earth characteristics.

Lasers

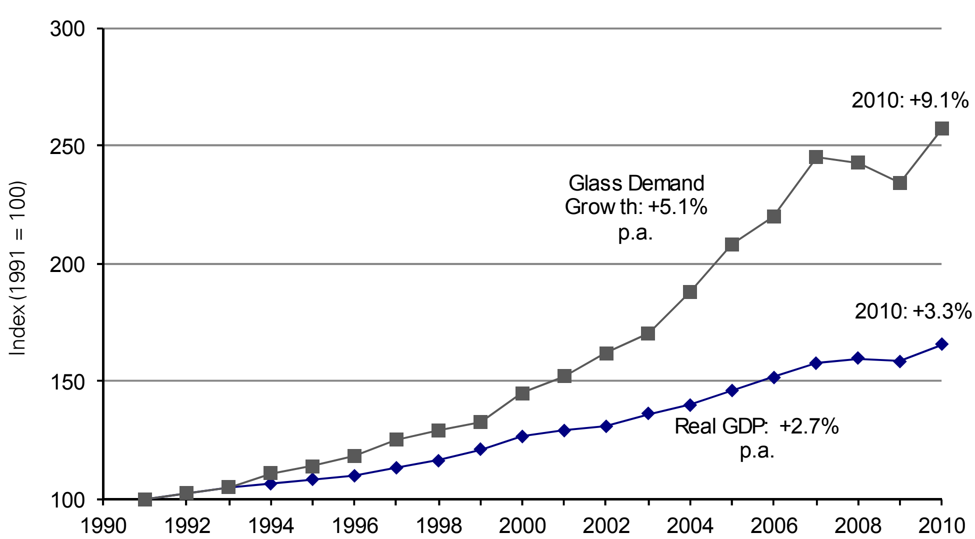
Yttrium is used to form yttrium-aluminium-garnet (YAG) lasers, the most widely used active laser medium in solid state lasers. YAG can be “doped” with other rare earth elements, like neodymium and erbium, to produce laser variants with unique properties for specialized applications.

DB growth assumptions

The global financial crisis resulted in a significant demand contraction in the glass industry in 2009. However, the global recovery has supported the glass industry and global glass demand is now above pre-GFC levels. Most of this recovery has been driven by increased demand in emerging markets, whilst developed markets have remained subdued.

Float glass, which is what modern windows are made of, has been the key driver to market growth, as global urbanization and the emergence of the BRIC economies has led to an increase in construction and glass demand.

Figure 68: Global float glass demand vs. real GDP growth (1991-2010)

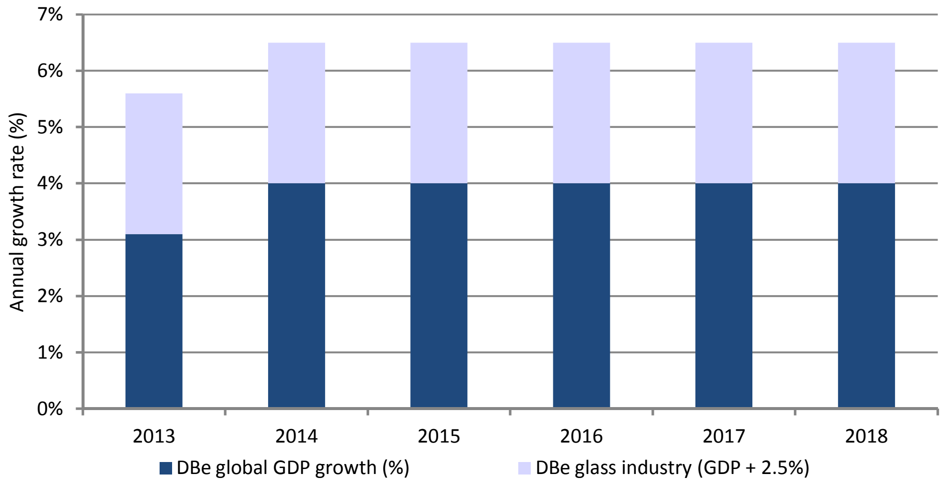


Source: Deutsche Bank, Nippon Sheet Glass Co. Ltd.

Over the last 20 years, float glass demand has grown at 5% per annum. In comparison, real GDP growth increased at a rate of 2.7% per annum. Over the last 10 years, float glass demand has exceeded GDP growth by an average 2.5 percentage points:

We have applied this historical premium to GDP growth as an estimate of growth in the glass industry out to 2018. We expect rare earth consumption in the glass industry to increase broadly in line with the growth of the glass market.

Figure 69: DBe glass industry growth v. DBe global GDP growth rate



Source: Deutsche Bank

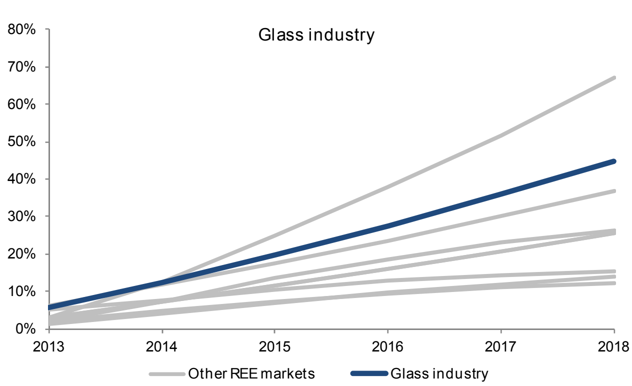
We believe that this growth assumption skews our industry forecast towards emerging markets that are driving global glass demand. The 2.5% buffer also allows for an increase in value-added products (like stained glass), that are more rare earth intensive.

Figure 70: DBe demand growth rate for global glass industry 2012-2018

	2012	2013	2014	2015	2016	2017	2018
DBe global GDP growth (%)	-	3.1%	4.0%	4.0%	4.0%	4.0%	4.0%
Glass growth (GDP+2.5%)	-	5.6%	6.5%	6.5%	6.5%	6.5%	6.5%
Glass industry (REE t)	**7,500**	**7,920**	**8,435**	**8,983**	**9,567**	**10,189**	**10,851**
% growth	**-**	**5.6%**	**6.5%**	**6.5%**	**6.5%**	**6.5%**	**6.5%**

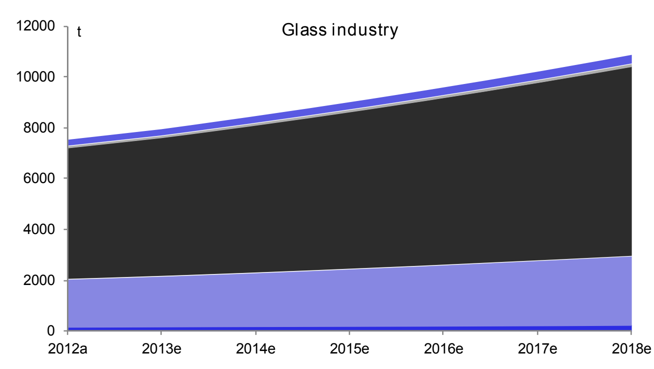
Source: Deutsche Bank, Nippon Sheet Glass Co. Ltd.

Figure 71: Cumulative demand growth for glass industry



Source: Deutsche Bank Future data are forecasts

Figure 72: Rare earth demand in glass industry (2012-18)



Source: Deutsche Bank

Metallurgy

Figure 73: Key rare earth elements

La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Y
26%	52%	5.5%	17%						

Source: Deutsche Bank, US Geological Survey

Rare earth metal alloys linked to global steel consumption

Rare earth elements are able to be added to other metals like steel and aluminum to produce alloys with improved physical properties over the parent materials.

Mischmetal – the first practical application for rare earths

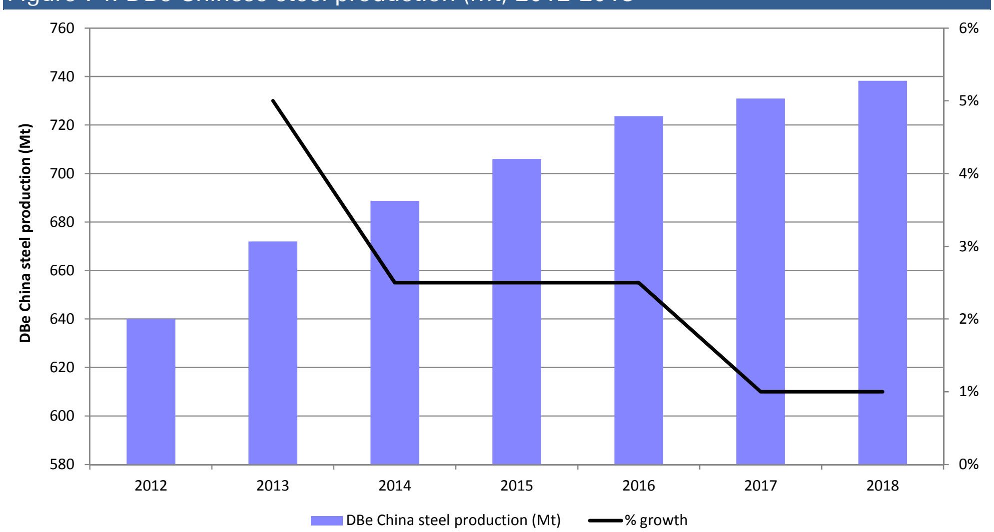
Mischmetal is an alloy of rare earth elements derived from the high-temperature 'cracking' of monazite ore. It is used in a number of applications, the most common being in the ferrocerium "flint" ignition device on lighters and torches. Carl Auer von Welsbach first produced mischmetal in 1885 as a by-product when extracting radioactive thorium from monazite sands.

Mischmetal contains a number of rare earth elements in naturally occurring proportions, but is largely dominated by cerium and lanthanum (being the two most abundant rare earth elements). Other rare earth elements were discovered through extraction techniques applied to mischmetal. Mischmetal is also used in battery alloys (see page 64).

DB growth assumptions

The rare earth applications in metallurgy are broad; however we expect growth in rare earth alloys to be consistent with overall steel consumption. We have used DB forecasts for Chinese steel production to align our growth forecasts with China, the primary market for metal alloy production.

Figure 74: DBe Chinese steel production (Mt) 2012-2018



Source: Deutsche Bank

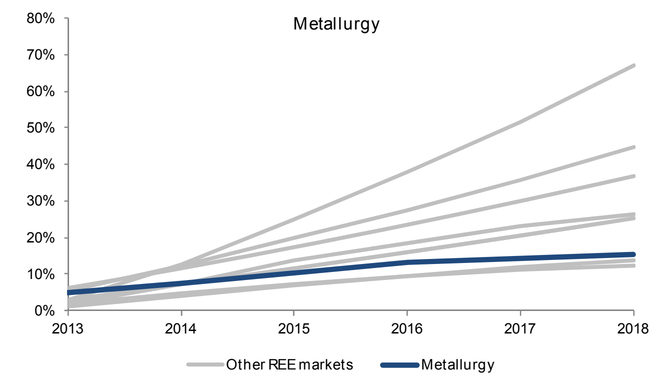
We expect Chinese steel production to remain relatively strong in the short term (DBe 5% growth in 2013, 2.5% growth out to 2016), but decline in outer years as the Chinese economy cools and matures, and the scrap market develops. This tapering applies a conservative growth forecast in outer years, which is consistent with our view that metal alloys are not a key long term driver of rare earth demand.

Figure 75: DBe demand growth rate for metal alloys 2012-2018

	2012	2013	2014	2015	2016	2017	2018
DBe China steel prod'n (Mt)	640.0	672.0	688.8	706.0	723.7	730.9	738.2
% growth	-	5.0%	2.5%	2.5%	2.5%	1.0%	1.0%
Metal alloys (REE t)	**10,710**	**11,246**	**11,527**	**11,815**	**12,110**	**12,231**	**12,354**
% growth	**-**	**5.0%**	**2.5%**	**2.5%**	**2.5%**	**1.0%**	**1.0%**

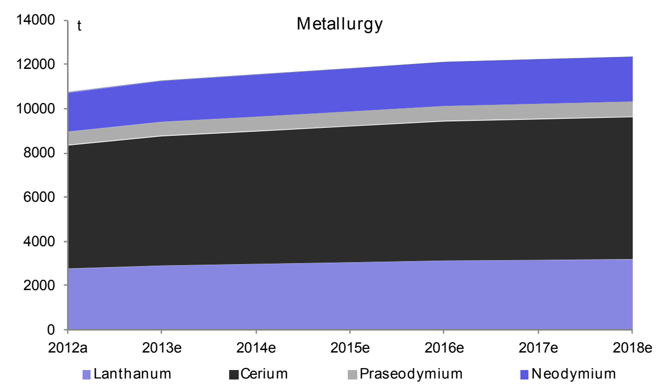
Source: Deutsche Bank

Figure 76: Cumulative demand growth for metallurgy



Source: Deutsche Bank Future data are forecasts

Figure 77: Rare earth demand in metallurgy (2012-18)



Source: Deutsche Bank

Ceramics

Figure 78: Key rare earth elements

La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Y
17%	12%	6%	12%						53%

Source: Deutsche Bank, US Geological Survey

The unique properties of rare earth elements are integrated into multiple applications in ceramics to improve particular qualities of products. Rare earths can be added to ceramic glazes to control colouring. Ceramic capacitors used in electronic circuits are doped with rare earth elements to improve their operating life and electrical properties.

Hydrophobic applications in ceramics

Materials with hydrophobic properties are used in applications that require water-resistance to operate in high-moisture environments. Durable materials like metals and ceramics can be treated with polymeric modifiers to produce hydrophobic qualities, but this method doesn't last long when used in harsh environments.

Ceramics can be made with rare earth elements, like cerium and lanthanum, allowing the product to exhibit the hydrophobic properties of the rare-earth element. This process is long-lasting and efficient, and provides a growth market for rare earth demand in ceramics.

DB growth assumptions

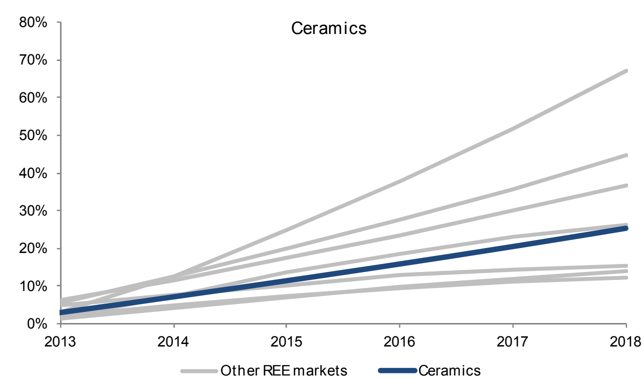
Ceramics is a relatively small portion of rare earth demand (c.6% of total market in 2012), and not a key focus for future growth. Technological advances in ceramics are driving new rare earth applications, particularly in high-temperature environments. However, most of the ceramic applications are in industrial uses and skewed towards slower-growing, developed markets. We expect rare earth demand in the ceramics industry will grow in line with global GDP forecasts, shown below.

Figure 79: DBe demand growth rate for ceramics 2012-2018

	2012	2013	2014	2015	2016	2017	2018
DBe global GDP growth (%)	-	3.1%	4.0%	4.0%	4.0%	4.0%	4.0%
Ceramics (REE t)	**6,491**	**6,692**	**6,960**	**7,238**	**7,528**	**7,829**	**8,142**
% growth	**-**	**3.1%**	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**4.0%**

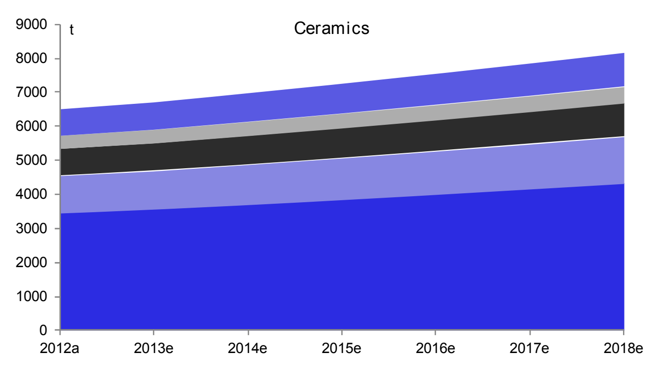
Source: Deutsche Bank

Figure 80: Cumulative demand growth for ceramics



Source: Deutsche Bank Future data are forecasts

Figure 81: Rare earth demand in ceramics (2012-18)



Source: Deutsche Bank

Rare earth emerging markets

Magnets

Figure 82: Key rare earth elements

La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Y
		22%	67%	3.8%		2%	0.2%	5%	

Source: Deutsche Bank, US Geological Survey

Magnetic applications are the key driver of rare earth demand growth

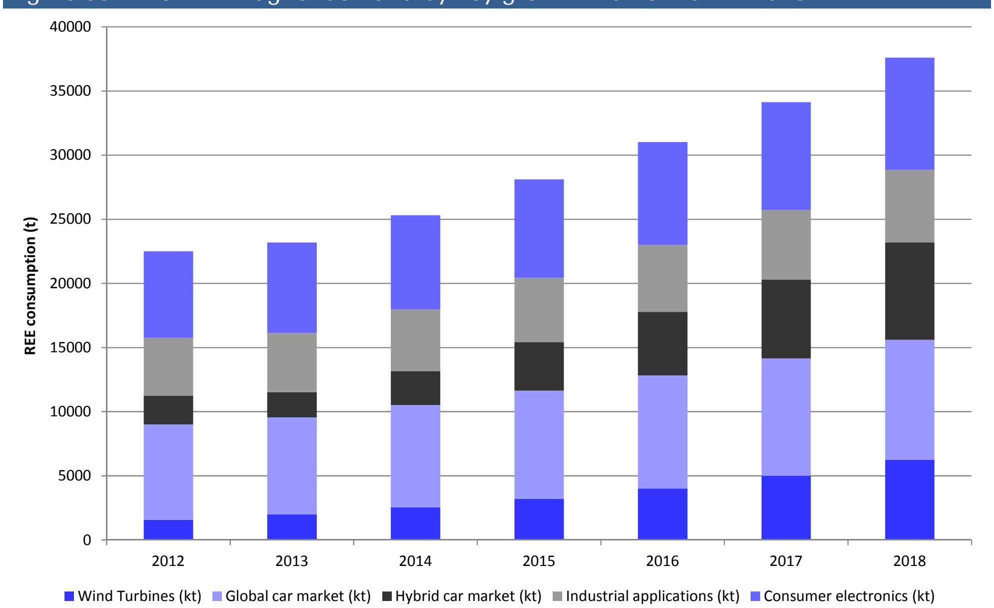
The permanent magnet industry is a key consumer of rare earths due to the superior magnetic flux densities rare earth elements possess over more traditional magnetic materials (like iron alloys).

The application was introduced in the 1960s when samarium-cobalt (Sm-Co) alloys were first developed. Over time, neodymium-iron-boron magnets became the dominant alloy magnets, with a magnetic energy 2.5x greater than their Sm-Co predecessors. Samarium is still used in some magnetic applications, particularly in high-temperature environments (like turbomachinery) where a high coercive force prevents Sm-Co magnets from de-magnetizing in intense heat.

Smaller, more powerful magnets creating new applications each year

Due to the increased magnetic flux generated by neodymium magnets, they are able to provide the same performance as other alternatives and be much smaller in size. This is the key driver for increased demand as smaller magnets has led to smaller, more efficient components and an increase in new technologies, leading to further opportunities for neodymium magnets to be incorporated into designs.

Figure 83: DBe REE magnet demand by key growth market 2012 - 2018



Source: Deutsche Bank, International Energy Agency

- Neodymium magnets have revolutionized computing and data storage in the last 15 years, with smaller, lighter magnets controlling the moving parts in electronics and hard drives.

- Tiny neodymium magnets are used in earphone speakers, portable electronic devices and a number of other electronic applications in the household. The smaller size has driven the move to a portable electronic world, but also allowed an increase in performance in other applications, like high-performance speakers, without affecting unit size.

- The strength of the neodymium magnets is also contributing to advancements in "green technologies" (see wind energy outlook on page 57). Increasing the power of the magnetic field used in generators increases the current produced and makes for more efficient power generation.

