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MP-IDSA

Issue Brief

India's Deep Sea Mining Endeavours: A Search for Climate Solutions in Deep Waters

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Summary

While India has become a power surplus nation, it will account for the largest energy demand growth over the next two decades. From depending heavily on fossil fuel, India has rapidly shifted towards clean and renewable sources of energy. India is developing reliable deep-sea mining technologies and platforms to tap ocean resources to address its need for rare earth minerals that increasingly power renewable energy sources.

Introduction

India is one of the world's fastest growing major economies with a population of around 1.4 billion, and is likely to become world's third largest economy in 2027. The economic and social development of its large populace is intrinsically linked with its energy requirements and consumption. The energy needs of India are therefore bound to grow in future and its energy security is going to be of strategic importance.

Even as India is poised to be a crucial player in the global energy market, its accomplishment in energy development has been extraordinary. From being a power deficient nation with profound leaning on coal for its energy requirements, its journey to a power surplus nation is incredible. Presently, its total installed electricity capacity stands slightly more than four lakh MW. India is the third largest renewable energy producer in the world and non-fossil fuel sources contribute 40 per cent of its installed electricity capacity.[1]

India ranks fourth globally in energy consumption behind China, the US and the European Union (EU). As per the International Energy Agency (IEA), India is likely to overtake the EU by 2030 and to move up to the third spot.[2] Per capita energy consumption in 2021–22 in India was however awfully low at 1255kWh, almost one-third of the global average.[3] The IEA has forecasted that in the coming two decades, India would account for the largest energy demand growth.

Renewable Energy and India

From depending heavily on fossil fuel, India has rapidly shifted towards clean and renewable sources of energy. It has provided electricity connection to millions and promoted schemes like Unnat Jyoti by Affordable LEDs for All (UJALA) and Street Lighting National Programme (SLNP) enhancing energy efficiencies. Concerns for climate change and sustainable development goals (SDGs) have pushed India to expand its renewable sources of energy. Setting an eye on becoming the world's largest green hydrogen hub, India in January 2022 approved the National Hydrogen Mission to reduce dependency on fossil fuels. The present decade has also witnessed unprecedented reforms, technological advancements, policy decisions and collaborations in the turf of solar and wind energy, both of which have the potential to surge ahead of coal and gas.

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[1] "**Renewable Energy in India**", Press Information Bureau, Ministry of New and Renewable Energy, Government of India, 9 September 2022.

[2] "**India to Overtake EU as World's Third Largest Energy Consumer by 2030: IEA**", *The Economic Times*, 9 February 2021.

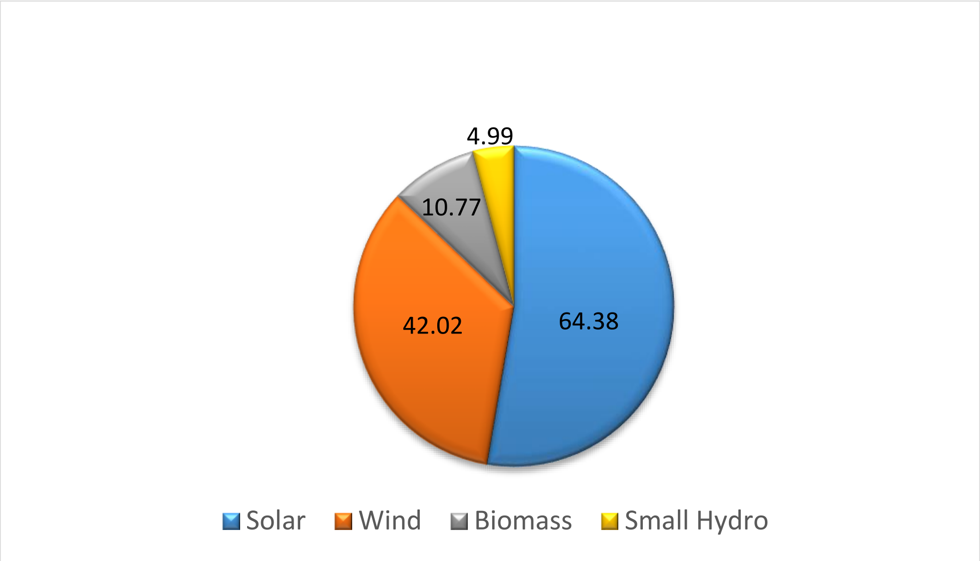
[3] "**Share of Non-fossil Fuel Based Generation Capacity in the Total Installed Capacity of the Country likely to Increase from 42% as on Oct, 2022 to more than 64% by 2029-30**", Press Information Bureau, Ministry of Power, Government of India, 22 December 2022.

