U.S. DEPARTMENT OF ENERGY

2010 Critical Materials Strategy Summary

The United States is on the cusp of a clean energy revolution. In its first Critical Materials Strategy, the U.S. Department of Energy (DOE) focuses on materials used in four clean energy technologies: wind turbines, electric vehicles, solar cells and energy-efficient lighting (Table 1). The Strategy evaluates the extent to which widespread deployment of these technologies may increase worldwide demand for rare earth elements and certain other materials. It also considers likely trajectories for future supply of these materials and the potential for supply-demand mismatch. Conclusions include:

- Several components of the clean energy technologies—including permanent magnets, batteries, photovoltaic (PV) thin films and phosphors—depend on materials at risk of supply disruptions in the short term (0–5 years). Those risks will likely decrease in the medium (5–15 years) and long term.
- Clean energy technologies currently constitute about 20 percent of global consumption of critical materials. As clean energy technologies are deployed more widely in the decades ahead, their share of global consumption of critical materials will likely grow.
- Of the materials analyzed, five rare earth metals (dysprosium, neodymium, terbium, europium and yttrium) and indium are assessed as most critical (Figures 1 and 2). In this report, "criticality" is a measure that combines importance to the clean energy economy, and risk of supply disruption.
- Rare earth metals are not in fact rare. They are found in many countries, including the United States, Canada and Australia. However, at present, more than 95% of production for rare earth metals is currently in China. Bringing new mines online requires long lead times and large capital outlays.
- Critical materials are often only a small fraction of the total cost of clean energy technologies. Therefore, price increases for these materials may not have significant impact on price of the final product or demand for the technologies. The lack of response to price signals suggests the possibility of supply

Table 1. Materials in Clean Energy Technologies and Components

		CLEAN ENERGY TECHNOLOGIES AND *COMPONENTS*				
		Solar Cells	Wind Turbines	Vehicles		Lighting
	MATERIAL	*PV films*	*Magnets*	*Magnets*	*Batteries*	*Phosphors*
Rare Earth Elements	Lanthanum				●	●
	Cerium				●	●
	Praseodymium		●	●	●	
	Neodymium		●	●	●	
	Samarium		●	●		
	Europium					●
	Terbium					●
	Dysprosium		●	●		
	Yttrium					●
	Indium	●				
	Gallium	●				
	Tellurium	●				
	Cobalt				●	
	Lithium				●	

