

Rare Earth Elements Processing



INVESTMENT CHALLENGES FOR U.S. PROJECTS

Rare earth elements (REEs), vital for cutting-edge technologies, are sourced from minerals like bastnaesite. Their extraction involves intricate processes, including solvent extraction and ion exchange, to isolate and purify each metal due to their chemically similar natures. REEs are critical in manufacturing powerful magnets, energy-saving lighting, and efficient catalytic converters—key components in wind turbines, electric vehicles (EVs), and electronics. With surging demand propelled by clean energy and tech sectors, sustainable sourcing, and recycling of REEs become crucial. These practices help circumvent resource scarcity and ensure an equilibrium between technological advancement and environmental conservation.

Applications requiring rare earth.

China's Influence	Mining (%)	70.0%
	Processing (%)	87.0%
	Export Rules	Restricted
Electric Vehicles (incl. batteries)		✓
Aerospace		✓
Defense Technologies		✓
Mobile Electronics (incl. batteries)		✓
Satellites/Space (incl. batteries)		✓
Robotics (incl. batteries)		✓
Wind Turbines		
Solar Panels		
Nuclear Power		
Energy Storage		✓
Grid Infrastructure		
LED Lighting		

Magnetic Rare Earths = Neodymium, Praseodymium, Dysprosium, and Terbium

Risks to establishing domestic rare earth processing.

Feedstock Scarcity	Major	Domestic processing faces challenges from limited mining, lack of midstream counterparties, and intense price competition with China.
Competition for Labor	Major	Labor competition challenges are due to the specialized skill requirements, higher attractiveness of alternative sectors, and remote facility locations.
Need for Technical Expertise	Mild	Scaling requires optimized separation techniques due to closely related chemical properties, advancing recycling from electronic waste, and integrating these methods into scaled infrastructure.
Immature Market	Major	Significant commercial hurdles exist, including reliance on a few large buyers, opaque global markets with volatile pricing, and intense global competition on price and delivery certainty.
Lack of Price Competitiveness	Major	Price competitiveness in rare earths is hindered by China's dominance, which benefits from established economies of scale to undercut global prices.
Lack of Investor Interest	Major	Investor reluctance stems from high capital costs, China's dominance, complex technologies, strict environmental regulations, and market opacity.

Overview of rare earth processing.

Upstream Material	Common Mid-Stream Technologies	Mid-Stream Product Outputs
Rare earth concentrate	<ul style="list-style-type: none"> Physical Beneficiation [gravity separation, magnetic separation, crushing, grinding, flotation] Hydrometallurgy and Pyrometallurgy [leaching, SX, calcination, precipitation, electrowinning, molten salt electrolysis] Ion-exchange methods may replace SX 	Rare earth oxides, metals, and alloys