Table 1: Installed Capacity of Electricity Production in India (as on 28 February 2023)

Source	Installed Capacity (MW)	Percentage of Total
Coal	211.06	51.2
Renewable	122.11	29.62
Hydro	46.85	11.37
Gas	24.82	6.02
Nuclear	6.78	1.64
Diesel	0.59	0.14

Source: Central Electricity Authority, Government of India.

Pie Diagram 1: Renewable Energy Installed Capacity (MW)



Source: Central Electricity Authority, Government of India.

Table 1 shows the installed capacity of electricity production in India, as on 28 February 2023. The contribution of renewables is nearly 41 per cent with production of around 169 GW (including large hydro). Pie Diagram 1 illustrates that the wind and solar have lion's share of around 87 per cent of the total renewable energy installed capacity.

The story of renewable energy in India dates back to 1960s when windmills were developed by the National Aeronautical Laboratory (NAL).[4] In 1982, the Department of Non-conventional Energy Sources (DNES) was established under the Ministry of Energy. Confronted by oil crisis, India started seeking alternative sources such as renewable energy to achieve energy security, economic development and to mitigate climate change. In 1992, the DNES was rechristened as Ministry of Non-Conventional Energy Sources and was thereafter renamed as the Ministry of New and Renewable Energy (MNRE) in 2006.

[4] "**Renewable Energy in India**", no. 1.

The charter of MNRE is to develop and deploy new and renewable energy and it is the nodal Ministry of Government of India for issues pertaining to new and renewable energy.[5] In 2019, Government of India made a commitment for an investment of around Rs 4 lakh crore for the next three years to meet renewable energy target of 175 GW by 2022.[6] The MNRE is presently working on its target of achieving 500 GW by 2030 from non-fossil sources. Investments to the tune of US$ 25 billion are anticipated by 2023 in the renewable energy sector.[7]

India and Wind Energy

With steady growth for more than three decades, India currently ranks fourth globally in Renewable Energy Installed Capacity, including large hydro, solar and wind power. The installed capacity in wind power stood at 42.02 gigawatt (GW) as in February 2023. What remains most stimulating is the aggressive target of 30 GW by 2030 from offshore wind energy which the MNRE has set for itself,[8] a commitment which can generate enough confidence amongst project developers in Indian market.

With rapid urbanisation, the onshore wind industry is facing problems such as paucity of land resources and exhaustion of best windy sites. On the other hand, the better-quality obstruction free wind availability in open seas has resulted in spotlight turning towards offshore wind energy. India's large peninsular area with an equally large coastline of 7,516 kms enhances prospects of harnessing offshore wind energy. To tap this vast renewable energy potential, Government of India in 2015 notified the 'National Offshore Wind Energy Policy' which designated the Ministry of New and Renewable Energy as the nodal Ministry for development of Offshore Wind Energy in India.

The MNRE has been entrusted with the responsibility of Development and Use of Maritime Space within the Exclusive Economic Zone (EEZ) of the country and for overall monitoring of offshore wind energy development in the country. Significant headway has been made since then. The initial assessment undertaken by National Institute of Wind Energy (NIWE) indicates a total wind energy potential of 302 GW at 100 meters hub height.[9] The MNRE has further specified that initial studies indicate

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[5] **"What is the Ministry all about?"**, Ministry of New and Renewable Energy (MNRE), Government of India.

[6] Anshul Joshi, **"India to Invest Rs 4 lakh crore to Meet 175 GW Renewable Energy Target by 2022: R K Singh"**, *The Economic Times*, 11 December 2019.

[7] Paurush Omar, **"Renewable Energy Sector to Attract $25 billion in Investments in 2023"**, *Livemint*, 22 December 2022.

[8] **"Year- End Review 2022- Ministry of New and Renewable Energy"**, Press Information Bureau, Ministry of New and Renewable Energy, Government of India, 20 December 2022.

