



argusmedia.com

Rare earth market overview

Argus Forum, Tokyo
24 January 2019

Mark Seddon
Senior Manager, Consulting Services (Metals)
Argus Media Ltd.

London
Houston
Washington
New York
Portland
Calgary
Santiago
Bogota
Rio de Janeiro
Singapore
Beijing
Tokyo
Sydney
Dubai
Moscow
Astana
Kiev
Porto
Johannesburg
Riga

Market Reporting
Consulting
Events

illuminating the markets

Agenda

- ❖ Argus Consulting Services
- ❖ Introduction
- ❖ Supply Overview
- ❖ Demand Overview
- ❖ Trade
- ❖ Prices
- ❖ Future Dynamics/Conclusions

Argus Consulting Services

illuminating the markets

Market Reporting
Consulting
Events

About Argus Consulting Services

Argus Consulting Services helps clients to understand their markets better and define strategies to succeed within them

Single Client Work

Market Studies

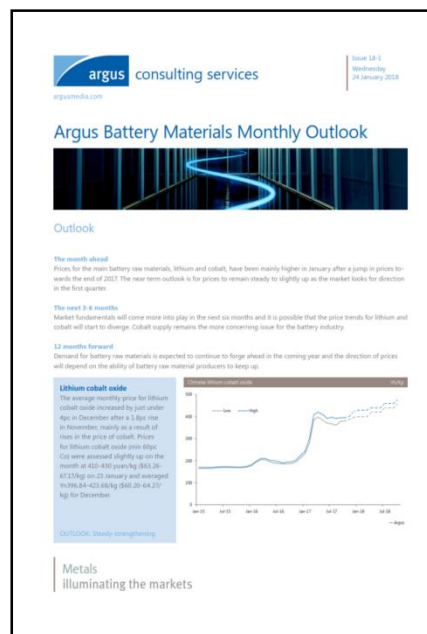
Strategic Planning

Supply, Demand & Pricing Analysis

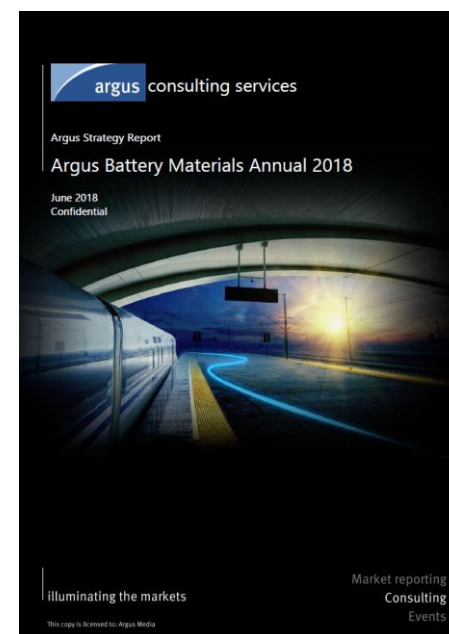
Market Supply Strategy

- Bespoke research and analysis
- Typically 'Market Strategy' projects
- We help clients evaluate potential investments and support market entry decisions
- Our work is built off the foundation of Argus data and knowledge