Figure 1. Short-Term (0–5 years) Criticality Matrix

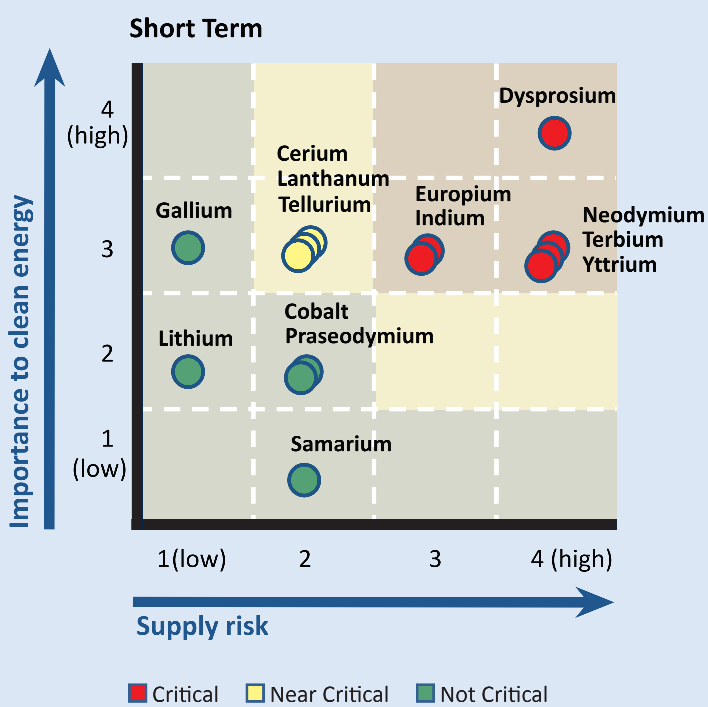
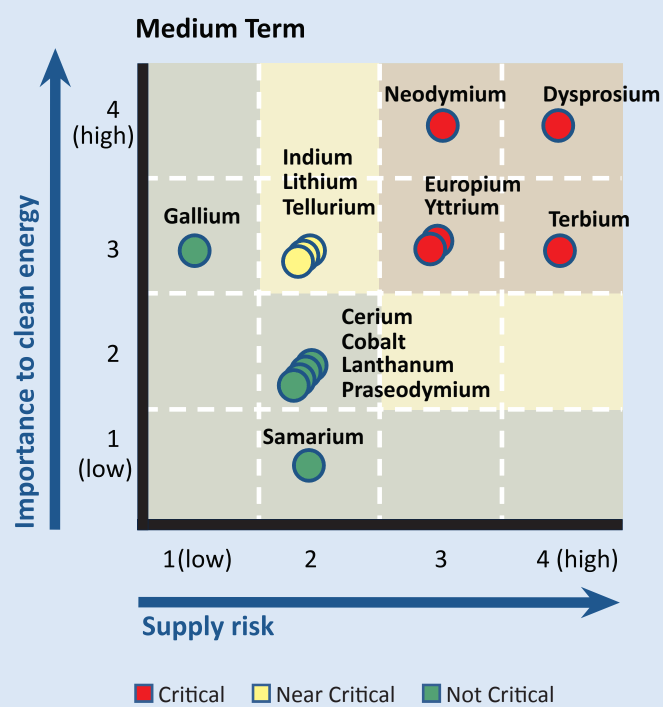


Figure 2. Medium-Term (5–15 years) Criticality Matrix



shortages. An example of growing material demand set against limited additional supply in the future is shown in Figure 3.

- Sound policies and strategic investments can reduce the risk of supply disruptions, especially in the medium and long term.
- Data with respect to many of the issues considered in this report are sparse.

Strategy

In this report, DOE announces its plan to (i) develop its first integrated research plan with respect to critical materials, building on three workshops convened by the Department during November and December 2010; (ii) strengthen its capacity for information gathering on this topic; and (iii) work closely with international partners, including Japan and Europe, to reduce vulnerability to supply disruptions and address critical material needs. DOE will work with other stakeholders—including interagency colleagues, Congress and the public—to shape policy tools that strengthen the United States' strategic capabilities. DOE also announces its plan to develop an updated Critical Materials Strategy, based upon additional events and information, by the end of 2011.

DOE's strategy with respect to critical materials rests on three pillars. First, diversified global supply chains and multiple sources of materials are required to manage supply risk. This means taking steps to facilitate extraction, refining and manufacturing here in the United States, as well as encouraging additional supplies around the world. In all cases, extraction and processing should be done in an environmentally-sound manner. Second, substitutes must be developed. Research leading to material and technology substitutes will improve flexibility to meet the material needs of the clean energy economy. Third, recycling, reuse and more efficient use could significantly lower world demand for critical materials. Research into recycling processes coupled with well-designed policies can help make recycling economically viable over time.

Program and Policy Directions

This Strategy considered the following eight broad categories for program and policy directions: (i) research and development, (ii) information gathering, (iii) permitting for domestic production, (iv) financial assistance for domestic production and processing, (v) stockpiling, (vi) recycling, (vii) education and (viii) diplomacy. As the nation's leading funder of research on the physical sciences, DOE's capabilities with respect to materials research are substantial. Topics identified for priority research attention include rare earth substitutes in magnets, batteries, photovoltaic films and phosphors; environmentally sound mining and materials processing; and recycling.