[9] **"Offshore Wind"**, Ministry of New and Renewable Energy, Government of India.

an estimated offshore wind energy potential of about 70GW within identified zones of Gujarat and Tamil Nadu.

The story of global offshore wind energy is around three decades old. The first offshore wind turbine was established in 1991 (decommissioned in 2017) in Denmark, as a demonstration project.[10] India's endeavours in this area commenced in 2013 with the project 'Facilitating Offshore Wind Energy in India (FOWIND)', which intended to identify potential zones in Gujarat and Tamil Nadu to foster India's transition towards clean technologies. The project was undertaken with assistance of Global Wind Energy Council (GWEC) and was supported by European Union (EU).

Another project, Offshore Wind Power project in India (FOWPI) supported by EU is underway since 2015 and has provided invaluable assistance in capacity building of Indian stakeholders and for Pre-Financial-Investment-Decision. The data obtained from satellite and other sources has helped in identification of eight potential offshore zones off Gujarat and Tamil Nadu and formulation of the preliminary assessment report. As per the report, prospects exist for exploitation of 36 GW and 35GW of offshore wind energy off Gujarat and Tamil Nadu respectively.

Proactive actions have been taken further and the ministry has initiated steps such as issuance of Strategy Paper for offshore wind development which envisages three models for developing these offshore wind sites. Another significant progress has been commissioning of a Light Detection and Ranging (LiDARs) off Gujarat coast near Pipavav in 2017 for Offshore Wind Resource assessment. The data collected has been analysed to validate the satellite data and published by NIWE.[11]

In India, the offshore wind energy is, therefore, poised for quantum jump with fair amount of certainty. The pace at which activities are shaping is unprecedented. India has set its eye on developing its first offshore wind energy project off Gujarat coast for power generation of 2 GW. Recently, Government of India gave approval-in-principle for an estimated investment of Rs 16,000 crore for setting up offshore windmills. Additional investment to the tune of Rs 20,000–24,000 crore is expected for onshore transmission facilities and infrastructure.[12] The tenders for four blocks of sea-bed each with potential of 1 GW of wind power plant in the Gulf of Mannar, off South Tamil Nadu by NIWE are likely to be out very soon. India would achieve a milestone with this tender which is first of its kind for leasing the sea-bed under the model-3 of strategy paper for offshore wind development projects.[13]

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[10] "**World's First Offshore Wind Facility Completely Dismantled**", *Renewable Energy World*, 9 August 2017.

[11] "**Offshore Wind Energy**", National Institute of Wind Energy, Ministry of New and Renewable Energy, Government of India.

[12] Kapil Dave, "**20,000 MW Offshore Wind Power Project in Gujarat Gets Nod**", *The Times of India*, 7 February 2023.

[13] M. Ramesh, "**India's First Tender for Offshore Wind Projects by Month End**", *The Hindu-Business Line*, 20 March 2023.

Renewable Energy and Rare Earth Elements

The optimal generation of renewable energy and transition to green energy will require significant amounts of conventional and Rare Earth Elements (REEs). The REEs include 17 elements of which 15 elements belong to Lanthanides group (including Lanthanum) along with Yttrium and Scandium. The term rare earth element is actually a misnomer as these elements are not rare, they are rather fairly abundant but are scattered in low concentration in the earth's crust. The mining and extraction of REEs is said to have started in America in 1950s by the Molybdenum Corporation of America (Molycorp), a company which dominated the REE business till 2000.[14]

The hunt for REEs and its increasing global demand is due to its enormous high-end usages. The areas where REEs are utilised include electronic gadgets such as television screens, computers, mobiles, medicine diagnostics, radar detection devices, high temperature superconductors, rechargeable batteries, biofuel catalysts, hybrid automobiles, wind turbines, among others.[15] The major reserves of REE ores have found to be present in China, US, Russia, Australia, Canada, South Africa and India. In 2017, as per reports, around 80 per cent of the total mined REEs in the world was from China.