Outlook Publications



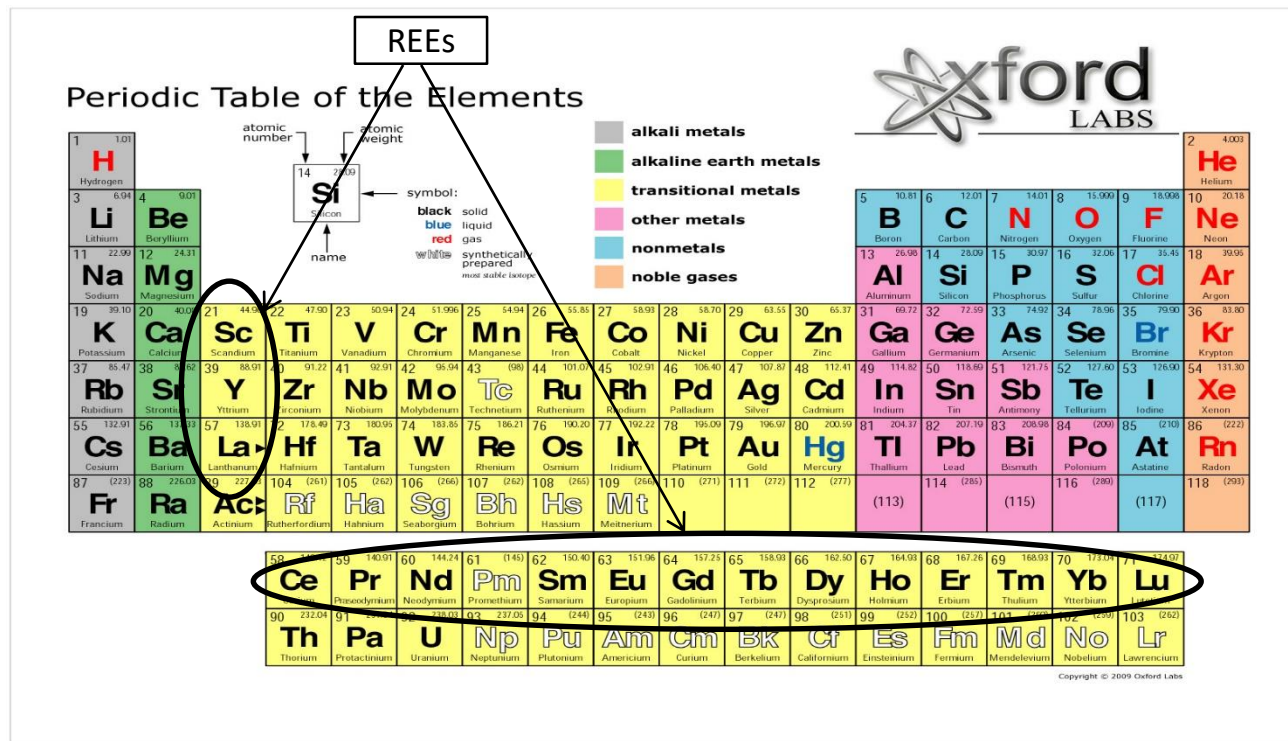
Multi Client Studies



Introduction

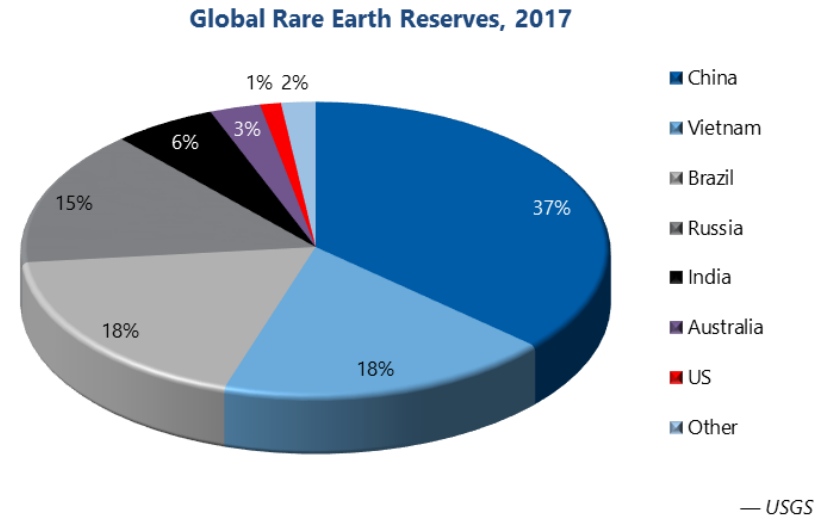
illuminating the markets

Market Reporting
Consulting
Events



Reserves

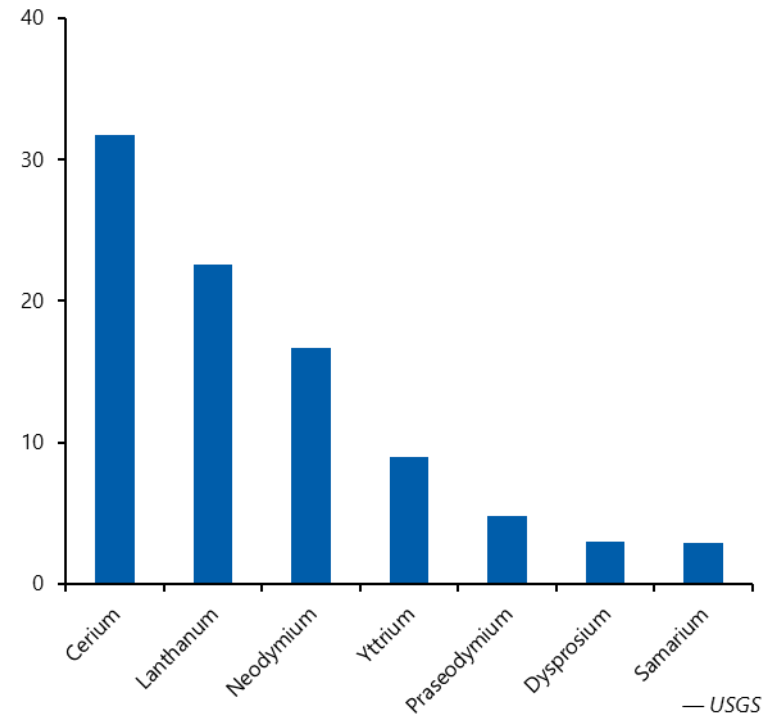
- China dominates reserves of rare earths – close to 40pc of the global total
- Brazil and Vietnam both represent around 18pc
- Russia also has significant RE reserves – 15pc
- India, Australia and US account for 1-6pc of global reserves
- Relative abundance of rare earths in the earths crust, but mineable concentrations less common



Reserves

- Relative abundance of LREEs:
 - Cerium = +30mn t
 - Lanthanum = +20mn t
 - Neodymium = +15mn t
- HREEs less abundant but still not that rare:
 - Dysprosium $\approx$ 3mn t
- Mineable resources more the issue

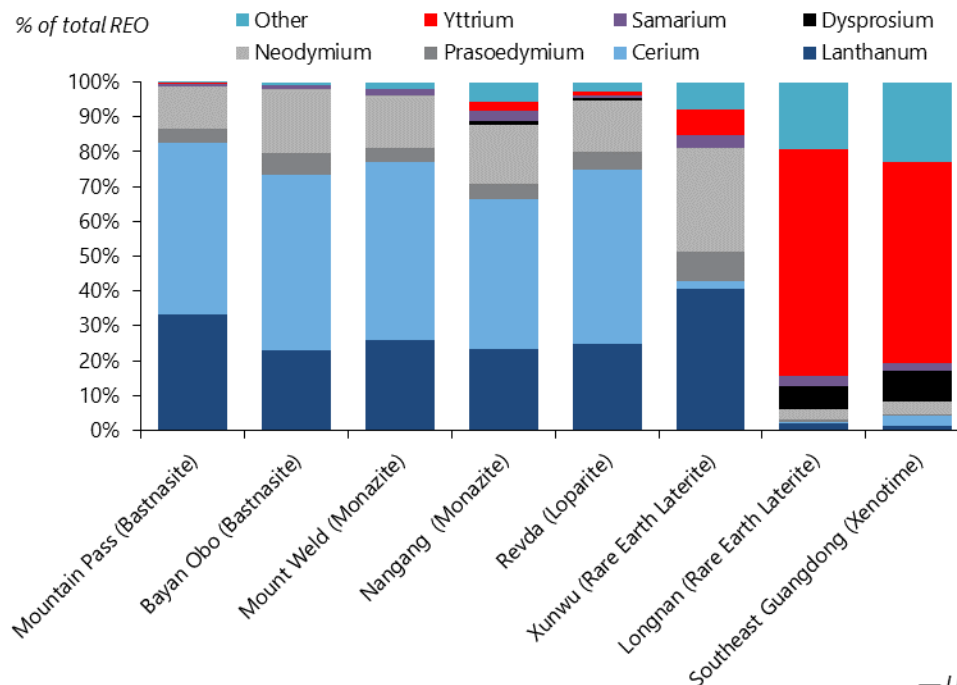
Global resources of individual rare
earths (mn t REO)



