Policy brief

From mine to magnet

Positioning Malaysia as a robust player in the emerging global supply chain

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Foreword by Datuk Prof Dr Mohd Faiz Abdullah

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Foreword

Rare earth elements are often described as the “vitamins” of modern technology – small in quantity, yet indispensable ingredients in the machineries that define human progress. These minerals not only power the magnets that spin our turbines and run the circuitry of our digital lives but also fuel the lifeblood of modern military technologies.

Today, the scramble for rare earths has evolved into a sophisticated form of geoeconomic chess, fraught with contestation, where control over these resources confers large geoeconomic power and leverage. In this contest, China’s dominance over complex refining processes, coupled with escalating export bans on materials and technologies in response to rising economic tensions, has created a window of opportunity.

Malaysia here stands at the precipice of opportunity. As a global player in rare earth processing, the challenge before us is not merely to extract and refine, but to build an ecosystem that endures – an ecosystem grounded in innovation and environmental stewardship, and one that withstands the test of geopolitical tides and times.

Yet, we must remain cognisant of the ecological perils of this industry. We find ourselves caught between the lucrative and the perilous reach of resource exploitation and environmental stewardship, as Malaysia’s richest deposits lie beneath the verdant canopy of sensitive ecosystems. Therein lies the quintessential challenge: how do we harness the earth’s bounty without severing our responsibility toward the planet?

This policy brief offers a timely and necessary contribution to that ambition, outlining the contours of a forward and globally engaged strategy, one that recognises the pursuit of mineral self-sufficiency and its reshaping of global supply chains. This study offers not just technical proposals but steps toward a reinforcing agency in a rapidly changing world.

If the 20th century was defined by oil and the geopolitics of energy, then this epoch will be shaped by the geopolitics of critical minerals. Amid this emerging order, nations that combine industrial certainty, technological depth and environmental integrity will lead.

This document offers more than an analysis; it is a call for conscious deliberation. As Johann Wolfgang von Goethe reminds us, ‘What is not started today is never finished tomorrow.’ The path we choose now will determine whether we remain as mere processors in a lucrative industry or emerge as major contenders in an emerging global value chain – from mine to magnet.

Datuk Prof Dr Mohd Faiz Abdullah
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Key takeaways

- The global race for critical minerals is accelerating. Rare earths, essential for producing high-performance magnets, batteries and defence technologies, now anchor many emerging global supply chains. The US-China geoeconomic rivalry has added additional dimensions of competition, as supply chain bifurcation and export controls actively reshape global mineral supply chains, offering opportunities for Malaysia to broaden its geoeconomic agency.

- Malaysia is endowed with significant deposits of rare earths and is home to one of the world's largest refineries (i.e., Lynas Rare Earths, Ltd.), yet local industrial integration remains constrained by various governance bottlenecks, a lack of upstream integration and an underdeveloped downstream industrial base. Successfully navigating these challenges and integrating a full-cycle supply chain could unlock an estimated RM91.9 billion in GDP contribution and 96,900 jobs by 2050. (See Appendix II for more details)

- Challenges in the sector include a fragmented governance structure between the federal and state levels of government, resulting in non-optimal coordination and uncertainties that discourage sector investment. The lack of a robust upstream supply ecosystem likewise discourages mid- and downstream development of refining and magnet fabrication capacity, impacting its ability to secure higher value-added stages in the value chain. Lastly, funding for geological mapping and exploration is needed to further drive the sector.

- To overcome these challenges, Malaysia must establish a coherent and integrated governance architecture to guide sector development, such as deepening the institutionalisation of the Special Task Force for the Development of the Rare Earths Industry by creating an advisory and industrial coordination body, while aligning with state agencies. Operators should likewise be tied to compliance audits to maintain regulatory certainty, efficacy and investor confidence. In parallel, a circular economy framework for residue management would enhance material recovery and create additional pathways for sustainable industrial linkages.

- Further, a clear upstream-to-downstream strategy must drive end-to-end manufacturing. This entails creating formal pathways for venture capital and exploration funding, expanding global research and technical cooperation through a unified centre of excellence and localising supply chains for critical chemical inputs. Vertical and horizontal integration must remain a priority, and sustainable mining methods must be incentivised through partnerships with global firms and institutions. SME "plug-in" programmes should likewise be considered to promote inclusive growth across the supply chain.

- Lastly, there is a need to embed ESG, social trust and sustainability principles as a central pillar of sector development. Inculcating the principles of free, prior and informed consent in community engagement is crucial to prevent and protect sector legitimacy, while a robust traceability framework is needed to verify the provenance of materials and ensure alignment with global standards and best practices.

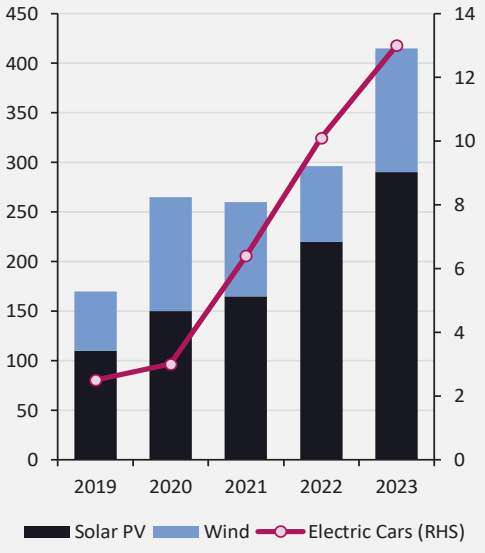
1.0 Growing economic importance of rare earths

The global transition toward clean energy and advanced technologies has intensified the demand and significance of rare earths (REs) and rare earth elements (REEs), a group of critical minerals essential for producing high-performance permanent magnets used in electric vehicles (EVs), wind turbines and advanced electronics. As the energy transition accelerates, the International Energy Agency (IEA) estimates that over 90% of global electricity capacity expansion between 2022 and 2027 will come from renewables, while the demand for REEs from green energy technologies will continue rising steeply through 2040.[1]

Data shows that the pace of green energy investments in 2024 had effectively doubled since 2022, with more growth expected over the next decade.[2] These trends are expected to continue, as unit costs of green technologies continue to reduce (Fig. 2) and Environmental, Social and Governance (ESG) reporting standards become increasingly important for global firms. Particularly, EVs are set to drive much of future REE demand through the application of neodymium-iron-boron (NdFeB) super magnets (modern EVs require approximately 1–2 kg of REEs).[3] Wood Mackenzie further projects the demand for NdFeB magnets to grow by 114% by 2030 and 293% by 2050.[4] Beyond EVs, other permanent magnet applications in consumer electronics, aerospace and defence technologies will account for 29% of the REE market.[5]

Fig. 1. Rapid innovations in clean technology are major growth drivers

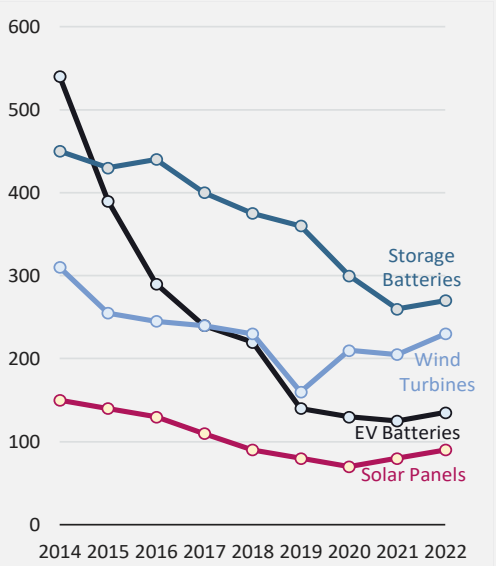
Annual capacity addition in gigawatts for renewables and EV sales in million units



Source: International Energy Agency[6]

Fig. 2. Clean energy technology costs are close to all-time lows

Average price for selected green technologies in US$/kWh (nominal)



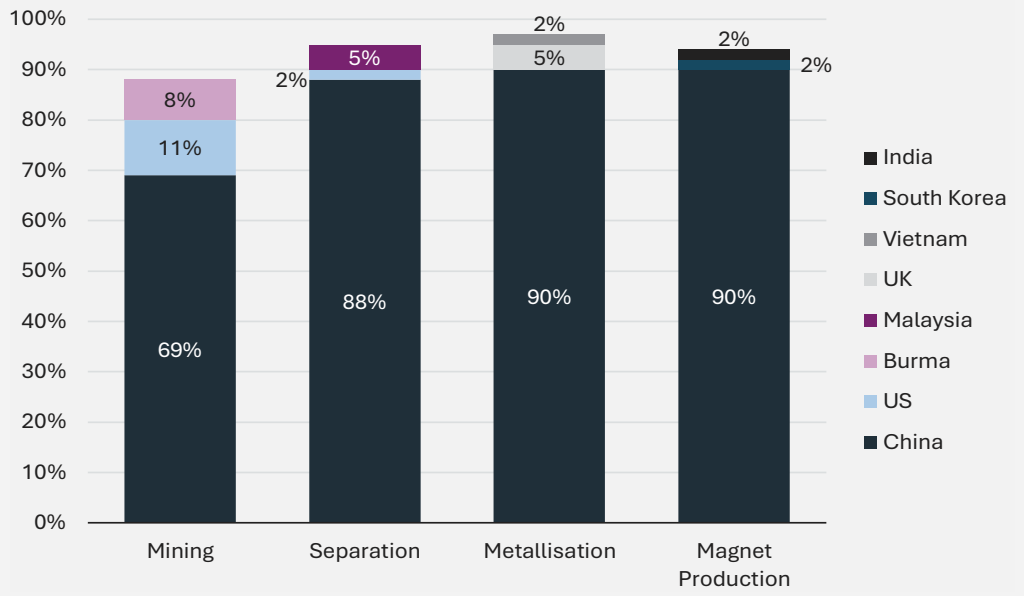
Source: Adapted from the International Energy Agency[7]