Shortage in dysprosium to be addressed by engineering solution

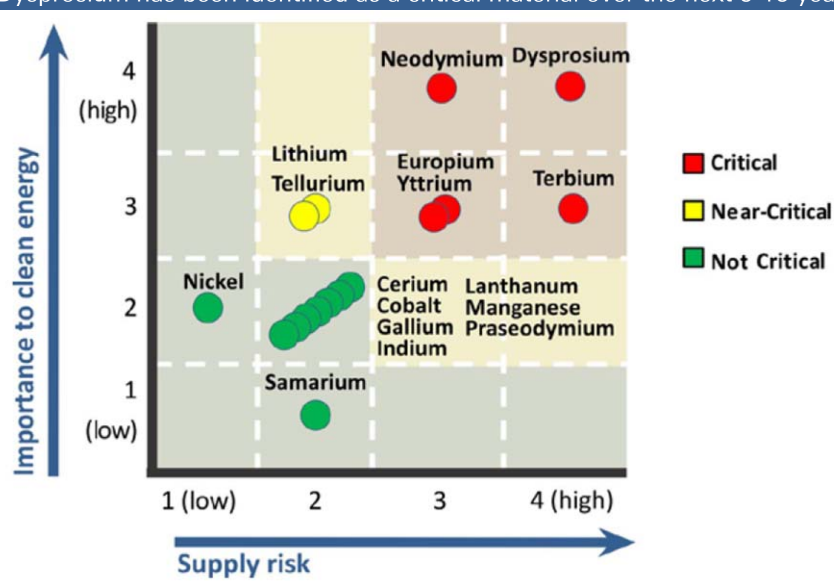
Coercivity: is the measurement of the applied magnetic field required to reduce the magnetization of a material to zero; put another way, a high coercivity implies that a material has a strong magnetic field that is resistant to other magnetic substances.

Neodymium-iron-boron magnets have a very strong magnetic field, but coercivity is highly dependent on temperature; as the magnet heats and coercivity decreases, the magnet becomes more susceptible to other magnetic fields. For this reason, Nd-Fe-B magnets cannot operate at high temparatures.

- Sm-Co magnets do not have the magnetic strength of Nd-Fe-B magnets, but have a stronger coercivity at high temperatures, creating a niche market for low-quality magnets in high temperature environments.
- Where quality cannot be compromised (like in wind turbines), dysprosium is added to the neodymium magnet to increase coercivity.

Dysprosium is a heavy rare earth element that has a low natural abundance, and is normally less than 0.5% composition of bastnasite/monazite ores. For this reason, dysprosium availability is dependent on production from xenotime and ion-adsorption clays in southern China. Dysprosium oxide prices peaked at over US$2,100/kg in 2011 and currently sit at c.US$220/kg (in comparison, neodymium oxide peaked at US$230/kg in 2011 and is now c.US$40/kg).

Figure 84: Dysprosium has been identified as a critical material over the next 5-15 years



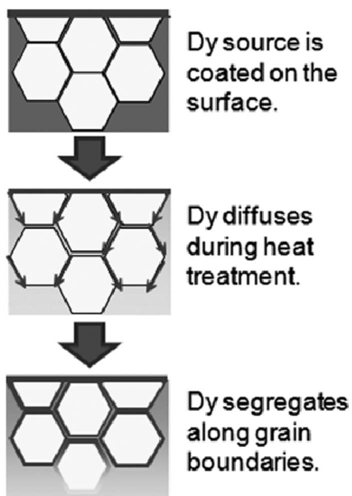
Source: CSIRO, US Department of Energy, Critical Materials Strategy, December 2011

There has been an industry push to develop new ways to decrease dysprosium intensity required in magnets. A key development has been the 'grain boundary diffusion process':

In 2000, Park *et al* reported a process where a thin layer of dysprosium metal (of a few micrometres thickness) was applied to the surface of thin neodymium sintered magnets and then heat treated. Results showed the coercivity of the magnets was twice that of normal neodymium magnets.

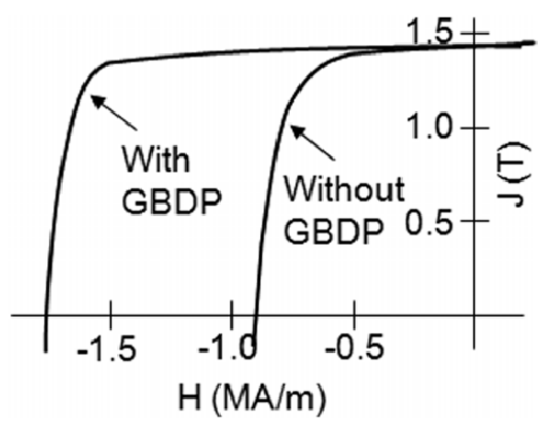
Nakamura et al took this further in 2005, integrating dysprosium and other heavy REEs as a coating along the individual grain boundaries of the Nd-Fe-B sintered magnets. Despite the overall dysprosium content being less, the coercivity of the magnets was strong and higher temperatures were required to force demagnetization. This method is now referred to as the 'grain boundary diffusion process' (GBDP):

Figure 85: Schematic illustration of GBDP



Source: CSIRO, Journal of Physics D: Applied Physics

Figure 86: Impact of GBDP on Nd-Fe-B demagnetization



Source: CSIRO, Journal of Physics D: Applied Physics

To account for this structural change in rare earth consumption in the magnet market, we have decreased our forecasted dysprosium use in magnet from 5% to 3% over the next three years. This is a major factor for dysprosium demand remaining largely stable despite the increase in magnet demand.

Figure 87: DBe rare earth consumption as % of total REE demand in magnets

Magnets	2012	2013	2014	2015
Y	0%	0%	0%	0%
La	0%	0%	0%	0%
Ce	0%	0%	0%	0%
Pr	22%	22%	22%	22%
Nd	67%	67%	68%	69%
Sm	4%	4%	4%	4%
Eu	0%	0%	0%	0%
Gd	2%	2%	2%	2%
Tb	0%	0%	0%	0%
Dy	*5%*	*5%*	*4%*	*3%*
Total	**100%**	**100%**	**100%**	**100%**

Source: Deutsche Bank

Wind energy outlook

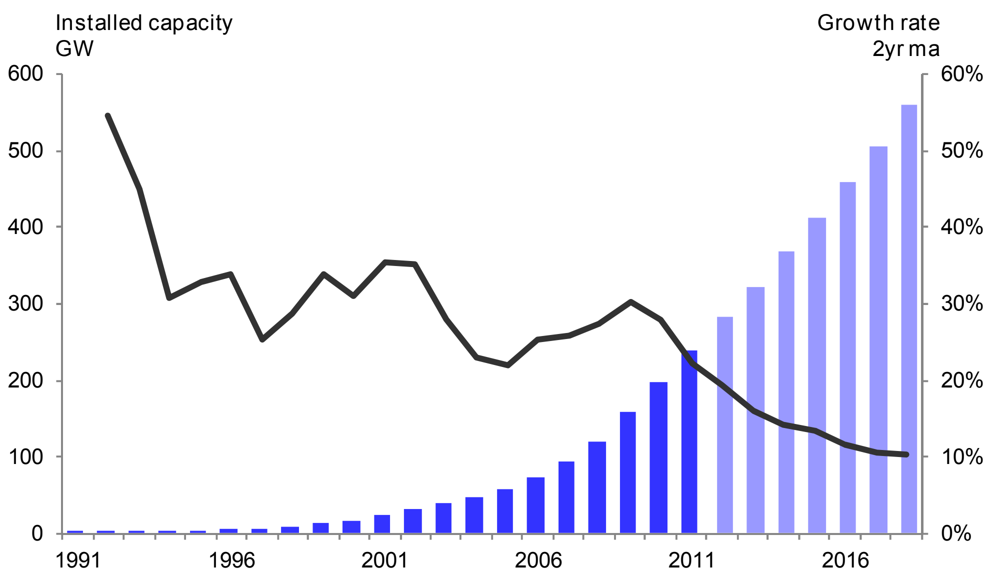
Wind energy outlook commentary by DB's Environmental, Social and Governance analyst Tim Jordan

Historical growth has been strong, but the outlook depends on ongoing policy support

Wind is a proven energy technology and the second-largest source of renewable electricity generation after hydro. But in most applications it is only cost-competitive with non-renewable electricity with the support of government policies.

Subsidies such as renewable portfolio standards, feed-in tariffs and carbon prices have driven rapid growth in wind capacity, with global installed capacity growing at more than 20% each year over the last decade. And the outlook is for ongoing growth, though the rate of growth is expected to moderate to ~10% annually later this decade. The International Energy Agency's (IEA) latest Medium-Term Renewable Energy Market Report projects that installed wind capacity will grow from 282 GW in 2012 to 559 GW in 2018.

Figure 88: Growth of installed wind capacity is set to moderate



Source: Global Wind Energy Council, International Energy Agency, Deutsche Bank

Policy support varies country to country

Wind costs have fallen, though they remain above wholesale grid prices in most countries. For that reason, ongoing support from government policies is important for the growth outlook.

- In the United States, there are renewable energy portfolio standards in 29 states, a national-level producer tax credit for renewable generation, and tightening national controls on coal-fired plants. US president Barack Obama announced that permitting of renewable energy projects would be streamlined.
- Japan has a strategy that calls for 30% renewables by 2030, and has a generous feed-in tariff for wind and other renewables.
- Europe has ambitious climate policies and strong policy support for renewable energy.
- Australia has a national renewable energy target of 20% by 2020, the majority of which will be met by wind power, though planning law changes in several states may slow down the rate of deployment.

- China's 12th five-year plan, updated in 2012, calls for wind capacity to reach 200 GW by 2020.

Offshore installations offer access to better wind resources

Offshore wind farms face technical challenges and construction risks and have only been constructed in Europe and China so far. But offshore facilities offer access to better wind resources with less turbulence, and coastal sites are often near population centres, reducing transmission distances and making grid connection easier. The IEA projects that offshore wind installed capacity will grow from 5.4 GW in 2012 to 28.2 GW in 2018.

Figure 89: Offshore wind turbines outside Copenhagen, Denmark

Source: iStockphoto

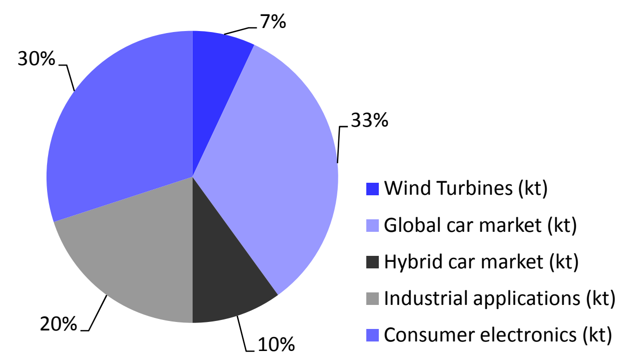
Risks

Risks to the outlook for ongoing growth in wind installation include weakening policy support, landowner resistance and persistent myths about energy supply variability.

DB magnet growth assumptions

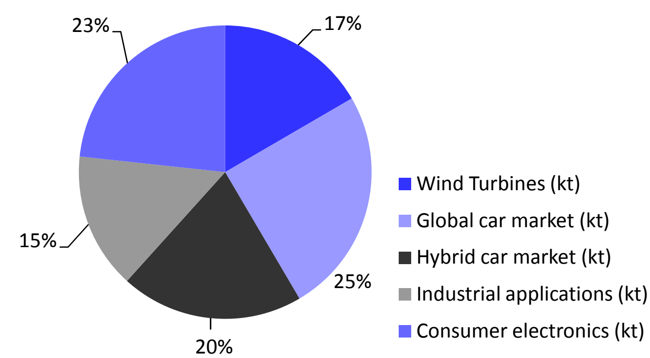
Due to the range of rare earth magnet applications, we expect there will be a number of growth industries competing for REE magnet supply by the end of this decade. The major market for magnets is currently global car production (43% of demand); however it is important to note the key industries (hybrid/electric vehicles, wind turbines) are not large components of today's market but will dominate demand over the next few years.

Figure 90: REE magnet demand by key market 2012



Source: Lynas Corporation

Figure 91: DBe REE magnet demand by key market 2018



Source: Deutsche Bank

We have sourced industry growth rates from both DB analysts and external sources to determine an overall growth rate for rare earth magnets:

Wind turbines (7% of 2012 market): as discussed, forecast rates for wind turbines are highly dependent on government legislation and project subsidies. However, based on existing laws and global emission targets, the International Energy Agency is forecasting c.13% CAGR in installed capacity (both onshore and offshore) from 2013 to 2018:

Figure 92: Onshore wind capacity and projection by region (Gigawatts)

	2011	2012	2013	2014	2015	2016	2017	2018
OECD	**148**	**174**	**188**	**208**	**226**	**243**	**260**	**279**
OECD Americas	51.7	66.5	72.3	83.6	92.6	101	110.2	120.4
OECD Asia Oceania	5.5	6.3	7.7	9.3	11	12.6	14.2	16.1
OECD Europe	90.6	100.8	108.4	115.4	122.6	129.3	135.9	142.2
Non-OECD	**85**	**103**	**125**	**148**	**173**	**199**	**226**	**253**
Africa	1	1.1	1.6	2.6	3.5	4.4	5.2	6.1
Asia	16.8	19.5	21.7	24.2	27.5	30.8	34.1	37.4
China	62.4	75.3	91.3	108.3	126.3	145.3	165.3	185.3
Non-OECD Europe	2.2	3.5	4.3	5	5.5	6	6.7	7.3
Non-OECD Americas	21	3.3	5.6	7.9	9.9	11.7	13..4	15.2
Middle East	0.1	0.1	0.2	0.3	0.4	0.6	0.8	1.2
Total	**232**	**277**	**313**	**357**	**399**	**442**	**486**	**531**
% growth		**19%**	**13%**	**14%**	**12%**	**11%**	**10%**	**9%**

Source: International Energy Agency, "Medium-Term Renewable Energy Market Report 2013"

Figure 93: Offshore wind capacity and projection by region (Gigawatts)

	2011	2012	2013	2014	2015	2016	2017	2018
OECD	**3.8**	**5**	**7.2**	**9.5**	**10.8**	**13.1**	**16.5**	**20.2**
OECD Americas	0	0	0	0.2	0.4	0.5	0.8	0.9
OECD Asia Oceania	0	0	0.1	0.2	0.3	0.5	0.5	1
OECD Europe	3.8	5	7.1	9	10.1	12.1	15.2	18.3
Non-OECD	**0.3**	**0.4**	**0.5**	**1.5**	**2.7**	**4.2**	**6.0**	**8.0**
Africa	0	0	0	0	0	0	0	0
Asia	0	0	0	0	0	0	0	0
China	0.3	0.4	0.5	1.5	2.7	4.2	6.0	8.0
Non-OECD Europe	0	0	0	0	0	0	0	0
Non-OECD Americas	0	0	0	0	0	0	0	0
Middle East	0	0	0	0	0	0	0	0
Total	**4.1**	**5.4**	**7.7**	**11**	**13.5**	**17.3**	**22.5**	**28.2**
% growth		**32%**	**43%**	**43%**	**23%**	**28%**	**30%**	**25%**

Source: International Energy Agency, "Medium-Term Renewable Energy Market Report 2013"

Direct-drive to provide the multiplier effect for rare earth demand in wind technology

There are currently three competing wind turbine technologies in the global market:

- **Geared non-rare earth turbine:** the incumbent technology, 'geared non-rare earth' turbines use gearboxes to manage rotor torque and speed. Multiple gears are required to allow the turbine to move from rest to full capacity. The size of the gearbox required is generally proportional to wind turbine output, so scalability is a major issue with the gearbox approach. Gearbox failure and maintenance cost is also a consideration.
- **Geared rare earth turbine:** this is an intermediate product in the market that uses permanent rare-earth magnet generators to take some stress off the gearboxes. These units are more reliable, and can be lighter in weight, but the gearbox failure is still a concern, and damage can extend to the generator as well. A geared rare earth turbine uses c.120-150kg of neodymium-iron-boron magnets per megawatt capacity.
- **Direct drive turbine:** the latest technology is the direct drive design, where high-powered magnets are used to induce rotation through alternating magnetic fields within the turbine. The direct drive approach saves space and weight by not needing a gearbox, and can be used in both offshore (no risk of gearbox failure) and large-scale turbines. As a general rule, a 3MW wind turbine will use c.2,000kg of neodymium-iron-born magnets; equivalent to c.650-700kg per megawatt capacity.

DB's HK/China Head of Alternative Energy Research, Michael Tong, believes the current market share for geared non-rare earth turbines is c.70%, with the other 30% of the market consuming rare earths in some form.

The world's largest offshore wind farm, the 'London Array', was inaugurated by David Cameron on 4th July, 2013. The field hosts 175 3.6MW direct-drive wind turbines by Siemens.

- We believe direct-drive turbines are c.10% of current installed capacity, with c.20% of the market being geared-rare earth turbines.
- Over time, it is expected that direct-drive will increase market share as a) offshore wind becomes a greater source of energy and b) the falling cost of Nd-Fe-B magnets induces economies of scale and the viability of wind technology become more attractive.

Rare earths (Nd, Pr and Dy) make up c.27% of neodymium-iron-boron magnets by weight, so we can infer that rare earth consumption per megawatt is 178kg/MW for direct-drive, 40kg/MW for geared rare earth and nil in geared non-rare earth turbines.

Figure 94: DBe wind technology market share and impact on rare earth demand 2011-2018 (cumulative growth)

	2011	2012	2013	2014	2015	2016	2017	2018
Geared non-REE market share	70%	68%	67%	65%	62%	59%	56%	52%
Geared non-REE market (GWh)	166	193	214	237	256	272	285	293
REE content (kg/MWh)	-	-	-	-	-	-	-	-
REE used (t)	-	-	-	-	-	-	-	-
Geared REE market share	20%	20%	20%	20%	20%	20%	20%	20%
Geared REE market (GWh)	47	56	64	74	83	92	102	112
REE content (kg/MWh)	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
REE used (t)	1,893	2,256	2,566	2,944	3,303	3,674	4,069	4,477
Direct drive REE market share	10%	12%	13%	15%	18%	21%	24%	28%
Direct drive REE market	24	33	43	57	74	95	121	154
REE content (kg/MWh)	177.9	177.9	177.9	177.9	177.9	177.9	177.9	177.9
REE used (t)	4,207	5,796	7,620	10,106	13,109	16,854	21,580	27,449
Average REE kg/MWh	**25.8**	**28.6**	**31.8**	**35.5**	**39.8**	**44.7**	**50.5**	**57.1**
Total REE used (t)	**6,100**	**8,053**	**10,187**	**13,050**	**16,412**	**20,528**	**25,649**	**31,927**
% growth	**-**	**32%**	**26%**	**28%**	**26%**	**25%**	**25%**	**24%**

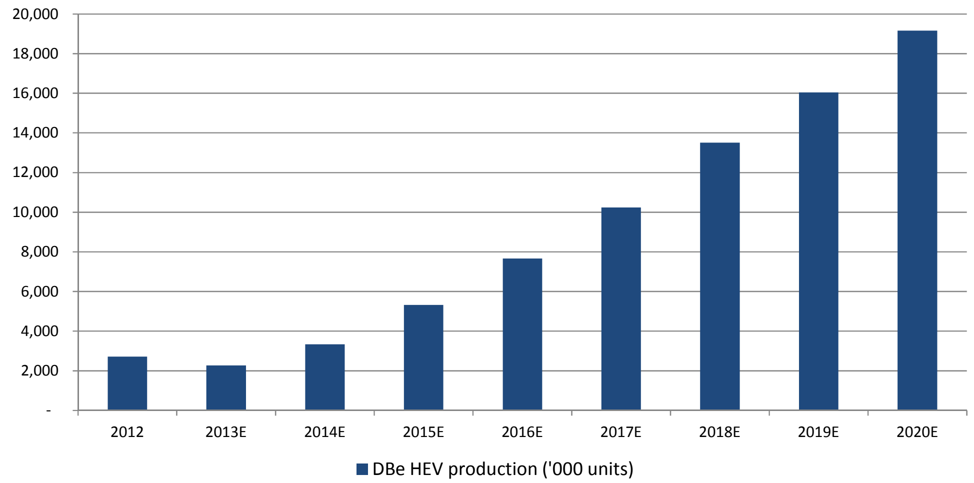
Source: Deutsche Bank, International Energy Agency   Future data are forecasts

We expect direct-drive technology to grow at c.16% per annum, taking market share from the older, and more inefficient 'geared non-rare earth' technology. If this occurs, rare earth consumption will grow at a faster rate than overall wind capacity due to the increase rare-earth intensity required in direct-drive.