Reserves

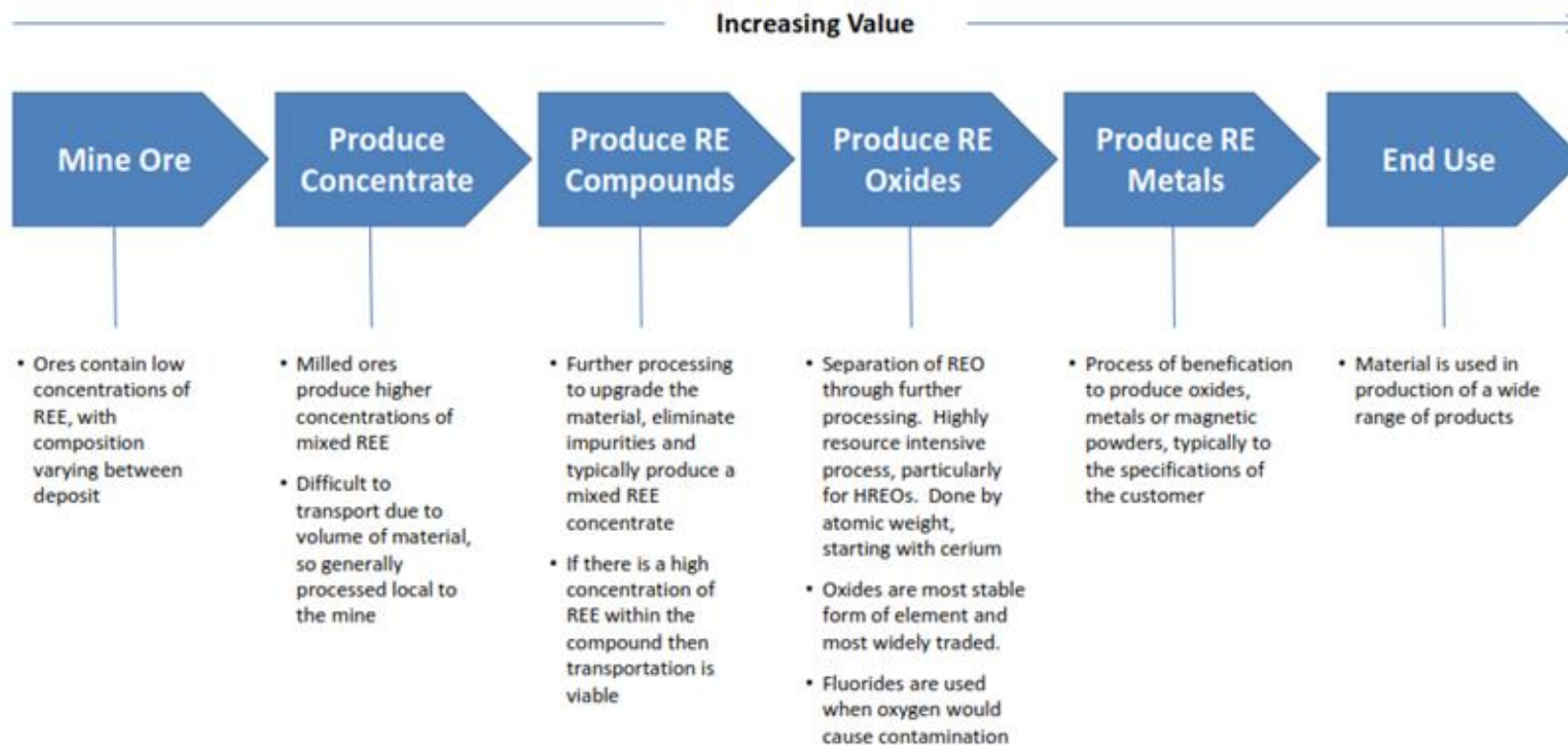
- Bastnasite, Monazite and Loparite are the main cerium and light lanthanide-containing minerals
- Xenotime is the main Yttrium-containing rare earth mineral & also high in dysprosium
- Two main types of rare earth laterites (ion adsorption clays) in southern China:
 - Type A (Xunwu) – V. low Ce & higher La, Nd & Pr
 - Type B (Longnan) – V. high yttrium and dysprosium

Rare earth content of selected source materials



— USGS

Rare earth refining process



Rare earth requirements by industry

The eight industry sectors require different types of rare earth and options to substitute can be limited.

Industry	RE used	LRE/HRE	Substitution potential
Glass	Cerium, Lanthanum, Praseodymium, Neodymium, Yttrium	LRE	High
Neodymium magnets	Neodymium, Praseodymium, Dysprosium, Gadolinium, Terbium	HRE/LRE	Low-Medium
Refinery catalysts	Lanthanum, Cerium	LRE	Low
Battery alloys	Lanthanum, Cerium, Neodymium, Praseodymium, Samarium	LRE	Between battery types
Metallurgy (excl. batteries)	Cerium, Lanthanum, Neodymium, Praseodymium	LRE	Medium
Phosphors	Yttrium, Cerium, Lanthanum, Gadolinium, Europium, Terbium	LRE/HRE	Low
Ceramics	Yttrium, Lanthanum, Cerium, Neodymium, Praseodymium	LRE	High
Catalytic converters	Cerium, Lanthanum, Neodymium, Praseodymium	LRE	Low
Other	Cerium, Lanthanum, Yttrium, Neodymium, Praseodymium, Samarium, Gadolinium, Other REOs	LRE/HRE	N/A