1.1 Rising geoeconomic competition in REE landscape

As the world's leading exporter of rare earth oxides (REOs), China is a global giant in the refining and manufacturing of REE products. While accounting for approximately 69% of global mineral production, it accounts for 88% of its refining capacity (Fig. 3).[8] Research suggests that some bilateral agreements between China and resource-rich nations were based on resource-backed loans that can be repaid directly through mineral exports or where minerals themselves are offered as collateral.[9]

Fig. 3. While upstream extraction is reflective of geography, the supply of refined RE and downstream use is highly concentrated in China

Market share (%) of top three countries in the REE value chain, by process, 2025



Source: IDTechEx, 2025[10]

In December 2023, Chinese authorities announced a ban on the export of permanent magnet technologies, building on existing bans related to RE extraction and separation techniques. Authorities simultaneously tightened rules on the export of several key industrial minerals,[11] widely seen as a response to curbs on advanced semiconductor technology under the US CHIPS Act. Following the "Liberation Day" tariffs, Beijing further implemented sweeping export curbs on seven REEs and permanent magnets, leading to subsequent negotiations to reopen critical mineral supply chains.[12] At the time of writing, such disputes remain ongoing.

These developments coincide with a relatively price-inelastic global supply curve in the short term amid new emerging technologies (as new mining and processing capacity cannot be quickly scaled up even when prices rise).[13] This supply rigidity

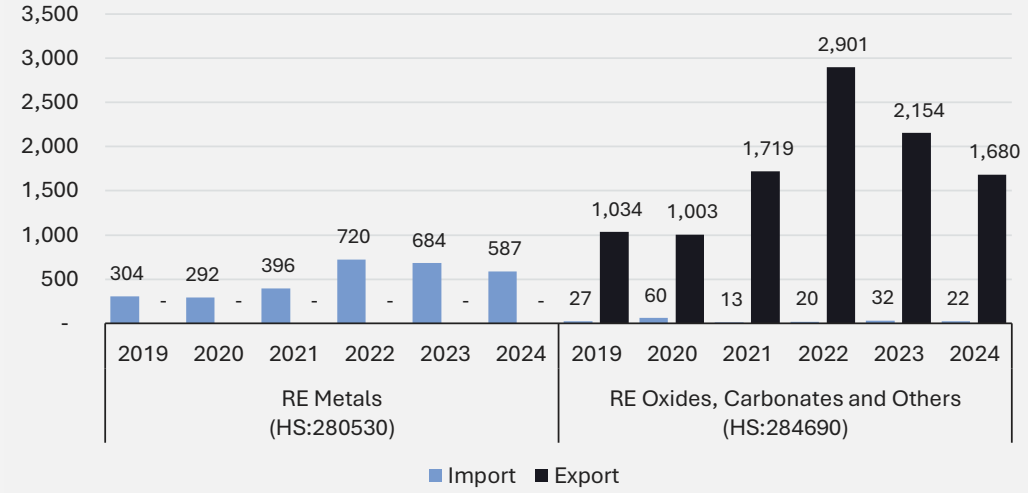
means ongoing trade tensions between the US, the EU and China would exacerbate long-term supply chain vulnerabilities, driving material prices higher. Global spending on renewables reached a record US$600 billion in 2022, reinforced by the EU's push to reduce energy dependence on Russia. Meanwhile, the US aims to develop a self-sufficient supply chain, a process that the RAND Corporation estimates will take 10–15 years,[14] creating a strategic window for Malaysia to position itself within global value chains.

1.2 Malaysia's industrial REE landscape

Malaysia hosts a unique position in the global RE value chain, specifically in the midstream separation phase. As Fig. 3 shows, globally, Malaysia is the second largest refiner after China, accounting for an estimated 5% of separated REOs in 2025. The Lynas Advanced Materials Plant (LAMP) in Gebeng produces a variety of both light and heavy REOs sourced from Mount Weld in Western Australia (total capacity of 22,000 tonnes per annum) and is one of the few vertically integrated REE processing facilities outside China.

Fig. 4. Malaysia's value-added export of REE oxides is substantial

Export and import values for REE sector (RM millions), HS 2022



Source: MATRADE database, 2025[15]

Malaysia's midstream strength is not, however, commensurate with its local upstream extraction capacity. There are few REE upstream operations (apart from a pilot project in Kenering), resulting in midstream concentration. In 2024, Malaysia imported RM586 million worth of RE metals (HS:280530), 99% of which originated from Australia, while exporting RM1.68 billion worth of oxides and concentrates (Fig. 4). The primary purchasers of this output are China and Japan, with the latter signing

an agreement with Lynas giving Japanese firms priority purchaser rights over the firm's growth capacity until 2038, guaranteeing Japanese access to Australian RE resources.[16] While this arrangement strengthens Malaysia's integration into global value chains, it also creates allocation constraints on domestic feedstock for downstream expansion, unless supported by targeted industrial partnerships.

Malaysian policymakers have indicated policy shifts toward developing local " non-radioactive" REE (NR-REE) mining, especially from the abundant ion-adsorption clay (IAC) deposits in Malaysia (estimated at 16.1 million metric tonnes),[17] which contain a higher concentration of heavy REEs, such as terbium and dysprosium (more valuable than light REEs). For context, these deposits are often described in policy documents as "non-radioactive" due to the perceived low presence of thorium and uranium[18] below regulatory thresholds. However, some studies have suggested that certain IAC deposits may contain levels of Naturally Occurring Radioactive Material (NORM) approaching or above this threshold[19,20].

To encourage the midstream and preserve natural resources, the government had imposed an export ban on unprocessed local REEs. However, a single Malaysian-incorporated company, MCRE Resources, was granted a special exemption permit to export a limited quantity of local RE carbonates (RECs) from its Kenering mine in Gerik for research purposes. Although Malaysian-owned, it has exclusive technical ties to China Rare Earth Corporation and is 36% owned by Qingdao Joyful Investment Co. Ltd[21]. Notably in 2025, Singapore's Southern Alliance Mining Ltd acquired a 40% equity stake in the firm[22], reflecting strategic multinational participation in the venture. Unlike Lynas, MCRE processes local IAC-derived carbonates, an intermediate upstream product yet to be separated into individual oxides, destined for Chinese midstream refiners (in 2024, MCRE exported 6,348 tonnes (worth RM174 million) of RECs).[23] In parallel, local firms are beginning to explore opportunities in midstream processing for Malaysian IAC-REEs. Notably, the Malaco Mining Group have announced ambitions to establish a domestic processing plant, with plans to integrate downstream development focusing on heavy REEs. Complementing these efforts, Khazanah Nasional has reportedly[24] initiated exploratory partnerships with foreign firms aimed at developing downstream capabilities[25]. Realising this capability however will require substantial investment and alignment in domestic feedstock, industrial research and commercial scale deployment.

1.3 Malaysia's role in global REE landscape, and opportunities for downstream development

According to estimates from the Ministry of Natural Resources, Environment and Sustainability (NRES), Malaysia's REE sector is projected to generate some RM91.9 billion in GDP contribution and 96,900 jobs by 2050, with most economic value and employment stemming from downstream activities.[26] It should be noted however that these estimates exclude potential shifts arising from the adoption of

artificial intelligence and robotics. While the industry is expected to depend initially on foreign partnerships, investment and expertise, a long-term transition toward a localised REE landscape is likely (see Appendix II for more details).

Domestic downstream processing yields significantly higher returns compared with primary REE exports, often exceeding multiples of the initial value.[27] Despite its potential, however, REE processing is both capital- and resource-intensive and, coupled with heavy global price competition, results in tightly controlled operating margins for midstream refiners. Due to such factors, a robust and cost-effective supply chain in upstream extraction for midstream feedstock is essential as a catalyst for full value chain development.

Nevertheless, Malaysia's landscape, while concentrated in the midstream, presents a strong case for downstream expansion in metallurgy, permanent magnet manufacturing and component fabrication. Table 1 broadly illustrates the full industrial ecosystem and investment opportunities, with major operations occupying the oxide separation phase. For Malaysia to unlock greater economic multipliers, it will require targeted efforts to expand both upstream capabilities for domestic use and investments into metallurgy, REE fabrication and magnet manufacturing for EV components.