Global car market (33% of 2012 market): The traditional car market is a major consumer of rare-earth magnets due to the weight efficiencies generated by replacing common geared or mechanically-driven parts (like in power steering columns) with small rare earth magnets. Despite being a major component of rare-earth consumption at the moment, we expect the global car industry to grow at c.4% per annum, well below other rare-earth applications. By 2018, we expect the global car market to be c.25% of magnet consumption.

Hybrid/electric car market (10% of 2012 market): Hybrid and electric vehicles use neodymium magnets in 40-50 different applications per car. As an example, a Toyota Prius uses c.1kg of neodymium per electric motor (two motors per vehicle). Although only 10% of the magnet market in 2012, we expect over 20% CAGR growth in magnet consumption in HEV cars out to 2018. We apply our US automotive industry teams HEV growth forecasts as an estimate of magnet demand in the HEV industry:

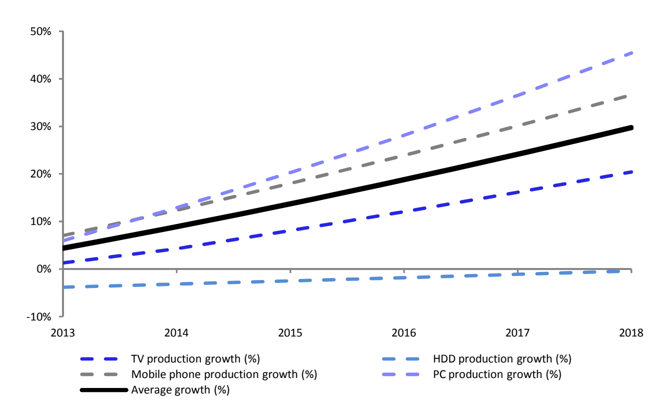
Figure 95: DBe hybrid and electric vehicle production 2012 - 2020



Source: Deutsche Bank

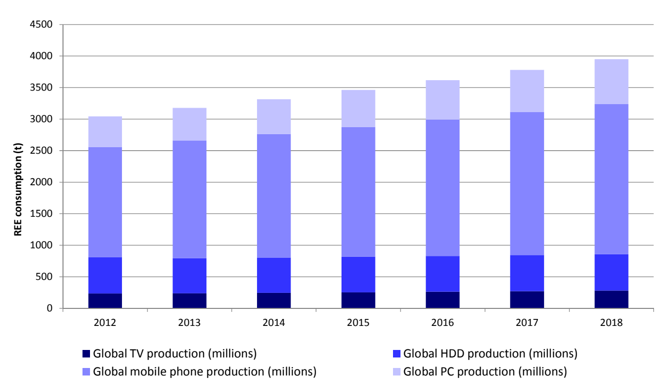
- **Consumer electronics (30% of 2012 market):** The application of rare earth magnets in consumer electronics has been the catalyst for vast technological advances over the last 20 years and has led to the decreasing size of computers and personal devices today. We apply the average of DB growth rates for televisions, personal computers, mobile phones and hard disk drives to forecast the increase in magnet demand from consumer electronics.

Figure 96: DBe growth rates in TV, HDD, PC's and phones



Source: Deutsche Bank

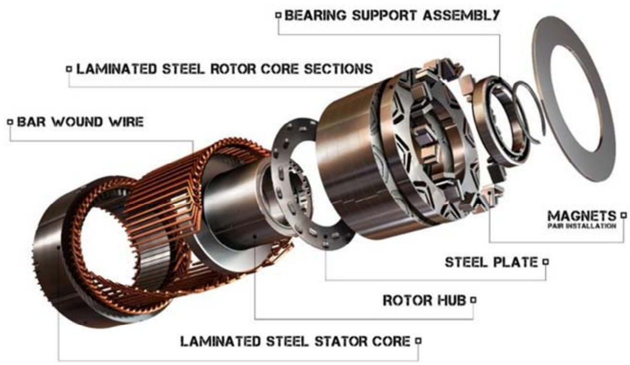
Figure 97: DBe unit production in consumer electronics



Source: Deutsche Bank

- **Industrial applications (20% of 2012 market):** Neodymium-Iron-Boron magnets are used in a variety of industries. Although 20% of the current magnet market, we see this demand driver as largely dependent on developed markets, and not a key driver for magnet demand. We assume rare-earth magnet use in industrial applications grows in line with the global GDP growth rate.

Figure 98: Permanent magnet electric motor design



Source: CSIRO presentation, DB Future Metals conference, 26/06/2013

Figure 99: Smaller appliances possible with RE magnets

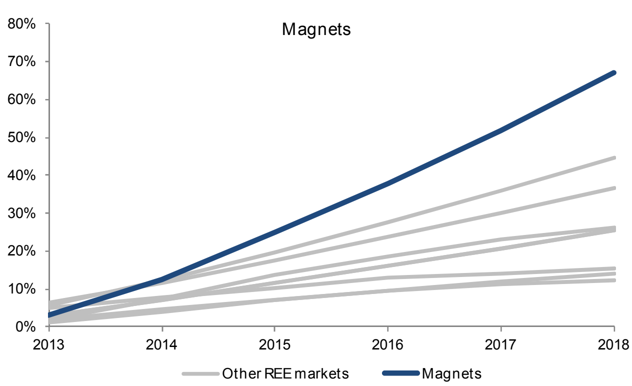
Source: CSIRO presentation, DB Future Metals conference, 26/06/2013

Figure 100: DBe demand growth rate for magnets 2012-2018

Key market growth (%)	2012	2013	2014	2015	2016	2017	2018
Wind Turbines (REE t)	1,575	1,392	1,593	1,793	1,976	2,152	2,344
% growth	-	*-11.6%*	*14.4%*	*12.6%*	*10.2%*	*8.9%*	*8.9%*
Global car market (REE t)	7,425	7,566	7,967	8,437	8,808	9,134	9,372
% growth	-	*1.9%*	*5.3%*	*5.9%*	*4.4%*	*3.7%*	*2.6%*
HEV car market (REE t)	2,250	1,955	2,624	3,765	4,964	6,169	7,588
% growth	-	*-13.1%*	*34.2%*	*43.5%*	*31.8%*	*24.3%*	*23.0%*
Industrial applications (REE t)	4,500	4,640	4,825	5,018	5,219	5,428	5,645
% growth	-	*3.1%*	*4.0%*	*4.0%*	*4.0%*	*4.0%*	*4.0%*
Consumer electronics (REE t)	6,750	7,045	7,350	7,675	8,018	8,378	8,757
% growth	-	*4.4%*	*4.3%*	*4.4%*	*4.5%*	*4.5%*	*4.5%*
Magnets (REE t)	**22,500**	**22,598**	**24,359**	**26,689**	**28,985**	**31,262**	**33,705**
% growth	**-**	**0.4%**	**7.8%**	**9.6%**	**8.6%**	**7.9%**	**7.8%**

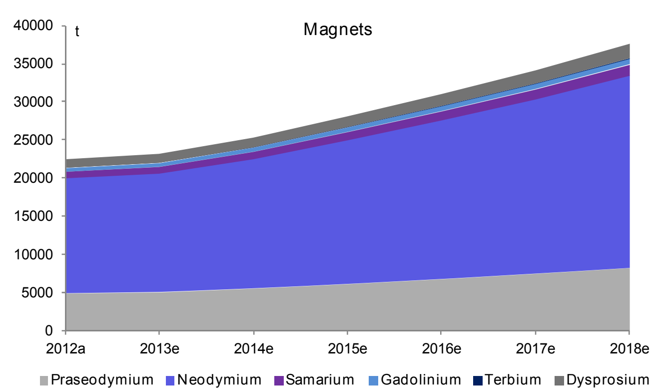
Source: Deutsche Bank

Figure 101: Cumulative demand growth for magnets



Source: Deutsche Bank Future data are forecasts

Figure 102: Rare earth demand in magnets (2012-18)



Source: Deutsche Bank

Battery Alloys

Figure 103: Key rare earth elements

La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Y
50%	33%	3.3%	10%	3.3%					

Source: Deutsche Bank, US Geological Survey

Battery alloys and their use in hybrid and electric car (HEV) technology will be a key growth market over the next 5-10 years as the world looks to shift away from carbon dependence. However, there are two main issues preventing HEV vehicles from entering the mass market:

- **Unit cost compared to fuel-based vehicles:** A lithium-ion battery currently costs between $10,000 and $20,000 per unit, depending on size and power. CSIRO's Energy Storage Technologies research scientist, Dr. Anand Bhatt, believes that the average consumer will not be incentivized to buy a hybrid/electric car until performance metrics and total cost are in line with a traditional fuel-based alternative.
- **Consumer anxiety around battery range:** despite most people only ever travelling to and from work each day in their vehicles, the average consumer holds concerns about being restricted to a 150-200km range between charges. To appeal to the mass market, hybrid/electric vehicles need to improve battery range and extend battery life cycle, which can be as low as 3 years at the moment.

CSIRO's Dr. Anand Bhatt believes car batteries need to decrease from $500/kWh to $100/kWh to be cost-effective

Dr. Bhatt believes the technology required to increase energy intensity within the battery cell can be delivered in the next few years. This development can increase the range and life of the battery, but unit cost will largely be driven by material costs.

Figure 104: Li-ion batteries the leading technology

Source: CSIRO presentation, DB Future Metals conference, 25/06/2013

Figure 105: Infrastructure may be an issue in HEV growth

Source: iStockphoto

Nickel-metal-hydride (NiMH) batteries

Rare earth elements are a key component in rechargeable NiMH batteries, allowing hydrogen storage within the lattice of the battery electrode to be used in future applications. NiMH batteries have 2-3 times the capacity of a similar-sized, more common NiCd battery, with an energy density almost as great as a lithium-ion cell, the more expensive battery alternative. The $RENi_5$ class of batteries has a particularly high percentage content of rare earths (mainly cerium and lanthanum oxide), and is used primarily in electric car batteries.

NiMH batteries are the incumbent technology used in Toyota Prius hybrid vehicles and, due largely to the popularity of the Prius, makes up c.60% of the current car battery market.

Notes on NiMH batteries from DB's US automotive industry research team

- NiMH technology is not a viable option for plug-in hybrids and full electric vehicles; development in these fields will be through Li-ion batteries.
- In 2012, Toyota released the Prius+ model in Europe; the first Toyota Prius with a lithium-ion battery.
- Toyota's official stance on the move to Li-ion battery was to save space in the trunk, but this could be a pre-cursor to a more meaningful transition for Toyota in coming years.
- Toyota still has a very strong market share in hybrids, resulting in NiMH having a 59% market share in 2013 (YTD); this is down from 99% in 2010.

Recycling and product substitution potential downside factors

There is already a developed recycling industry for NiMH batteries to recover the nickel and cobalt through pyrometallurgical processes. The slag, which contains rare earth elements, is then used as landfill or construction aggregate. An economic way of retaining the rare earth elements, either in pure or alloy form, for re-application could develop over time, however this will largely be driven by rare earth prices, and lanthanum and cerium are the most abundant of the rare earth suite.

Electric vehicle outlook

Electric vehicle outlook commentary by DB's Environmental, Social and Governance analyst Tim Jordan

Yet to win significant market share, but trends are supportive

Stricter fuel efficiency standards, environmental concerns and oil price volatility are leading vehicle manufacturers and consumers to consider electric vehicles (EVs).

But EVs are yet to capture a significant share of the car market. According to data from the International Energy Agency's Electric Vehicle Initiative, the stock of passenger car EVs worldwide at the end of 2012 was over 180,000, representing just 0.02% of the total passenger car stock.

Large-scale deployment will depend on overcoming drivers' 'range anxiety', reducing the cost of batteries and making charge-points or battery swap stations widely available.

Targets and subsidies should help deployment, but costs must come down

A number of governments are setting goals for electric vehicle deployments to signal the extent of their ambition. Targets from countries that are members of the IEA's Electric Vehicle Initiative add up to a stock of 20 million EVs by 2020. While that target is not a forecast, it gives an indication of the extent of ambition.

Many countries offer some kind of assistance for electric vehicles:

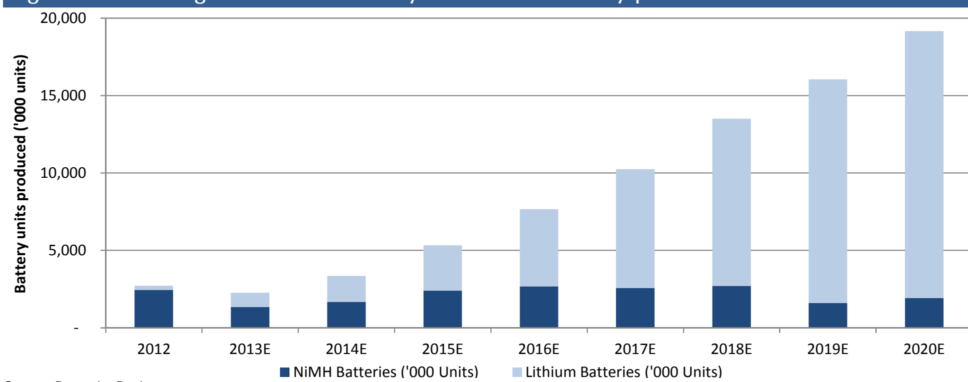
- Japan offers tax incentives for hybrid and electric vehicles and subsidies for electric vehicles.
- China offers subsidies for hybrid and electric vehicles.
- Denmark exempts EVs from registration and road taxes and has put money towards charging infrastructure.
- Germany exempts EVs from road taxes and has nominated four regions as 'showcase regions'
- Spain offers incentives worth up to 25% of the vehicle purchase price before taxes, up to EUR 6,000.
- The United States offers up to USD 7,500 tax credit for vehicles based on battery capacity and a tax credit of 30% for commercial vehicle support equipment.

Despite these incentives, electric vehicles are likely to remain more expensive than petrol equivalents, even with government subsidies, unless substantial cost reductions are achieved.

DB battery alloy growth assumptions

The current rare earth intensity in battery alloys is largely due to the market dominance that NiMH batteries currently enjoy. However, it is expected that over the next few years, lithium ion batteries will largely replace NiMH batteries in hybrid/electric vehicles.

Figure 106: DBe global NiMH battery vs. lithium battery production 2012 - 2020



Source: Deutsche Bank

Despite significant product replacement occurring in the industry, REE demand from battery alloys should continue to grow over the medium term. We apply our US automotive industry analysts' growth forecasts for the hybrid and electric vehicle industry (over 20% CAGR growth to 2018), and also consider the expected market share shift from 65% NiMH batteries in 2012 to 80% lithium-ion batteries in 2018.

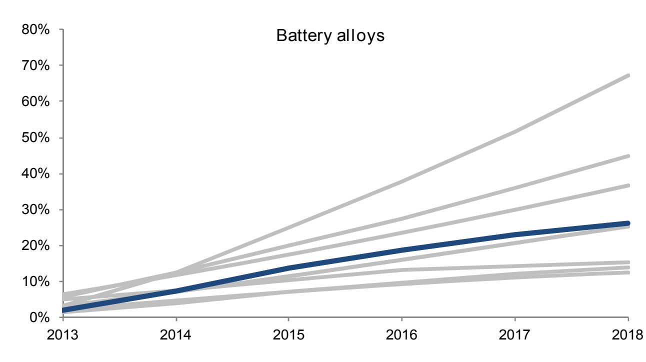
Allowing for the declining battery market share, we expect rare earth demand from NiMH battery alloys to grow at c.4% per annum over the next six years:

Figure 107: DBe demand growth rate for battery alloys 2012-2018

	2012	2013	2014	2015	2016	2017	2018
HEV batteries ('000s)	2,715	2,274	3,342	5,330	7,665	10,243	13,507
NiMh market share (%)	65%	59%	50%	45%	35%	25%	20%
NiMH batteries ('000s)	1,776	1,337	1,671	2,399	2,683	2,561	2,701
% growth	-	1.9%	5.3%	5.9%	4.4%	3.7%	2.6%
Battery alloys (REE t)	**11,264**	**11,478**	**12,086**	**12,799**	**13,363**	**13,857**	**14,217**
% growth		**1.9%**	**5.3%**	**5.9%**	**4.4%**	**3.7%**	**2.6%**

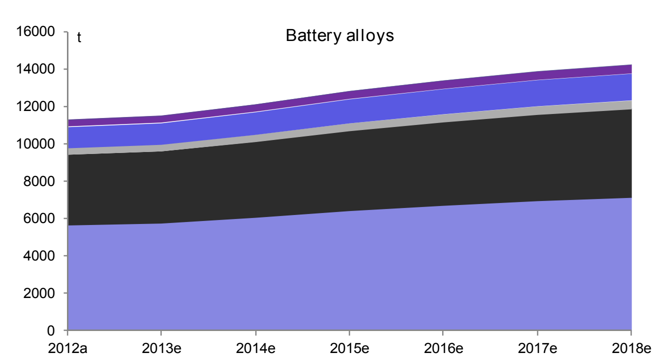
Source: Deutsche Bank

Figure 108: Cumulative demand growth: battery alloys



Source: Deutsche Bank Future data are forecasts

Figure 109: Rare earth demand in battery alloys (2012-18)



Source: Deutsche Bank

Polishing Powders

Figure 110: Key rare earth elements

La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Y
31%	65%	3.5%							

Source: Deutsche Bank, US Geological Survey

Rare earth oxides (mainly cerium) are used in polishing powders that can be applied to glass to create a superior polished surface.

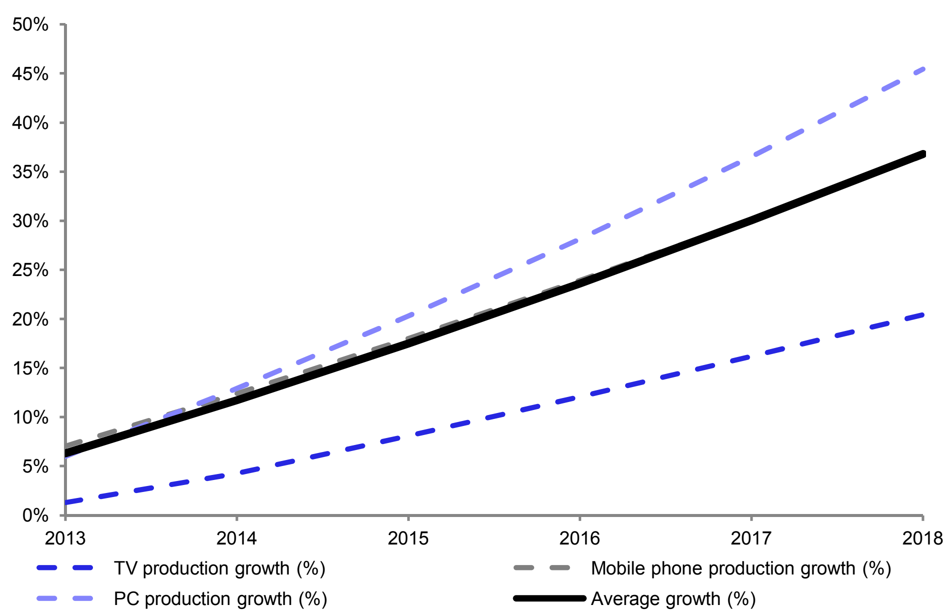
- The chemical reaction of the compound with the glass forms cerium silicate, which fills microscopic scratches in the glass.
- This chemical change, along with cerium's physical hardness, makes it an excellent polishing agent.
- This application is used on appliances such as TVs, computers, mobile phones and any other electronic device with a glass visual screen.

DB growth assumptions

Rare earth use in polishing powders is highly price elastic, but as the key elements used in this industry is cerium and lanthanum, our price forecasts suggests ample supply for polishing powders over the next few years.

We have generated a weighted average growth rate for polishing powders, based on DB growth rates for televisions, personal computers and mobile phones, all product that use highly polished glass on visual displays:

Figure 111: DBe REE polishing powder demand by key market 2012 - 2018



Source: Deutsche Bank

Figure 112: Rare earth oxides in powder form

Source: LYC investor presentation

Figure 113: Consumer electronics growing at >5% p.a.