Supply Overview

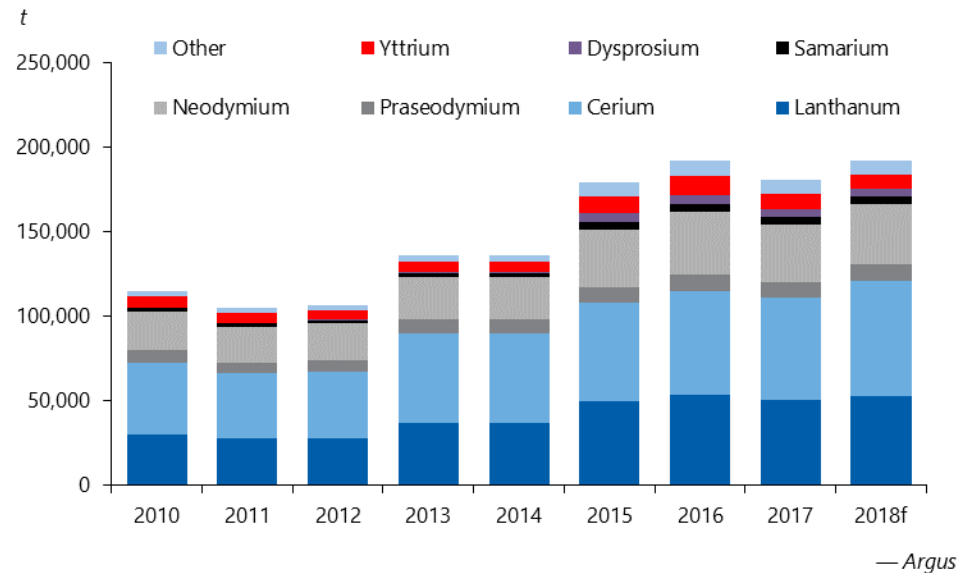
illuminating the markets

Market Reporting
Consulting
Events

Rare Earth Production

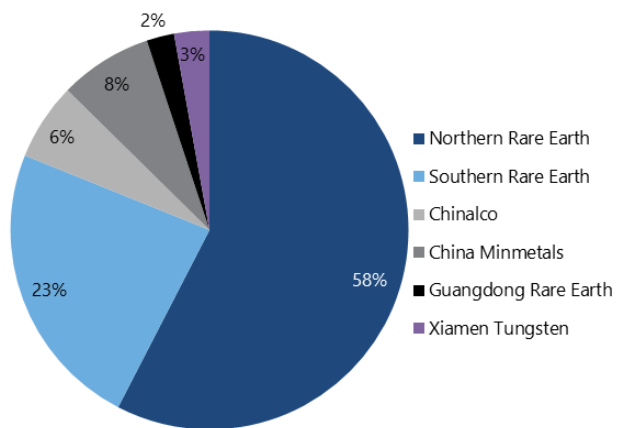
- Gradual decline in production from 2008 to 2011/12 - Chinese controls on output and exports
- Jump in production 2013/14 - reaction to higher prices
- Further jump in 2015/16 - 'illegal' production in China (despite Molycorp closure)
- Increase in 2018 - Mountain Pass?

Estimated global REO production, 2010-18



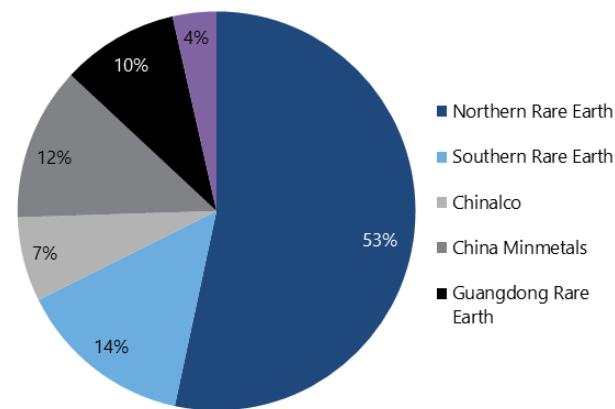
Rare Earth Production

Chinese RE mining quota by company, 2018



— MIIT

Chinese RE separation quota by company, 2018



— MIIT

Demand Overview

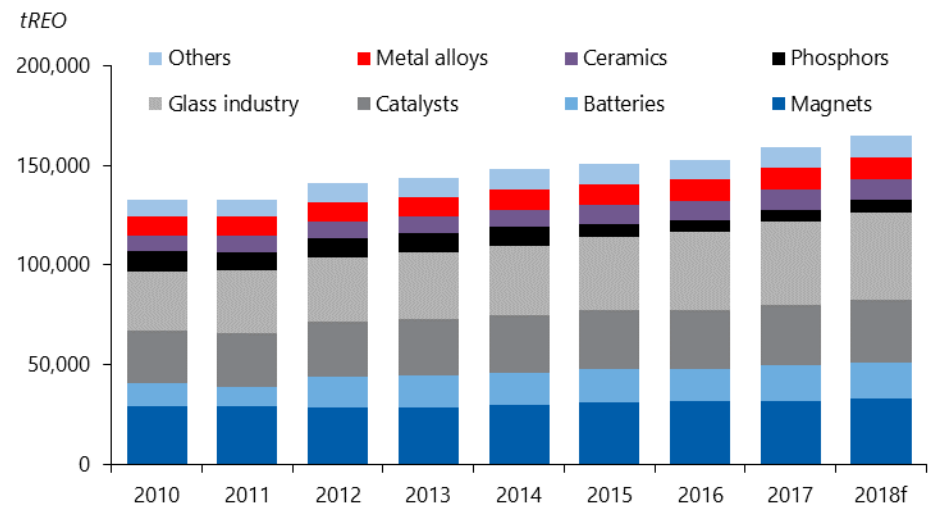
illuminating the markets

Market Reporting
Consulting
Events

Rare Earth Demand

- Steady growth in RE demand in volume terms:
 - ≈132,000t REO in 2010 to ≈165,000t REO in 2018 (CAGR = 3 pc/yr)
- Volume growth is steady supported by:
 - Traditional industries for LREEs (e.g. glass, catalysts & ceramics)
 - Rapidly expanding industries such as the wind energy, battery-electric vehicle and consumer electronics industries
- REO demand has declined in the battery alloy and lighting phosphor industries due to increasing competition from non-RE-based technologies

Estimated global REO consumption by application, 2010-18

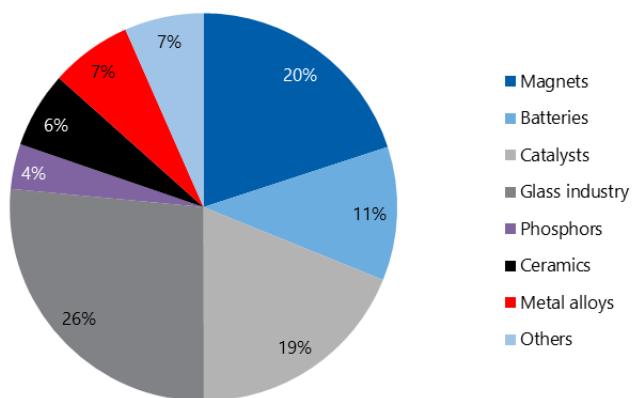


— Argus

Rare Earth Demand

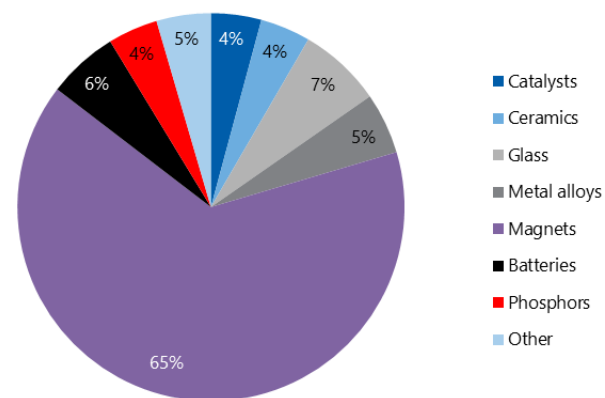
Rare earth consumption by application, 2018 (volume & value)