Table 1. Malaysian industrial plans target downstream in REEs

Illustration of rare earth industrial ecosystem

Upstream mining		Midstream refining		Downstream industrials		
REE extraction	REE beneficiation	REE oxide production	REE metal and alloys	REE fabrication	REE-based products	End-use products
Exploration and mining	Magnetic separation	Oxide separation, refinement	Chemical processing, REE metallurgy	REE-based permanent magnets	Hard disks, sound systems	Consumer electronics (computers, handphones, AV systems)
Crushing and grinding - separating from rock	Chemical leaching and purification	Alloying with other metals (metallisation)		Catalysts for industrial application	EV motors, renewable electric generators	EV and hybrid cars, solar panels, wind turbines

Source: Adapted from "Blueprint for the establishment of rare earth-based industries in Malaysia", ASM[28]

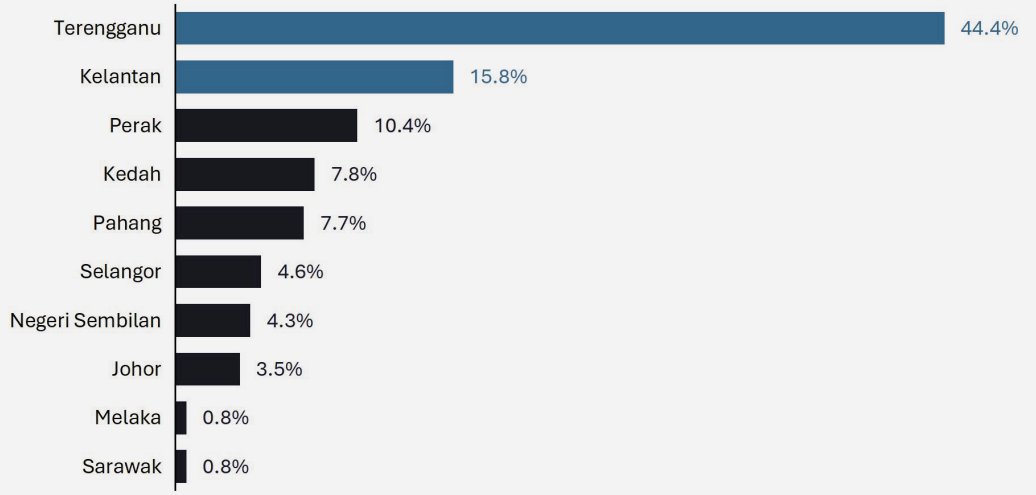
At the firm level, which primarily focuses on oxide exports, it should be noted that the economic spillovers of the LAMP are considerable. An economic assessment report estimated that the LAMP contributed RM970 million in GDP to the economy

in 2018, over RM400 million in local inter-industry purchases and 3.7% of Kuantan's total gross value addition.[29] Further, since 2024, several key MOUs have been signed, namely the Lynas-Kelantan upstream collaboration framework on the IAC processing of Mixed REC[30] and its agreement with South Korea's JS-Link to develop a plant capable of producing up to 3,000 tonnes of NdFeB magnets annually[31]. Besides this, on 26 October 2025, Malaysia signed a bilateral critical minerals MOU with the US aimed at strengthening cooperation and governance in the REE sector[32].

For state and local governments, the REE upstream is likewise fiscally attractive, as land- and mineral-related sources account for most state coffers.[33] According to the Invest Perak board, in 2023, Perak collected RM40 million (half from royalties) in revenue from the Kenering REE mine.[34] However, export leakages remain a concern. In a parliamentary reply, former NRES Minister Nik Nazmi reported that of the 19,081 tonnes of local REs exported, an estimated 16,000 tonnes (84%) were exported illegally.[35] If these exports were legally taxed, state earnings could have reached RM250 million. IAC deposits are also relatively geographically dispersed, with Perak, Kedah, Terengganu and Kelantan accounting for over 75% of inferred REE deposits (see Fig. 5). This gives state governments strong fiscal incentives to expand mining operations but likewise highlights the need for federal-state coordination and robust institutional and environmental frameworks, as many deposits lie in forest reserves.

Fig. 5. Malaysia's east coast contains over 60% of inferred REE potential

Percent share (%) of REE reserves in Malaysia by state in tonnes



Source: JMG via The Edge[36]

Internationally, Malaysia is also emerging as an important non-China supplier in the diversifying global value chain. In 2024, the US Geological Survey reported that Malaysia supplied about 13% of US REO imports,[37] reflecting an upward trend since the start of US-China trade tensions. Nevertheless, for Malaysia to capture full-cycle permanent magnet value chains, the domestic capacity to both attract and drive domestic investment to transform refined oxides into metals, alloys and magnets is needed.

2.0 Overview of Malaysia's REE regulatory landscape

The governance of mineral resources in Malaysia, including REEs, is rooted in the Federal Constitution, wherein the Ninth Schedule (List II - State List) places land management, vetting of ownership, fees and mining rights within the powers of the respective state governments. Federally, the Mineral Development Act 1994 empowers the Department of Minerals and Geoscience (*Jabatan Mineral dan Geosains*, or JMG) under the NRES to regulate, inspect and monitor mine exploration at the macro-level, while the issuance of licenses for exploration and land use remains under state jurisdiction. In this vein, the JMG sets the bar in establishing technical standards, advises on geological suitability and coordinates cross-border mineral policies.

Despite this, the governance of upstream mining activities is shaped by regulatory bodies at multiple levels (Appendix I). In practice, developing a mine requires several principal activities, including conducting a feasibility study, designing the mine, acquiring mineral rights, filing an Environmental Impact Assessment (EIA) report and preparing the site. Initial prospecting and exploration are typically regulated by state authorities, operationalised through their respective State Mineral Enactments (through the state director of land and mines) to issue licenses and leases and oversee mining-related activities.

2.1 Standard operating procedures and regulations on mining

To prevent unregulated development, on 20 December 2023, the NRES introduced and circulated standard operating procedures (SOPs) to state governments that covers the exploration, mining and post-mining phases of REE mining.[38] The SOPs reinforce the moratorium on unprocessed REE exports, announced concurrently with its rollout.[39] This means that, in practice, any company awarded an NR-REE mining license must also plan for local processing or obtain a special permission to export. Currently, only one such permit was granted to a pilot project in Kenering; no other projects have been allowed to ship unprocessed REEs abroad.[40] However, as land and mining rights are wholly state matters, the SOPs' implementation depends heavily on state-level buy-in. By late 2024, only a handful of states were receptive to the guidelines, seeing them as necessary for securing REE projects (Table 2).

Table 2. State-level adoption of NR-REE SOPs

State	Estimated amount of REEs (tonnes, share (%) of total)	SOP adoption status	Activities
Perak	1.69 (10.4%)	Adopted	Implemented pilot project in Hulu Perak
Pahang	1.25 (7.7%)	Adopted	Approved 220 hectares in Sungai Wang for NR-REE mining
Negeri Sembilan	0.69 (4.3%)	Adopted	Approved two sites totalling 400 hectares for NR-REE mining
Kedah	1.26 (7.8%)	Pending	SOP under consideration; no adoption as of May 2025
Kelantan	2.56 (15.8%)	Not Adopted	No official adoption reported
Terengganu	7.19 (44.4%)	Not Adopted	No official adoption reported
Johor	0.56 (3.5%)	Not Adopted	No official adoption reported
Selangor	0.75 (4.6%)	Not Adopted	No official adoption reported
Sarawak	0.13 (0.8%)	Not Adopted	No official adoption reported

Source: The Edge,[41] FMT,[42] SOP of NR-REE Mining in the State of Perak[43] and Negeri Sembilan[44]

The NE-REE SOPs set detailed technical and procedural standards covering all critical areas in the value chain, aiming to prevent unregulated mining and ecological spillovers and ensure controlled development. Chiefly, environmental safeguards and monitoring systems are reinforced to mitigate the risk of ecological and water contamination linked to in-situ leaching (ISL), mandating EIAs and monitoring leachate chemistry and rehabilitation plans. However, it is worth noting that by May 2025, only Perak, Pahang and Negeri Sembilan have adopted the SOPs, while key resource-rich states (Terengganu and Kelantan) had not, hinting at federal-state tensions involving the political economy of mineral development.

2.2 Environmental regulations and policies

Mining activities are governed by the Mineral Development Act 1994 under the JMG, which requires operators to submit an Operational Mining Scheme (OMS) outlining extraction methods and safety, environmental and rehabilitation plans. While federal inspectors oversee compliance, enforcement often involves state authorities with their own mining laws, such as Kedah's Mineral Enactment 2004.[45] Although the National Mineral Council was revived to harmonise these laws, alignment remains voluntary as mineral rights are constitutionally vested within a state's purview.

Environmental regulations are anchored in the Environmental Quality Act 1974 (EQA) and enforced by the Department of Environment (DOE), criminalising the release of pollutants into air, water or soil beyond prescribed limits without proper authorisation. Crucially, Section 34A of the EQA empowers the government to require an EIA for all proscribed activities. By 2015, the EIA Order was updated to include in-situ

leaching and projects with potential radioactive discharge, closing previous loopholes and ensuring REE projects undergo rigorous assessment.[46] The DOE's approval often requires specific conditions, including limits on effluent discharge, monitoring wells and post-closure rehabilitation plans.

Under the EQA and the Atomic Energy Licensing Act (AELA), scheduled wastes from REE refining (particularly those containing thorium) are tightly regulated for labelling, storage, transport and isolation to prevent contamination. Permanent disposal facilities (PDFs) are required for long-term containment, while byproducts, such as neutralisation underflow show reuse potential in construction and agriculture, though a large-scale application remains under debate. Lynas's operations serve as a key case study. Its cracking and leaching process generate thorium-bearing residue typically exceeding the regulatory radioactive threshold of 1 Bq/g for NORM[47,48], estimated at around 6 Bq/g[49], although some sources claim a higher figure due to differing methodologies and assumptions accounting for radionuclide decay-chain effects[50,51,52]. Despite running above AELB's regulatory threshold, Lynas operates within International Atomic Energy Agency (IAEA) safety standards[53,54] and the firm is required to store such residues in PDFs and invest in research on thorium treatment and commercialisation. Due to the high regulatory bar set by regulators, global investors in REE downstream operations will see this case as an important benchmark for its investment prospects in Malaysia, meanwhile, amendments to the AELA in September 2025 may likewise augur well for investors.