Source: iStockphoto

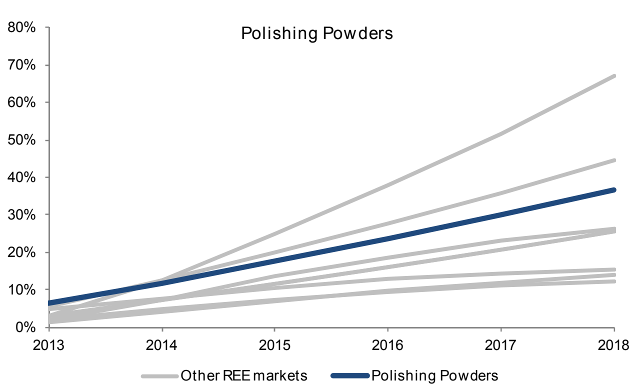
We expect rare earth demand from polishing powders to grow at over 5% per annum out to 2018:

Figure 114: DBe demand growth rate for polishing powders 2012-2018

	2012	2013	2014	2015	2016	2017	2018
Global TV production (m)	235.0	238.0	245.0	254.0	263.3	273.0	283.0
% growth	-	1.3%	2.9%	3.7%	3.7%	3.7%	3.7%
Global mobile phone prod'n (m)	1,744.0	1,867.0	1,960.0	2,058.0	2,160.9	2,268.9	2,382.4
% growth	-	7.1%	5.0%	5.0%	5.0%	5.0%	5.0%
Global PC production (m)	486.7	515.8	549.5	585.4	623.6	664.4	707.8
% growth	-	6.0%	6.5%	6.5%	6.5%	6.5%	6.5%
Total	**2,466**	**2,621**	**2,755**	**2,897**	**3,048**	**3,206**	**3,373**
% growth		**6.3%**	**5.1%**	**5.2%**	**5.2%**	**5.2%**	**5.2%**

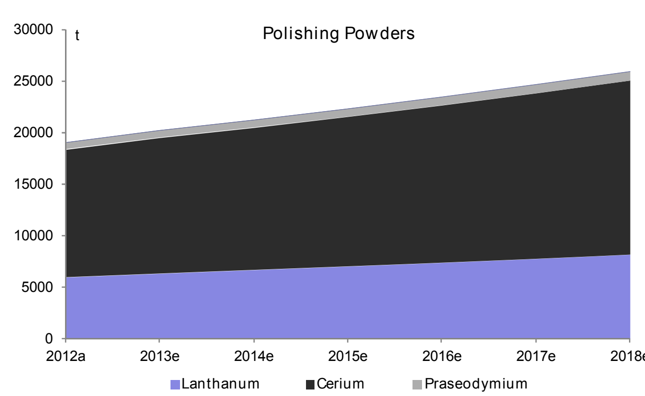
Source: Deutsche Bank

Figure 115: Cumulative growth for polishing powders



Source: Deutsche Bank Future data are forecasts

Figure 116: Rare earth use in polishing powders 2012-18



Source: Deutsche Bank

Phosphors

Figure 117: Key rare earth elements

La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Y
8.5%	11%				4.9%	1.8%	4.6%		69%

Source: Deutsche Bank, US Geological Survey

Color applications driving demand

Phosphors are used in televisions, computer screens and any other visual display that uses cathode ray tube, liquid crystal display or plasma display panel technologies. Various rare earth-bearing compounds are used to generate the spectrum of colours presented on the visual screen. They are:

RED: *Europium-yttrium* compounds

GREEN: *Terbium*-fluoride-zinc sulphide

BLUE: *Cerium*-strontium sulphide

When activated by photons (generated by electricity), these phosphors will emit a coloured luminescence which can be seen by the viewer.

LEDs driving energy efficiencies in lighting applications

Recent technological advances are making light-emitting diodes (LEDs) more powerful, cost effective and an environmentally-friendly alternative to traditional incandescent and fluorocarbon lighting options (which are more rare-earth intensive):

Lighting: improvements in LED technology are leading to vast improvements in size, cost and durability of LEDs as a consumer-based lighting technology:

- In 2009, a 13-watt LED lamp was equivalent in brightness to a standard 40-watt incandescent bulb.
- By 2011, a 6-watt LED could achieve the same results whilst having an expected lifespan of 50,000 hours compared to 1,000 hours for a standard 40-watt incandescent bulb.
- A 6-watt LED lamp will produce c.14kg of CO_2 emission per year, compared to c.89kg for a standard incandescent light bulb. A building can decrease carbon emissions by up to 85% by exchanging all incandescent lighting with LEDs.

Television and PCs: LEDs can be used as backlighting in LCD screens, replacing 'cold cathode fluorescent (CCFL) technology. Using LEDs as the lighting source for a visual screen can increase the possible colour spectrum by as much as 45%, whilst being made thinner and more cost-efficient due to the size of LEDs required to produce the same lighting performance.

This move away from incumbent technologies towards LEDs will impact the intensity of rare earth consumption in these markets.

- Although rare earths are used in LED technology, they are not required to store the same amount of energy build-up needed to emit light (phosphorescence)
- In LEDs, the light source is electrons releasing energy in the form of photons (electroluminescence) and can be driven through electric currents.

Figure 118: White LED strip used in TV backlighting

Source: iStockphoto

Figure 119: Incandescent, LED and CFCC light bulbs (L-R)

Source: iStockphoto

DB growth assumptions

The phosphor market is facing some structural industry changes, as a push towards energy efficient lighting and higher product quality within televisions are driving the market towards light-emitting diode (LED) technologies, which have much lower rare-earth consumption intensity.

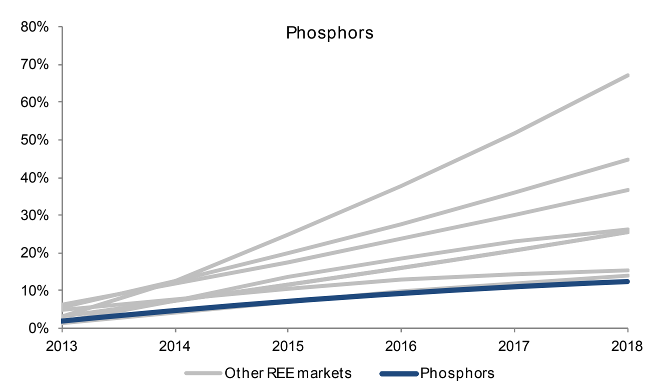
We expect lighting to dominate the phosphor market in the coming years, with global growth rates in line with global GDP growth. However, we expect LED penetration rates to continue at c.20% per annum, increasing market share from 5% in 2012 to 15% in 2018. This will discount the overall market growth rate; on our numbers, rare earth demand from phosphors will grow at c.2% per annum.

Figure 120: DBe demand growth rate for phosphors 2012-2018

	2012	2013	2014	2015	2016	2017	2018
DBe global GDP growth (%)	-	3.1%	4.0%	4.0%	4.0%	4.0%	4.0%
DBe LED market share	5%	6%	7%	9%	10%	12%	15%
Phosphors (REE kt)	**9,496**	**9,687**	**9,946**	**10,184**	**10,391**	**10,556**	**10,666**
% growth	**-**	**2.0%**	**2.7%**	**2.4%**	**2.0%**	**1.6%**	**1.0%**

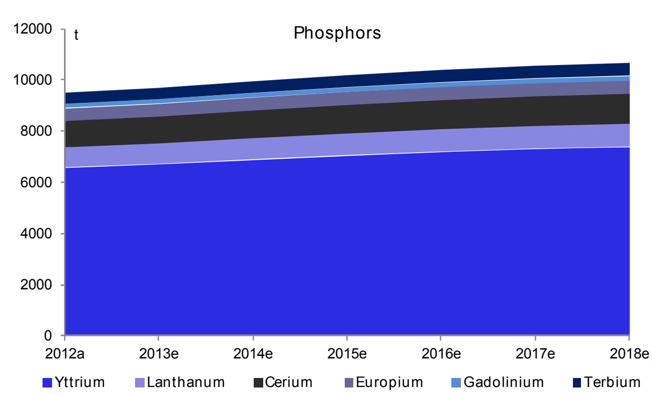
Source: Deutsche Bank

Figure 121: Cumulative demand growth for phosphors



Source: Deutsche Bank Future data are forecasts

Figure 122: Rare earth demand in phosphors (2012-18)



Source: Deutsche Bank

Other applications

Rare earth elements are used in a multitude of applications that sit outside the broad markets we have outlined above. A few examples include:

- **Cerium** used in water purification
- **Gadolinium** in magnetic refrigeration
- **Samarium** in defence applications (ships, submarines, aircraft, missiles)
- **Neodymium** magnets in magnetic resonance imaging (MRI)

Figure 123: High temperature applications require Sm

Source: CSIRO presentation, DB Future Metals conference, 25/06/2013

Figure 124: MRIs are smaller and lighter with rare earths

Source: CSIRO presentation, DB Future Metals conference, 25/06/2013

DB growth assumptions

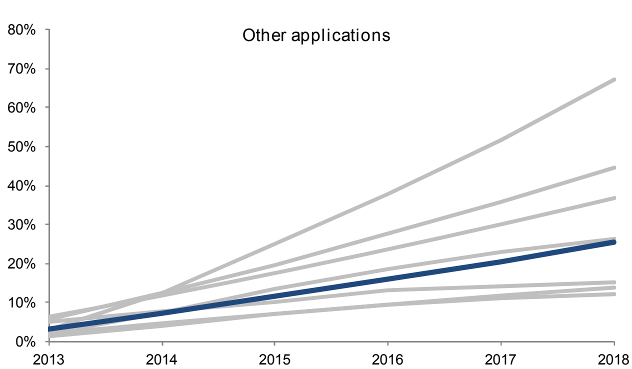
Other rare earth applications accounted for c.7% of demand in 2012. We expect these applications to grow broadly in line with global GDP forecasts over the next five years

Figure 125: DBe demand growth rate for other rare earth applications 2012-2018

	2012	2013	2014	2015	2016	2017	2018
DBe global GDP growth (%)	-	3.1%	4.0%	4.0%	4.0%	4.0%	4.0%
Other applications (REE kt)	**6,996**	**7,213**	**7,501**	**7,801**	**8,114**	**8,438**	**8,776**
% growth	**-**	**3.1%**	**4.0%**	**4.0%**	**4.0%**	**4.0%**	**4.0%**

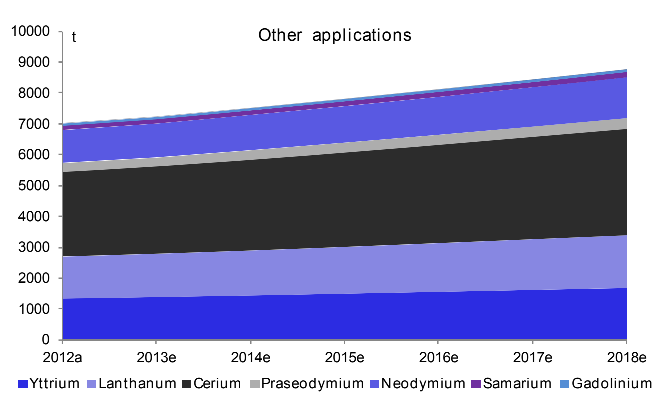
Source: Deutsche Bank

Figure 126: Cumulative demand growth: other uses



Source: Deutsche Bank Future data are forecasts

Figure 127: Rare earth use in other applications (2012-18)



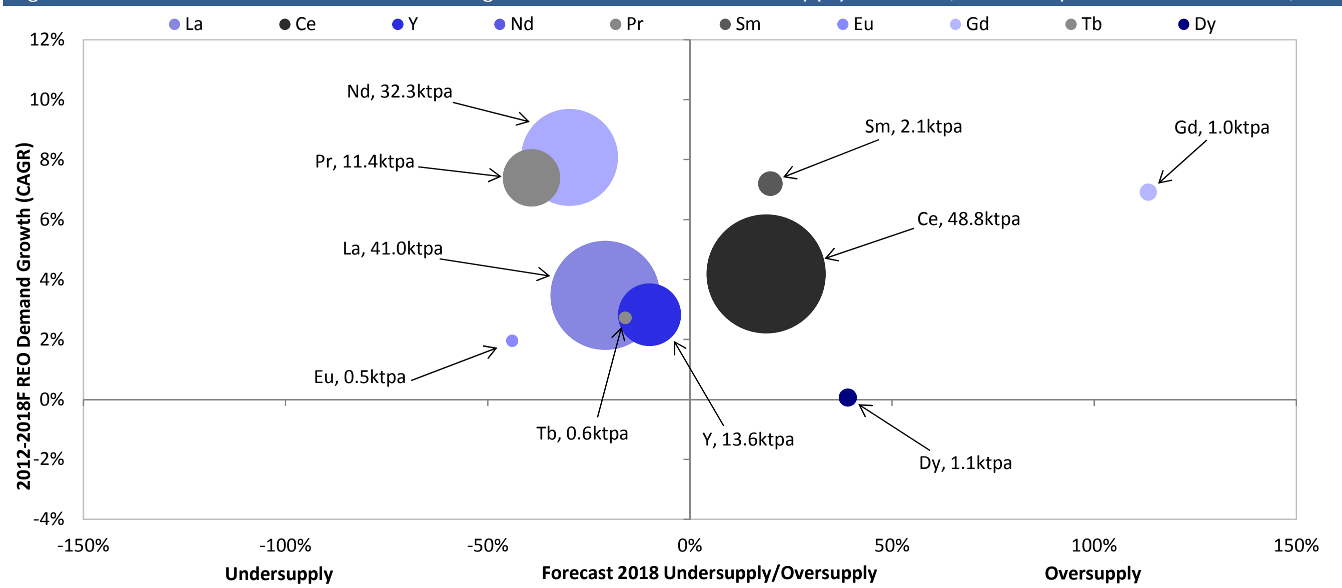
Source: Deutsche Bank

Rare earth pricing

Elements in high-quality applications in greatest demand

Based on our global supply and demand assumptions, we have identified the key rare earth elements in greatest undersupply in coming years and the pricing impacts this will likely have. Conversely, we have shown that over-production and product substitution will drive down pricing levels for some rare earth products.

Figure 128: DBe rare earth CAGR demand growth vs. DBe rare earth supply in 2018 (bubble represents market size)



Source: Deutsche Bank

Key rare earths moving towards undersupply

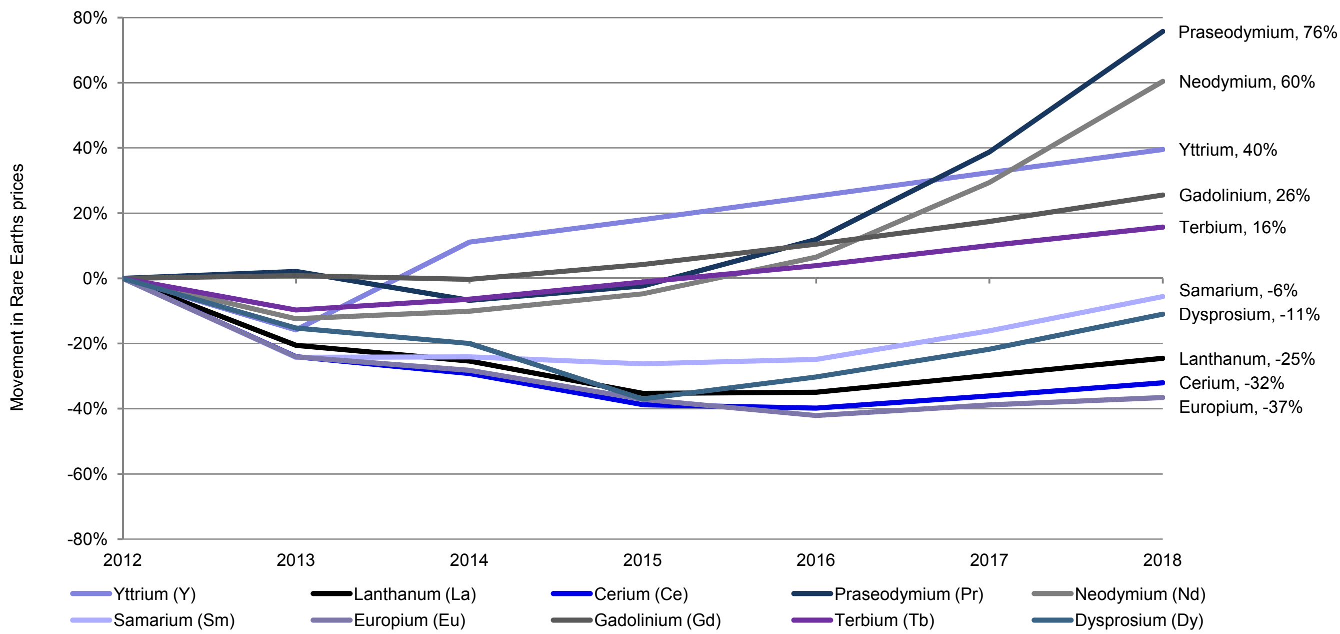
- **Neodymium and praseodymium:** demand for these products is driven predominately by the growth in the magnet industry, but due to the relatively low natural abundances of these elements we expect Nd and Pr prices to stay well supported out to 2018.
- **Yttrium:** driven by the broad range of applications (including ceramics, glass, phosphors), yttrium demand will remain strong. Yttrium supply is highly leveraged to production rates of mines targeting xenotime and high-Y ion adsorption clays in southern China.

Key rare earths moving towards oversupply

- **Lanthanum and cerium:** over-production of La and Ce is widely considered to be inevitable due to the relative abundance of these elements in rare earth ores and the increase in global production driven by Nd and Pr demand. Despite being lower-quality, lower price commodities, they are used heavily in the catalyst industry, and lower costs will drive increased use in polishing powders.
- **Dysprosium:** Despite being recognized as a critical element, dysprosium is only used in the magnet industry, where efforts are being made to remove Dy dependence. Prices in the US$250-400/kg range should hold in the near-term.

DB rare earth pricing forecasts (2012 – 2018)

Figure 129: DBe rare earth oxide price movements 2012 – 2018 (re-based to 2012 actuals)



Source: Deutsche Bank

Figure 130: DBe rare earth oxide pricing forecast 2012 - 2018

REO price (US$/kg)	2012a	2013e	2014e	2015e	2016e	2017e	2018e
Yttrium	18	15	20	21	22	24	25
% growth		*-16%*	*32%*	*6%*	*6%*	*6%*	*5%*
Lanthanum	8	7	6	5	5	6	6
% growth		*-21%*	*-6%*	*-13%*	*0%*	*8%*	*7%*
Cerium	8	6	6	5	5	5	6
% growth		*-24%*	*-7%*	*-14%*	*-2%*	*6%*	*6%*
Praseodymium	55	56	51	54	61	76	96
% growth		*2%*	*-9%*	*5%*	*15%*	*24%*	*27%*
Neodymium	55	48	49	52	58	71	88
% growth		*-12%*	*3%*	*6%*	*12%*	*22%*	*24%*
Samarium	6	5	5	4	4	5	6
% growth		*-24%*	*0%*	*-3%*	*2%*	*12%*	*13%*
Europium	922	700	662	580	534	564	585
% growth		*-24%*	*-5%*	*-12%*	*-8%*	*6%*	*4%*
Gadolinium	20	20	20	21	22	24	25
% growth		*1%*	*-1%*	*5%*	*6%*	*6%*	*7%*
Terbium	698	630	653	690	725	768	807
% growth		*-10%*	*4%*	*6%*	*5%*	*6%*	*5%*
Dysprosium	413	350	330	260	288	323	368
% growth		*-15%*	*-6%*	*-21%*	*11%*	*12%*	*14%*

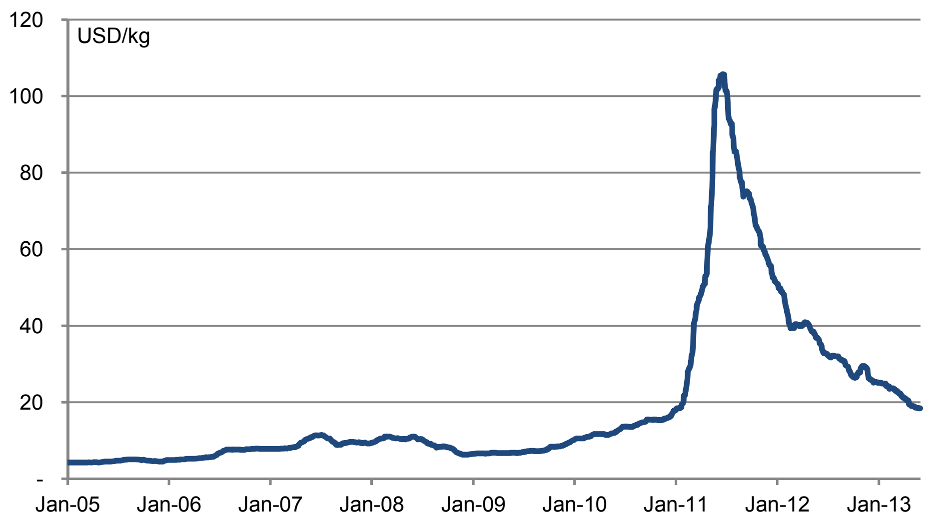
Source: Deutsche Bank

Realised prices driven by deposit quality and final product

Moving away from the "rare earth basket price" definition

Efforts to understand the current pricing environment for multi-element rare earth deposits has led to the "rare earth basket price" approach to referencing price. This definition takes current refined rare earth prices and the percentage composition of rare earths in a mineral resource to determine a weighted average price.

