

A Brief Overview of Recent Rare-Earth Supply & Pricing Dynamics

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Overview

- Introduction
- Current Rare-Earth Supply
- Rare-Earth Pricing
- Future Sources of Rare-Earth Supply

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The Rare-Earth Elements

57	58	59	60	62	63	64	65	66	67	68	69	70	71	39
La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Y
138.905	140.116	140.908	144.242	150.362	151.964	157.253	158.925	162.500	164.930	167.259	168.934	173.043	174.967	88.906
LIGHT				MEDIUM			HEAVY							

- Definitions based on the processing of concentrates
- Used by metallurgists / flow sheet engineers
- Not universally used in the rare-earths industry

The Rare-Earth Elements

57 La 138.905	58 Ce 140.116	59 Pr 140.908	60 Nd 144.242	62 Sm 150.362	63 Eu 151.964	64 Gd 157.253	65 Tb 158.925	66 Dy 162.500	67 Ho 164.930	68 Er 167.259	69 Tm 168.934	70 Yb 173.043	71 Lu 174.967	39 Y 88.906
LIGHT				MEDIUM				HEAVY						

- Rare earths of most interest for permanent magnets

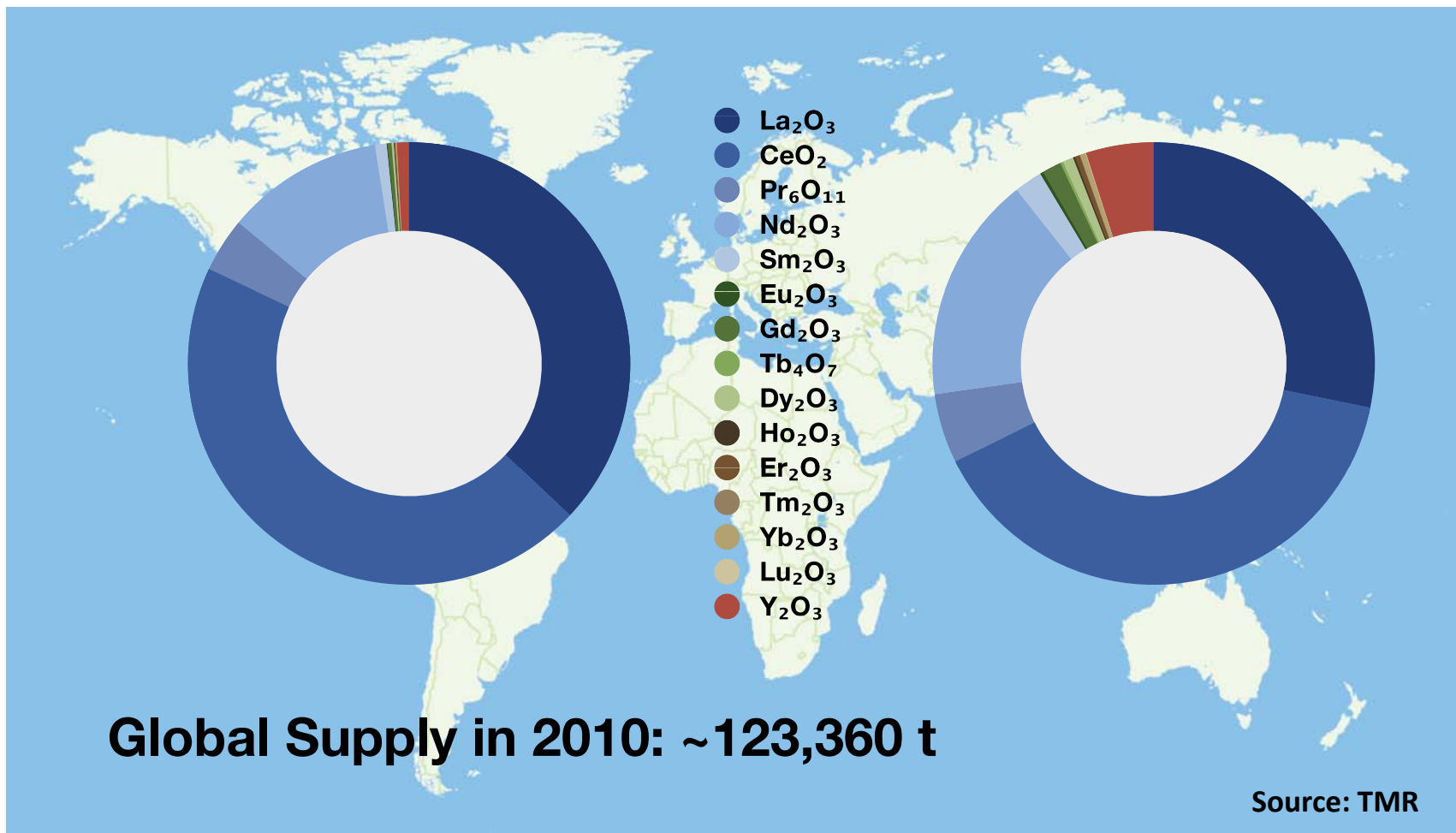
Abbreviations

- REE: rare-earth element
- REO: rare-earth oxide
- LREE / LREO: light REE / light REO
- MREE / MREO: medium REE / medium REO
- HREE / HREO: heavy REE / heavy REO
- TREE / TREO: total REE / total REO