The emerging focus, however, is on the ISL of IAC deposits. Unlike open-pit mining, ISL avoids large-scale excavation and tailings by desorbing the minerals underground. In the Kenering pilot project, a diluted ammonium sulphate solution is injected into the soil to recover REE ions from clay particles.[55] The enriched solution is then pumped through a network of wells and processed into lanthanide carbonates. This technique generates minimal solid waste generation, since ore bodies are not physically excavated. According to the JMG, the pilot project minimises land clearing and tree felling,[56] with audits to ensure compliance with local regulations. In addition, emerging extraction technologies, such as circular harvesting, developed in Brazil by Aclara Resources, offer promising low-impact alternatives by using rotational extraction, where land is sequentially leached, harvested and rehabilitated in small zones, reducing environmental and chemical footprints through localised control,[57] particularly suitable for high-rainfall, tropical climates.

2.3 Malaysia's economic policies related to REE development

Malaysia is positioning itself as a preferred destination for downstream high-value investment by offering tax incentives targeted at strategically important sectors. Four primary schemes apply to REE projects: Pioneer Status (PS) and Investment Tax Allowance (ITA),[58] Reinvestment Tax Allowance and Accelerated Tax Allowance schemes (Table 3).

Table 3. Tax incentives available for REE projects

Stage	Incentive scheme	Description	Eligibility	Duration	Key benefits
Initial investment period	Pioneer Status (PS)	Income tax exemption on statutory	Suitable for firms expecting early profits	5–0 years	70%–100% income tax exemption. Losses can be carried forward for 7 years.
	Investment Tax Allowance (ITA)	Tax allowance on qualifying capital expenditure	Ideal for firms with large CAPEX and slower returns	5–10 years	60%–100% allowance on capital expenditure, offset against statutory income.
Post-initial period	Reinvestment Allowance (RA)	Encourages reinvestment after initial incentives expire	Must operate for at least 3 years	Up to 15 years	60% capital expenditure allowance, offset up to 70% of statutory income.
Long-term support	Accelerated Capital Allowance (ACA)	Faster write-off capital expenditure to improve cash flow	Claimable after RA is fully exhausted	3 years	40% in Year 1, 20% in Years 2 and 3. Shorter duration, but supports cash flow

Source: Malaysian Investment Development Authority (2024)[59]

Firms may also apply under either the Incentive for Strategic Projects or Incentive for High Technology.[60] While REE projects may qualify under either category, depending on their position in the value chain, the Incentive for Strategic Projects offers more favourable benefits, which includes a 100% investment tax allowance and a 10-year Pioneer Status period, making this the more lucrative option.[61] However, it is crucial to note that only one incentive category may be selected for a given REE activity (simultaneous applications are prohibited). Together, these schemes create a strong continuum of incentives and support for REE sector development.

A notable feature of Malaysia's REE policy is its decentralised royalty tax. Malaysia permits its states to dictate their own royalty tax structures for mining. According to the National Tax Research Centre, a standard rate of 5% on the market value is charged on extracted metallic minerals, including REEs.[62] However, under Article 110 of the Federal Constitution, states are allowed to customise rates for individual minerals.[63] Evidence finds that, at the extreme, some states use this discretion to propose royalty rates as high as 50%,[64] though these cases remain exceptions. Consequently, the cost structures of mining projects may be subject to state-level uncertainty.

To secure domestic supply and foster local midstream capacity, the Malaysian government announced an export moratorium for unbeneficiated REEs[65] (except for approved operators). While this policy aims to incentivise domestic midstream refining, few sufficiently scaled local pathways for export has left upstream mining less economical. Strengthening industrial and commercial partnerships between local and foreign firms could help establish such capabilities, for instance, the MOU signed between Malaco Sdn Bhd and the French company Carester in July 2025 to support the development of Malaysia's REE industry, align with ESG principles and advancing Malaysia's green agenda.[66]

3.0 Gap identification, challenges and policy analysis

While the NR-REE SOPs create a structured and accountable mining framework, stakeholder consultation reveals operational gaps and challenges. Interviews with federal, state and private sector players indicate practical constraints in coordination capacity, technological expertise and industrial fragmentation that continue to hinder full-cycle development. These insights form the basis for identifying key regulatory and institutional gaps in REE governance.

3.1 Fragmented jurisdiction and coordination deficit

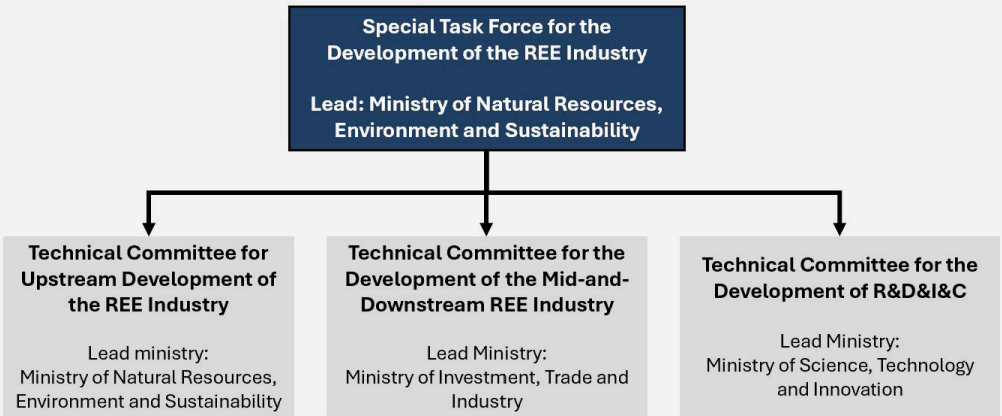
Malaysia's ambition to develop a globally competitive REE sector faces a disjointed governance structure between federal and state authorities and agencies. Stakeholder interviews indicate that, while federal policymakers envision an integrated REE value chain that supports downstream industrialisation, control over upstream mining activities is constitutionally vested with state governments, impacting end-to-end supply chain resilience. Stakeholders also noted that federal authorities have not been consulted over the details of partnerships involving states and foreign companies. Moreover, crucial data are often kept within the respective body. This forms an imbalance that impairs Malaysia's ability to effectively coordinate an REE strategy and risks creating various disconnected state-level projects.

The REE institutional architecture has limited mechanisms for federal-state coordination, as stakeholders indicate that the top-down approach lacks an

institutionalised "clearing house" capable of resolving jurisdictional frictions. The Special Task Force for the Development of the Rare Earths Industry (henceforth referred to as the REE Special Task Force) in Malaysia, spearheaded by the NRES, comprises the ministers, chief secretaries and secretaries of the treasury of the Ministry of Investment, Trade and Industry (MITI); the Ministry of Science, Technology and Innovation (MOSTI); the Ministry of Finance and the Ministry of Economy, as well as the director of the JMG, with technical committees outlined in Fig. 6, and while it was formed to streamline regulation, stakeholders indicate that it runs in parallel to, rather than in concert with, the National Mineral Council, impacting its ability to align with key resource-rich states for upstream development. Investment facilitation had also been vested in various bodies, such as the East Coast Economic Region Development Council, which, despite strong investor engagement, has limited statutory authority. This fragmentation also extends to approvals, where overlapping mandates and duplication between the DOE and the JMG have caused delays. Stakeholders suggest integrating the JMG's technical expertise directly into the DOE's EIA process for upstream mining projects to improve coordination and review cycles.

Midstream refining compounds existing governance gaps, as there is no dedicated framework governing refining and separation activities. While the SOPs for upstream ISL operations are available, no equivalent guideline addresses specific waste disposal and circular recycling of REE processing by-products, and enforcement is based on self-reporting. This means that, while state governments control land and minerals, refining falls under federal oversight, creating an unintegrated upstream-midstream coordination mechanism crucial for REE export readiness. Such fragmentation undermines Malaysia's ability to ensure both commercial and ESG viability of its REE value chain. Unifying the governance framework linking exploration, mining, processing and ecological management under a single coordinating structure is vital.

Fig. 6. Technical committees of the Special Task Force for the Development of the REE Industry



Source: Internal government briefing document[67]

3.2 Strategic input and supply chain vulnerabilities

Malaysia's REE refining industry, while centred on the LAMP, faces critical vulnerabilities arising from a dependence on strategic inputs. Although the LAMP sources a sizable amount from local chemical producers, the facility also relies on foreign suppliers for critical speciality chemicals indispensable to produce high-purity levels required for commercial REEs. Heightened geoeconomic tensions resulting in shifts in global industrial policies could leave Malaysia exposed to external shocks beyond its control. These risks are compounded by technological dependence, as capabilities remain tied to foreign expertise, limiting Malaysia's ability to scale domestic upstream potential before investment windows narrow.

Simultaneously, questions persist about the sufficiency of Malaysia's REE resource base to support large-scale refining. Current reserve estimates rely largely on inferred indicative surveys, as a comprehensive nationwide geological examination has yet to be conducted due to cost constraints, estimated at RM200,000 per square kilometre.[68] This suggests a need to expand investment pathways for global venture capital for mineral exploration. Importantly, it should be noted that, as mineral exploration activity increases, additional deposits could be identified, potentially revising current inferred estimates upward. In this vein, Malaysia's Budget 2026 allocates RM10 million for REE resource mapping in high-potential areas, alongside support for joint industrial ventures led by Khazanah.[69]

3.3 Weak industrial integration and lack of REE industrial clustering

Critically, Malaysia currently lacks an upstream that can produce at scale and has yet to develop entrenched domestic capacity for IAC-REE metallisation, a vital step before converting IAC-REEs into usable products. Despite hosting one of the world's largest processing facilities, there are few existing local pathways from midstream to downstream manufacturing in permanent magnets, alloy production and batteries and its components due to supply arrangements between Lynas and its Japanese partners.[70] This could impact the availability of domestic REOs for local downstream development in the absence of integrated investments.