Figure 131: Composition 'basket price' for standard light REE ore (2005 – present)



Source: Asian Metals, Deutsche Bank

This approach to price referencing has a number of issues:

- The "rare earth basket price" shows the weighted average price of a refined rare earth product (>99% REO); these prices can be realized only on projects designed to mine, process and refine rare earth elements to a near-pure product.

- Comparisons between two assets cannot be made because the "rare earth basket price" refers to the average price for a kilogram of rare earths as per the ratio of rare earth elements present, but not the overall rare earth grade of the deposit.

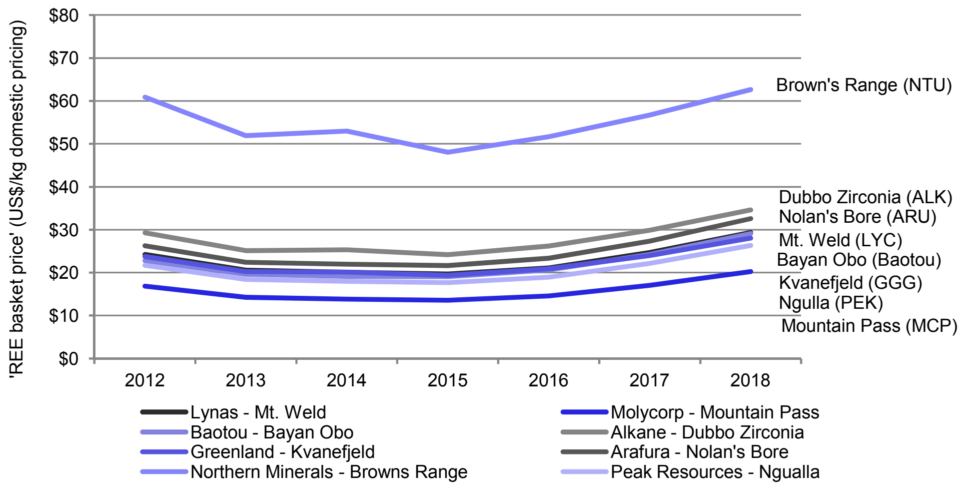
- The "rare earth basket price" does not reflect supply and demand for individual elements, so the key demand elements that are driving price support can't be easily identified.

Future of Chinese export duty rates also impacts realized price

Another consideration is the Chinese domestic price against ex-China FOB pricing. The difference is a function of duty rates (0%, 15% or 25% depending on the element) and also the supply and demand dynamics outside China with a larger premium achieved when ex-China demand for products is high. In our realized price forecasts, we assume a 15% premium will be achieved for lanthanum, cerium and neodymium products until 2016 when we believe Chinese consumption equals Chinese production.

In Figure 132, we have shown the theoretical "rare earth basket price" for a number of projects that are in production or varying stages of development. The "rare earth basket price" is driven by the composition of the deposit, however this does not consider deposit grade or project economics:

Figure 132: 'Rare earth basket price' of some ASX-listed REE deposits and global peers



Source: Deutsche Bank, company data

A comparison between some ASX-listed resources is shown in Figure 133; it is important to note that many of these deposits have other associated metals like uranium, zircon and niobium that could provide supplementary revenue streams:

Figure 133: Resource metrics for some ASX-listed REE deposits and global peers

Rare earth deposit	Rare earth resource (Mt)	Rare earth ore grade (%)
Lynas (LYC)- Mt. Weld	14.9	9.8%
Molycorp (MCP.N)- Mountain Pass	34.8	6.6%
Baotou - Bayan Obo	800	6.0%
Alkane (ALK) - Dubbo Zirconia	73.2	0.75%
Greenland (GGG)- Kvanefjeld	956	1.08%
Arafura (ARU) - Nolan's Bore	47.0	2.6%
Northern Minerals (NTU) – Brown's Range	1.44	0.73%
Peak Resources (PEK) - Ngualla	21.6	4.5%

Source: Company data

'In-situ resource value' the best metric to compare resources

In our view, the best way to compare the intrinsic value of a rare-earth deposit is the in-situ value of the resource on a US$/t basis. To achieve this, we take the weighted average of rare earth prices for the resource (the 'REE basket price'), multiply by the rare-earth ore grade (%) of the deposit, and re-base to a per tonne basis.

Applying our rare earth pricing forecasts (see page 74) to the individual resource metrics, we can infer how the intrinsic value of each asset will move as rare element earth markets move independently and certain elements shift into over- or undersupply.

Figure 134: Example of deposit data used to calculate 'in-situ resource value' - LYC

DBe price (US$/kg)	2012	2013	2014	2015	2016	2017	2018
Yttrium	$18	$15	$20	$21	$22	$24	$25
Lanthanum	$8.2	$6.5	$6.1	$5.3	$5.3	$5.8	$6.2
Cerium	$8.4	$6.4	$6.0	$5.2	$5.1	$5.4	$5.7
Praseodymium	$55	$56	$51	$54	$61	$76	$96
Neodymium	$55	$48	$49	$52	$58	$71	$88
Samarium	$5.9	$4.5	$4.5	$4.4	$4.5	$5.0	$5.6
Europium	$922	$700	$662	$580	$534	$564	$585
Gadolinium	$20	$20	$20	$21	$22	$24	$25
Terbium	$698	$630	$653	$690	$725	$768	$807
Dysprosium	$413	$350	$330	$260	$288	$323	$368

Rare Earths basket composition: Lynas – Mt. Weld (% REE content)			
Yttrium	0.76%	Samarium	2.44%
Lanthanum	23.88%	Europium	0.53%
Cerium	47.55%	Gadolinium	1.09%
Praseodymium	5.16%	Terbium	0.09%
Neodymium	18.13%	Dysprosium	0.25%

REE basket price (US$/kg domestic pricing)	2012	2013	2014	2015	2016	2017	2018
Lynas - Mt. Weld	$24.3	$20.6	$20.0	$19.7	$21.1	$24.7	$29.3

REE resource	Resource (Mt)	Ore Grade (%)
Lynas - Mt. Weld	14.95	9.80%

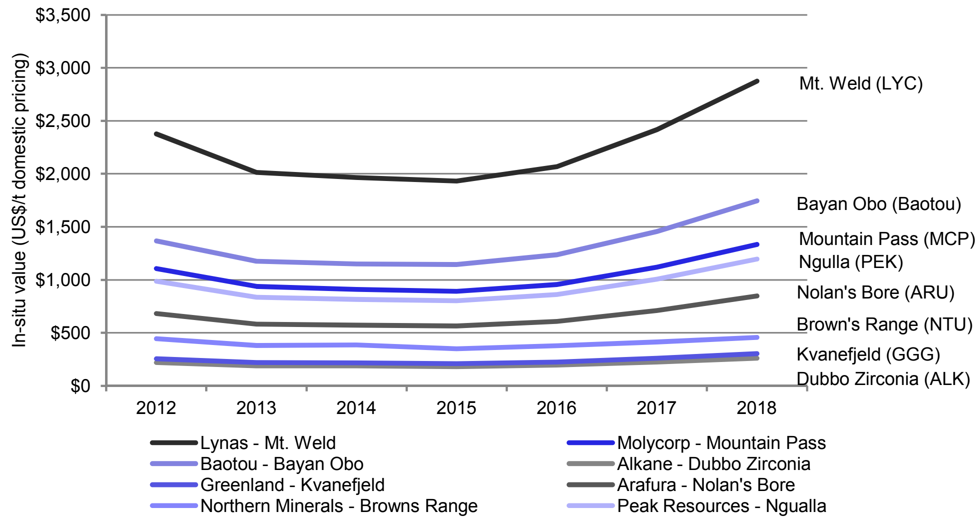
In-Situ value - (US$/t)	2012	2013	2014	2015	2016	2017	2018
Lynas - Mt. Weld	$2,376	$2,014	$1,965	$1,931	$2,066	$2,417	$2,875

Source: Deutsche Bank, company data

The 'in-situ resource value' metric assesses the underlying value of a tonne of ore from a rare earth deposit, and because multiple deposits can be considered on a common base (US$/t), asset comparisons can be made.

Figure 135 shows the 'in-situ resource value' of a number of ASX-listed rare earth assets as well as the two major global peers, Baotou's Bayan Obo operation in China and Molycorp's Mountain Pass mine in California, USA. Although the Mount Weld deposit (LYC) does not have the greatest 'rare earth basket price', the high-grade nature (9.8% rare earth grade) of the deposit makes the underlying value on a per tonne basis very attractive, in our opinion.

Figure 135: DBe 'in-situ value' of some ASX-listed REE deposits and global peers



Source: Deutsche Bank, company data

It is important to note that the 'in-site resource value' metric does not consider associated minerals or final processing streams and product qualities. Despite this, we believe a common base is necessary to determine project quality, and this calculation gives an unaltered, intrinsic value for a rare earth deposit versus peers.

Value-add processing routes will define realized price

Our rare earth supply and demand analysis has been developed on the basis of '>99% rare earth oxide (REO) purity' of products. There are multiple options in terms of potential saleable rare earth products, from concentrates, carbonates, chlorides, oxides and rare earth metals. All products have different processing requirements, demand markets and payability discounts to >99% REO prices; these factors will all impact project economics and realized prices.

Unprocessed ore

It is not common for unprocessed ore to be sold; generally a concentration step is at least completed to make transport more economic. For example, Lynas mine material at Mount Weld before concentrating material from c.10% to c.35-40%. For deposits close to China, it is possible that ore might be sent from other countries to China in the future, but not likely.

Concentrates

Post cracking and leaching, a mixed rare earth carbonate (MREC) is produced. There is a market for this product to be sold however it is generally further treated as part of an integrated process. A MREC is generally separated via solvent extraction. In the future, it may be possible for companies to sell concentrate as a MREC rather than a finished product. This would greatly reduce the initial capex requirements, however pricing of sales are obviously at a discount to products such as carbonates, chlorides and oxides. For example, Mount Weld concentrate ore (35-40%) is cracked in Malaysia using a sulphuric acid bake.

Carbonates, chlorides and oxides: the key seaborne market

Products leaving a processing plant are usually in the form of carbonates, chlorides and oxides depending on the end use application requirements. Oxides are the most pure product and are therefore desirable.

Intermediate products: sent from smelters to consumers (SEG)

Some elements are difficult to separate and therefore as a result they are sold as an intermediate product, one such example is Samarium, Europium, Gadolinium carbonate (SEG) which is produced at sites such as Lynas' processing plant in Malaysia. Due to the low tonnes produced, the combined product does not undergo further separation onsite. Technological barriers also exist beyond the economies of scale.

- An intermediate product can be sold to Chinese smelters e.g. Molycorp (through Neo materials) has two plants, JMR for heavy rare earths and ZMR for light rare earths separation inside China.
- There is some spare capacity at Rhodia's heavy rare earth refining operations in France; depending on ex-China demand and economics of refining, Rhodia could become an offtake partner for an intermediate SEG product.
- As the products are sold in a lower-quality, mixed form, they are sold at a discount to the 'weighted-average' spot price of contained rare earth products.

In the below table, the SEG average selling price over the last 3 years (2010 – 2013) is shown along with the prices for each of the individual end products and the theoretical price based on Lynas' composition of each product (78% Sm, 4.3% Dy, 15.3% Eu and 2.3% Tb). The average selling price is 36% of the final end products for Lynas. As the SEG ratios for each component can vary, the discount to end product prices will vary for each product. The discount effectively represents the toll treating charge to produce final products.

Figure 136: SEG pricing

Date	SmEuGd	Sm	Dy	Eu	Tb	Theoretical	Ratio
Average	101	10.1	739	1476	1152	291.5	0.36

Source: Asian Metal

- We assume LYC's SEG product realizes a 40% pricing ratio going forward.

Similar to SEG, neodymium and praseodymium can be sold as a mixed Nd/Pr oxide. Over an eight-year period, the average discount (based on Lynas' composition of 78% Nd, 22% Pr) of the mixed product is approximately 87% of the refined oxide prices.

Figure 137: Neodymium and Praseodymium pricing

	NdPr	Nd	Pr	Theoretical	Ratio
Average	49.66	60.12	53.00	58.53	0.87

Source: Asian Metal

- We assume LYC's Nd/Pr oxide realizes a 90% pricing ratio going forward.

Rare-earth products: magnets, phosphors etc.

It is also possible for companies to continue downstream from the mining and separation processes to capture more of the final end product margin. This is a concept that Molycorp has been involved in with its 'Magna-quench' magnet technology.

Costs – valuing China environmental impact is important

We have completed a supply and demand analysis to determine likely prices for each element based on our estimated surplus or deficit positions. Another important consideration is the cost structure of the industry and the behavior of each of the major producers.

The Chinese cost structure is largely opaque for a number of reasons: 1) rare earths are produced as a by-product of iron ore in parts of Inner Mongolia, 2) there are a number of small scale private operations and 3) the cost of environmental cleanup is not currently incorporated but will become an increasingly important dynamic in the market.

- Costs are largely a driven by the following areas:
  - **Processing** – Typically the largest contributor to costs and is primarily a function of the cost of energy (reagents, power, fuel etc.).
  - **Mining** – largely related to stripping ratios and grade. This is normally a minor part of the overall cost base.
  - **Transport** – shipping and proximity to ports. Costs can be reduced by concentrating the naturally mined material to reduce volumes
- Lynas have guided towards a cash operating cost of US$14-15/kg of product once ramp up to 22ktpa has been achieved; costs at the 11ktpa run rate are likely to be US$18-19/kg in our view. Our expectations for LYC costs are shown in Figure 138:

Figure 138: DB assumed production and operating costs for LYC (US$/kg)

	2013F	2014F	2015F	2016F	2017F	2018F
Production (kt)	0.6	7.2	15.0	19.6	22.0	22.0
Cash costs (US$/kg)	33.3	23.4	18.4	16.0	15.8	15.5

Source: Deutsche Bank

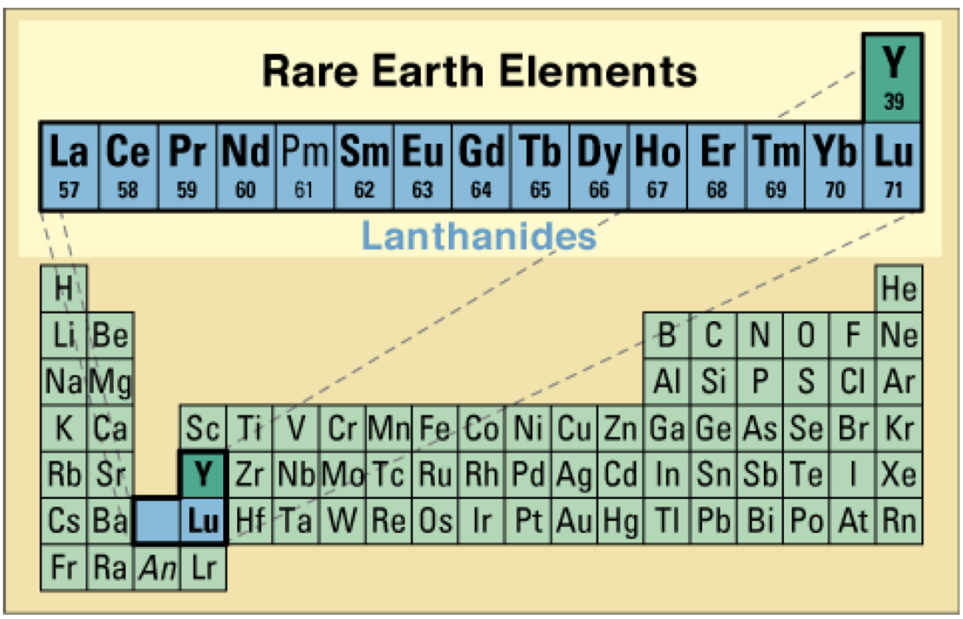
- Molycorp has access to cheap power through natural gas co-generation, acid recycling and reagent production onsite. The company's current goal is to achieve US$6 - $7/kg once ramp up to the Phase 1 run rate of 19ktpa has been achieved. This was reiterated as late as May, 2013.
- As outlined above, Chinese production will face increasing costs as environmental impacts are considered. It is our estimate that most operating costs in China are c.US$10/kg excluding environmental cleanup costs and any quota or tax requirements. In late 2012 and again in 2013, Baotou lowered production and even halted it completely for periods of time. We believe this was in response to falling prices and elevated inventory levels. Pausing production represents rational behavior in a weak pricing environment and would suggest that profitability was limited during this period.
- Lynas and Molycorp's public statements that production will vary in line with underlying demand suggests that prices will not likely fall further from current levels as producers will remain rational.

What are rare earths?

Rare earths comprise 15 metallic elements that are collectively known as the Lanthanide series. Yttrium (Y) and Scandium (Sc) are usually grouped with the rare earth family because of their similar properties. Lanthanides are often broken into two groups: light rare earth elements (LREEs) and heavy rare earth elements (HREEs).

Markets for light and heavy rare earths are generally very different. The HREEs are not as abundant as LREEs and therefore generally have higher extraction costs and spot prices; consequently, there are also fewer applications for heavy rare earths.

Figure 139: Rare earth elements on the periodic table



Source: LYC Investor Presentation, 03/08/2011

A list of the elements classified as 'rare earths' is provided in the below table.

Figure 140: Rare earth elements and chemical symbols

Element	Symbol	Element	Symbol
Lanthanum	La	Terbium	Tb
Cerium	Ce	Dysprosium	Dy
Praseodymium	Pr	Holmium	Ho
Neodymium	Nd	Erbium	Er
Promethium	Pm	Thulium	Tm
Samarium	Sm	Ytterbium	Yb
Europium	Eu	Lutetium	Lu
Gadolinium	Gd	Yttrium	Y

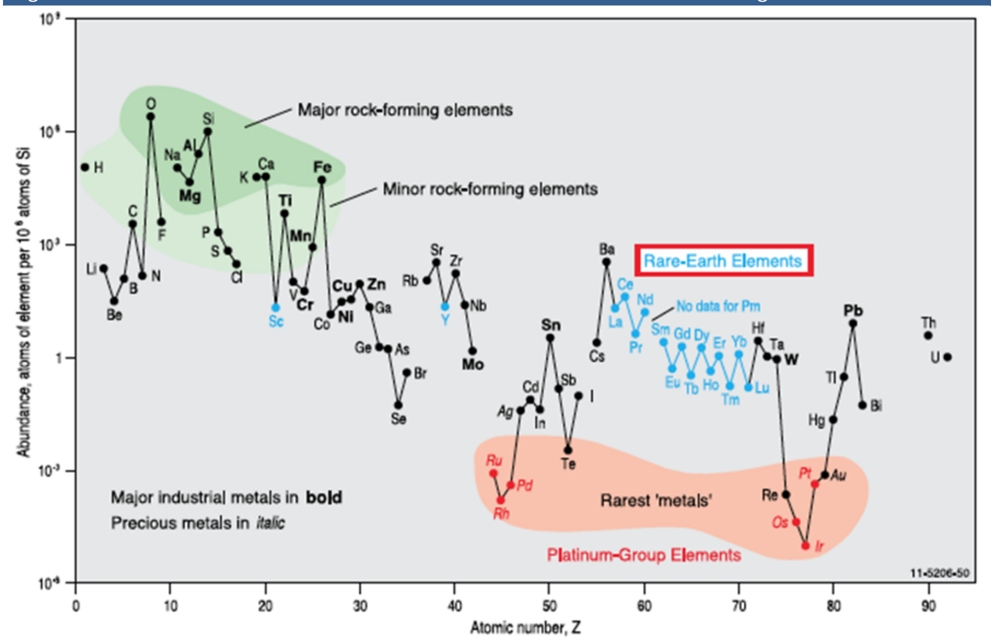
Source: Deutsche Bank

This elemental suite is broken down into two groups based on atomic number, with the distinctive characteristics being natural abundance, ease of separation and application.