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Current Rare-Earth Supply



Current Rare-Earth Supply

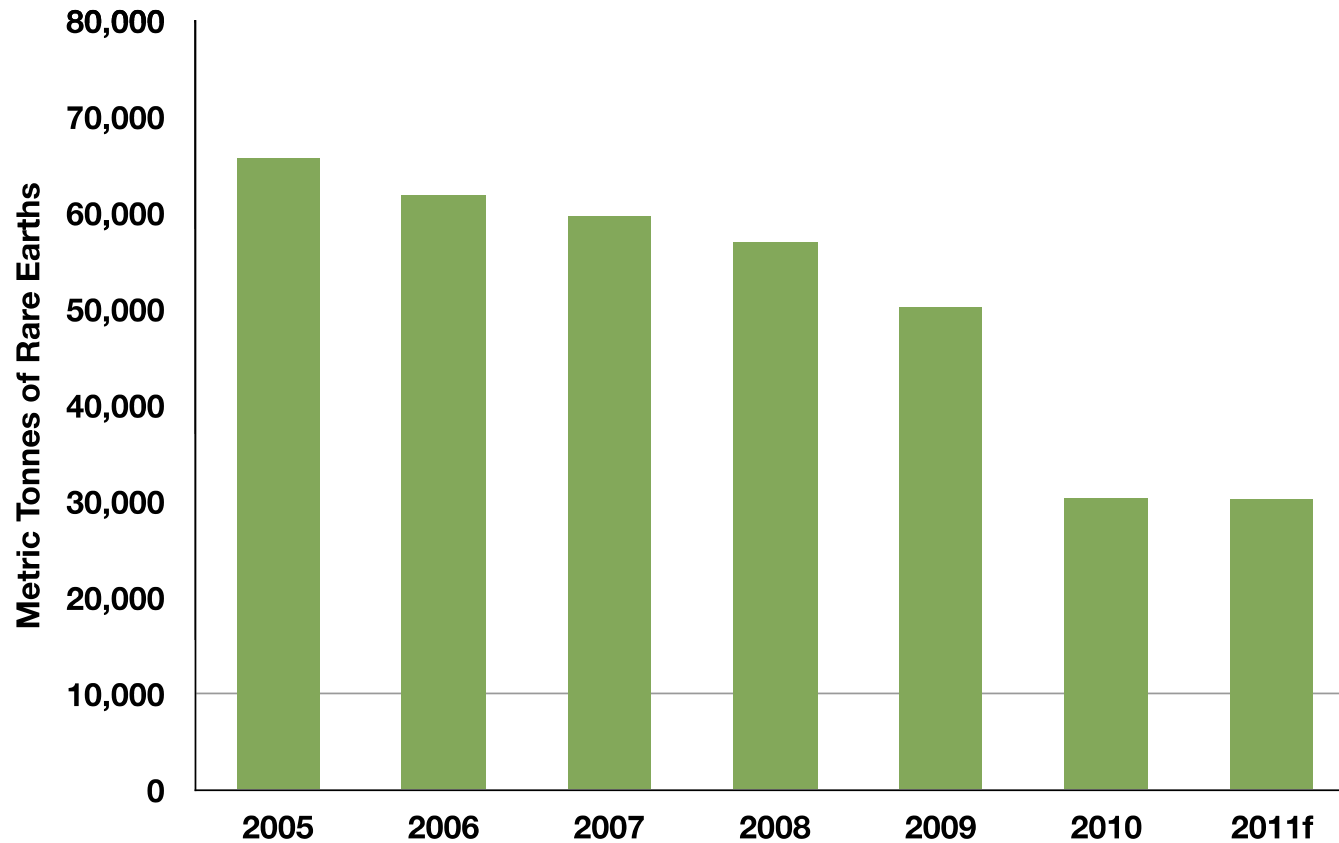


Current Rare-Earth Supply

- China now produces ~96% of total world supply
- Lower costs in China collapsed rest of supply base
- Almost ALL downstream processing is based in China
- In recent years, China has imposed export quotas
 - Ostensibly to remediate environmental issues
 - BUT: production quotas have not decreased
 - Encourages inward re-location and investment
 - Little controversy until July 2010