The nascency of horizontal integration deepens these challenges. Unlike established oil and gas clusters, the REE industry lacks established and operating industrial parks where research, refining and metallisation are co-located. This hampers current synergies with existing domestic industries in green technologies, EVs and batteries, while raising transaction costs and missed opportunities for knowledge spillovers that drive industrial competitiveness. While Malaysia had historically lacked horizontal integration, recent developments, notably the JS Link-Lynas partnership, signal early yet proactive steps toward onshoring such linkages. Until such supply chains are fully operationalised, efforts to deliberately integrate

industrial clusters will be essential to positioning Malaysia as a hub for end-to-end manufacturing.

3.4 Talent and R&D disparity

The REE sector faces significant R&D and talent constraints, particularly in IAC-REE geology, refining, metallurgy and mining engineering. The shortage of specialised expertise has meant historic reliance on foreign partners to bridge technological and research gaps. Stakeholder consultations indicate that, while upstream interest is strong, most firms lack the extraction technology and expertise necessary to operationalise mining projects. These are amplified by high analysis costs (up to RM6 million for sampling and RM12 million for a 5,000-acre site), creating high barriers to entry for local firms.

The capital-intensive nature of R&D also limits SME participation without targeted support to attract venture capital and create industrial "plug-in" pathways. The National Capital Region Technology and Innovation Sector has introduced grants covering up to 50% of project costs, while the Malaysian Industry–Government Group for High Technology (MIGHT) and local universities are working toward building a sustained talent pipeline. However, stakeholders affirmed that local research remains fragmented, with limited data-sharing between research institutes and a weak alignment with industrial needs, undermining Malaysia's capacity to pioneer environmentally sustainable upstream and downstream technologies. Sustainability research, such as green hydrometallurgy, reagent recycling and effluent treatment, also remains underdeveloped in grant priorities, leaving potential ESG-aligned innovations disconnected from industry use. Building a robust sustainability ecosystem will require deliberate investment and stronger collaboration in the industrial strategy.

3.5 Environmental impacts and land-use conflicts

Developing rare earth resources in Malaysia poses environmental and land-use dilemmas, as many deposits often overlap with sensitive ecosystems and community lands (Fig. 7). The federal policy nominally prohibits mining in gazetted Permanent Forest Reserves (PFRs), with the NRES affirming that no mining is to take place in these areas. However, Section 13(1) of the National Forestry Act 1984 stipulates that state governments may excise land from PFRs through a gazette notification, legally removing the conservation status for extractive purposes. This creates a development-conservation governance dilemma. Federal authorities warn that opening forest areas would undermine conservation pledges (albeit non-binding), including Malaysia's pledge to maintain 50% forest cover, while states under fiscal pressure view untapped minerals as a revenue source.

Stakeholders estimate that only 18.8% of estimated reserves are minable outside PFRs, sharpening the trade-off between exploitation and conservation. The challenge is compounded by the geological reality that ISL mining is best suited for hillslopes, many of which fall in PFRs. There is a possibility that as accessible sites deplete, the pressure to degazette PFRs may intensify. Existing mechanisms exist, such as Ecological Fiscal Transfer (EFTs), which aim to incentivise states to improve biodiversity conservation and establish new protected areas – the more states conserve, the more funds will be disbursed. However, states are only allowed to utilise EFTs for conservation-related efforts rather than for development purposes. This technicality could make EFTs less attractive if mining projects project greater returns.

Unregulated ISL carry hidden dangers, such as chemical leaching, which can migrate and contaminate soil and groundwater if not tightly monitored and controlled.[71] As land and mineral policing falls primarily under state jurisdiction, states face the dual challenge of deterring illegal operators and balancing conservation against fiscal incentives for resource exploitation.

Fig. 7. Map overlay of REE deposits and Permanent Forest Reserves

Source: "Garis panduan ekplorasi unsur nadir bumi [Guidelines for the exploration of rare earth elements]", JMG[72]

Stakeholders emphasised that ESG frameworks for mining operations remain underapplied and unevenly enforced, particularly outside listed companies. Though ESG compliance has become a prerequisite for international market access,[73] most upstream miners fall outside Bursa Malaysia's Sustainability Reporting Framework, which applies to listed entities. This inconsistency potentially exposes exporters to market and reputational risk in key markets. The Orang Asli blockade in Kampung Pos Lanai in 2021 against a planned rare earth mine[74] illustrates the importance of managing social impacts that can escalate into global reputational risk if such output is exported.

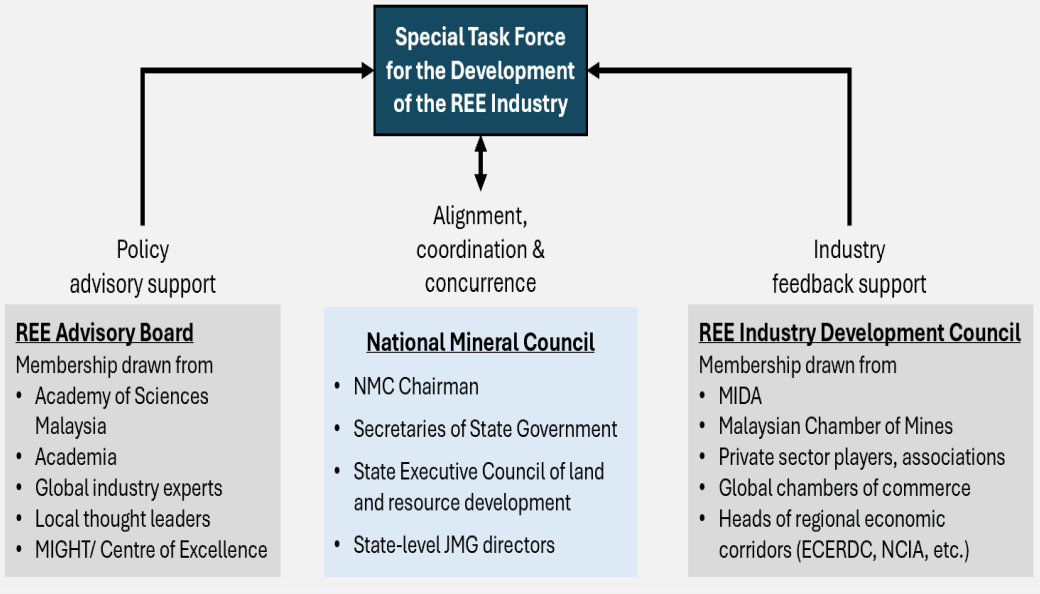
4.0 Policy recommendations

4.1 Strengthening governance and institutional architecture

4.1.1 Enhancing institutional depth and coordination alignment of REE Special Task Force

Government stakeholders have emphasised integrating the federal framework within an inclusive and representative mechanism with state agencies. This requires alignment between the REE Special Task Force and the National Mineral Council (NMC) under a framework that both aligns with federal priorities, while avoiding a top-down approach.

Fig. 8. Proposed institutional deepening for the Special Task Force for the Development of the REE Industry in Malaysia



A proposed redesign of the REE Special Task Force offers a structured, multi-stakeholder and bottom-up approach in response to coordination gaps, in a shared framework of federal and state authorities. The membership makeup of the REE Special Task Force could remain, but the formal mechanisms for input and alignment may be expanded. This approach attempts to address shortfalls by reducing policy and information silos, enhancing federal-state alignment on REE policies and creating a space for public-private dialogue.

The expanded REE Special Task Force must prioritise bridging the long-standing institutional gaps by creating a shared platform for dialogue, alignment and consensus-building between federal and state authorities for land and REE mining matters through the NMC. As the NMC is the formal body mandated to coordinate federal-state mineral policies, proposals developed under the REE Task Force should be consulted by and tabled for NMC endorsement to enhance federal-state coordination and coherence. Direct engagement with state governments on licensing, land use and fair mining rents would reduce jurisdictional friction. It should also be noted that stakeholders emphasise the adoption of an enabling and collaborative approach to state mining rights by federal bodies to better encourage alignment with state agencies.

A combined top-down and bottom-up approach would accelerate federal-level investment policy execution, while engagement with state governments would ease bottlenecks in licensing, land access and regulatory compliance. This effort should be supported by regular joint JMG-NRES meetings to harmonise standards for sustainable mineral development, mining rights and transparency in line with national priorities.

Establishing an REE Advisory Board offers independent technical rigour

As the REE sector is highly technical, rapidly evolving and deeply connected to international supply chains, Malaysia's ability to capture value depends on the continuous flow of specialist knowledge on policy coordination. An REE Advisory Board would institutionalise this expertise by convening both local and international specialists (potentially including those from the IAEA, IEA, critical mineral centres of excellence, etc.) in geology, metallurgy, market and supply chain intelligence. The Board's role would be to provide non-binding evidence-based recommendations and independent policy critiques to enhance industry development, while maintaining strong sustainability and environmental safeguards.

Beyond the technical input, the Advisory Board would serve to strengthen Malaysia's credibility with international partners by embedding technical soundness in the policy-making process. Reporting directly to the REE Special Task Force secretariat (the NRES), it would allow independent review of policies before implementation, assess current and planned industrial policies and regulations and anticipate market and technological shifts to guide domestic R&D priorities.

