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Growing Importance of Rare Earth Elements: Background and Implications

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The supply of rare earth elements (REEs) has become increasingly important in the context of natural resources security. Concern about the international availability of REEs is driven by their role in high-tech end-applications, including defence and electricity generation, and by the policies of China. As a dominant producer of REEs, China can successfully limit their supply on the world market. However, the growth of the REE industry outside of China limits the opportunities for using access to REEs to exert political pressure on importers. Diversification of REE supply is becoming an important prerequisite for the international competitiveness of highly industrialised countries, and should be a priority for Poland.

Characteristics and Applications. The REE group comprises so-called lanthanides (lanthanum, cerium, neodymium, europium, dysprosium, promethium, lutetium, praseodymium, terbium, holmium, thulium, samarium, erbium, ytterbium, and gadolinium) as well as yttrium and scandium. Thanks to their heat resistant, magnetic and phosphorescent properties, REEs are widely used in IT equipment (such as hard drives and LCD monitors), cell phones, and hybrid cars. Despite the fairly limited annual consumption of REEs (anywhere in the range of 135 to 140 thousand tons, compared with 13–14 million tons in the case of copper and zinc), they are indispensable for the technologically advanced products of the energy generation, defence, automobile and IT communications industries. Advanced defence systems and technologies—unmanned platforms, missile guidance systems, stealth, and the like—all depend on REE input. Individual REEs are difficult to substitute. Most often, they can only be replaced by another rare earth element, as is the case with neodymium and praseodymium. Furthermore, demand for REEs is not uniform. Cerium accounts for 40% of global REE consumption, followed by lanthanum (26%), neodymium (18%) and yttrium (7%), but the tension between supply and demand is highest in the case of dysprosium, europium and terbium, as reflected in their price.

The U.S. Department of Defense considers seven elements (dysprosium, erbium, europium, gadolinium, neodymium, praseodymium, yttrium) to be "strategically important" for U.S. security. Demand from the American defence industry accounts for just 8% of total U.S. demand for REEs (a few dozen tons), but it pertains to so-called heavy rare earths, i.e. dysprosium, europium, terbium: expensive, hard to access, and mined exclusively in China. The European Commission sees all REEs as crucial for the EU's international competitiveness. In the light of the EU's climate policy and given the plans to expand the use of low emissions technologies, the EC has voiced its concern about access to sufficient supplies of dysprosium and neodymium (important in wind turbines), cerium (solar panels and photovoltaic cells), and europium and gadolinium (managing thermonuclear process).

Geographic Concentration of the REE Industry. Aside from their role in manufacturing, the growth of interest in REEs stems from the concentration of REE mining, refining and processing activities in China, whose policies are effectively limiting the international availability of REEs. Around 95% of the REEs mined worldwide, i.e. of the industrially applicable rare earth oxides, come from China, along with as much as 90% of more refined REE alloys. These figures include illegal production. China is also the world's largest REE consumer (60%), whereas Japan, which ranks second (20% of global annual consumption) is entirely dependent on Chinese imports. Since 2011, official Chinese production has oscillated around 90–94 thousand tons, and REE export quotas have been slashed from 60 to 30 thousand tons.

Chinese dominance is only partly attributable to their resource base, estimated at 37–50% of the recoverable REE deposits of 114 million tons. Other countries with proven, commercially viable REE deposits, include the U.S. (10–13% of reserves), Australia and Russia (6% each). The Chinese REE industry has developed a genuine competitive edge, whereas mines in other parts of the world, such as the United States, were closed after a string of grave environmental accidents. REE mining continued in Brazil, India and Malaysia. As a result, China was well positioned to respond to dynamic growth in global REE demand (75% in the period between 2002 and 2012).