Current Rare-Earth Supply

Demand For Chinese Rare-Earth Exports



Sources: IMCOA, Chinese Ministry of Commerce & TMR

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Rare-Earth Pricing

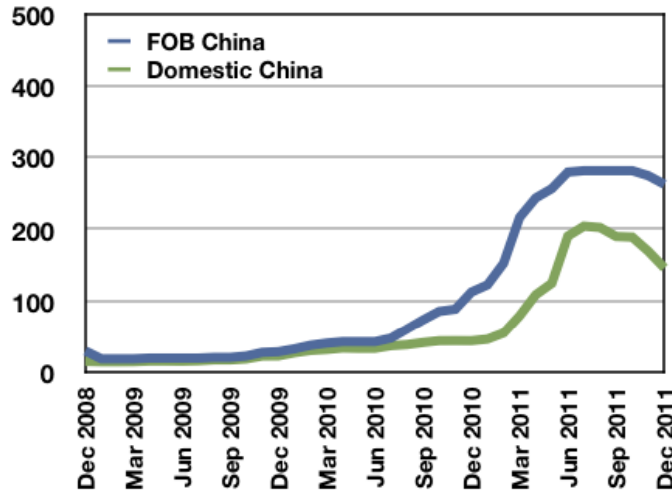
- July 2010 on: huge price increases for LREE exports
- Quota limit lead to imposition of a quota surcharge
- Prices increased for HREEs too

Rare-Earth Pricing

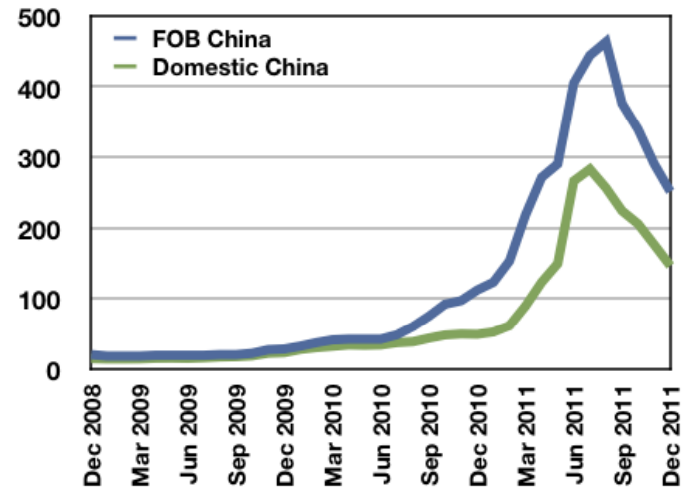
- Inflection point in Feb 2011 for domestic China prices
 - Increased internal speculation / stockpiling by traders
 - Re-routing of REEs to uncontrolled export outlets
- Chinese permanent-magnet industry caught off guard
 - Led to price increases only previously seen outside of China
 - Led to much longer lead times for magnets
 - Led to more arduous payment terms for magnets

Rare-Earth Pricing

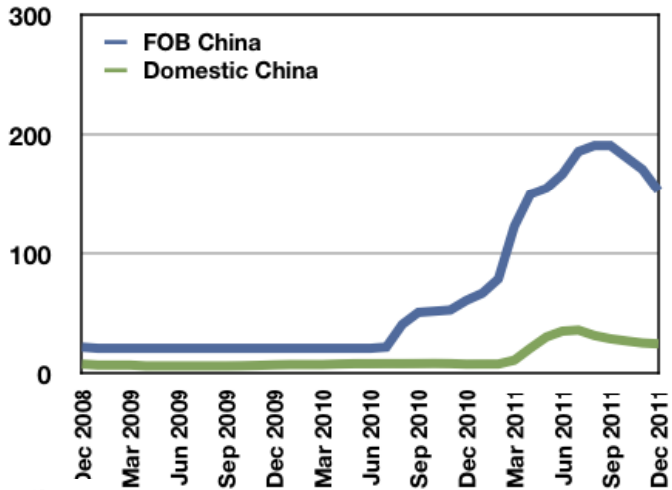
99% Pr metal (\$/kg)



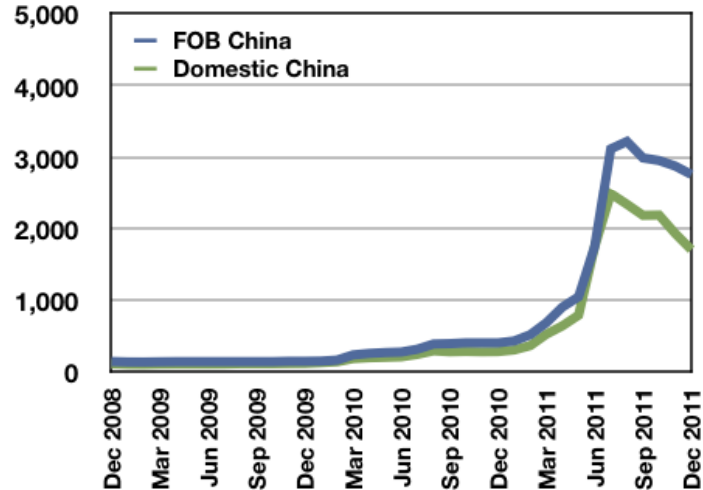
99% Nd metal (\$/kg)