Volume



— Argus

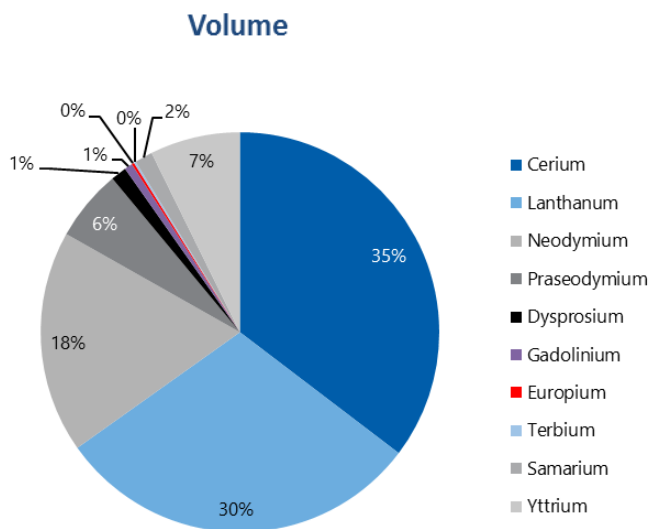
Value



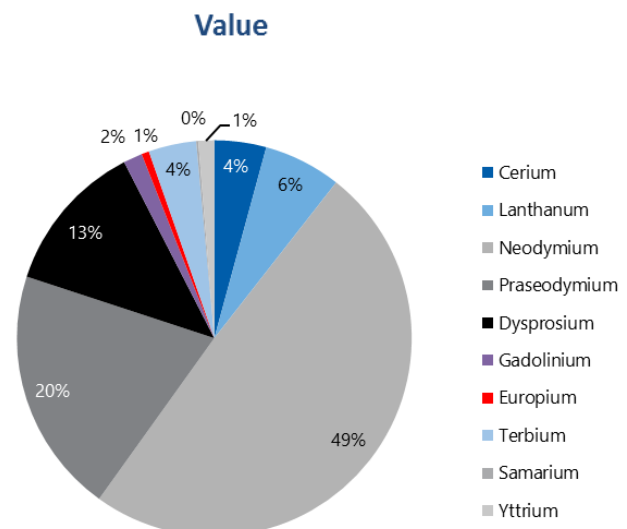
— Argus

Rare Earth Demand

Rare earth consumption by element, 2018 (volume & value)



— Argus



— Argus

Trade

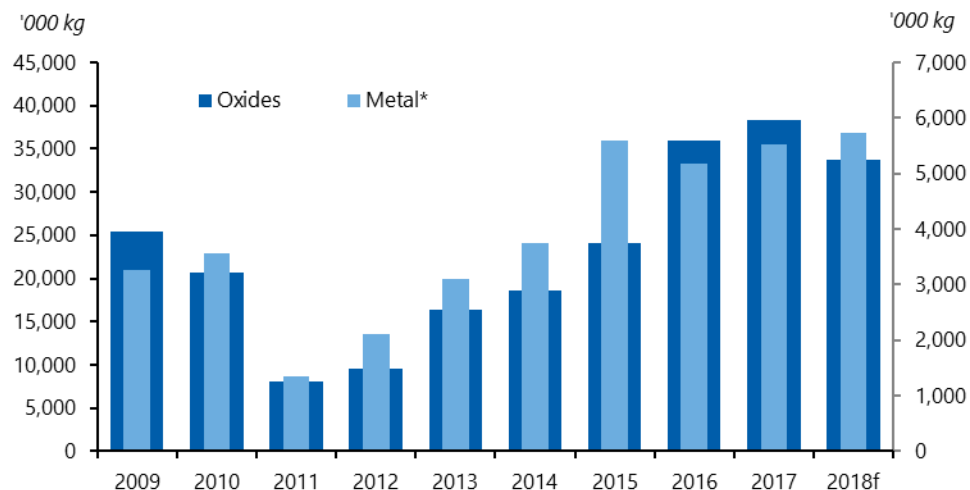
illuminating the markets

Market Reporting
Consulting
Events

Trade

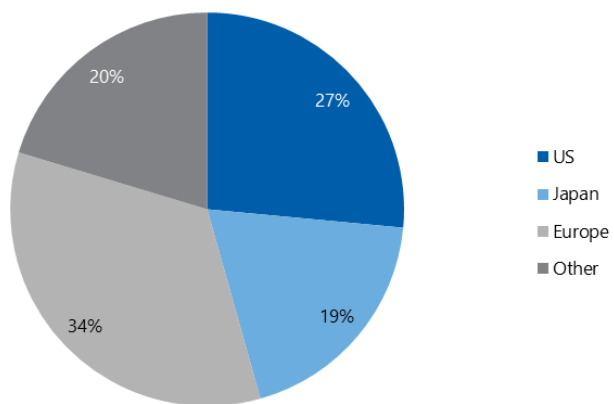
- Chinese exports dropped dramatically 2009-2011 (export restrictions, mainly to Japan):
 - Oxides $\approx$ 25.4mn kg to 8.0mn kg
 - Metal $\approx$ 3.3mn kg to 1.3mn kg
- Strong growth in exports since 2012 (relaxing of export restrictions & removal of export quota/taxes in 2015):
 - Oxides $\approx$ 8.0mn kg to 38.4mn kg
 - Metal $\approx$ 1.3mn kg to 5.5mn kg
- Forecast for 2018:
 - Oxides $\approx$ drop to 33.7mn kg
 - Metal $\approx$ slight rise to 5.7mn kg

Chinese rare earths exports, 2009-18



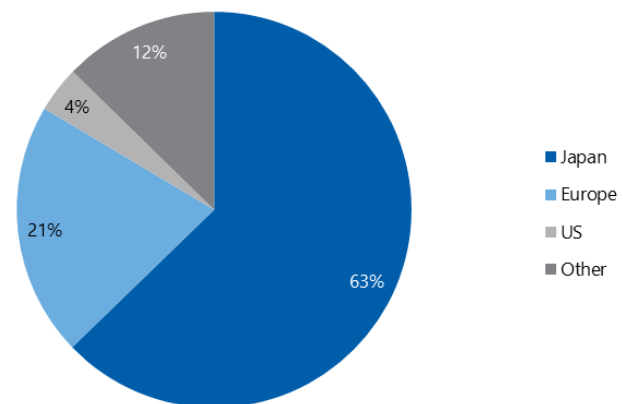
Notes: * - right-hand axis
— Official customs data