Given the demand and supply reasons, the REEs of late have been gaining immense strategic value becoming crucial link in the complex global value chain. The Rare Earths crunch in 2010, though short-lived, elicited geopolitical considerations and proposals started floating to look for alternate solutions such as mining in Amazon rainforest or sea bed or even looking at the option of obtaining it from the moon. The US proclamation that mining of REEs is an issue pertaining to national security therefore seems to be unambiguous.[16]

Elements such as Copper, Nickel, Manganese, Cobalt and REEs are critical for transition to clean energy. Compared to energy systems using fossil fuel, the clean energy technologies such as solar photovoltaic cells, wind farms and electric vehicles involve extensive requirement of these minerals. While the requirement of Copper, Nickel, Cobalt and Manganese is essential for high performance and high energy storage batteries having longevity, the REEs are imperative for production of wind turbines and EV motors. As per the IEA, the demand of these minerals is expected to see a steep rise of 40–70 per cent in the next two decades in order to meet the Paris Agreement goals.[17]

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[14] **"Science Matters: The Case of Rare Earth Elements"**, Science History Institute.

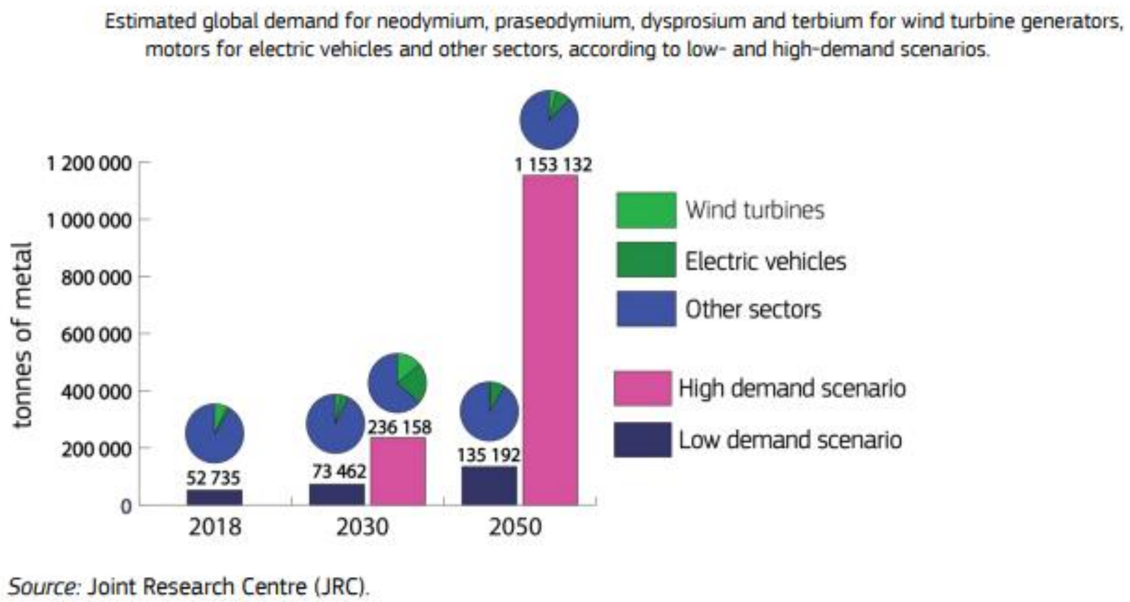
[15] V. Balaram, **"Rare Earth Elements: A Review of Applications, Occurrence, Exploration, Analysis, Recycling, and Environmental Impact"**, *Geoscience Frontiers*, Vol. 10, No. 4, July 2019, pp. 1285–1303.

[16] Carolyn Gramling, **"Rare Earth Mining May Be Key to Our Renewable Energy Future. But at What Cost?"**, *Science News*, 11 January 2023.

[17] **"The Role of Critical Minerals in Clean Energy Transitions"**, IEA Executive Summary.

The technological advancements in offshore wind turbine of late have started showing industry’s inclination towards direct drive permanent magnet generators being preferred over conventional heavy gear boxes (which requires more steel and concrete) due to their reduced weight and enhanced reliability as well as efficiency. The requirement of RREs for the generators is extremely critical and hence is a major challenge in adoption of offshore wind technology.

Further technological innovations and research in the field are now toying with the idea that owing to small size, light weight and nearly zero resistance, superconductor generators are superior over permanent magnet generators, especially for larger offshore turbines. Superconductor generators will lead to enhanced demand for REEs (Yttrium). As per a report by the Joint Research Centre (JRC), the European Commission’s science and knowledge service, an estimated global demand of certain crucial REEs for low and high demand scenarios has been depicted as below.