99% Sm metal (\$/kg)



99% Dy metal (\$/kg)



Rare-Earth Pricing

- Disconnect between export & internal only recent:
 - Caused by implementation of quota-related surcharges
 - LREEs – most of price increase was from surcharges
 - Effects on magnet producers – depends where alloys made
 - Alloys made in China NOT subject to export quotas
 - Chinese & some Japanese manufacturers less affected

Rare-Earth Pricing

- All prices have decreased in recent months
 - Significant reduction in volumes of official exports
 - Trader concerns about new official invoicing system
 - Need to liquidate existing inventories ahead of implementation
 - Trader concerns about getting 2012 allocations
 - Future quota allocations depend on past revenues and volume
 - Prices dropped to “get product out of the door”

Rare-Earth Pricing

- So how were Nd-Fe-B-type magnet prices affected?
 - Depends on the material grade
- E.g. N, N-M, N-H, N-SH, N-UH, N-EH & N-AH grades
 - Different quantities of specific REEs present
 - Different intrinsic coercivities (H_{ci})
 - Different maximum working temperatures (T_{mw})

Rare-Earth Pricing

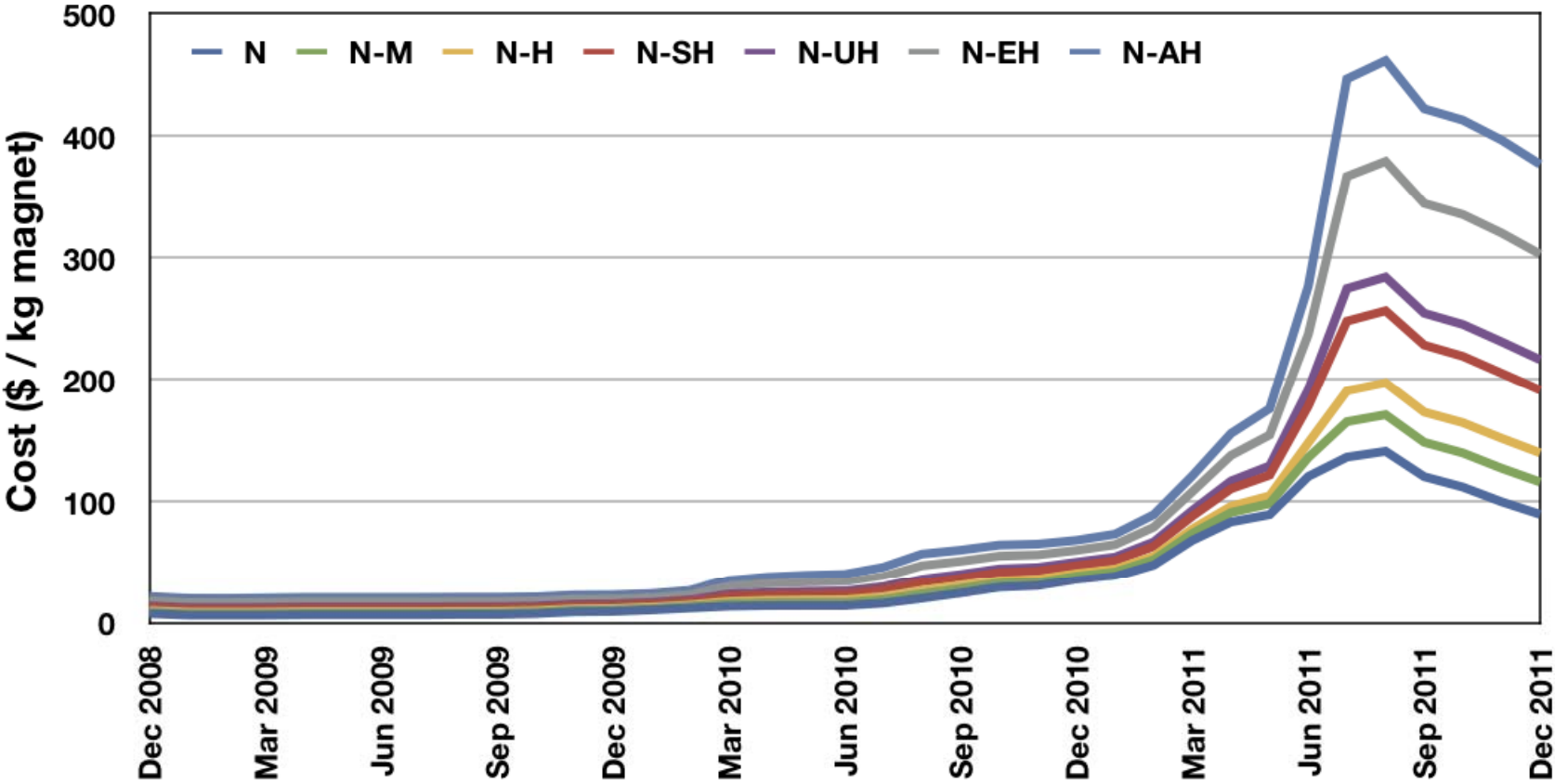
Typical characteristics of Nd-Fe-B-type magnet material grades

