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Rare Earth Elements in India: India’s Position in Global Rare Earth Economy

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Foreword

India today stands at a defining moment in its journey towards Viksit Bharat 2047. As the world undergoes profound geopolitical, technological, and economic transitions, access to critical resources has emerged as a key determinant of national strength. Among these, Rare Earth Elements (REEs) occupy a uniquely strategic position, quietly powering the technologies that define modern life, while simultaneously shaping the future of national security and global competitiveness.

Rare earths are no longer just industrial inputs; they are strategic assets. They are essential to defence systems, advanced electronics, renewable energy technologies, space applications, electric mobility, telecommunications, and digital infrastructure. In an increasingly uncertain global environment, where supply chains are vulnerable and resource dependencies are being reassessed, India's ability to secure and develop its rare earth ecosystem has become more critical than ever.
This report reflects our belief that India must move decisively from being a passive participant in global supply chains to becoming a confident producer, processor, innovator, and steward of critical minerals. While India is endowed with significant rare-earth potential, unlocking this opportunity requires a holistic approach that integrates policy foresight, technological capability, environmental responsibility, and human capital development.

At the heart of this transformation lies India's youth. Our young population represents not only demographic strength but intellectual and innovative capital. Empowering young minds with knowledge, skills, and opportunities in areas such as mineral exploration, advanced materials, defence manufacturing, clean energy technologies, and research & development is essential for building long-term national resilience. The rare earth sector offers a powerful platform where science, sustainability, security, and entrepreneurship converge.

As a country, we must also recognize that self-reliance in critical minerals is intrinsically linked to national security. Dependence on limited global sources for materials vital to defence and strategic technologies is a vulnerability India cannot afford. We believe that, through collective action, India can emerge as a responsible and resilient leader in the global critical minerals landscape.

As we look ahead, let us view rare earth elements not merely as resources beneath the ground, but as enablers of India's future, fuelling innovation, strengthening security, and empowering our youth to shape a stronger, more self-reliant nation.

Dr. Vijay Kalantri
Chairman
MVIRDC World Trade Center Mumbai

Introduction to Rare Earth Elements (REEs)

In the era of clean energy, digital connectivity, and advanced weaponry, Rare Earth Elements (REEs), a group of 17 metals, including the 15 lanthanides, as well as scandium and yttrium, form the invisible backbone of modern technology. Their unique magnetic, electronic, and optical properties make them indispensable for a wide range of applications, from wind turbines and electric vehicles to smartphones and guided missiles. Despite being relatively abundant, their complex extraction and processing make them strategically valuable. But what makes them truly powerful isn't just their utility; it's who controls them.

Recently, the tides have changed, What makes rare earths truly powerful is not just their utility but the strategic control over their supply chains. Over the last two decades, China has quietly but decisively consolidated a near-monopoly over the global supply of rare earths, controlling the lion's share of mining, refining, and manufacturing capacities. This dominance has transformed what should be a straightforward mineral resource issue into a potent lever of geopolitical influence. As the world races to decarbonize and bolster technological sovereignty, REEs have emerged as a new front in global power struggles. The ongoing tensions surrounding supply chains, export restrictions, and strategic stockpiling reveal that rare earths are no longer just commodities; they are vital instruments of economic strength and national security in an increasingly competitive international arena.

Rare Earth Elements (REEs) are a group of 17 metallic elements that play a quiet yet indispensable role in the modern world. Despite their name, rare earth elements are not truly "rare" in terms of their natural occurrence. Instead, the term reflects the historical difficulty in identifying, separating, and economically extracting these elements from the Earth's crust. REEs are widely dispersed in nature but are seldom found in concentrations high enough to be easily mined, which has contributed to their strategic and economic significance.

The group of rare earth elements consists of the 15 lanthanides on the periodic table: lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium, along with scandium and yttrium. These elements share similar chemical properties, which makes their separation complex and resource-intensive. All REEs are metals, and collectively they are often referred to as rare earth metals.

A common misconception surrounding REEs is that they are extremely scarce in nature. Several rare earth elements are relatively abundant. Cerium, for example, is more abundant in the Earth's crust than copper, while lanthanum and neodymium occur in concentrations comparable to widely used industrial metals such as chromium, nickel, zinc, tin, and lead. Even the least abundant REEs, thulium and lutetium, are present in the Earth's crust at levels nearly 200 times higher than gold. The challenge, therefore, lies not in the availability of these elements but in the technical difficulty of extracting and refining these elements in an environmentally and economically viable manner.