Source: Joint Research Centre, The European Commission’s science and knowledge service, 2016.

REEs and Seabed Mining

The scarcity of these selected metals and RREs on land, their increasing demand and presence in higher concentration in some parts of seabed, has thus shifted the focus on seabed mining as a potential option for harnessing the mineral wealth.[18] The exploration and exploitation of deep-sea minerals, though considered by many as a way out for transition from fossil fuel-based economy to a blue economy, is not free from environmental, technological and social challenges. The oceans are our greatest

[18] **“Deep Sea Technology”**, National Institute of Ocean Technology, Ministry of Earth Sciences, Government of India.

ally in the fight against the climate change. Hailed as the lungs of the planet, the oceans generate 50 per cent of oxygen and absorb a quarter of all carbon dioxide emissions. They also absorb 90 per cent of the excess heat due to the greenhouse effect which gets circulated due to ocean currents.

Conservationists have been vociferous in expressing the adverse impact of deep-sea mining on the ocean environment which is already facing threats from global warming, ocean acidification, pollution, plastic debris, and over fishing. The fear of deep-sea mining having cascading effect on ocean stability and ocean food web therefore needs to be factored into prior to undertaking any activity in the last untouched frontier of this planet. The oceans are the largest habitat of life, numerous of them being unknown and yet to be discovered.

A survey conducted in Clarion-Clipperton zone (CCZ), an area comprising 4.5 million sq km in the Pacific Ocean revealed the presence of 154 unknown bristle worm species. The existence of numerous unknown species, the ecosystems and the risk of losing such vast, unexplored and unknown knowledge can be a monumental error. There is a fair amount of possibility that once profits starts pouring, it would become tough to resist deep-sea mining.[19] Despite growing debates over the ethics of deep-sea mining, it is likely that in future, the economics would determine and drive these searches to extra-terrestrial sources or ocean floors.

The deep seabed minerals exploration and exploitation in 'the Area' defined as the seabed and subsoil beyond the national jurisdiction limits, is regulated by the International Seabed Authority (ISA). ISA is an autonomous organisation established by United Nations Convention on the Law of the Sea (UNCLOS) on 16 November 1994. A contract with the ISA is imperative to undertake activities related to exploration and exploitation of seabed mineral in the Area. So far, 29 exploration contracts for an area comprising more than 1.3 million sq km of the ocean floor have been issued in the Indian, Atlantic and Pacific oceans.

The contracts granted thus far include national government participants of India, France, Germany, Japan, China, South Korea and Russia and to the state sponsored private entities of Singapore, Cook Islands, Tonga, Nauru and Kiribati. The Clarion-Clipperton zone, Central Indian Ocean Basin (CIOB) and Exclusive Economic Zones (EEZ) of Cook Islands, French Polynesia and Kiribati have emerged as the potential area of interest which holds commercial viability of deep sea mining.[20]

In 1987, India became the first country to be conferred with the status of pioneer investor and has exclusive rights allocated by the ISA over an area of 75,000 sq km in the CIOB for exploration and developmental activities for the polymetallic nodules.

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[19] Barclay Ballard, **"Deep-sea Mining Could Provide Access to a Wealth of Valuable Minerals"**, *The New Economy*, 13 May 2019.

[20] **"The International Seabed Authority and Deep Seabed Mining"**, *UN Chronicle*, United Nations, May 2017.

The survey, environmental assessment and development of deep sub-sea technology which form part of a long-term programme have been drawn by the Ministry of Earth Sciences (MoES) and are being implemented methodically and scientifically.

India plans to develop reliable deep-sea mining to tap ocean resources to address its need for rare earth minerals from the CIOB which has estimated resource prospects of around 380 million tonnes of polymetallic nodules consisting of 4.7 million tonnes of nickel, 4.29 million tonnes of copper, 0.55 million tonnes of cobalt and 92.59 million tonnes of manganese. The huge mineral resources can help India in becoming self-sufficient in these critical metals and cut the supply chain vulnerabilities.[21]

India has accorded the much-needed impetus to its Deep Ocean Mission (DOM) and earmarked a budget of Rs 4,077 crore for a period of five years commencing in 2021.[22] Deep-sea mining technology, apart from being challenging, has strategic implications, hence is commercially not available. The National Institute of Ocean Technology (NIOT) has been relentlessly working on developing these complex indigenous technology in phases. Development of in-situ soil tester and its demonstration at 5,462 m depth at the Test mine site has been completed.