Creating an REE Industry Development Council would provide market legitimacy through private sector feedback

This multi-stakeholder council would provide an institutional platform for market-informed policy formulation and regulatory alignment with the needs of the industry. Consolidating representations from private, regional development bodies and the MIDA would allow the council to integrate evolving industrial perspectives as global trends shift, helping align standards, cement offtake commitments and investment priorities. Furthermore, including local associations and international chambers of commerce would allow the government to quickly signal policy changes and bridge communication gaps with international investors and venture capital.

4.1.2 Outlining a structured governance framework for refiners

Stakeholders emphasised the need for clear and predictable midstream regulations and horizons. This paper does not take a position on any individual operator but highlights the need for science-based, predictable waste handling for all midstream operators. This scenario approaches the question of sector-wide governance rather than viewing at the firm level. To this end, license considerations should ensure that operational certainty is accompanied by strict environmental safeguards. Leveraging the REE Advisory Board proposed in Recommendation 4.1.1, formalising important criteria and requirements related to waste and residue handling, disposal and management would strengthen international regulatory clarity and credibility, help allay investor concerns on the continuity of midstream operations and encourage downstream competitiveness.

Consider progressive renewal of REE refining licenses contingent on compliance with defined criteria

To signal operational certainty, a strategic progressive renewal license with formal mechanisms tied to annual compliance audits could be considered. This aims to strike a balance between investor certainty, while preserving the primacy of regulatory authorities. Functionally, this means operating licenses are easily renewed/ rolled over without a full reapplication over time if the firm passes set criteria, which could potentially include:

- Quarterly operational reports and compliance audits on conditions set by regulatory authorities.
- Independent baseline environmental and radiological safety verification.
- Validated waste extraction facilities and PDFs (if applicable) with accredited third-party verification, proof of financing and approved designs.
- No major safety incidents involving staff or public health.
- Financial assurance thresholds are met.
- Independent auditing and verification of waste management standards.

- Clear revocation/stop-work order triggers, such as sustained exceedance of waste management standards and fraud/non-compliance auditing.
- Community engagement and robust grievance mechanisms.

This option allows for a clear operational framework, while retaining strong regulatory mandates. If conditions are not met during annual reviews, the license automatically lapses or restrictions apply. Regulators may further develop approvals tied to specific feedstock from an identified and traceable mine linked exclusively for the license holder and owned facilities, subject to enforceable license conditions. As a baseline, criteria should be observed under a minimum three-year period. These processes and criteria must be predictable, scientific and aligned with international best practice while being free from political or commercial bias. After fulfilling all necessary operational and environmental criteria, firms may qualify for longer tenures once benchmarks have been consistently met. Amendments to the AELA offers policy space to simultaneously strengthen oversight requirements and lengthen operational licenses for qualifying firms that consistently meet mandated safety standards.

Regulators must also address the issue of waste management and reuse, especially in cases where radioactive material is present. Thorium management has been a recurring global challenge in REE refining. In earlier regulatory debates, one approach considered was the extraction and commercialisation of the element. However, given the nascency of the global thorium market and its limited immediate uses, a more pragmatic approach should emphasise safe immobilisation supported by sustained R&D partnerships and international cooperation for thorium's use in nuclear fuel and energy, in line with the government's energy ambitions.[75] This allows regulators to formalise technical cooperation with the REE Advisory Board, industry operators and international agencies (such as the IAEA or through bilateral engagements), preventing "stranded thorium" stockpiles. Further, licenses could be designed to balance operational certainty with time-bound and conditional milestones to avoid global supply chain disruption, such as on the sufficient completion of PDFs and waste reduction milestones. Nevertheless, such decisions rest exclusively in the hands of relevant regulators.

4.1.3 Reviewing and consolidating institutional coordination mechanisms in environmental management

Stakeholders have highlighted the fragmented jurisdiction and inconsistent enforcement between federal and state authorities that continue to hinder effective oversight of REE projects.

To address this, a review panel under the National Mineral Council could be established with a mandate to review REE project proposals (at the pre-development stage before the EIA and OMS application processes) and resolve disputes in policy implementation.

This mechanism should function as an integrated review panel, similar to Canada's joint review panels for projects that fall under both federal and provincial jurisdiction, i.e., a single integrated review process with members appointed by both levels of government. Complementing this, state-level participation in joint-enforcement task forces should be formalised.

In parallel, current fiscal mechanisms that underpin environmental protection should be re-examined by the review panel. The cost-benefit effectiveness of EFTs should be reviewed to better balance conservation with state development needs. The use of EFTs should be expanded for state development to offset the opportunity costs from the restriction of the degazettement of forest areas.

The review panel could also oversee the coordination of enforcement. As on-the-ground detection is often performed by state authorities, the panel should ensure federal agencies formally enlist state forestry and land officers through joint enforcement task forces. This both addresses concerns over the DOE's manpower and improves monitoring of remote sites. States should also be equipped with basic water-quality monitoring tools to feed data into federal databases, ensuring polluters are consistently sanctioned.

4.1.4 Streamline EIA and OMS approval process

To ensure environmental integrity and administrative efficiency, Malaysia should adopt a harmonised framework that integrates environmental and mining assessments for REE projects. A unified approach should streamline approval, reduce duplication and enhance coordination between regulatory authorities (the DOE, the JMG and the state). Australia's Environmental Protection and Biodiversity Conservation (EPBC) Act provides a useful reference on how bilateral federal and state assessments enable a "one project, one assessment" model that satisfies both criteria.

Policy option 1: JMG-led integrated assessment framework

Under this model option, the EQA could be amended to designate the JMG as the lead agency for mining-related EIAs, allowing concurrent evaluation of both the OMS and environmental assessment. This would allow geological, operational and environmental considerations to be reviewed holistically rather than sequentially. To operationalise this option, the JMG should develop REE-specific criteria in consultation with the DOE and state governments, ensuring that environmental safeguards and requirements are consistent with federal standards. This approach, although administratively difficult, leverages the JMG's technical and geological expertise, while reducing duplication. Robust capacity-building and institutional safeguards (dual accountability mechanisms) are likewise required to prevent dilution of the DOE's environmental oversight functions.

Policy option 2: Joint DOE–JMG assessment and approval mechanism

An alternative approach would be to formalise a joint DOE–JMG review and approval committee at the state and federal levels. This option would not require primary legislative amendments but would require institutional collaboration in assessment and monitoring.

The following falls under this arrangement:

- EIA submissions for REE projects are jointly reviewed by DOE and JMG representatives from both federal and state governments.
- Data and baseline studies will be jointly shared across agencies through a centralised digital platform.
- Public consultation and hearings are conducted jointly to satisfy both jurisdictions.
- Post-approval monitoring and enforcement are collaboratively conducted, ensuring dual accountability for environmental and operational compliance.

To ensure effectiveness, this framework should be supported by clear terms of reference, dispute-resolution processes and capacity development for cross-disciplinary expertise. Over time, this model could evolve into a formalised Federal-State REE Project Assessment Panel. This model is similar to Australia's EPBC, hence reducing bureaucratic fragmentation, while maintaining environmental oversight.

4.1.5 Developing global research cooperation ties through a unified centre of excellence

A proposed unified centre of excellence (COE) for REE development under the MIGHT/MOSTI would unify and pool research capabilities under a single national strategy, serve as a platform for international collaboration and private sector engagement and promote investment into capital-intensive projects beyond the reach of a single institution. A central focus should be on developing the technologies needed to both sustainably mine upstream REEs and achieve globally competitive benchmarks for REOs and metallurgy in line with global ISO requirements, which are essential for entry into high-value markets in permanent magnets, advanced manufacturing and green energy technologies.

Positioning the COE as the nexus for global research cooperation with leading research hubs and industry players would enable knowledge transfers and capacity building and encourage long-term industry development. For instance, potential cooperation with international organisations, such as Canada's Critical Minerals Centre of Excellence, Japan's Organisation for Metals and Energy Security (JOGMEC), and South Korea's Korea Mine Rehabilitation and Mineral Resources Corp (KOMIR), can help organise national research agendas and foster global partnerships based on Malaysia's industrial competitive advantages.

4.2 Managing environmental risks and promoting sustainability

4.2.1 Institutionalising "free, prior and informed consent" to strengthen sustainability and community trust

To ensure meaningful participation, the DOE and state authorities should strengthen the principle of free, prior and informed consent (FPIC) in the emerging Social Impact Assessment framework, ensuring that residents are involved in project scoping, given access to project assessments and function as a continuous engagement mechanism throughout the project lifecycle. Dedicated community liaison units within state regulatory agencies could be tasked with FPIC compliance, reducing the burden on existing regulatory officers.

Indeed, policymakers could pilot a National FPIC guideline for the REE sector, establishing protocols for project-level implementation, documentation and conflict resolution through the REE Advisory Board in Recommendation 4.1.1, with the support of state leaders through the NMC. In addition to current consultations on revenue-sharing models with state leaders, FPIC guidelines should also incorporate an engagement strategy with both state and local communities. This would develop a beneficial shared guideline that allocates a portion of mining royalties or profits to the local community, giving them a stake in projects through mandatory Corporate Social Responsibility partnerships with local NGOs and enterprises.