Grade family	H_{ci} (Am^{-1})	H_{ci} (kOe)	T_{mw} ($^{\circ}C$)	Pr (wt%)	Nd (wt%)	Dy (wt%)
N	955	12	80	8	23	1
N-M	1,115	14	100	8	22	2
N-H	1,355	17	120	7	21	3
N-SH	1,590	20	150	6	21	5
N-UH	1,990	25	180	6	20	6
N-EH	2,385	30	200	6	16	9
N-AH	2,785	35	240	5	14	12

Source: TMR estimates / assumptions

Rare-Earth Pricing

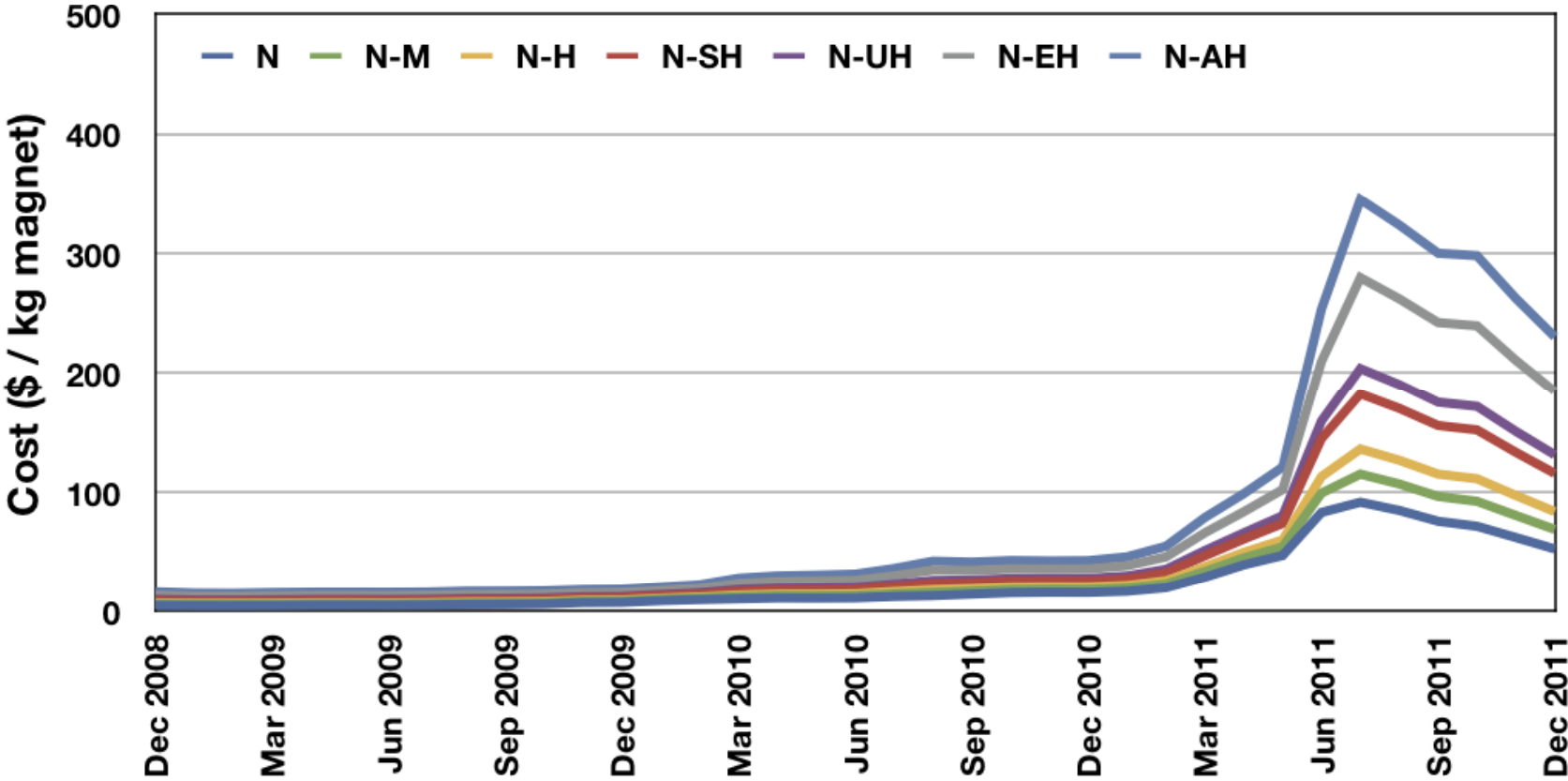
Total REE costs (FOB / export China) for Nd-Fe-B-type magnets