The test of mining machine for locomotion and manoeuvrability at a depth of 5,270 m at CIOB has been undertaken to assess the functioning of various systems at extreme hydrostatic pressure and very low temperatures. The machine was operated for 2.5 hours and covered a distance of 120 m. It has achieved distinction of being the first tethered seabed moving machine to operate at this depth and is now being augmented with various other systems such as mechanical pickup, collector system, crusher, feeder and pumping system.

Concurrently, work is in progress to develop Unmanned Remotely Operable Vehicle (ROSUB 6000) rated for 6,000 m and a three crew capacity self-propelled manned submersible MATSYA designed for 6,000 m depth under Mission Samudrayaan for deep sea minerals exploration and exploitation.[23]

The contract between MoES and ISA for exploration of Polymetallic nodules was initially signed in 2002 for 15 years and has been extended twice for a period of five years in 2017 and 2022.[24] In addition, contract for exploration of Polymetallic Sulphides in Central Indian Ridge and Southwest Indian Ridge region has been

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[21] **"India's Exclusive Rights to Explore Polymetallic Nodules from Central Indian Ocean Seabed Basin Extended by Five Years"**, Press Information Bureau, Ministry of Earth Sciences, Government of India, 21 August 2017.

[22] **"Cabinet Approves Deep Ocean Mission"**, Press Information Bureau, Cabinet Committee on Economic Affairs (CCEA), 16 June 2021.

[23] Barclay Ballard, **"Deep-sea Mining Could Provide Access to a Wealth of Valuable Minerals"**, no.19.

[24] **"Union Minister Dr Jitendra Singh says, the world today recognises India's Blue Economy resources and the International Seabed Authority with headquarters in Jamaica has officially designated India as a "Pioneer Investor"**, Press Information Bureau, Ministry of Earth Sciences, Government of India, 1 February 2023.

signed in 2016.[25] These developments and endeavours are also in line with the India's vision of 'Atmanirbharta'.

Conclusion

From the prism of geo-economics, prioritising deep sea mission seems as an inescapable necessity for India. The availability of REEs is crucial for India as it aspires to take centre-stage in manufacturing of strategic defence systems, semiconductors and clean energy systems. Presently, India's requirement of REEs is met mostly through imports. India therefore must explore options to harness its land-based sources and collaborate with like-minded partner countries to meet the growing demand of critical minerals and REEs.

The existing collaboration between Toyoto Tsusho Corporation, Japan and IREL, India must be taken forward to build more extensive framework of cooperation and collaboration.[26] To enhance REEs refining activities in India and boost the sector, a Memorandum of Understanding (MoU) was signed between Indian Rare Earth Limited (Department of Atomic Energy) and Toyota Tsusho Corporation, Japan (designated by Ministry of Economy, Trade and Industry of Japan) in November 2012 and further renewed in February 2022. The MoU envisages technology sharing, joint ventures schemes and cooperation to cater for the smooth and stable supplies of REEs for both the countries.

The Toyota Tsusho Corporation has been undertaking REEs production activities at Visakhapatnam through its subsidiary unit. India has future plans to start REEs mining activities at more sites such as coastal belt in Puri, Odisha and collaboration with Japan would be crucial in such endeavours. Japan also aims to commence extraction of rare earth metals from deep sea in 2024 by developing robotic deep sea mining technology. It has one of the world's richest seabed minerals deposit in the areas such as Okinawa trough and Minami-Torishima islands. A collaboration between India and Japan to tackle the challenges of deep sea mining and technology development thus holds immense potential and could prove vital.

The contours of deep sea mining which pose strong environmental, technological and social challenges also provide India an alternate and a viable solution to meet its quest for these critical minerals. Scientific pursuits, environmental assessments and scaling up of capacity and capabilities must therefore continue as India advances for further exploration of the deep ocean for resources.

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[25] **"Harnessing Ocean Resources"**, Press Information Bureau, Ministry of Earth Sciences, Government of India, 4 August 2022.

[26] **"Mining of Rare Earth Elements"**, Press Information Bureau, Department of Atomic Energy, Government of India, 6 April 2023.

About the Author

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