The eight programs and policies address risks, constraints and opportunities across the supply chain, as shown in Figure 4. DOE's authorities and historic

Figure 3. Neodymium Oxide Supply and Demand

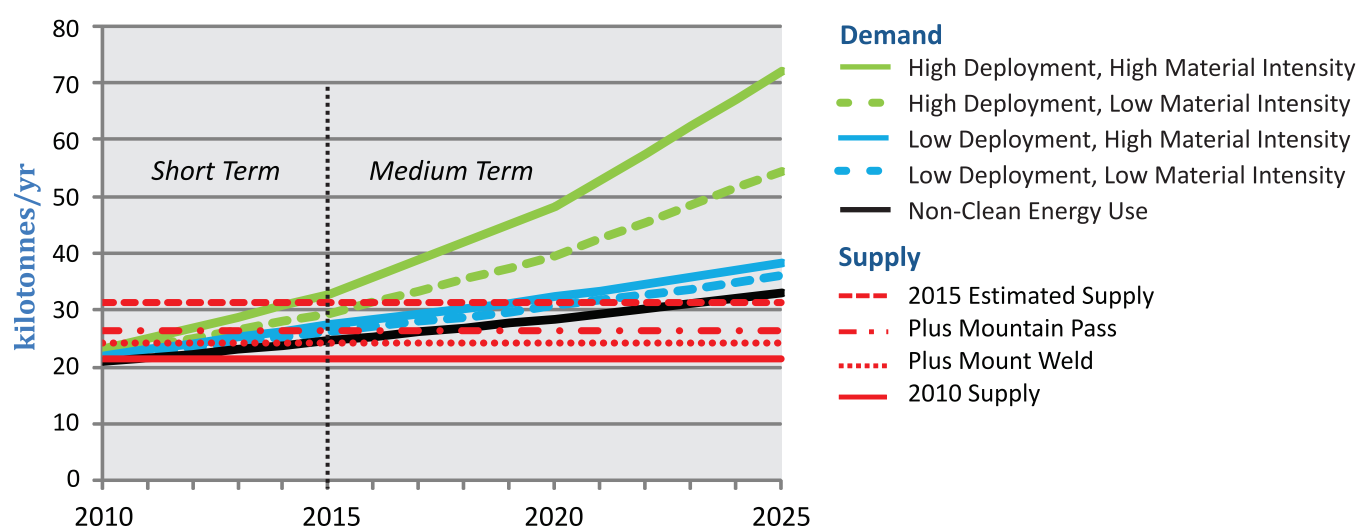
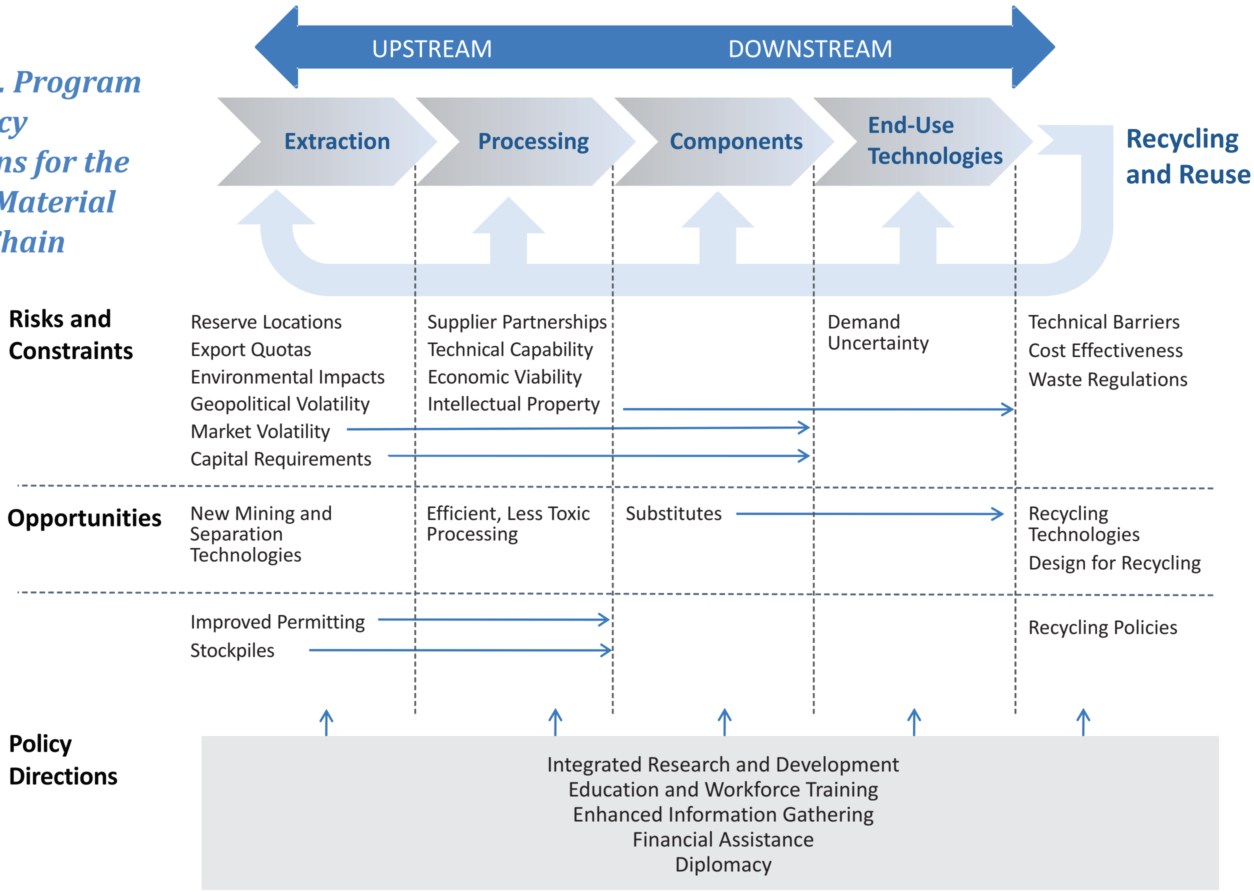