Source: TMR estimates

Rare-Earth Pricing

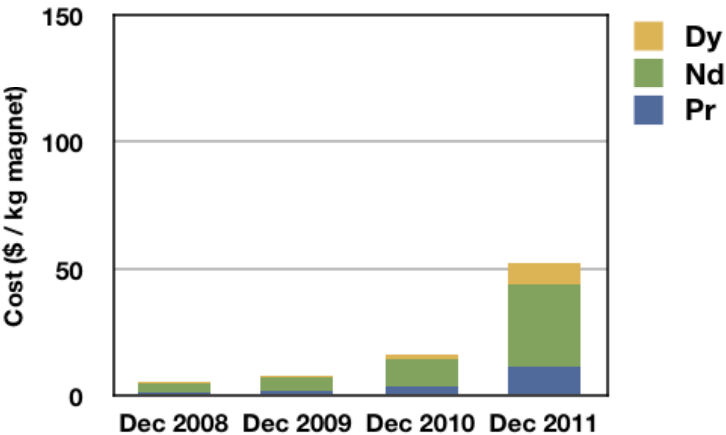
Total REE costs (domestic China) for Nd-Fe-B-type magnets



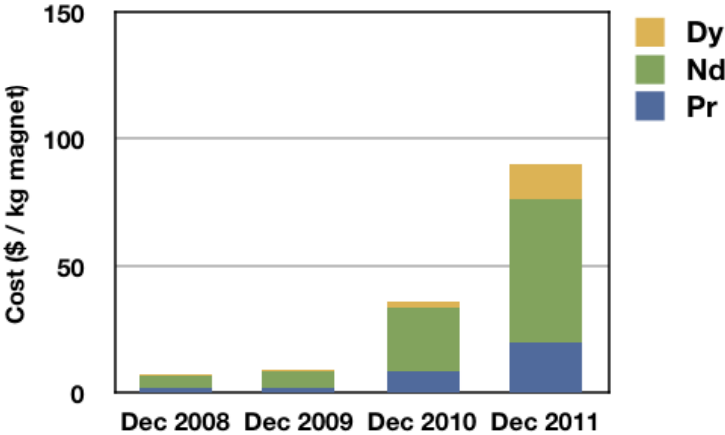
Source: TMR estimates

Rare-Earth Pricing

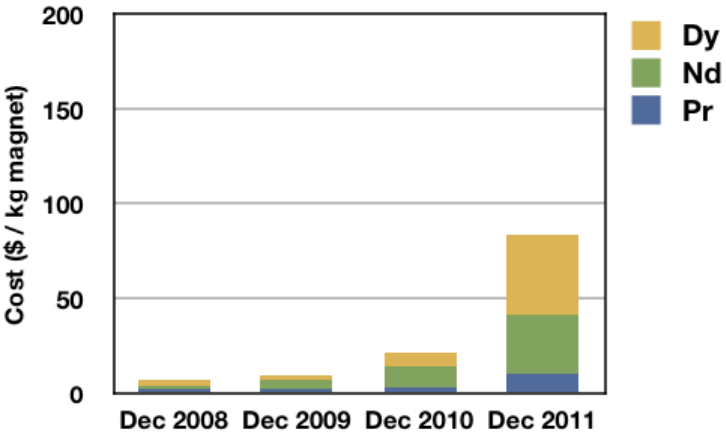
REE costs (domestic China) for N-type magnets



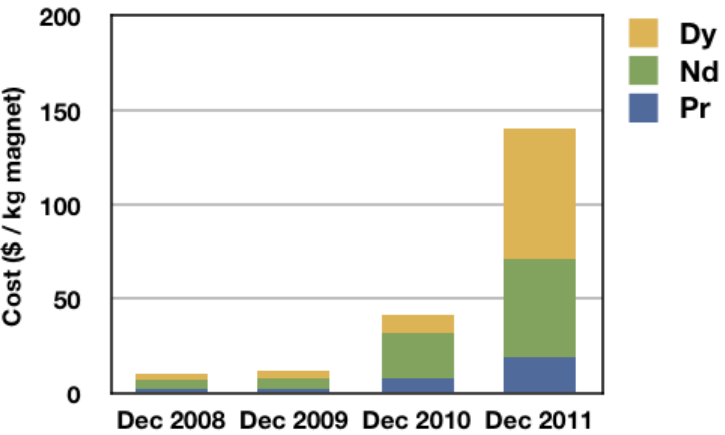
REE costs (FOB China) for N-type magnets