- **Light rare earths (atomic numbers 57-62):** lanthanum, cerium, praseodymium, neodymium, promethium, samarium.

- **Heavy rare earths (atomic numbers 63-71):** europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium.
- Yttrium has similar chemical properties to the heavy rare earths, and is commonly considered part of this group.
- Scandium is associated with rare earth deposits, but economic extraction is mainly as a by-product and not necessarily associated with mining rare earths.

Figure 141: Relative abundance of rare earths vs. other rock-forming elements



Source: US Geological Survey

In the following section we list out the key properties of each of the rare earth elements, typical applications and historical pricing. Our supply and demand analysis includes rare earth elements that are produced in economic quantities and are used in significant applications; these include:

- Light rare earths
  - Lanthanum
  - Cerium
  - Praseodymium
  - Neodymium
  - Samarium
- Heavy rare earths
  - Europium
  - Gadolinium
  - Terbium
  - Dysprosium
- Other
  - Yttrium

Light rare earth elements (LREE)

Lanthanum (La)

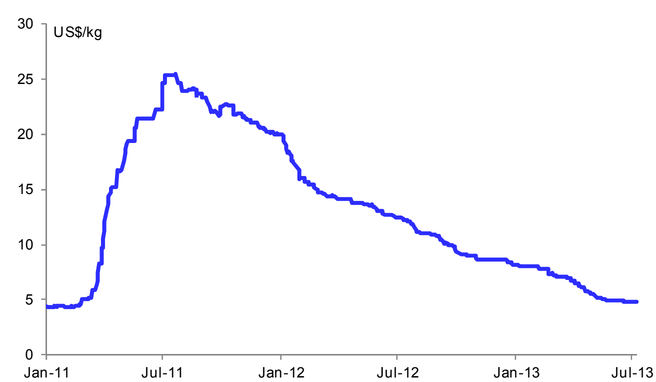
Lanthanum is the first of the light rare earth elements (LREEs) by atomic number. It is a malleable, ductile metal that has been used in commercial applications since the late 1800s.

Main applications: catalysts, battery alloys, glass, polishing powders and metallurgy

As Lanthanum is c.20-40% of most rare earth ore deposits, it is produced on a larger scale, and is hence less expensive, than other rare earth oxides. For this reason, lanthanum oxides are widely used across a number of industries:

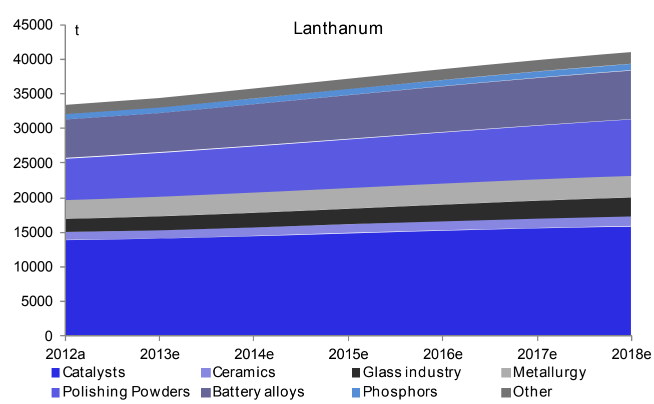
- Lanthanum is a major component of nickel-metal hydride batteries used in hybrid automobiles. Due to the high cost to separate lanthanum from the other lanthanide metals, a primary alloy is used (which is c.50% lanthanum). A typical hybrid automobile battery requires 10-15kg of lanthanum.
- A number of lanthanum compounds are used in fluid catalytic cracking. Lanthanum makes up two-thirds of rare earth consumption in catalysts.
- Lanthanum oxide improves the alkali resistance of glass and is beneficial in making special optical glass (like infrared-absorbing glass). Camera and telescopic lenses are also made with lanthanum due to the high refractive index and low dispersion of rare earth glass.

Figure 142: Lanthanum price movement since 2011



Source: Asian Metals, Deutsche Bank

Figure 143: Lanthanum demand by application industry



Source: Deutsche Bank

Figure 144: DBe supply/demand model for lanthanum (2012-2018)

Lanthanum	2012	2013	2014	2015	2016	2017	2018
Supply (t)	21,499	22,714	27,576	31,175	32,450	32,450	32,450
% growth		*6%*	*21%*	*13%*	*4%*	*0%*	*0%*
Demand (t)	33,445	34,445	35,783	37,240	38,592	39,865	41,046
% growth		*3%*	*4%*	*4%*	*4%*	*3%*	*3%*
Surplus/(deficit) (t)	-11,946	-11,731	-8,207	-6,065	-6,142	-7,415	-8,596
DBe price (US$/kg)	**8.2**	**6.5**	**6.1**	**5.3**	**5.3**	**5.8**	**6.2**
% growth		*-21%*	*-6%*	*-13%*	*0%*	*8%*	*7%*

Source: Deutsche Bank

Cerium (Ce)

Cerium is the most abundant of the rare earth elements, normally making up 40-50% of a rare earth deposit (as a point of comparison, cerium, as the rare earth with greatest natural abundance, is 0.0046% of the Earth's crust by weight).

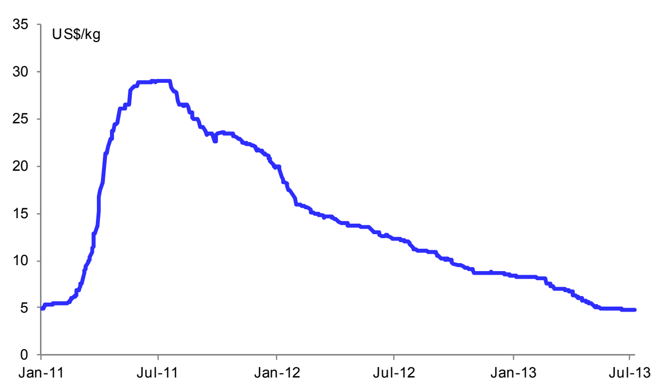
The metal was first discovered in 1803, but not successfully separated from the other rare earths until the 1830s.

Main applications: glass, polishing powders, metallurgy, catalysts and battery alloys

Cerium has a number of applications due to its attractive chemical properties and relative abundance as a rare earth product:

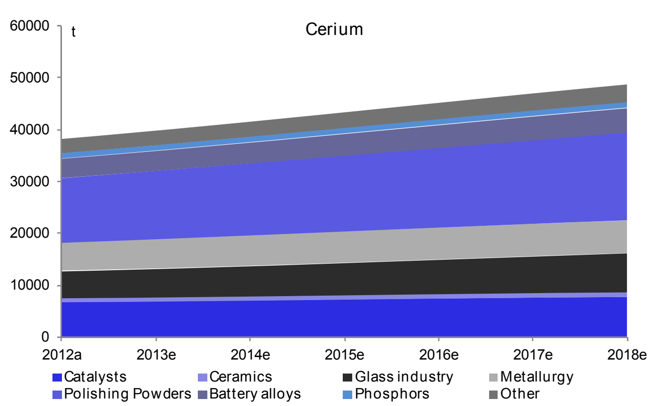
- Cerium oxide is an important component of glass product and glass polishing powders.
- Cerium is used in a number of catalyst applications; these include automobile catalytic converters (to reduce CO emissions in exhaust gases) and fluid catalytic cracking (in petroleum refining). Cerium is also used as an additive to diesel fuel to reduce carbon emissions.
- Cerium is also used in metal alloys and battery alloys used in hybrid and electric vehicles.

Figure 145: Cerium price movement since 2011



Source: Asian Metals, Deutsche Bank

Figure 146: Cerium demand by application industry



Source: Deutsche Bank

Figure 147: DBe supply/demand model for cerium (2012-2018)

Cerium	2012	2013	2014	2015	2016	2017	2018
Supply (t)	38,701	41,702	49,922	55,696	58,033	58,033	58,033
% growth		*8%*	*20%*	*12%*	*4%*	*0%*	*0%*
Demand (t)	38,166	39,799	41,533	43,393	45,243	47,033	48,823
% growth		*4%*	*4%*	*4%*	*4%*	*4%*	*4%*
Surplus/(deficit) (t)	536	1,902	8,389	12,302	12,790	11,000	9,210
DBe price (US$/kg)	**8.4**	**6.4**	**6.0**	**5.2**	**5.1**	**5.4**	**5.7**
% growth		*-24%*	*-7%*	*-14%*	*-2%*	*6%*	*6%*

Source: Deutsche Bank

Praseodymium (Pr)

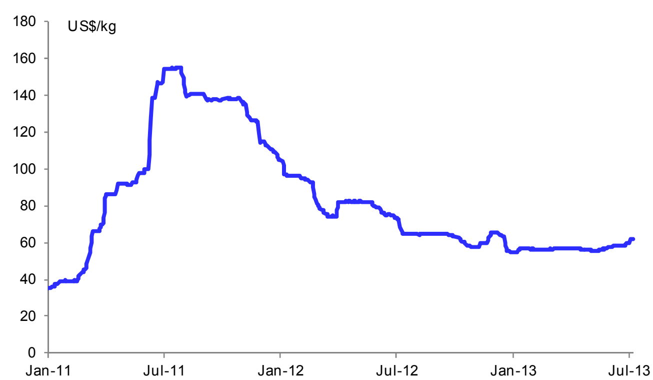
Praseodymium is a soft, malleable metal too reactive to be found in its natural form. Cerium was isolated from rare-earth-bearing minerals in the 1830s, and a residue named "didymium" was isolated from the gangue material (containing mainly lanthanum) a short time later. In 1885, "didymium" was separated into two salts that are now known as praseodymium and neodymium.

Praseodymium is named after the Greek words for "green" and "twin", a reference to the paired discovery with neodymium, and the yellow-green colour of praseodymium in solution.

Main applications: magnets, metallurgy and ceramics

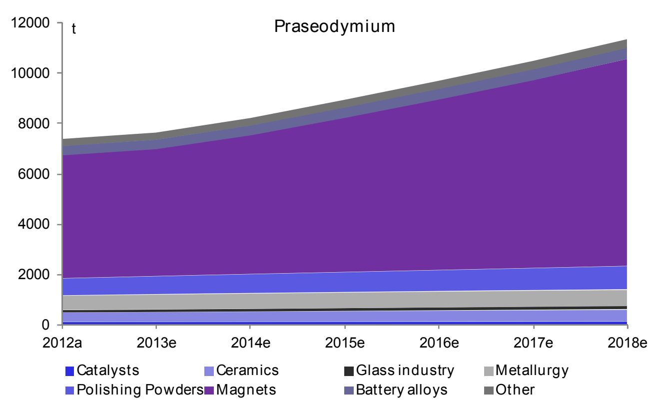
- Praseodymium is a major constituent of rare earth magnets (DBe 22% of rare earth consumption); the magnet industry is the major growth market for dysprosium and will drive prices towards US$100/kg, in our view.
- Praseodymium is present in 'mischmetal', an early stage rare earth metal alloy that is still in use today in flint lighters and torches.
- Praseodymium compounds are used extensively in glass and enamel industries to produce yellow-coloured products.
- Another use of praseodymium is as an alloying agent, particularly in aircrafts.

Figure 148: Praseodymium price movement since 2011



Source: Asian Metals, Deutsche Bank

Figure 149: Praseodymium demand by industry



Source: Deutsche Bank

Figure 150: DBe supply/demand model for praseodymium (2012-2018)

Praseodymium	2012	2013	2014	2015	2016	2017	2018
Supply (t)	5,035	5,238	6,079	6,649	6,915	6,915	6,915
% growth		*4%*	*16%*	*9%*	*4%*	*0%*	*0%*
Demand (t)	7,413	7,671	8,242	8,968	9,721	10,506	11,372
% growth		*3%*	*7%*	*9%*	*8%*	*8%*	*8%*
Surplus/(deficit) (t)	-2,378	-2,433	-2,163	-2,319	-2,806	-3,591	-4,457
DBe price (US$/kg)	**55**	**56**	**51**	**54**	**61**	**76**	**96**
% growth		*2%*	*-9%*	*5%*	*15%*	*24%*	*27%*

Source: Deutsche Bank

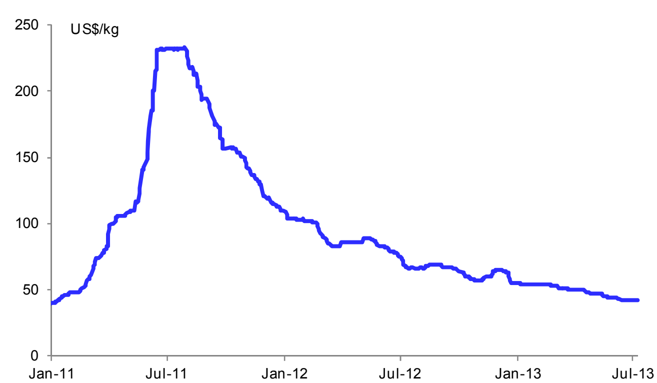
Neodymium (Nd)

Neodymium is a soft, silvery metal that is never found naturally in metallic form; instead it is mixed with other lanthanides in common ore minerals of monazite and bastnäsite. It was first discovered in 1885, and is relatively abundant within the Earth's crust (normally 15-20% of rare earth-bearing bastnäsite and monazite deposits).

Main applications: magnets, metallurgy, and ceramics

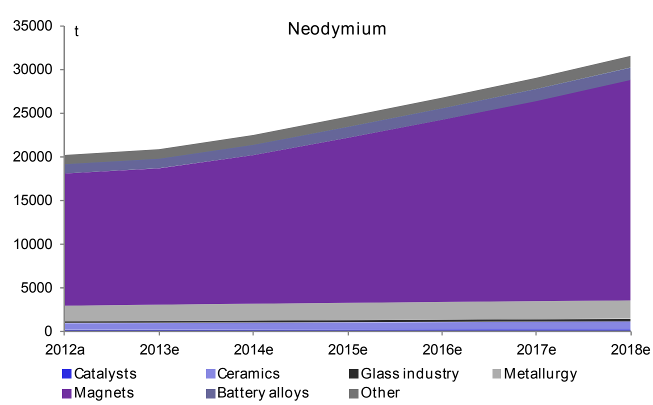
- Used in high strength permanent magnets for applications such as speakers, headphones, disk drives, electric motors (e.g. in hybrid cars which use c.1kg per vehicle). Magnets using Nd are some of the strongest available and are lighter than many other alternatives.
- Wind turbines are a key growth market for neodymium, with the magnets used large quantities in some turbines, particularly in the growing 'direct-drive' technology.
- Also used in metal alloys, high temperature ceramics and in battery alloys.

Figure 151: Neodymium price movement since 2011



Source: Asian Metals, Deutsche Bank

Figure 152: Neodymium demand by application industry



Source: Deutsche Bank

Figure 153: DBe supply/demand model for neodymium (2012-2018)

Neodymium	2012	2013	2014	2015	2016	2017	2018
Supply (t)	16,439	17,155	19,965	21,730	22,655	22,655	22,655
% growth		*4%*	*16%*	*9%*	*4%*	*0%*	*0%*
Demand (t)	20,244	20,894	22,748	25,145	27,368	29,687	32,258
% growth		*3%*	*9%*	*11%*	*9%*	*8%*	*9%*
Surplus/(deficit) (t)	-3,805	-3,739	-2,783	-3,414	-4,713	-7,032	-9,602
DBe price (US$/kg)	**55**	**48**	**49**	**52**	**58**	**71**	**88**
% growth		*-12%*	*3%*	*6%*	*12%*	*22%*	*24%*

Source: Deutsche Bank

Promethium (Pm)

Promethium is a radioactive element that does not have any major economic applications as a rare earth material type. Most of the global supply of promethium comes from uranium-style ore bodies as opposed to rare-earth rich deposits.

- Due to the negligible demand market and disassociation with rare earth production, we therefore do not include it in our supply/ demand analysis.

Applications of promethium

- Mainly used for research in radiation applications, x-ray, heat/power sources.
- Some luminous paint applications use promethium
- Also used in atomic batteries (devices that use energy from the decay of a radioactive isotope to generate electricity).

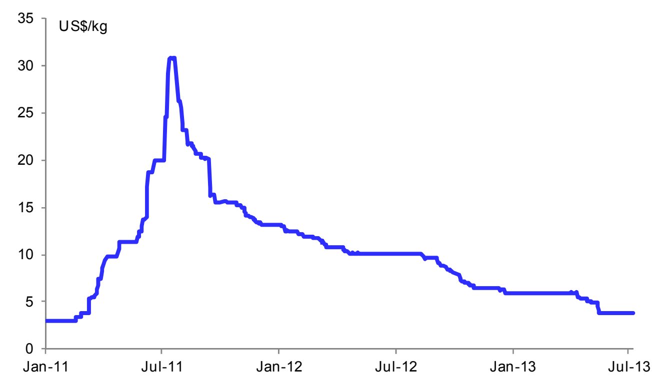
Samarium (Sm)

Samarium is a silvery metal, usually hard in nature as an oxide. The element was first discovered in 1879. It is relatively abundant (similar levels to tin). It is found in both monazite and bastnäsite deposits.

Main applications: Magnets, battery alloys and glass applications

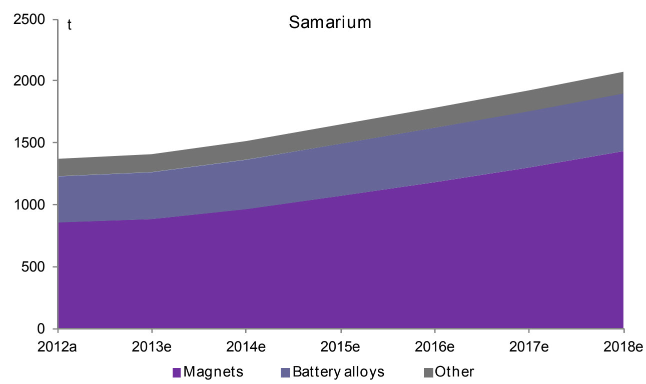
- The samarium-cobalt magnet is the main use for samarium in the current market. These magnets are normally viewed as secondary to neodymium magnets, but the advantage of Sm-Co magnets is that they retain magnetic strength at elevated temperatures (above 700 degrees).
- This quality is necessary in a number of applications, including military uses such as guided missiles and some bombs.
- Samarium is used in control rods as part of nuclear reactors.
- Its also used as a doping agent in lasers.

Figure 154: Samarium price movement since 2011



Source: Asian Metals, Deutsche Bank

Figure 155: Samarium demand by application industry



Source: Deutsche Bank

Figure 156: DBe supply/demand model for samarium (2012-2018)

Samarium	2012	2013	2014	2015	2016	2017	2018
Supply (t)	1,785	1,883	2,211	2,380	2,494	2,494	2,494
% growth		*6%*	*17%*	*8%*	*5%*	*0%*	*0%*
Demand (t)	1,370	1,408	1,515	1,651	1,787	1,928	2,080
% growth		*3%*	*8%*	*9%*	*8%*	*8%*	*8%*
Surplus/(deficit) (t)	415	475	696	729	707	566	414
DBe price (US$/kg)	**5.9**	**4.5**	**4.5**	**4.4**	**4.5**	**5.0**	**5.6**
% growth		*-24%*	*0%*	*-3%*	*2%*	*12%*	*13%*

Source: Deutsche Bank

Heavy rare earth elements (HREE)

Yttrium (Y)

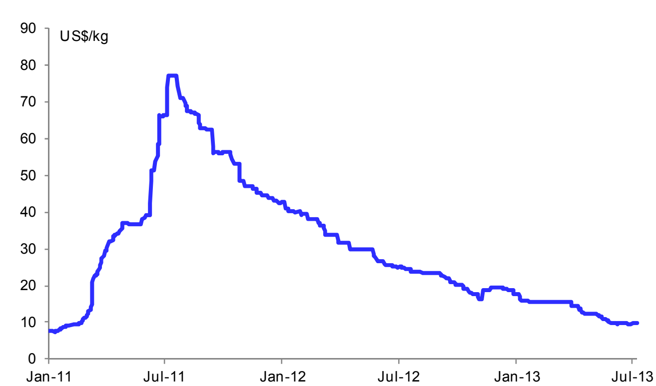
Yttrium is a silver-metallic transition metal found in close association with the 'rare earth' group of elements. Similarities between yttrium and the rare earth metals are much more apparent than observed with scandium (yttrium's neighbor on the periodic table).