4.2.2 Enhancing traceability and chain of custody in REE supply chain

Malaysia's REE industry risks losing access to ESG-aligned markets without credible proof of responsible sourcing. Malaysia should strengthen traceability across its REE supply chain to secure access to high-value ESG-aligned markets. A robust traceability system would capture both ESG performance and align Malaysia closer with global frameworks, such as the EU's Critical Raw Minerals Act.[76]

To achieve this, a government-led digital chain-of-custody platform should be created to trace every stage of REE production and shipment. This would provide end-to-end assurance and proof of origin from sustainable sources, while meeting global market requirements, akin to a digital product passport. The platform should be integrated with Malaysia's existing i-ESG and, alongside the development of the MySMI framework, could strengthen compliance and ensure local producers can participate in ESG-compliant supply chains – thus, standardising due diligence and reporting mechanisms across the industry including non-public-listed entities.[77] Simultaneously, REE firms should be encouraged to enhance credibility in international supply chains by seeking the Initiative for Responsible Mining Assurance certification,[78] which uses third-party auditing standards, while disclosing sustainability measures. As such, independent certification and reporting

would help demonstrate that Malaysian REEs are responsibly sourced, reinforcing market access and investor confidence.

On the regional level, Malaysia should leverage the ASEAN Mineral Cooperation Framework to advance shared ESG standards and interoperability traceability systems. This would position Malaysia as a regional leader in responsible mineral governance and sustainable supply chain innovation.

4.2.3 Consistently updating technical waste management standards through multilateral cooperation

In line with the proposed establishment of a COE and pursuing multilateral partnerships, Malaysia should leverage partnerships with other global institutions and technical experts. Potential collaboration with Canadian, South Korean and Japanese centres of excellence, coupled with global institutes, such as the International Council on Mining and Metals, is essential to develop harmonised standards that align with international guidelines, hence ensuring environmental protection, while providing operational clarity to investors.

A multilateral approach could, for example, involve a joint Malaysia-Australia research compact that determines long-term solutions for waste management. This could involve joint co-funding research with mutual COEs to explore the pathways available for circular economy reuse to create additional economic value. To ensure independence, joint research must include international experts from partner COEs and other internationally reputable experts. Such research should develop a set of quantitative, science-based criteria that could help serve the JMG and DOE in determining holistic benchmarks for a successfully rehabilitated mine site, covering soil, water and ecological parameters.

Regulators should also translate these standards into enforceable financial and technical requirements, ensuring that waste facilities are properly sited and backed by credible assurance mechanisms. Stakeholders emphasise that regulators should codify minimum engineering requirements for all REE waste storage and disposal facilities for refiners, which include specifications for containment systems, covers and protection buffers. Firmly entrenched sitting criteria should be established to avoid ecologically sensitive areas and ensure compatibility with local geology and hydrology (in cases involving ISL mining).

The proposed COE should not only provide policy support but also develop and disseminate sustainable techniques for IAC mining. Partnerships and exchanges with international institutes and established COEs, such as with JOGMEC and KOMIR,

could facilitate training programmes for JMG officers, industry staff and university graduates in IAC-REE geology and mining engineering. This would allow graduates in the latter to transition immediately into exploration and mining projects, filling the talent gap, while embedding global best practices.

Furthermore, to address chemical waste from REE processing, the DOE and the JMG should drive the development and adoption of best available techniques in REE refining to minimise waste, similar to guidelines created for petrochemical waste.[79] Incentives, such as R&D grants, tax breaks or a dedicated Clean REE Technology Fund, can accelerate innovation in solvent recycling, green hydrometallurgy and zero-liquid discharge systems. Companies that adopt such low-waste methods could be rewarded with expedited approvals or qualify for special green certificates, while discharge standards are progressively tightened to phase out high-pollution techniques. A waste-reduction tax credit, tied to demonstrable cuts in per-unit waste generation, could further drive industry adoption.

4.2.4 Developing circular economy framework for REE production

A circular economy framework is essential to close the material loop. REE processing produces substantial volumes of secondary materials that, if properly managed, can be reintegrated into the production cycles of other sectors, such as construction and agriculture, hence improving economic efficiency and sustainability. Currently, Malaysia lacks a structured framework to recover, recycle and repurpose secondary by-products from REE processing, with most residue classified as waste rather than potential inputs for reuse in other sectors. With that, efforts are underway to develop guidelines to reclassify scheduled waste as reusable minerals that could be repurposed into roadwork materials and cement additives.

Improving research coordination through the proposed COE in Recommendation 4.1.5 can drive the development of recovery technologies for further downstream industrial use. Complementary measures, such as inter-ministerial regulatory fast-tracking for projects involving non-radioactive materials reuse and a voluntary “circular economy compliance” label for firms meeting verified sustainability benchmarks, can further advance circular economy objectives. Such measures would also support the creation of high-skilled green jobs in recycling technologies, material sciences and sustainable process engineering and auditing.

4.3 Enhancing industrial pathways and economic development

4.3.1 Developing pathway for global venture capitals in mineral exploration

Malaysia's ambition to become a competitive player in the REE space requires consistent access to high-risk capital to fund early-stage exploration, mapping and innovation. Global venture capital (VC) is the natural financing instrument for this purpose, yet Malaysia lacks a clearly defined pathway for international VC participation in exploration and mining. Although the Securities Commission revised its VC framework in November 2022, there is no integrated link with mineral exploration. Coupled with perennial investor concerns on the federal-state gap in mining, foreign funds would remain cautious in investing capital, technology and expertise. This is important as developed economies seek to diversify their import sources.

Stakeholders have emphasised the need to design a formal transparent pathway for global VC firms to invest in upstream REE exploration and mining, co-designed by the Ministry of Finance, the Securities Commission and Bursa Malaysia. This pathway should focus on the following:

- Providing global investors clarity on mineral exploration licensing, ownership and investor rights, governance assurances and exit options.
- Clarity on ESG, safety and traceability standards.
- Reducing regulatory barriers for capital flows.
- Encourage investments through eligibility for VC fund tax exemptions on RE projects.
- Introducing standard contract models for exploration projects.

Bursa Malaysia could leverage its current framework for listing platforms (LEAP, ACE Market, etc.) to develop a dedicated pathway for mineral exploration backed by global VCs. This could be in the form of a "Mineral Exploration Board" with strict requirements on ESG and sustainability disclosures, while fiscal incentives could further mitigate the capital intensity of exploration. Both regulators and Khazanah Nasional could play a catalytic role by acting as a strategic ecosystem facilitator through collaboration with established mineral exchanges abroad, gathering valuable insight and expertise in designing the VC architecture, governance and disclosure standards for exploration ventures while signalling sovereign-level support.

Nevertheless, key risks must be acknowledged. Chiefly, sensitive federal-state concerns over mineral ownership create structural political-economy barriers to a single pathway and will require enhanced revenue-sharing mechanisms. Regulatory volatility, particularly considering past REE controversies, may also deter global VCs unless stronger FPIC protections are guaranteed. Finally, as Malaysia lacks a proven

track record in VC mine financing compared with regional hubs, global VCs may require steep incentives to invest capital resources.

4.3.2 Securing supply chains through studying feasibility of localising critical refining inputs

A comprehensive feasibility study should assess the technical and economic viability of producing critical extractants, lixiviants and reagents for REE operations domestically. This study should evaluate current production capacity, raw input supply chains and environmental compliance, while mapping industrial scaling pathways for both domestic use and export.

Further, to accelerate local capacity for industrial-grade standards for refining inputs, potential partnerships and joint private sector ventures with established global producers should be incentivised. In parallel, Pioneer Status tax incentives and subsidies should be offered to domestic players who integrate new speciality inputs using locally originated content into the local ecosystem, hence ensuring local producers capture greater value addition, while enhancing international supply security.

4.3.3 Establishing joint partnerships with global firms to strengthen cooperative approaches to sector development

Malaysia should prioritise the formation of strategic joint commercial partnerships with key global firms that possess both upstream and downstream capabilities and ESG-enabled market access. To this end, the Ministry of Foreign Affairs and MITI should establish a joint roadmap on strategic mineral partnerships with priority partners in Japan, South Korea, Brazil, Australia, Canada, the EU and the US. Such partnerships would enable Malaysia to reduce the risks of technological and commercial overdependence, diversify supply chains and accelerate integration into global mineral networks.

On the upstream, Malaysian miners face technological barriers, particularly ISL methods of IAC-REE extraction, where expertise remains largely concentrated from a single supplier. A strategy of global joint ventures could address this gap. For instance, Brazil's Aclara Resources has pioneered the use of "circular mineral harvesting" technology, which could be adapted to Malaysia's deposits and geology, with lanthanides produced feeding into local midstream refineries.

On the downstream, Malaysia should leverage multilateral frameworks, such as the EU's Critical Raw Minerals Act, to anchor ESG-aligned industrial integration. Potential commercial partnerships with EU firms, including Germany's Vacuumschmelze

and France's Carester SAS and MagREEsource, offer collaboration opportunities, especially in the context of ongoing Malaysia-EU FTA negotiations. Beyond Europe, various firms, such as the UK's Less Common Metals, Canada's Neo Performance Metals, South Korea's POSCO International and the US' Ucore Rare Metals and Energy Fuels, present strong collaboration potential in downstream metallurgy, permanent magnets and circular economy applications, such as REE recycling technologies. Notably, Energy Fuels is actively advancing research on the commercialisation of extracted thorium,[77] which could further drive Malaysia's nuclear energy strategy.

4.3.4 Developing industrial strategy for vertical integration, downstream anchoring and local participation

Before Malaysia can establish a viable full-cycle REE sector, a critical mass of supply must first be achieved. However, due to the export ban on REE feedstock, firms cannot legally monetise upstream mining on their own. The lack of beneficiation capacity thus creates a structural bottleneck, i.e., without a refinery, upstream output has little commercial value, while without upstream supply, refiners cannot operate at scale.