REE costs (domestic China) for N-H-type magnets

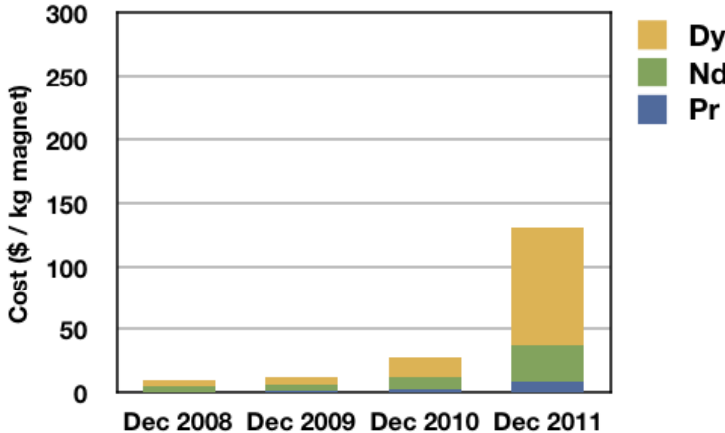


REE costs (FOB China) for N-H-type magnets

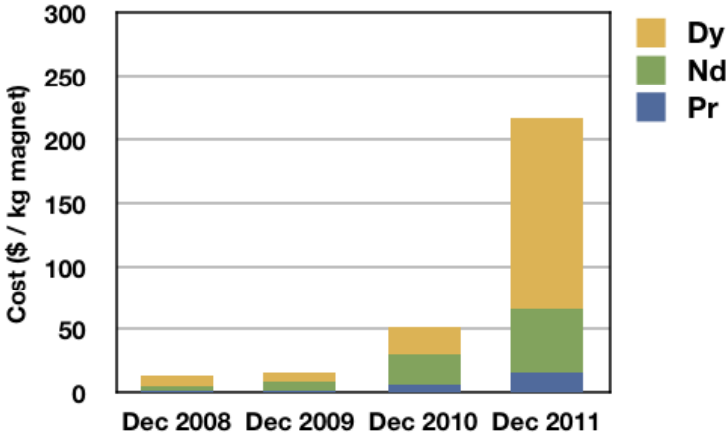


Rare-Earth Pricing

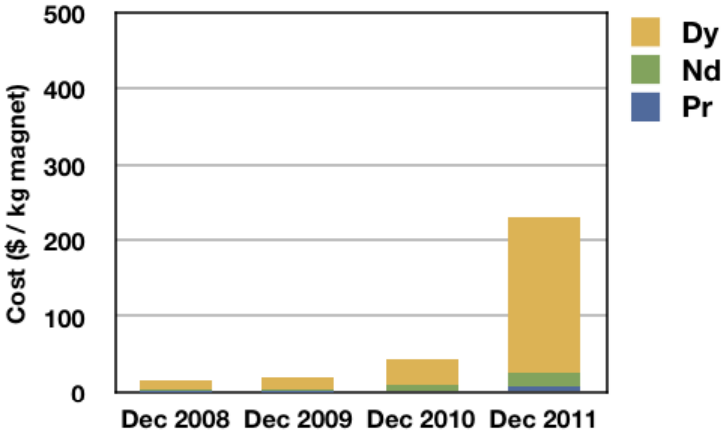
REE costs (domestic China) for N-UH-type magnets



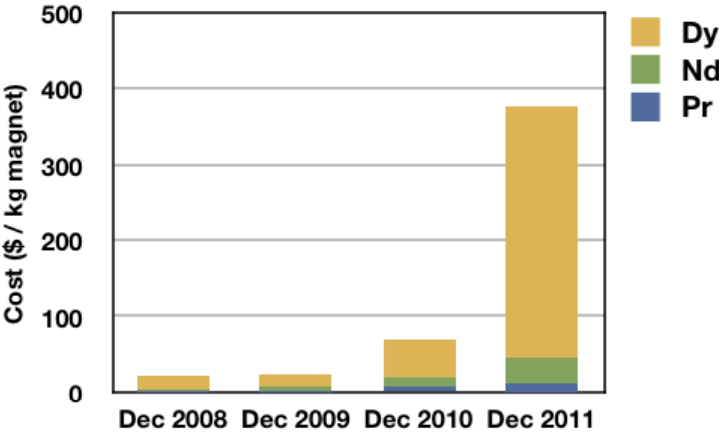
REE costs (FOB China) for N-UH-type magnets