Chinese REO exports by destination, 2018



— Official customs statistics

Chinese RE metal exports by destination, 2018



— Official customs statistics

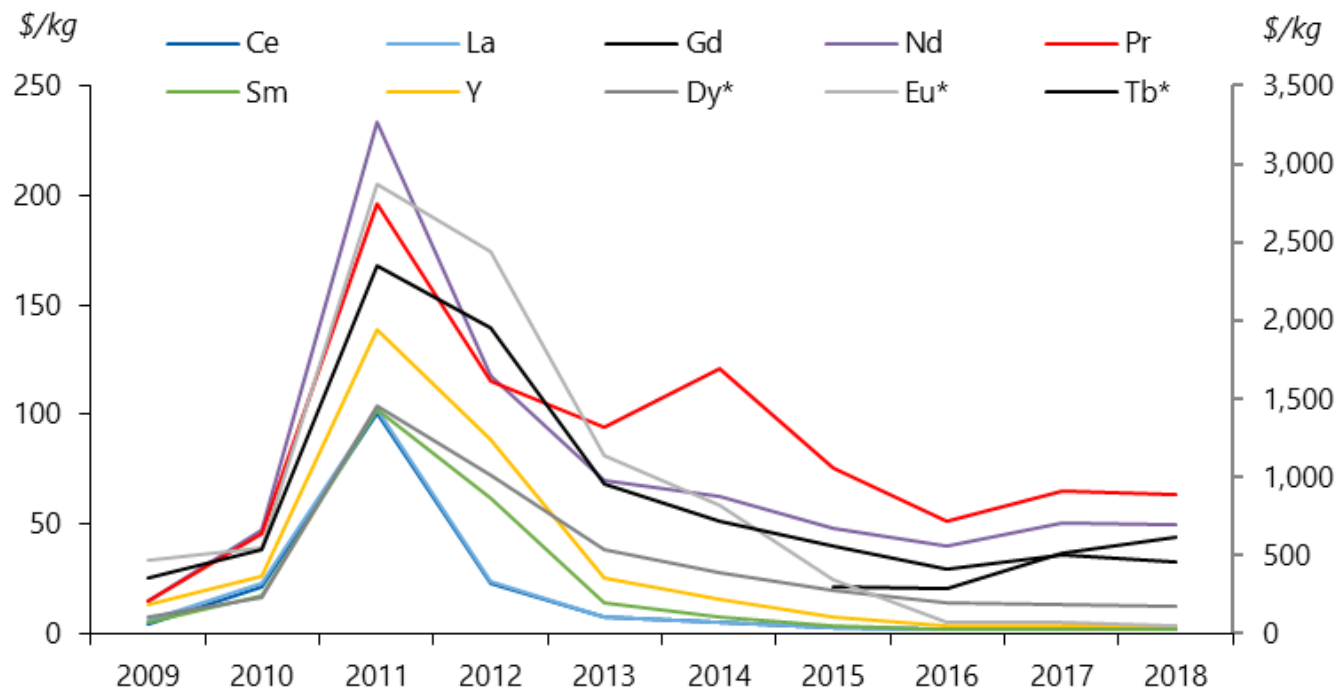
Prices

illuminating the markets

Market Reporting
Consulting
Events

Historic Rare Earths Pricing

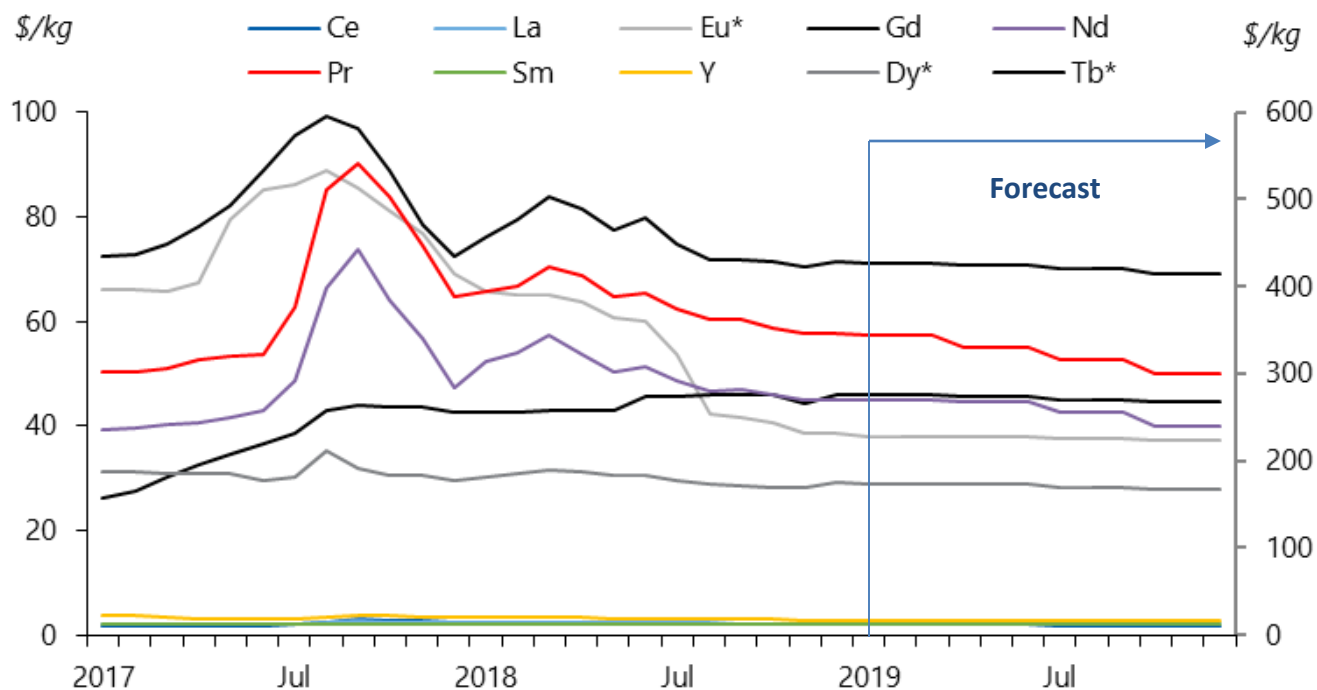
Annual average Chinese fob rare earth oxide prices, 2009-18



