

Critical Materials and the Critical Materials Institute

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What to do?

- Produce more
- Use what we do produce more efficiently
- Use less

How & who?

- Personal views

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- Rely largely on market forces, recognize time lags

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- Rely largely on market forces, recognize time lags
- Focus government efforts on facilitating well-functioning markets
  - International trade
  - Development of domestic resources
  - Information and strategic analysis
  - Research and education throughout the entire supply chain

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Creating Technological Options for Assuring Material Supply Chains

CMI Accelerating Energy Innovations

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U.S. DEPARTMENT OF ENERGY

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The Critical Materials Institute

- An Energy Innovation Hub
  - Supported by the US Department of Energy, Advanced Manufacturing Office
  - One of only four such Hubs supported by DOE.
- Budget of $120M, over five years
- Led by the Ames Laboratory
  - Four national labs
  - Seven university partners
  - Seven industrial partners
  - Approximately 300 researchers
- www.cmi.ameslab.gov

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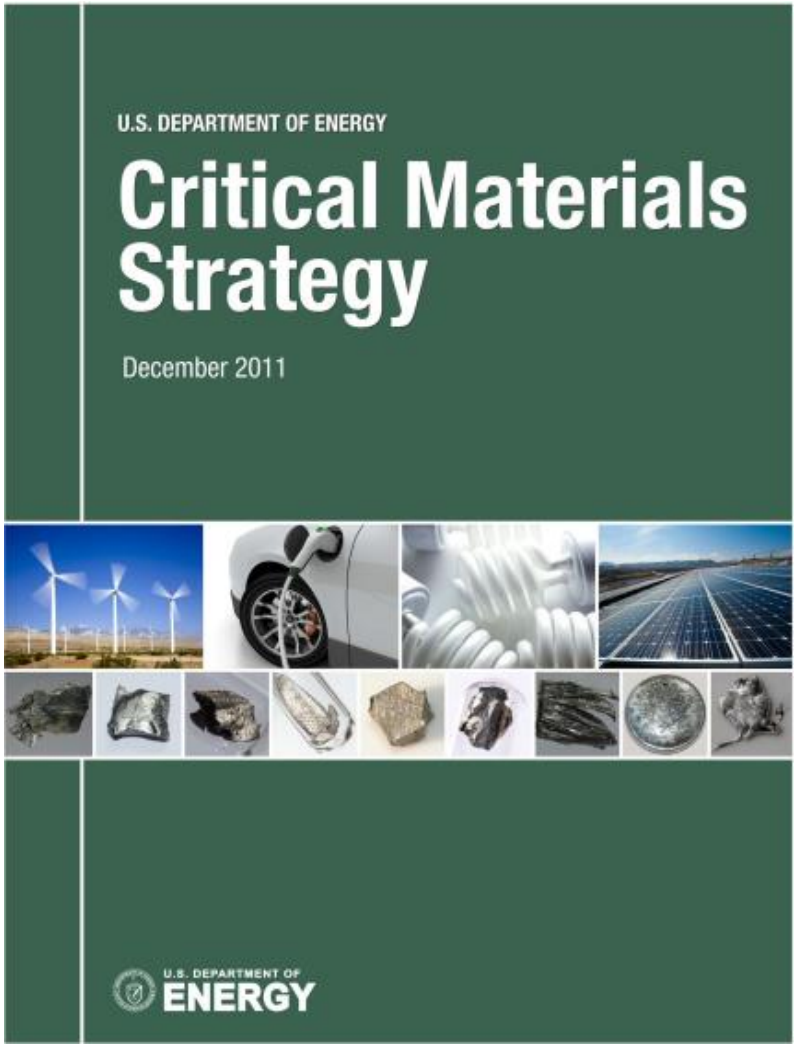
UV CUT GLASS
- Cerium
GLASS AND MIRRORS
POLISHING POWDER
- Cerium
DIESEL FUEL ADDITIVE
- Cerium
- Lanthanum
LCD SCREEN
- Europium
- Yttrium
- Cerium
COMPONENT SENS
- Yttrium
HYBRID NiMH
BATTERY
- Lanthanum
- Cerium
HYBRID ELECTRIC
MOTOR AND GENER
- Neodymium
- Praseodymium
- Dysprosium
- Terbium
CATALYTIC CONVERTER
- Cerium / Zirconium
- Lanthanum
25+ ELECTRIC MOTORS
THROUGHOUT VEHICLE
- Nd Magnets
HEADLIGHT GLASS
- Neodymium


SunMa
CUSTOM BR
SunMasterUSA.com
F71T12 - 100W
Sunlamp - DANGER - U
Follow Instructions. Use
equipped with a timer. HU
1862

A three-pillared research strategy

Innovation to:

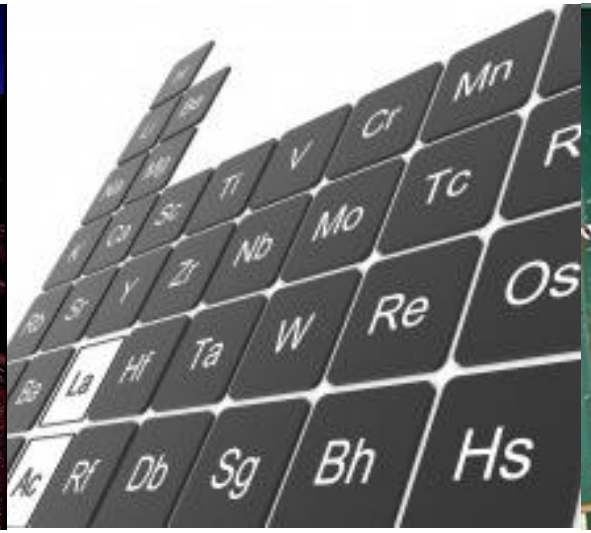
- diversify our sources
- make better use of existing supplies through recycling & re-use
- develop substitutes