REE costs (domestic China) for N-AH-type magnets

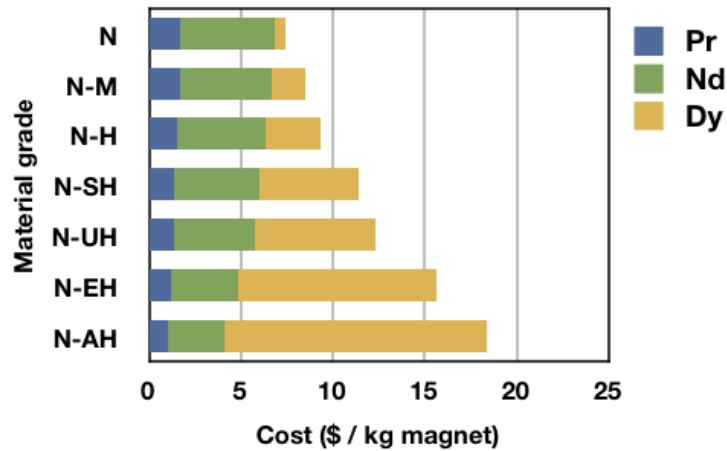


REE costs (FOB China) for N-AH-type magnets

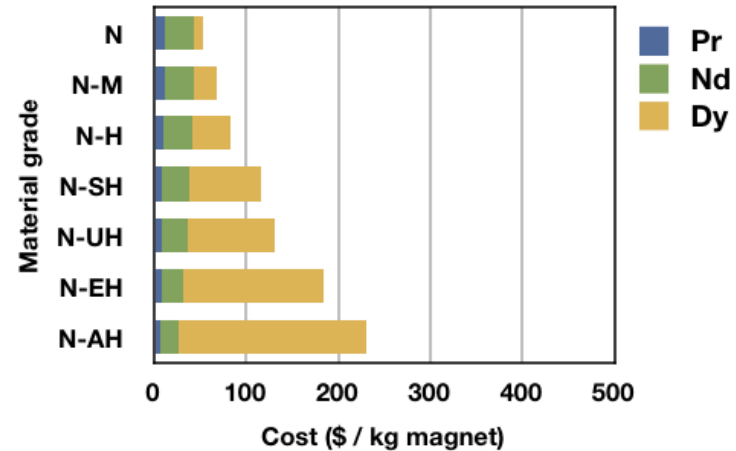


Rare-Earth Pricing

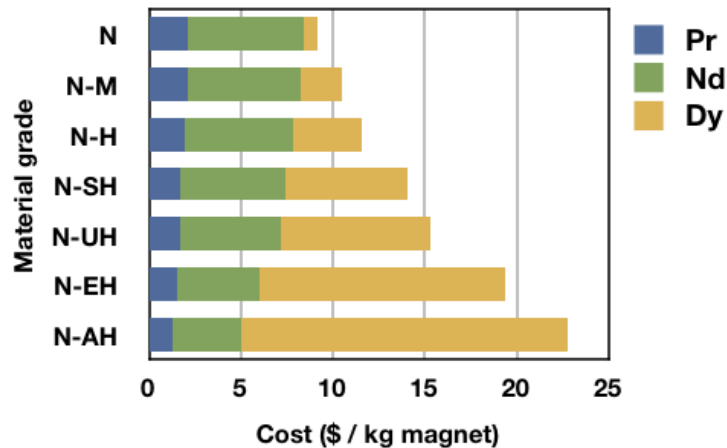
REE costs (domestic China) for magnets - Dec 2009



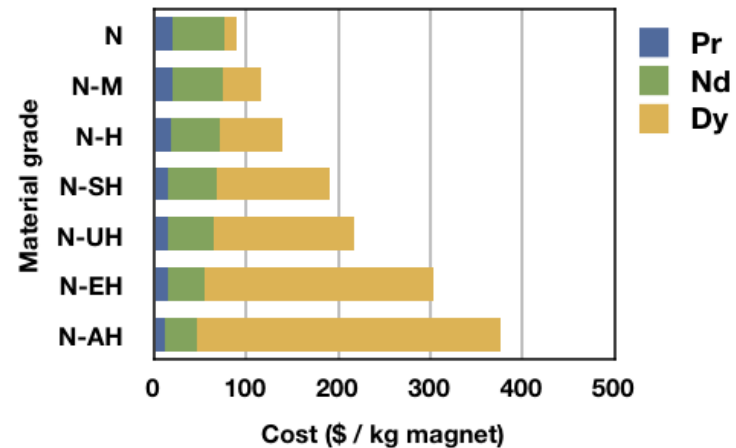
REE costs (domestic China) for magnets - Dec 2011



REE costs (FOB China) for magnets - Dec 2009



REE costs (FOB China) for magnets - Dec 2011



Rare-Earth Pricing

- In the short term, LREE prices will decline further:
 - Mountain Pass and Mount Weld will come on-stream soon
 - Significant production quantities of LREEs
- Some permanent demand destruction for La & Ce
 - Indirect effects on Nd & Pr relating to profitability of mine
 - Prices for Nd & Pr will likely be slower to decline
- In the long term, MREE/HREE prices will also decline
 - Additional sources of supply will come on-stream
 - But - much longer process to commercialization
 - Dy content in magnets is the key factor here

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Future Sources of Rare-Earth Supply



Thank You

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