— Argus

Historic Rare Earths Pricing

Monthly average Chinese fob rare earth oxide prices, 2017-19



Notes: * - right-hand axis
— Argus

Future Dynamics/Conclusions

illuminating the markets

Market Reporting
Consulting
Events

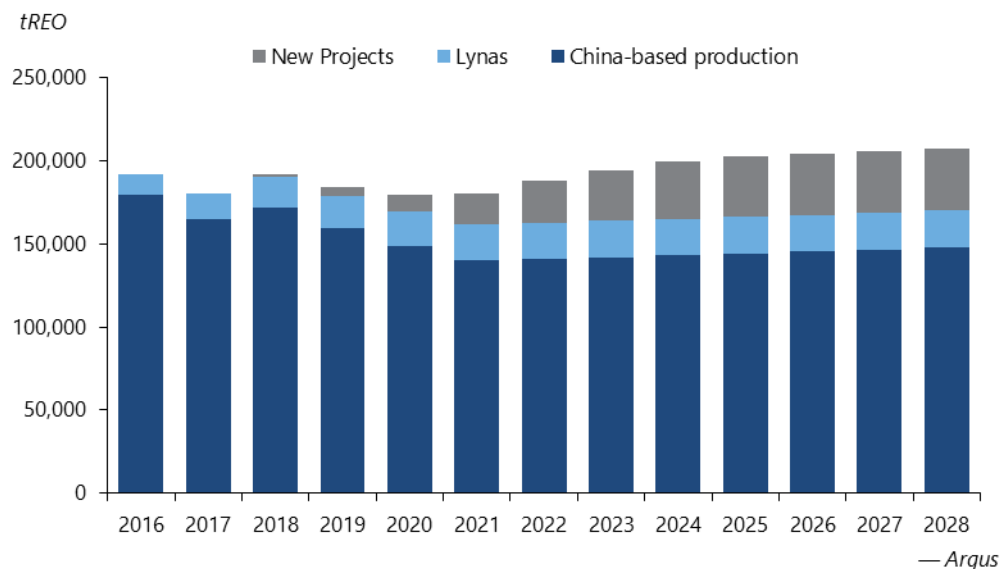
New projects that could affect supply

Rare Earth Project Tracker					
Company	Mine	Country	Stage of Development	TREO (mn t)	Production (tREO/yr)
Rainbow Rare Earths	Gakara	Burundi	575t REO concentrate exported by June 2018 (Sep 18)	10.00	0.14
Northern Minerals	Browns Range	Australia	Pilot plant commissioned; 2,578kg shipment to China (Dec 18)	9.00	0.06
Hastings Technology Metals	Yangibana	Australia	50pc increase in ore reserves; 5th offtake agreement (Nov 18)	17.02	0.22
Arafura Resources	Nolans Bore	Australia	DFS due end 2018; pilot plant produced Nd-Pr oxide (Dec 18)	56.00	1.46
Greenland Minerals and Energy	Kvanefjeld	Greenland	DFS completed; deal signed with Shenghe Resource (Aug 18)	956.00	10.30
Mkango Resources	Songwe	Malawi	Feasibility study due in 2019; resource update 1Q 19 (Dec 18)	31.80	0.47
Peak Resources	Ngualla	Tanzania	PFS completed in 2014; awaiting mining licence (Aug 2018)	214.40	4.60
Steenkampskraal Holdings	Steenkampskraal	South Africa	Raising finance for bankable feasibility study (Dec 18)	0.61	0.09
Alkane Resources	Dubbo Zirconia	Australia	Detailed engineering assessment ongoing	73.20	0.70
Avalon Advanced Materials	Nechalacho	Canada	Definitive feasibility study completed (October 2013)	269.40	3.90
Commerce Resources	Ashram	Canada	Pre-feasibility study ongoing	249.60	4.70
Galileo Resources	Glenover (JV)	South Africa	No longer focused on REE at the site (July 2017)	28.90	0.40
Geomega Resources	Montviel	Canada	NI 43-101 resource estimate completed (June 2015)	250.60	3.50
Matamec Exploration	Kipawa	Canada	Definitive feasibility study completed (October 2013)	19.70	0.08
Namibian Critical Metals	Lofdal	Namibia	Partnership agreement with Gecko Namibia (Nov 2017)	6.20	0.02
Pele Mountain Resources	Eco Ridge	Canada	Site sold. Now focusing on lithium reserves (July 2017)	59.30	0.09
Quest Rare Minerals	Strange Lake	Canada	No active work at/on site (April 2014)	492.50	4.43
Rare Element Resources	Bear Lodge	US	Pre-feasibility study completed (August 2015)	18.00	0.50
Rwenzori Rare Metals	Makuutu	Uganda	Exploration and PFS ongoing (Feb 2018)	>300	0.21
Search Minerals	Foxtrot	Canada	Feasibility study ongoing (Oct 17)	9.35	0.01
Hudson Resources	Sarfartoq	Greenland	Preliminary economic assessment completed (November 2011)	343.00	0.21
Ucore Rare Metals	Bokan Mountain	US	No longer developing Bokan Mountain	5.20	0.03

World Rare Earth Production Outlook

- Declining to 2021 (Chinese government targeting 140,000t REO in 2021) – mitigated by some production from new projects
- Moderate growth to 2025 - new projects and growth in China
- Slow growth after 2025

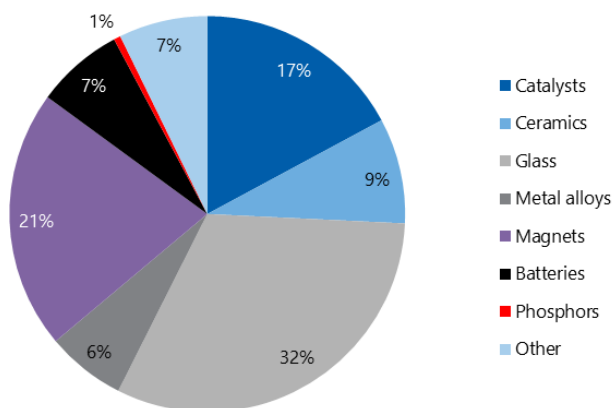
Forecast global REO production, 2016-28



Rare Earth Demand

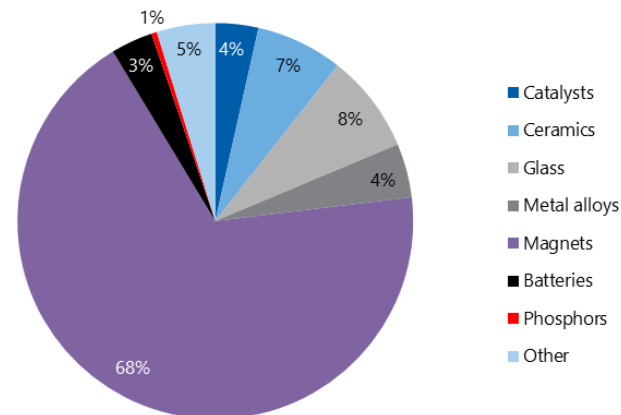
Rare earth consumption by application, 2028 (volume & value)