China's Policies. China intends to increase the effectiveness of its resource management, raise environmental protection standards in the light of greater social awareness of the negative impacts of the REE industry (the U.S. Environmental Protection Agency estimates that the Chinese REE mining and refining sector generates five times more sulphur dioxide than the U.S. oil and gas sector), and curb illegal mining and smuggling of REEs. In 2010, the Chinese authorities estimated that illegal mining accounted for as much as one third of total REE extraction in China, and that one sixth of the total volume of rare earth oxides was smuggled out of the country. Another important factor behind China's actions is the growing domestic demand for the REEs. China tops the list both in terms of increasing wind energy generation capacity, and in manufacturing wind turbines. Other factors involve maintaining the competitiveness of Chinese producers, restricting international competitors, and further boosting the Chinese high-tech industry. Foreign producers can secure REE supplies provided that they shift their activities to China.

To these ends, the Chinese REE industry is being consolidated and modernised, especially in the downstream sector. Closures of illegal mining sites are accompanied by strengthening of environmental scrutiny—particularly through the withdrawal of hazardous technologies. No new mining licenses will be issued until 2015, and their overall number will fall from 120 to ten. Aside from setting the limits for REE production available for exports, China is further disincentivising foreign sales, introducing export tariffs, as high as 25% in the case of europium and terbium. Attempts to engage in REE mining projects outside of China have yielded limited results. Acquisition of mines in Australia and the United States was blocked, although Australian authorities allowed a Chinese investor to hold a minority stake in one of the projects.

Importers' Response. The high level of dependency on REE imports from China has prompted new mining projects or a return to those previously abandoned. In 2011, a consortium consisting of Canadian and Japanese companies launched a REE mining in Quebec. In 2012, the United States and Australia launched two REE mines, with a total annual capacity of as much as 45 thousand tons. New projects are undergoing feasibility studies in South Africa and Australia, while Canada is preparing to expand its pilot projects into commercial ventures. Japan and the United States are at the forefront of REE recycling. However, difficulties with perfecting this technology with respect to especially sought highly elements, e.g., neodymium, means that the practical effect of recycling—increased REE supply—will not be felt until 2020. Limited commercial stockpiles (a few thousand tons) are maintained only by Japan and South Korea. Business and industrial circles in the United States and key REE importers in the EU (France, Germany) are shunning this option for fear of government intervention in this market. The U.S. is considering a return to REE stockpiling for defence purposes, and authorising the Department of Defense to enter into long-term contracts for the supply of select REEs. Germany entered into intergovernmental resource partnerships with Kazakhstan and Mongolia, foreseeing a transfer of REE exploration and production know-how and technologies in exchange for greater transparency of the partners' mining sectors, especially ensuring non-discriminatory treatment of German enterprises. French and Kazak geological services are conducting joint resource base assessments of REEs.

Conclusions. China is likely to remain the dominant player on the international REE markets, or a monopolistic producer in the case of certain elements. Regulating the volume of production and international availability of REEs is driven by the desire to enhance rationality in the use of the resources and to ensure that Chinese producers remain competitive in the high-tech industry, rather than to engage in "resource blackmail." Nothing indicates that China aims to coordinate REE supply policies with other BRICS countries or to create an REE cartel. In fact, the initiatives of the Chinese authorities, aimed at consolidating the domestic REE industry, could result in shortages of some elements, and turn China into a REE importer.

Further research into REE recycling and attempts to develop high-performance substitutes for the particularly sought-for REEs are likely in the case of countries that are planning a significant boost in the share of renewable energy in their energy mix, and should be a priority for other industrialised countries, including Poland with its plans to deploy nuclear power. As one of the priorities of Polish commercial diplomacy, REE should become a prominent topic on, for example, the agenda of science and technology dialogue with the United States, and with other importing countries, such as Germany in the context of its ongoing energy transformation (*Energiewende*). Official support for Polish companies seeking diversification of their investment portfolios via engaging in REE ventures abroad should include technical assistance in resource base assessment. The search for investors ready to engage in the identification and commercial development of domestic deposits should focus on companies with the most up to date REE mining and reprocessing technology, ensuring high environmental standards.