

Permanent Magnet for Energy Efficiency Systems

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Rare earth magnets are designed as the strong permanent magnets (PM)

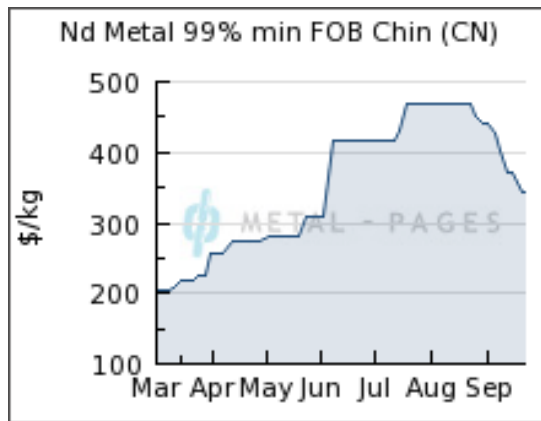
PM provides essential materials for energy efficiency systems

•**PM Application examples:**

- Cryogenic Compressor
- Medical treatment facilities
- Cell phones, computer, and TV
- Cars and hybrid cars: The electric motor in a Toyota Prius used about 1kg of neodymium in its permanent magnets (before 2010).
- Wind turbines: A ton of neodymium needed to make the big magnets used in each megawatt of wind-turbine capacity (rich resource near the coast)



Volatility of rare earth market challenges manufacturing of rare earth containing PM
rare earth metals have been among the highest-flying assets: price increase by >8 times in 8 years



Neodymium is one of the important elements for permanent magnets

Neodymium ~ \$10/kg in 2006

Neodymium > \$87/kg in May 2014 after peaked at about \$450/kg.

Data from <http://www.metal-pages.com/>

Some investors wish they had bought rare earth metals instead of gold, but researchers in US use this opportunity to undertake PM research





- The WTO is probing the trading problems of rare earth metals, as well as molybdenum and tungsten
- U.S.-based [Molycorp](#) has begun production at its California mine
- [Avalon Rare Metals](#) is developing a deposit in Canada's Northwest Territories.
- Japan has a deal for a rare-earth development project in Quebec
- Australia's [Lynas Corp.](#) is due to start mine production at its Mount Weld facility this year as well as potentially reopen a mine in South Africa
- Major supplier is China (>90%)

site of a rare earth metals mine in
Nancheng county, Jiangxi province, China



We use following approaches to reduce cost and increase the efficiency of PM (poster 24)

1. Studies of existing rare earth containing PM
 - Use less expensive rare earth materials to replace the expensive ones
 - Use of rare earth metal products effectively
2. Development of model alloys that can reduce the rare earth metal use
 - Use other magnetic materials to replace or partially replace the rare earth containing permanent magnets
other magnetic material example:
soft magnetic materials
3. Optimization the property and geometry for applications in Florida

Reducing the rare earth usage in the permanent magnet can reduce cost

57	58	59	60	61	62	63	64	65	66	67	68	69	70
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb
138.91	140.12	140.91	144.24	[144.91]	150.36	151.96	157.25	158.93	162.50	164.93	167.26	168.93	173.05

*Lanthanoids

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