Yttrium has a similar chemical reactivity as terbium (Tb) and dysprosium (Dy), and behaves like a heavy rare earth ion in solution; for this reason, yttrium is generally referred to as a heavy rare earth element (HREE).

Applications – Glass, phosphors, ceramics

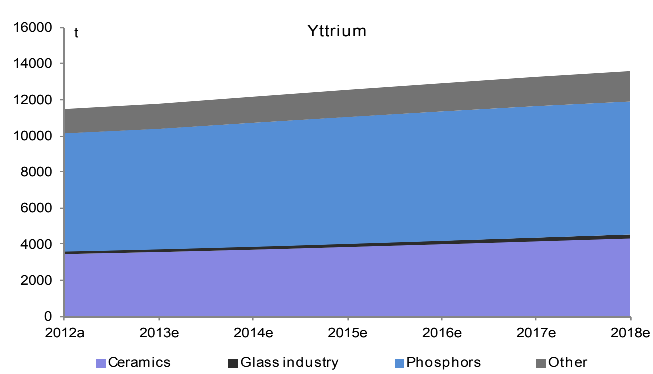
- Yttrium is the most commonly used rare earth element in phosphors (see page 70), particularly in visual screens. The yttrium element passes the absorbed energy onto another rare-earth element that emits a coloured luminescence.
- Solid oxide fuel cells, electrochemical conversion devices used to generate electricity from the oxidation of a fuel. The U.S. Department of Energy has flagged yttrium (along with cerium and lanthanum) as a critical element.
- Yttrium is used in the production of synthetic garnets for both industrial and cosmetic applications. Yttrium iron garnets (YIG) are very effective microwave filters as well as being efficient acoustic energy transmitters and transducers.
- Yttrium aluminum garnets (YAG) are used in high-power lasers that can cut through metal. Yttrium-based lasers are also used in the medical field.

Figure 157: Yttrium price movement since 2011



Source: Asian Metals, Deutsche Bank

Figure 158: Yttrium demand by application industry



Source: Deutsche Bank

Figure 159: DBe supply/demand model for yttrium (2012-2018)

Yttrium	2012	2013	2014	2015	2016	2017	2018
Supply (t)	12,219	12,177	12,243	12,250	12,250	12,250	12,250
% growth		*0%*	*1%*	*0%*	*0%*	*0%*	*0%*
Demand (t)	11,512	11,802	12,189	12,570	12,938	13,288	13,609
% growth		*3%*	*3%*	*3%*	*3%*	*3%*	*2%*
Surplus/(deficit) (t)	707	375	54	-320	-688	-1,038	-1,359
DBe price (US$/kg)	**18**	**15**	**20**	**21**	**22**	**24**	**25**
% growth		*-16%*	*32%*	*6%*	*6%*	*6%*	*5%*

Source: Deutsche Bank

Europium (Eu)

Europium is a hard, silvery metal which readily oxidizes with air and water. Its usage is mainly limited to phosphors, where the red phosphorescence of its compounds can be used to emit coloured light. It is found in monazite, xenotime and bastnäsite deposits around the world in small compositions (less than 0.5%).

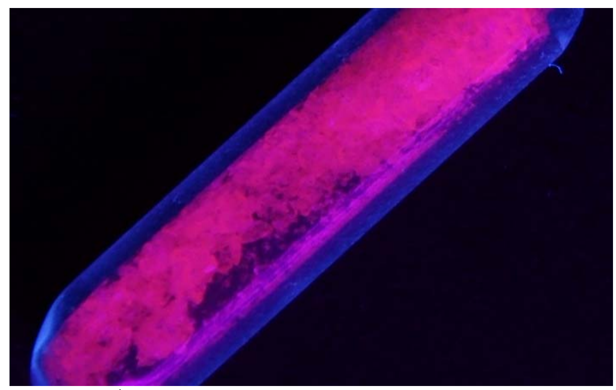
Applications: Phosphors

- Mainly used in televisions and fluorescent lamps and some other yttrium dominated phosphors linked to the colour red. Typically, TV screens use c.1g of europium per unit. Historically, europium was used in some magnetic applications associated with MNR spectroscopy.

Figure 160: Europium sulfate $Eu_2(SO_4)_3$ salt in a vial

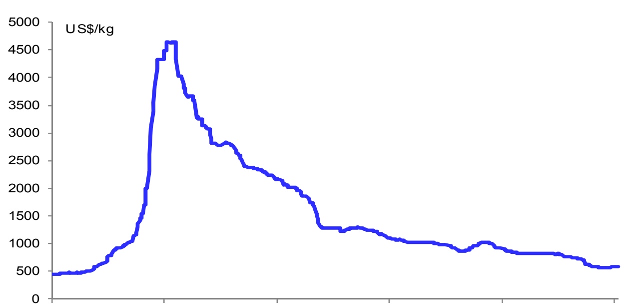
Source: www.smart-elements.com

Figure 161: Europium sulfate $Eu_2(SO_4)_3$ under UV light



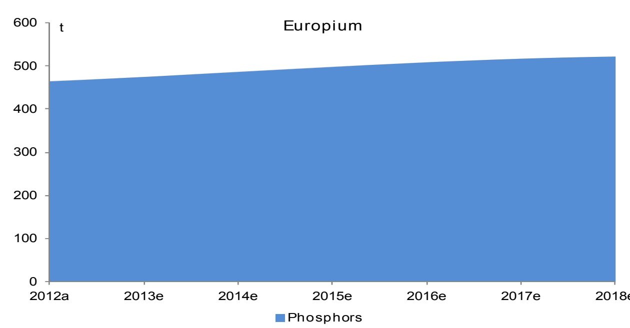
Source: www.smart-elements.com

Figure 162: Europium price movement since 2011



Source: Asian Metals, Deutsche Bank

Figure 163: Europium demand by application industry



Source: Deutsche Bank

Figure 164: DBe supply/demand model for europium (2012-2018)

Europium	2012	2013	2014	2015	2016	2017	2018
Supply (t)	183	194	242	271	293	293	293
% growth		*6%*	*25%*	*12%*	*8%*	*0%*	*0%*
Demand (t)	465	475	487	499	509	517	523
% growth		*2%*	*3%*	*2%*	*2%*	*2%*	*1%*
Surplus/(deficit) (t)	-282	-281	-245	-228	-216	-224	-230
DBe price (US$/kg)	**922**	**700**	**662**	**580**	**534**	**564**	**585**
% growth		*-24%*	*-5%*	*-12%*	*-8%*	*6%*	*4%*

Source: Deutsche Bank

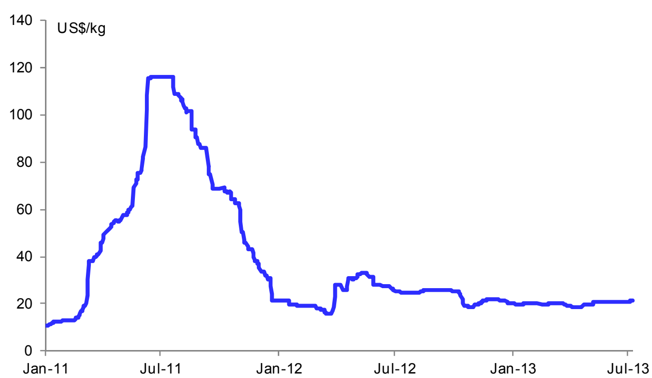
Gadolinium (Gd)

Gadolinium is another silver-coloured, malleable and ductile rare earth in the 'heavy' series. It was first found in the 1880s and then successfully isolated in 1886. It has high absorption capabilities making it suitable for a variety of specialty applications. It is typically found in both monazite and bastnäsite ores.

Main applications: Magnets, phosphors

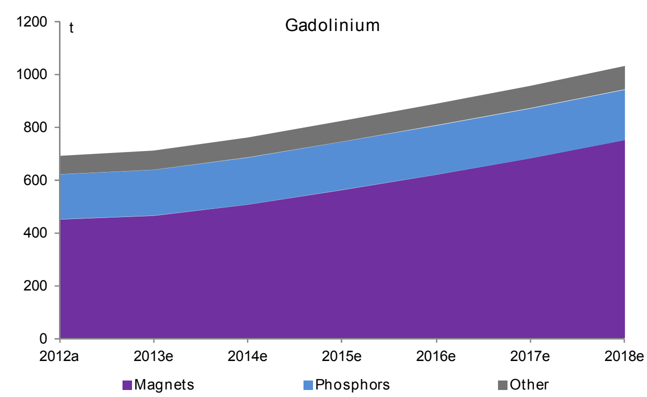
- Nuclear reactors and radiography mainly in magnetic usages.
- Magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA) applications.
- Phosphor applications, mainly in x-rays and colour television tubes
- Compact discs

Figure 165: Gadolinium price movement since 2011



Source: Asian Metals, Deutsche Bank

Figure 166: Gadolinium demand by application industry



Source: Asian Metals, Deutsche Bank

Figure 167: DBe supply/demand model for gadolinium (2012-2018)

Gadolinium	2012	2013	2014	2015	2016	2017	2018
Supply (t)	2,118	2,128	2,190	2,204	2,204	2,204	2,204
% growth		*1%*	*3%*	*1%*	*0%*	*0%*	*0%*
Demand (t)	692	711	761	824	890	958	1,033
% growth		*3%*	*7%*	*8%*	*8%*	*8%*	*8%*
Surplus/(deficit) (t)	1,426	1,417	1,429	1,380	1,315	1,246	1,171
DBe price (US$/kg)	**20**	**20**	**20**	**21**	**22**	**24**	**25**
% growth		*1%*	*-1%*	*5%*	*6%*	*6%*	*7%*

Source: Deutsche Bank

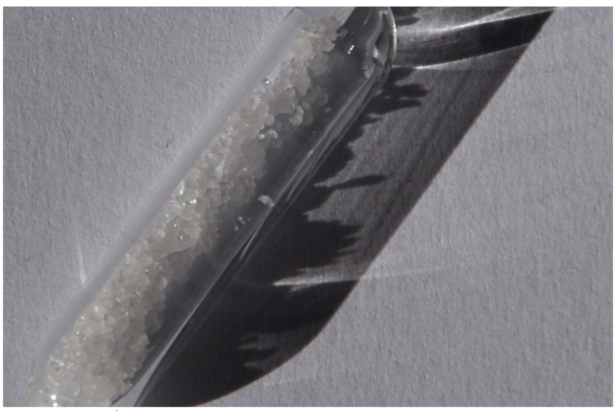
Terbium (Tb)

Terbium is a relatively soft, ductile material usually contained in other minerals such as monazite. It was first discovered in the 1840s. Most of the world's terbium supply is used in green phosphors due to the greenish phosphorescence of its compounds.

Applications – Magnets, polishing, phosphors

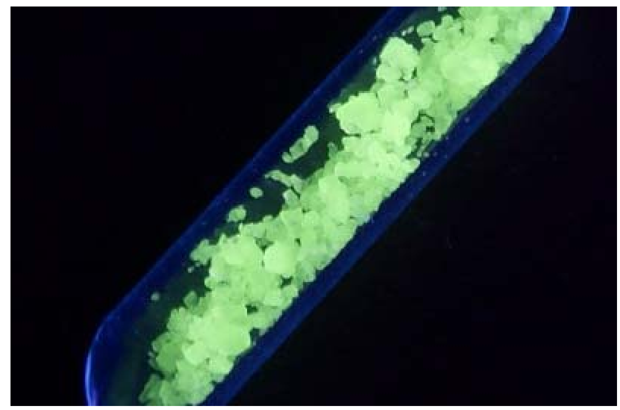
- Rare earth phosphors as part of fluorescent lamps and TVs to emit green light.
- Fuel cell applications that run at high temperatures as a stabilizing agent.

Figure 168: Terbium sulfate $Tb_2(SO_4)_3$ salt in a vial



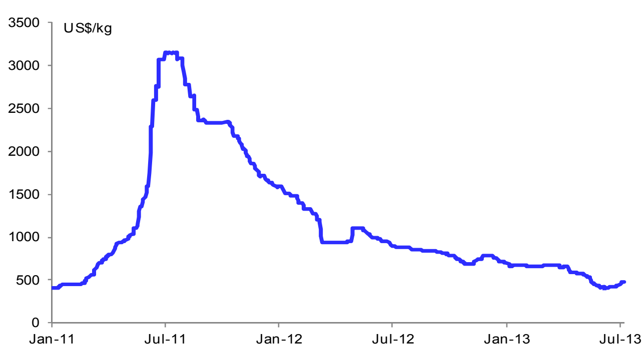
Source: www.smart-elements.com

Figure 169: Terbium sulfate $Tb_2(SO_4)_3$ under UV light



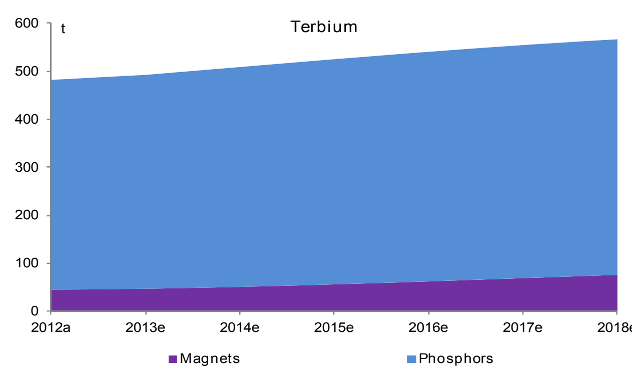
Source: www.smart-elements.com

Figure 170: Terbium price movement since 2011



Source: Asian Metals, Deutsche Bank

Figure 171: Terbium demand by application industry



Source: Deutsche Bank

Figure 172: DBe supply/demand model for terbium (2012-2018)

Terbium	2012	2013	2014	2015	2016	2017	2018
Supply (t)	428	445	469	473	476	476	476
% growth		*4%*	*5%*	*1%*	*1%*	*0%*	*0%*
Demand (t)	482	492	509	525	541	554	567
% growth		*2%*	*3%*	*3%*	*3%*	*3%*	*2%*
Surplus/(deficit) (t)	-54	-47	-40	-53	-64	-78	-90
DBe price (US$/kg)	**698**	**630**	**653**	**690**	**725**	**768**	**807**
% growth		*-10%*	*4%*	*6%*	*5%*	*6%*	*5%*

Source: Deutsche Bank

Dysprosium (Dy)

Dysprosium exists with other associated minerals rather than in pure form in nature. It was first found in the late 1800s but was not able to be used commercially until the 1950s. Its key advantage is its use for stability of magnets at increasing temperatures, a very unique property. Purity in end usage applications is essential.

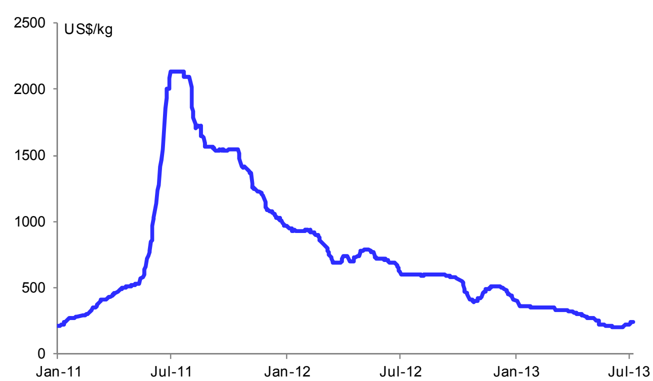
Applications: Magnets

- Neodymium iron boron magnets use dysprosium in order to increase the coercivity and thermal stability for magnet applications that are exposed to rising temperatures. The dysprosium consumption ranges from 1-10% of the overall percentage weight of the material depending on the application, with high performance motors and generators requiring the highest intensity of dysprosium.

Shortage in dysprosium to be addressed by engineering solution

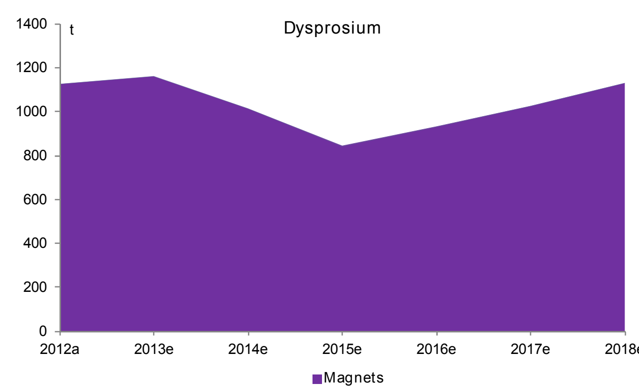
Due to the low natural abundance and high cost of dysprosium, there has been an industry push to develop new ways to decrease dysprosium intensity required in magnets. Technological advances have developed ways to apply dysprosium and other heavy rare earths as a coating along the individual grain boundaries of the Nd-Fe-B sintered magnets. Despite overall dysprosium content being less, the coercivity of the magnets is strong and higher temperatures were required to force demagnetization. This method is referred to as the 'grain boundary diffusion process' (GBDP).

Figure 173: Dysprosium price movement since 2011



Source: Asian Metals, Deutsche Bank

Figure 174: Dysprosium demand by application industry



Source: Deutsche Bank

Figure 175: DBe supply/demand model for dysprosium (2012-2018)

Dysprosium	2012	2013	2014	2015	2016	2017	2018
Supply (t)	1,505	1,526	1,557	1,563	1,569	1,569	1,569
% growth		*1%*	*2%*	*0%*	*0%*	*0%*	*0%*
Demand (t)	1,124	1,159	1,013	843	931	1,024	1,128
% growth		*3%*	*-13%*	*-17%*	*10%*	*10%*	*10%*
Surplus/(deficit) (t)	381	367	544	719	638	545	440
DBe price (US$/kg)	**413**	**350**	**330**	**260**	**288**	**323**	**368**
% growth		*-15%*	*-6%*	*-21%*	*11%*	*12%*	*14%*

Source: Deutsche Bank

Low volume rare earth markets

Scandium (Sc)

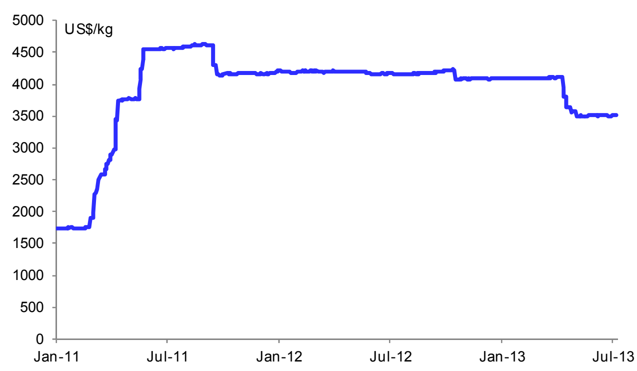
Scandium is a silvery-white, metallic transition metal, commonly grouped with rare earth elements. This classification is based on the presence of the element in many rare earth deposits, not on geochemical characteristics.

- Despite its presence in most rare earth deposits, production of scandium oxide as largely as a by-product when extracting other elements.
- Global production of scandium oxide is c.2tpa; c.400kg via by-product production and the rest from Russian stockpiles.