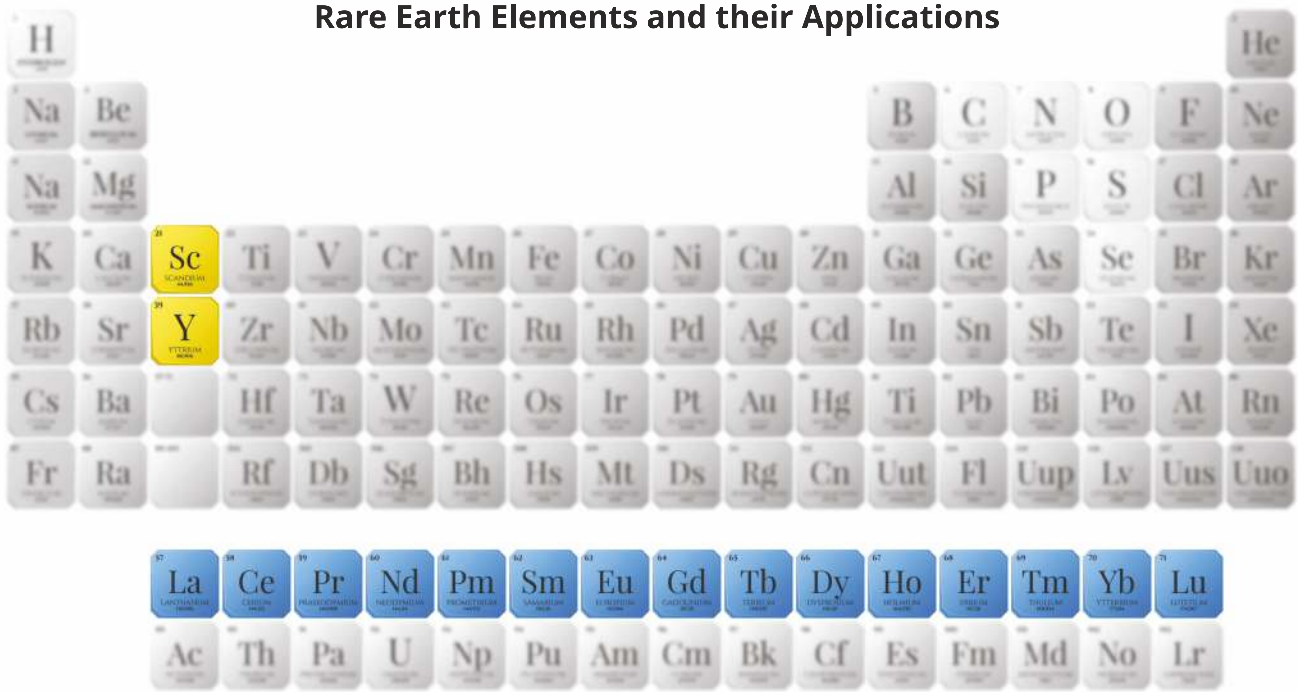
Although rare earth elements were first discovered in the late eighteenth century, beginning in 1788, their commercial and industrial significance remained limited for more than a century. Until the mid-twentieth century, global production of rare earth oxides (REOs) remained below 5,000 metric tons annually. During this period, REEs were primarily of academic interest, with only niche applications in laboratory research and specialized industrial processes. Their potential value had not yet been fully realized, largely due to limited technological demand and underdeveloped processing capabilities.

The situation began to change in the early 1950s and 1960s, when rapid technological advancements created new demand for materials with unique magnetic, optical, and catalytic properties. Rare earth elements proved to be exceptionally well-suited for these applications. They became critical components in colour television displays, petroleum refining catalysts, and early computer technologies. Over time, their use expanded into a wide range of high-value applications, including permanent magnets, phosphors, rechargeable batteries, precision optics, and advanced alloys.

In the decades that followed, the importance of rare earth elements increased dramatically alongside the growth of modern industries. Today, REEs are foundational to clean energy technologies such as wind turbines, electric vehicles, energy-efficient lighting, and solar power systems. They are equally vital to advanced manufacturing, defence systems, telecommunications, medical equipment, and digital infrastructure. Despite their limited visibility to end users, REEs are embedded deep within global value chains, making them essential to economic growth, technological progress, and national security.

As global demand for high-technology products and sustainable energy solutions continues to rise, rare earth elements have moved from being niche industrial materials to strategic resources of global importance. Their supply chains are now closely linked with geopolitics, trade policy, environmental regulation, and industrial competitiveness. Understanding what rare earth elements are, their origins, characteristics, and evolution in industrial use, is therefore a critical first step in appreciating their growing role in shaping the future of the global economy.

Rare Earth Elements and their Applications



Scandium (Sc)
Scandium is mainly used in lightweight aluminium alloys that offer high strength without adding much weight. These alloys are used in aerospace components and premium sports equipment. Scandium also finds applications in high-intensity lighting, fuel cells, and select semiconductor uses.

Yttrium (Y)
Yttrium plays an important role in advanced ceramics and metal alloys. It is widely used in high-temperature applications such as gas turbines and fuel cells. Yttrium is also essential for colour display technologies, LEDs, and laser systems used in industry and medicine.

Lanthanum (La)
Lanthanum is commonly used in optical glass for cameras, telescopes, and precision lenses, as it improves clarity and reduces distortion. It is also an important component in rechargeable batteries and is widely used in catalysts for petroleum refining.

Cerium (Ce)
Cerium is one of the most widely used rare earth elements. It is used in vehicle catalytic converters to reduce emissions and in polishing powders for glass, electronics, and precision optics. Cerium compounds are also found in self-cleaning coatings and various chemical processes.

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