To overcome this, Malaysia should prioritise joint and concurrent development of both upstream mines and midstream beneficiation operations. This requires targeted economic incentives tied to vertical integration and offtake agreements between upstream and midstream firms, ensuring that investment returns are distributed across the value chain. In addition, because exploration involves substantial upfront costs, the government could consider fiscal support mechanisms, such as corporate tax incentives and offsets, to reduce entry barriers and attract financially credible upstream players.

To complement national efforts and build on the momentum of the Kelantan-Lynas MOU, the REE Special Task Force could develop guidelines for a structured cooperation model between states and global refiners, enabling state-led development of sustainable REE feedstock and encouraging onshoring high-value-added activities (as mineral rights are state matters). This could widen the scope of cooperation between states seeking to diversify their supply chain strategies with firms across South Korea, Japan and the US, among others. These models could be enhanced through regional development agencies proactively seeking partnerships with foreign firms in permanent magnet, metallurgy, battery and other advanced materials to diversify downstream applications and integrate with global buyers, hence reducing commercial dependence.

To complement these efforts, dedicated REE Free Industrial Zones can be developed that integrate into existing industrial capacity, supported by research and innovation. These zones should bring together chemical producers, storage facilities, refineries, magnet manufacturers and waste handling systems to reduce transaction costs and create economies of scale. Linking them to major logistics corridors, such as the East Coast Rail Link and the Economic Accelerator Project nodes, would further promote connectivity. A well-facilitated ecosystem with regulatory support, shared infrastructure and trade-port integration would accelerate downstream investment. As the custodian of the Economic Accelerator Project's development, the MIDA should take charge of identifying and mapping potential areas to accelerate the establishment of downstream players.

To maximise its impact, REE Free Industrial Zones should also explore co-location with global research centres to serve as research hubs into batteries and green technology, among others. Ensuring that research generates proprietary or joint intellectual property will reduce reliance on imported technologies as the industry matures. Lastly, promoting fiscal tools, such as GITA and GITE tax exemptions to foreign investors, can help attract green and REE-based technology to be both researched and produced domestically.

Finally, policymakers should encourage local and SME integration through a dedicated "plug-in" strategy to supply inputs and other value-added services through local vendor development. Foreign investors should be required to disclose local procurement practices for their Malaysian operations. In addition, policymakers should promote local content through facilitating joint ventures in REE-based manufacturing investment for magnets, batteries and electric motors to ensure positive spillovers for domestic manufacturing supply chains. Performance-based incentives tied to increased local firm and worker participation should be considered for value-added and export-oriented supply chains.

Appendix I

Economic activities in REE value chain and relevant regulating agencies

Category	Activity	Agency	Scope of governance
Upstream	Exploration and estimation	JMG	Geological surveying, estimation, licensing of prospecting
		State Director of Land and Mines	Approval of land use and exploration licenses under state
	Mining and mineral processing	JMG	Licensing and oversight of mining operations
		DOE	EIA approvals and monitoring
		ATOM Malaysia	Licensing if radioactive materials present
	Mine decommissioning	JMG, DOE, ATOM Malaysia	Environment restoration, radiation safety and standards compliance
Midstream	Cracking, separation and purification	MITI	Oversight of strategic investments
		DOE	Approval of chemical waste and waste management
		DOSH	Workplace safety compliance (important for chemical handling)
		ATOM Malaysia	Licensing if radioactivity is present (if required)
		Royal Customs	Monitoring of import/exports of regulated materials and chemical precursors
	Plant decommissioning	DOE	Environmental restoration
		DOSH	Oversight of hazardous materials
		ATOM Malaysia	Radiation clearance and handling (if required)
Downstream	Metal and alloy production Device and component manufacturing	MITI	Promotion and approval of value-added manufacturing
		DOE	Monitoring of emissions, waste and environmental compliance
		DOSH	Safety standards in metallurgy
		Royal Customs	Excise taxes, classification and export/import of value-added mineral manufactures
	Recycling	DOE	Environmental monitoring
		DOSH	Industrial safety and compliance
		MITI	Policy support for circular economy and sustainability

Source: Adapted from Academy of Sciences Malaysia, 2014[81]

Appendix II

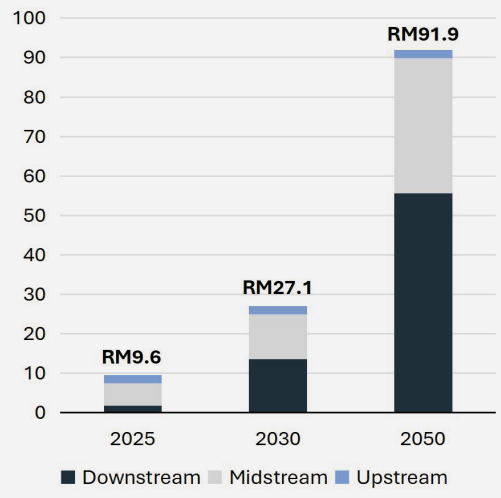
Malaysia's REE revenue growth 2025–2050

Projections based on NRES data from its report, *Business Model for the Development of Ion-Adsorption Clay Rare Earths Industry in Malaysia* (*2024*), estimate that Malaysia's REE value chain could contribute upwards of RM91.9 billion to GDP by 2050, with downstream activities far outpacing midstream and upstream revenues. These estimates emphasise the importance for Malaysia to shift its strategic focus to higher-value-added activities. It should be noted that these projections operate on optimistic linear growth assumptions. For instance, the report projects an increase in RE output to 30,000 tonnes per annum by 2030, exceeding conventional benchmarks. The estimates likewise excludes the possible impacts of robotics and Artificial Intelligence on employment outcomes.

Furthermore, by 2050, the industry is projected to create an estimated 96,900 job opportunities, which primarily focus on the downstream. However, this assumes the availability of upstream feedstock to meet the needs of mid-and downstream applications. While both upstream and downstream segments are likely to depend initially on foreign partnerships and technologies, the long-term development of local expertise would transition the sector toward a predominantly domestic workforce. The midstream segment, presently dominated by local hires, may gradually diversify if global partners enter the market.

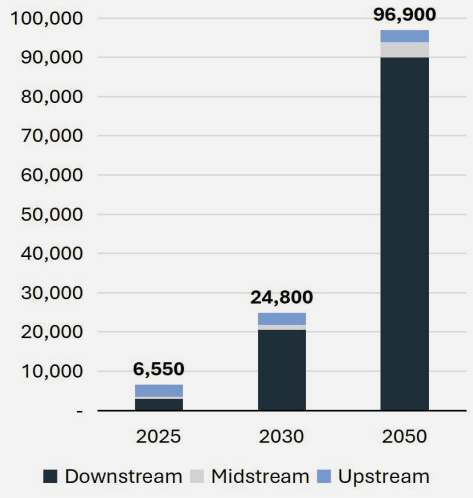
Downstream revenue dominates in long run

Estimated REE revenue targets across value chain, 2025–2050 (RM billions)



Largest opportunity for employment lies in downstream sectors

Estimated number of job employment across value chain, 2025–2050



Source: Authors' illustration based on data from "Business Model for the Development of Ion-Adsorption Clay Rare Earths Industry in Malaysia", NRES (2024)[82]

Abbreviations

ACA	Accelerated Capital Allowance
ACE	Alternative Credit Market
AELA	Atomic Energy Licensing Act
AELB	Atomic Energy Licensing Board
AU	Australian Dollar
COE	Centre of Excellence
DOE	Department of Environment
DOSH	Department of Occupational Safety and Health
EFT	Ecological Fiscal Transfer
EIA	Environmental Impact Assessment
EPBC	Environmental Protection and Biodiversity Conservation
EQA	Environmental Quality Act
ESG	Environmental, Social and Governance
EU	European Union
EVs	Electric Vehicles
FPIC	Free, Prior and Informed Consent
FTA	Free Trade Agreement
GDP	Gross Domestic Product
GITA	Global Investment Tax Allowance
GITE	Global Investment Tax Exemption
HS	Harmonized System (of Tariff Classification)
IAC	Ion-Adsorption Clay
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IRMA	Initiative for Responsible Mining Assurance
ISL	In-Situ Leaching
ITA	Investment Tax Allowance
JMG	Department of Minerals and Geoscience
JOGMEC	Japan Organisation for Metals and Energy Security
KOMIR	Korea Mine Rehabilitation and Mineral Resources Corp

LAMP	Lynas Advanced Materials Plant
LEAP	Leading Entrepreneur Accelerator Platform
MATRADE	Malaysian External Trade Development Council
MCRE	MCRE Resources Sdn Bhd
MIDA	Malaysian Investment Development Authority
MITI	Ministry of Investment, Trade and Industry
MOSTI	Ministry of Science, Technology and Innovation
MySMI	Malaysian Sustainability Index
NMC	National Mineral Council
NORM	Naturally Occurring Radioactive Material
NR-REE	Non-Radioactive Rare Earth Elements
NRES	Ministry of Natural Resources, Environment and Sustainability
NdFeB	Neodymium-Iron-Boron
OMS	Operational Mining Scheme
PDF	Permanent Disposal Facilities
PFR	Permanent Forest Reserve
PS	Pioneer Status
RA	Reinvestment Allowance
RECs	Rare Earth Carbonates
REE	Rare Earth Elements
REOs	Rare Earth Oxides
REs	Rare Earths
RM	Malaysian Ringgit
SAM	Sahabat Alam Malaysia
SME	Small and Medium Enterprises
SOPs	Standard Operating Procedures
UK	United Kingdom
US	United States
VC	Venture Capital

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