Applications

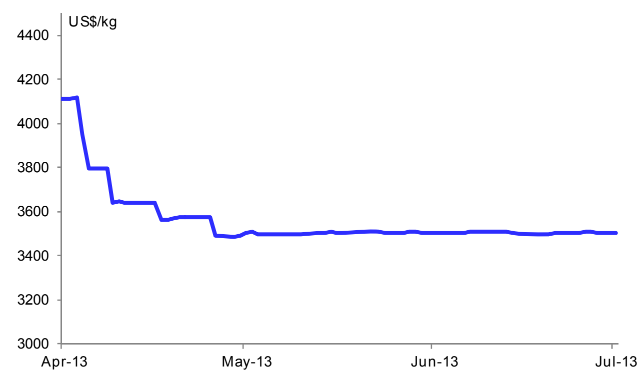
- The primary use of scandium is in aluminium alloys associated with minor aerospace industry components. Small quantities of scandium (as little as 0.5%) can have a significant impact on the strength of aluminium alloys, but due to the scarcity of the metal, scandium is only used in high-end products where quality is necessary.
- For lower-end products, cheaper titanium alloys are widely used. Scandium is also used in solid oxide fuel cells, high-density discharge lamps and as a tracing agent in oil refineries.

Figure 176: Scandium price movement since 2011



Source: Asian Metals, Deutsche Bank

Figure 177: Scandium price movement since Apr'13



Source: Asian Metals, Deutsche Bank

- Due to the small size of the scandium oxide market relative to other rare earths and the lack of end use applications, we have not included the element in our supply and demand analysis.

Heavy rare earths not included in supply/demand analysis

Beyond the rare earth elements already discussed, there are a further five heavy rare earths that currently have small trading markets:

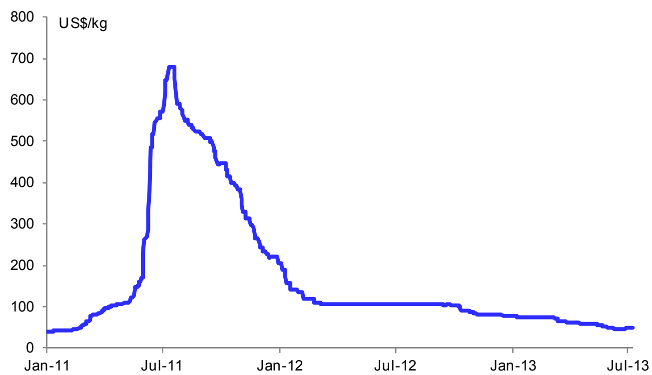
- Holmium (Ho)
- Erbium (Er)
- Thulium (Th)
- Ytterbium (Yb)
- Lutetium (Lt)

These elements have very similar chemical properties and consequently are difficult to isolate. As a result, spot trading markets are small, illiquid and sales are generally completed at pre-agreed rates.

We have not included these elements in our supply/demand analysis; however we have presented historical pricing charts for the elements below.

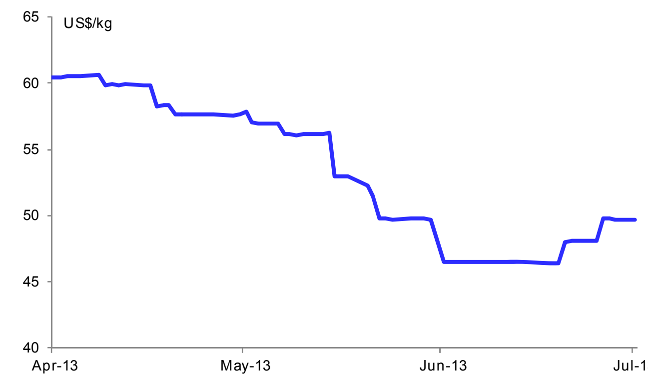
Holmium (Ho)

Figure 178: Holmium price movement since 2011



Source: Asian Metals, Deutsche Bank

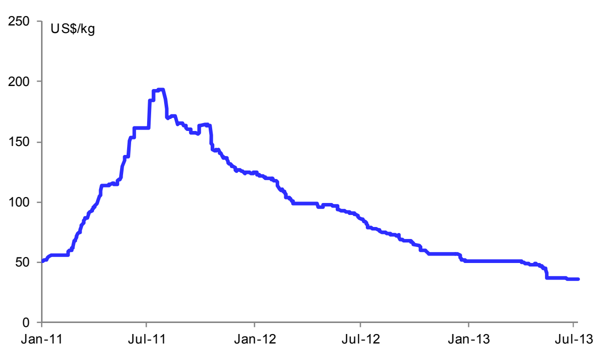
Figure 179: Holmium price movement since Apr'13



Source: Asian Metals, Deutsche Bank

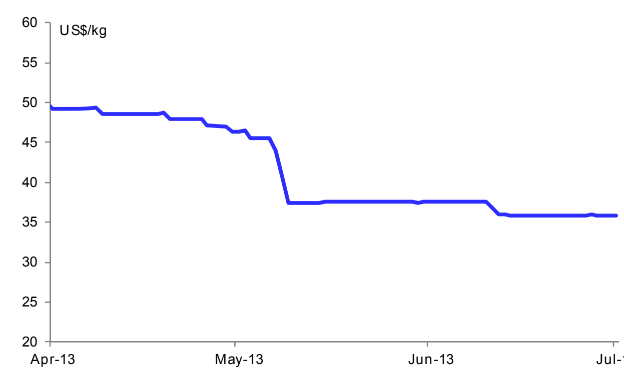
Erbium (Er)

Figure 180: Erbium price movement since 2011



Source: Asian Metals, Deutsche Bank

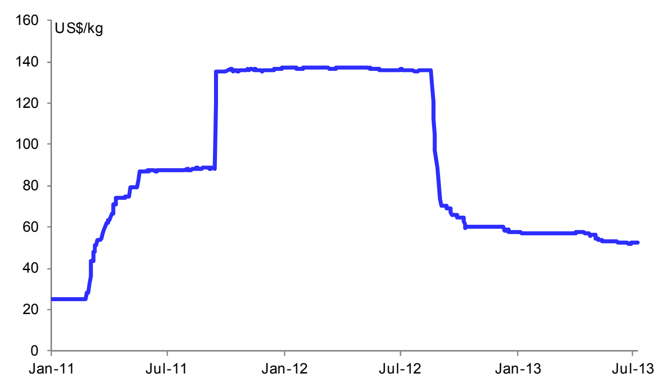
Figure 181: Erbium price movement since Apr'13



Source: Asian Metals, Deutsche Bank

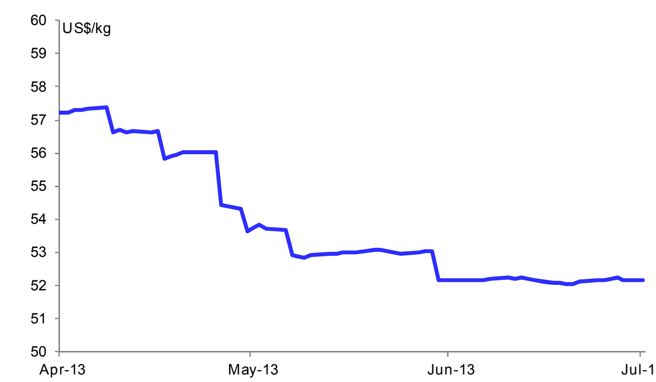
Ytterbium (Yb)

Figure 182: Ytterbium price movement since 2011



Source: Asian Metals, Deutsche Bank

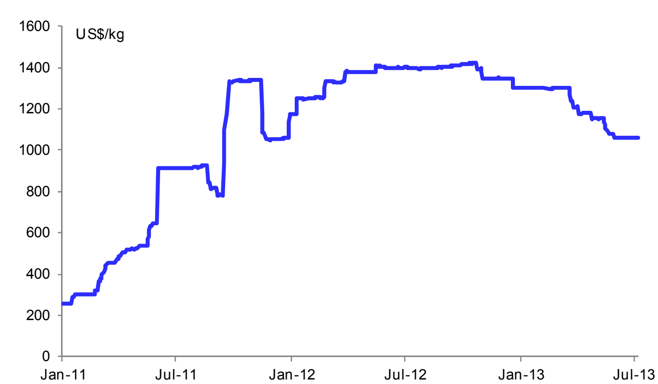
Figure 183: Ytterbium price movement since Mar'13



Source: Asian Metals, Deutsche Bank

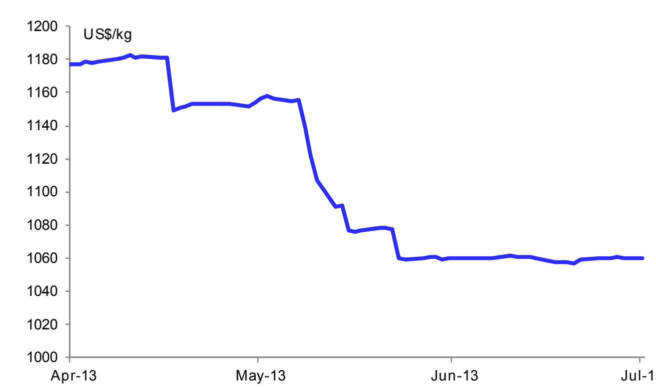
Lutetium (Lu)

Figure 184: Lutetium price movement since 2011



Source: Asian Metals, Deutsche Bank

Figure 185: Lutetium price movement since Mar'13



Source: Asian Metals, Deutsche Bank

Thulium (Tm)

There is no available historical pricing data for thulium.

Glossary

CAGR – Compound annual growth rate

CCFC – Cold cathode fluorescent

FCC – Fluid cracking catalyst

FOB – Free on board

HEV – Hybrid and Electric Vehicles

HREE – Heavy rare earth element

HREO – Heavy rare earth oxide

IEA – International Energy Agency

LCD – Liquid crystal display

LED – Light emitting diode

LREE – Light rare earth element

LREO – Light rare earth oxide

MREC – Mixed rare earth carbonate

NdPr – Neodymium/Praseodymium combined product

NiMH – Nickel metal hydride

REE – Rare earth element

REO – Rare earth oxides

SOE – State owned entity

WTO – World trade organization

YAG – Yttrium aluminium garnet

YIG – Yttrium Iron Garnets

Investment Thesis

Outlook

LYC has completed construction of Phase 1 in both Western Australia and Malaysia allowing for production of 11ktpa rare earths. It is now producing from Phase 1 at a rate appropriate for the current market conditions. Phase 2 production is forecast at an additional 11ktpa to allow for 22ktpa in total. While Phase 2 is now essentially complete, commissioning may be delayed depending on market conditions. We factor in a slow ramp-up due to our expectations for the overall rare earth market. We assume LYC reaches a 22ktpa run rate in 2016. At a 22ktpa throughput rate, current reserves are sufficient for greater than 25 years (after recoveries). We believe that the current subdued market conditions will put pressure on the balance sheet which is a key risk for the stock. We see downside to the current share price to reach our $0.30/sh Price Target, we therefore rate the stock a Sell.

Valuation

Our price target is set broadly in line with our DCF valuation. This is based on our bottom up pricing expectations for each of the individual elements produced. We also factor in what we believe to be appropriate discounts for products not sold in the pure form. We use a long term AUD/USD of 0.80 LT. We discount the life of mine cash flows using a nominal WACC of 13%, above the sector average of 10% given the poor clarity in the REO market. We have assumed operating costs of c.US$15/kg long term.

Risks

Upside risks include movements in forex (AUD/USD, AUD/MYR), the rare earth price and lower input costs than our expectations. Improving demand for rare earth based products beyond our expectations through global growth and reducing inventories further than anticipated presents possible upside to our pricing and volume assumptions.

Appendix: Companies mentioned

Figure 186: Companies mentioned list – Listed companies

Listed companies mentioned	Ticker	Exchange	Price Target
Rare earth mining companies			
Lynas	LYC	ASX	Sell, $0.30/sh
Molycorp Minerals LLC	MCP	NYSE	not covered
Alkane Resources	ALK	ASX	not covered
Greenland Minerals	GGG	ASX	not covered
Arafura Resources	ARU	ASX	not covered
Northern Minerals	NTU	ASX	not covered
Peak Resources	PEK	ASX	not covered
Avalon Rare Metals	AVL	TSX	not covered
Great Western Minerals	GWG	TSX	not covered
Rare Element Resources	RES/REE	TSX/NYSE	not covered
Inner Mongolia Baotou Steel Rare-Earth Hi-Tech Company	600111.CH	SSE	not covered
Other listed companies			
Siemens	SIEGn.DE	GER	Sell, EUR75/sh
Toyota Motor	7203.T	TYO	Buy, JPY7,600/sh
Chevron	CVX.N	NYSE	Buy, US$140/sh
LKQ Corporation	LKQ.OQ	NMS	Hold, US$26/sh
Hitachi Construction Machinery	6305.T	TYO	Hold, JPY2,500/sh

Source: Deutsche Bank, Bloomberg Finance LP Current prices as of 10· July 2013: Siemens 79EUR, Toyota 6,380JPY, Chevron 123USD, LKQ 26USD, Hitachi 2,134JPY, Molycorp 7.08USD

Figure 187: Companies mentioned list – Private companies

Private companies mentioned
Kazatomprom
Sojitz
Mount Kellett
Sichuan Jiangxi Copper Rare Earths Company
Nippon Sheet Glass Co. Ltd.
Neo Material Technologies (acquired by MCP in 2012)
Rhodia
BASF Global

Source: Deutsche Bank

Appendix: Resource data for deposits used in analysis

Figure 188: Resource composition for some ASX-listed REE deposits and global peers

Deposit	Resource (MT)	Grade (%)	Rare Earths Composition									
			Y	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy
Lynas (LYC)- Mt. Weld	14.9	9.80%	0.0%	25.5%	46.7%	5.3%	18.5%	2.3%	0.4%	0.0%	0.1%	0.1%
Molycorp (MCP.N)- Mountain Pass	34.8	6.57%	0.1%	33.2%	49.1%	4.3%	12.0%	0.8%	0.1%	0.2%	0.0%	0.0%
Baotou - Bayan Obo	800	6.00%	0.0%	23.0%	50.0%	6.2%	18.5%	0.8%	0.2%	0.7%	0.1%	0.1%
Alkane (ALK) - Dubbo Zirconia	73.2	0.75%	15.8%	19.5%	36.8%	4.0%	14.1%	2.2%	0.1%	2.2%	0.3%	2.0%
Greenland (GGG)- Kvanefjeld	956	1.08%	7.7%	27.5%	42.0%	4.2%	12.9%	1.8%	0.1%	1.1%	0.2%	1.1%
Arafura (ARU) - Nolan's Bore	47.0	2.60%	1.4%	19.1%	48.7%	5.9%	20.6%	2.3%	0.4%	1.0%	0.1%	0.3%
NTU - Browns Range	1.44	0.73%	53.6%	3.3%	7.7%	1.0%	4.2%	2.1%	0.4%	5.3%	1.2%	8.2%
Peak Resources (PEK) - Ngualla	21.6	4.54%	0.2%	27.6%	48.2%	4.7%	16.6%	1.6%	0.3%	0.6%	0.1%	0.1%

Source: Company data

References

Throughout this report, we have used industry data and market information which is available in the public domain. Sources of this information are:

- US Geological Survey
- British Geological Survey
- CSIRO

We have also included information and images from data sources that Deutsche Bank has subscribed to, and we have the rights to use this information:

- Asian Metals
- iStockphoto
- International Energy Agency

We have also sourced information from publicly available company and industry sources. We have referenced these sources and sought approval to reproduce this data where applicable.

Research Contribution

The authors of this report wish to acknowledge the contribution of Dr. Stephen Collocott and Dr. Anand Bhatt, both from CSIRO, who provided considerable industry knowledge on rare earth magnets and battery alloys respectively.

We also would like to acknowledge the global policy outlook for various industries provided by Tim Jordan, Environmental, Social and Governance analyst at Deutsche Bank, based in Sydney.

Finally, we wish to recognise the contribution made by Rahul Kedia, employee of Irevna, a division of CRISIL Limited, a third party provider to Deutsche Bank of offshore research support services.

Appendix 1

Important Disclosures

Additional information available upon request

Disclosure checklist

Company	Ticker	Recent price*	Disclosure
Lynas Corporation Ltd	LYC.AX	0.46 (AUD) 11 Jul 13	NA

*Prices are sourced from local exchanges via Reuters, Bloomberg and other vendors. Data is sourced from Deutsche Bank and subject companies

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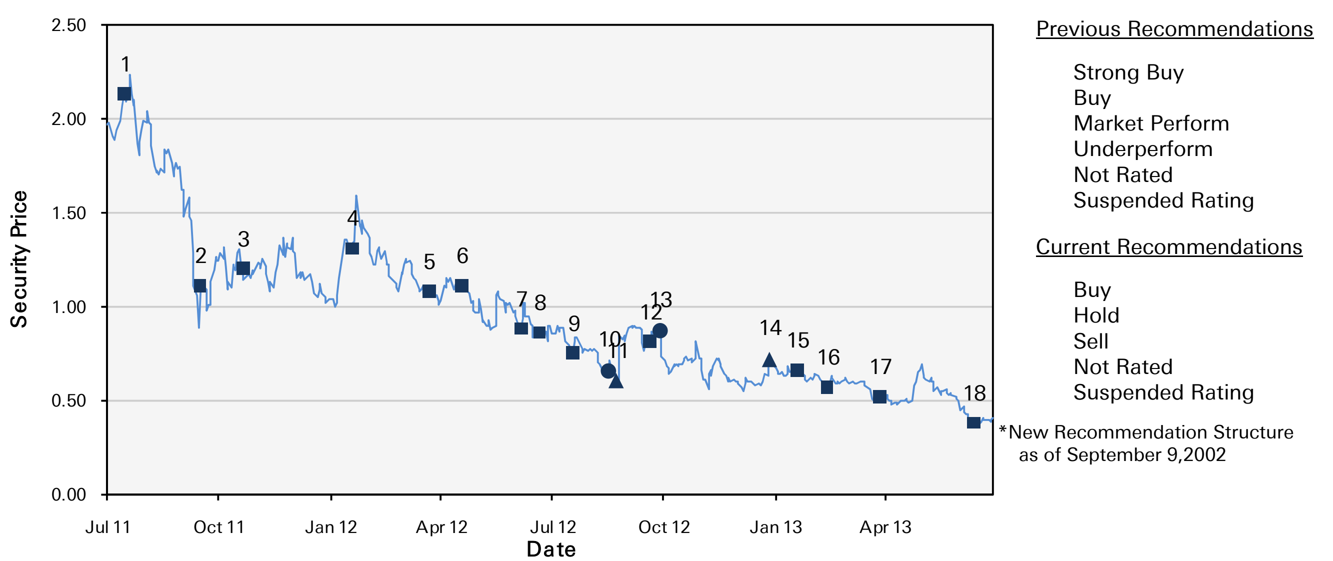
Historical recommendations and target price: Lynas Corporation Ltd (LYC.AX)
(as of 7/11/2013)



1.	28/07/2011:	Buy, Target Price Change AUD2.59	10.	29/08/2012:	Downgrade to Sell, Target Price Change AUD0.50
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5.	03/04/2012:	Buy, Target Price Change AUD2.05	14.	08/01/2013:	Upgrade to Hold, AUD0.65
6.	30/04/2012:	Buy, Target Price Change AUD2.00	15.	31/01/2013:	Hold, Target Price Change AUD0.70
7.	18/06/2012:	Buy, Target Price Change AUD1.90	16.	25/02/2013:	Hold, Target Price Change AUD0.71
8.	03/07/2012:	Buy, Target Price Change AUD1.80	17.	09/04/2013:	Hold, Target Price Change AUD0.72
9.	31/07/2012:	Buy, Target Price Change AUD1.25	18.	25/06/2013:	Hold, Target Price Change AUD0.58

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Sell: Based on a current 12-month view of total share-holder return, we recommend that investors sell the stock
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Notes:

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2. Ratings definitions prior to 27 January, 2007 were:

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    Sell: Expected total return (including dividends) of -10% or worse over a 12-month period

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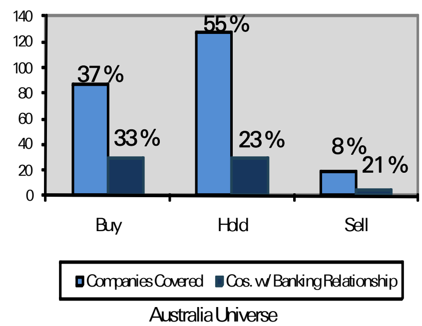

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