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.

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

Data from http://www.metal-pages.com/
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%).

Wall Street Journal-July 24, 2012
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

* Lanthanoids

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