Figure 4. Program and Policy Directions for the Critical Material Supply Chain



capabilities with respect to these categories vary widely. Some (such as research and development) relate to core competencies of DOE. Others (such as permitting for domestic production) concern topics on which DOE has no jurisdiction. In these instances, DOE will work with interagency colleagues and Congress to shape policy tools that strengthen the United States' strategic capabilities.

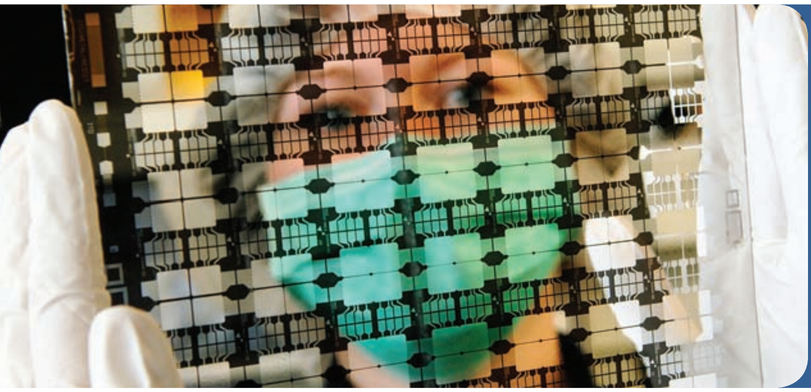
Next Steps

This Strategy is a first step. DOE expects to update the Strategy regularly to reflect changing circumstances and feedback received.

The scope of this report is limited. It does not address the material needs of the entire economy, the entire energy sector or even all clean energy technologies. Time and resource limitations precluded a comprehensive scope. Among the topics that merit additional research are the use of rare earth metals in catalytic converters and in petroleum refining.

DOE welcomes comments on this report and, in particular, supplemental information that will enable the Department to refine its Critical Materials Strategy over time. Comments and additional information can be sent to **materialstrategy@hq.doe.gov.**

For more information, or to download the full *DOE Critical Materials Strategy,* visit **www.energy.gov.**



For more information:

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