Five-Year Goals

Develop at least one technology, adopted by U.S. companies, in each of three areas:

Diversifying & expanding production



Developing substitutes

Reducing wastes

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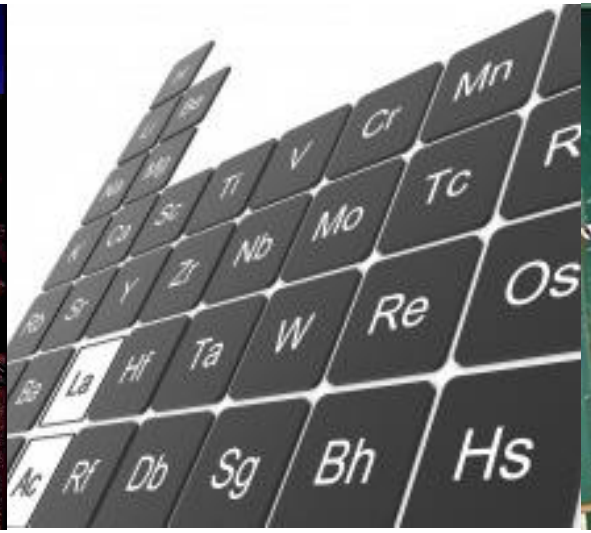

Developing substitutes

Reducing wastes

To date: 40 invention disclosures → 13 patent applications → 1 license

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Invention Disclosures

1. Extraction of rare earth elements from phosphoric acid streams ✪
2. Recovery of neodymium from neodymium iron boride magnets
3. Membrane solvent extraction for rare earth separations ✪ ✪
4. Selective composite membranes for lithium extraction from geothermal brines
5. Methods of separating lithium-chloride from geothermal brine solutions
6. Extraction of rare earths from fly ash ✪
7. Recovery of Dy-enriched Fe alloy from magnet scrap alloy via selective separation of rare earth elements ✪
8. Aluminum nitride phosphors for fluorescent lighting ✪
9. Novel surface coatings to improve the functional properties of permanent magnets
10. Additive manufacturing of bonded permanent magnets using a novel polymer matrix

✪ *Patent application submitted* ✪ *License awarded*

Invention Disclosures

11. Ceria-based catalyst for selective phenol hydrogenation under mild reaction conditions
12. Recycling and conversion of samarium cobalt magnet waste into useful magnet
13. Catalysts for styrene production
14. Task specific ionic liquids extractive metallurgy or rare earth minerals ✪
15. Separation of neodymium from praseodymium
16. High throughput cost effective rare earth magnets recycling system
17. Recycle of Fe Nd B Machine Swarf and Magnets ✪
18. Directly Printing Rare Earth Bonded Magnets
19. Procedure for Concentrating Rare-earth Elements in Neodymium Iron Boron-based Permanent Magnets for Efficient Recycling/Recovery
20. Enhancing Consumer Product Recycling via Rapid Fastener Eradication

✪ *Patent application submitted* ✪ *License awarded*

Invention Disclosures

21. Automated Printed Circuit Board Disassembly by Rapid Heating ✪
22. Electrochemistry Enabled Recovery of Value Metals from Electronics
23. Synthesis of High Surface Area Mesoporous Ceria
24. Self-Assembly of Low Surface Colloidal Nanoparticles into High Surface Area Networks
25. Selective Chemical Separation of Rare-Earth Oxalates (CSEREOX)
26. Carbothermic Preparation of $SmCo_x$ (x=5 to 8.5) Permanent Magnets Directly from Sm_2O_3
27. A One Step Process for the Removal of Nickel/Nickel Copper Surface Coating from the $Nd_2Fe_{14}B$ (neo) Permanent Magnets
28. Engineering Caulobacter Surface Protein for Rare Earth Element Absorption
29. Chemical Separation of Terbium Oxide (SEPTER) ✪
30. Novel Methods towards Selective Surface Modification of $Nd_2Fe_{14}B$ Magnets to Achieve High Performance Permanent Magnets

✪ *Patent application submitted* ✪ *License awarded*

Invention Disclosures

31. Mesoporous Carbon and Methods of Use
32. Castable High-Temperature Ce-Modified Al Alloys ✪
33. High Command Fidelity Electromagnetically Driven Calorimeter (High-CoFi EleDriCal) ✪
34. 3D Printable Liquid Crystalline Elastomers with Tunable Shape Memory Behaviors and Bio-derived Renditions
35. The Separation of Ancylite by Way of Magnetic Separation and Froth Flotation ✪
36. Recovering Rare Earth Metals using Bismuth Extractant ✪
37. Structural Optimization of Complex Materials using High-throughput Hierarchical Decomposition Methods
38. Novel 3D Printing Method to Fabricate Bonded Magnets of Complex Shape
39. Rare Earth Free High Performance Doped Magnet
40. Acid-free Dissolution and Separation of Rare-earth Metal

✪ *Patent application submitted* ✪ *License awarded*

Key story line: Innovation to create technological options

Thank You!

Questions?

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