Volume



— Argus

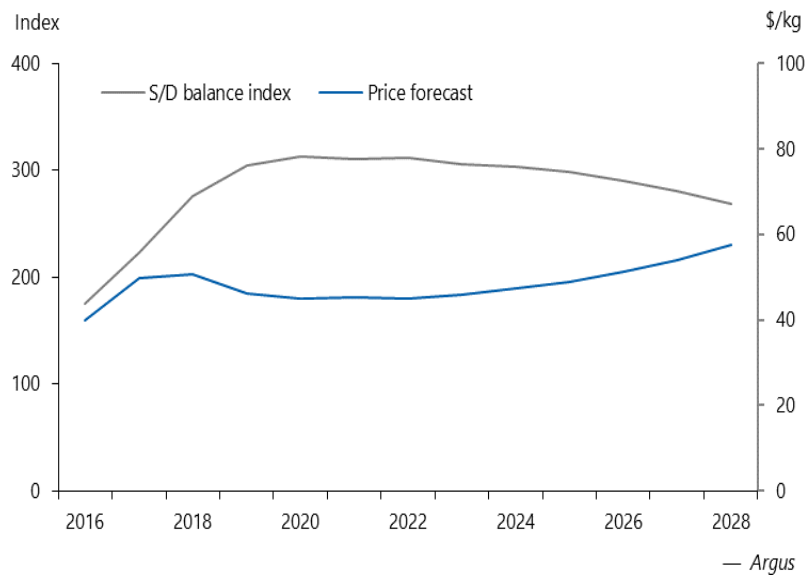
Value



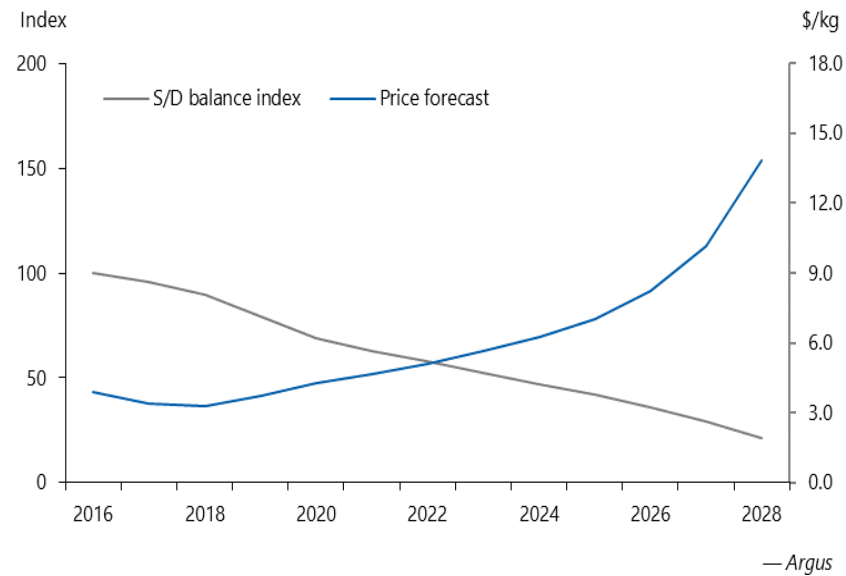
— Argus

Price Forecasts

Nd price forecast



Y price forecast



Future risks

- Supply risks
 - Chinese market dominance (changes in policy, protectionism, adding value downstream)
 - Stockpiles
- Downstream risks
 - Technological change (competing technologies e.g. batteries for EVs etc.)
 - Substitution risk (depends on application and product)
- Price risk (potential price volatility, price spikes)
 - Likelihood of supply squeeze leading to price rises?
 - Growing demand in certain sectors could push up prices for certain REEs (e.g. magnet materials?)

Conclusions

- China still keen to control production, reduce 'illegal' mining and add value to rare earth resources (ambitious target to reduce production to 140,000t by 2020/21)
- Success of new projects dependent on Chinese cut in output and sustained price rise (mix of elements also important)
- Magnet sector key to growth in rare earths demand (EVs and clean energy)

London
Houston
Washington
New York
Portland
Calgary
Santiago
Bogota
Rio de Janeiro
Singapore
Beijing
Tokyo
Sydney
Dubai
Moscow
Astana
Kiev
Porto
Johannesburg
Riga



Copyright © 2019 Argus Media group. All rights reserved.



Mark Seddon
Senior Manager, Argus Consulting (Metals)

Email: Mark.seddon@argusmedia.com

Phone: +44 20 7199 1747

Office: London

Web: www.argusmedia.com

Copyright notice

Copyright © 2017 Argus Media group. All rights reserved. All intellectual property rights in this presentation and the information herein are the exclusive property of Argus and and/or its licensors and may only be used under licence from Argus. Without limiting the foregoing, by reading this presentation you agree that you will not copy or reproduce any part of its contents (including, but not limited to, single prices or any other individual items of data) in any form or for any purpose whatsoever without the prior written consent of Argus.

Trademark notice

ARGUS, the ARGUS logo, ARGUS MEDIA, ARGUS DIRECT, ARGUS OPEN MARKETS, AOM, FMB, DEWITT, JIM JORDAN & ASSOCIATES, J18&A, FUNDALYTICS, METAL-PAGES, METALPRICES.COM, Argus publication titles and Argus index names are trademarks of Argus Media Ltd.

Disclaimer

All data and other information presented (the "Data") are provided on an "as is" basis. Argus makes no warranties, express or implied, as to the accuracy, adequacy, timeliness, or completeness of the Data or fitness for any particular purpose. Argus shall not be liable for any loss or damage arising from any party's reliance on the Data and disclaims any and all liability related to or arising out of use of the Data to the full extent permissible by law.

