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The role of Saudi Arabia in current strategic mineral supply chains

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Abstract:

This paper examines Saudi Arabia's emerging role in strategic mineral supply chains within a context of reduced dependence on China, combined with global energy transition objectives. The Saudi Vision 2030 efforts will dominate the country's industrial strategy, seeking to establish national mining power within global critical mineral supply chains.

Large state investments through the Public Investment Fund (PIF), the weight of companies such as Aramco and Ma'aden, and the diversification of international alliances are driving the value of Riyadh's significant mineral reserves and its geographical competitive advantage. However, Saudi Arabia will face challenges including its economy's dependence on oil, water scarcity, the need for skilled labor, environmental challenges, and a lack of transparency and human rights protection.

Keywords:

Arabian-Nubian Shield, Aramco, critical minerals, diversification, energy transition, Ma'aden, Saudi Arabia, Saudi Vision 2030, supply chains.

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1. Introduction: the global landscape of critical mineral geopolitics

Critical minerals are those considered essential for industrial production, digitalization, and the energy transition, and subject to potential supply restrictions that could significantly affect a country's economy[1]. These minerals are considered strategic when they are essential for a specific policy or economic activity, particularly in the defense and aerospace sectors.

Their criticality stems from the imbalance between supply and demand of geological reserves, extraction and processing limitations, and the vulnerability of supply chains[2].

Increasing demand

The global transition effort and the generalized growth in technological production have led to a considerable increase in demand for these minerals, with projections indicating continued growth in the future (decarbonization is a long-term process). According to the International Energy Agency, the Sustainable Development Scenario estimates a need for 27 million tons of raw materials for the energy transition, and up to 43 million tons under the Net Zero Scenario by 2040[3]. Electric battery manufacturing is an illustrative example, requiring lithium, cobalt, graphite, manganese, molybdenum, and nickel[4]. The International Energy Agency also estimates that demand for key minerals for clean energy technologies will increase by more than 40% for copper and rare earth

[1] Centro Superior de Estudios de la Defensa Nacional (CESEDEN), Ministerio de Defensa de España, *Los minerales estratégicos*, consultado el 21 de agosto de 2025, https://www.defensa.gob.es/ceseden/-/los-minerales-estrat%C3%A9gicos

[2] Centro Superior de Estudios de la Defensa Nacional (CESEDEN), Ministerio de Defensa de España. *Las restricciones en el comercio de los minerales críticos: hacia la fragmentación geoeconómica mundial*, consultado el 21 de agosto de 2025, https://www.ieee.es/Galerias/fichero/docs_analisis/2024/DIEEEA10_2024_MARHID_Restricciones.pdf

[3] Centro Superior de Estudios de la Defensa Nacional (CESEDEN), Ministerio de Defensa de España, *Diplomacia de minerales críticos, la IA desafiante y la batalla por el cambio climático: retos globales que marcarán décadas*, consultado el 21 de agosto de 2025, https://www.defensa.gob.es/ceseden/-/diplomacia-de-minerales-críticos-la-ia-desafiante-y-la-batalla-por-el-cambio-climático-retos-globales-que-marcarán-décadas

[4] Le Grand Continent, *10 puntos sobre los metales estratégicos*, 21 de marzo de 2023, consultado el 21 de agosto de 2025, https://legrandcontinent.eu/es/2023/03/21/10-puntos-sobre-los-metales-estrategicos/

elements, 60–70% for nickel and cobalt, and up to 90% for lithium by 2040[5]. Additionally, sectors such as defense and aerospace require significant quantities of titanium, beryllium, tungsten, aluminum, and rare earth elements for structural components, propulsion systems, sensors, and missile guidance systems[6].

High dependence on China

Supply chains for these minerals are clearly dominated by China, which controls at least two-thirds of the production or refining of several major critical minerals, including lithium, graphite, cobalt, nickel, copper, and rare earth elements. In the case of rare earths, China accounts for 90% of global production[7].

Geopolitical instability increases the risks associated with obtaining critical raw materials under such Chinese dominance. Consequently, there is a global trend towards reducing this dependency and diversifying exporters. In this context, the European Union has shifted toward a “de-risking” policy, materialized through the adoption of the Critical Raw Materials Act by the European Commission, marking a turning point, as it is binding for all Member States. It affects extraction and processing activities, reducing exposure to geopolitical risks in global supply chains[8].

Export restrictions

Growing concerns over economic security and raw material supply have translated into increased export restrictions. Countries such as China justify protective measures on national security grounds, significantly affecting global supply chains dependent on

[5] International Energy Agency (IEA), *The Role of Critical Minerals in Clean Energy Transitions: Mineral Requirements for Clean Energy Transitions*, IEA, París, 2021, consultado el 21 de agosto de 2025, https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

[6] SFA Oxford, Critical Minerals and Defense Technologies, consultado el 21 de Agosto de 2025, https://www.sfa-oxford.com/knowledge-and-insights/critical-minerals-in-low-carbon-and-future-technologies/critical-minerals-in-defence-and-national-security/

[7] Pascale Massot, "The China Challenge in Critical Minerals: The Case for Asymmetric Resilience," *The Diplomat*, 6 de junio de 2025, consultado el 21 de agosto de 2025, https://thediplomat.com/2025/06/the-china-challenge-in-critical-minerals-the-case-for-asymmetric-resilience

[8] Comisión Europea, *Ley Europea de Materias Primas Fundamentales*, consultado el 21 de agosto de 2025, https://commission.europa.eu/topics/competitiveness/green-deal-industrial-plan/european-critical-raw-materials-act_es

Chinese supply. OECD data show that in 2023 such restrictions were five times higher than in 2009. In total, up to 17,490 raw materials experienced at least one such restriction in 2023[9].

In recent months, China has intensified export restrictions on critical minerals, raising alarms in industries such as automotive manufacturing, given their high dependence on minerals for electric vehicle batteries[10]. As a result, countries such as the United States are seeking alternatives, supporting rare earth extraction projects in Australia, Brazil, South Africa, Saudi Arabia, Japan, and Vietnam through financing and diplomacy.

The potential for supply chain diversification remains untapped, as shown by the case of lithium reserves in countries such as Bolivia and Argentina, which account for almost half of the world's reserves but are not currently being exploited to their full potential[11].

Within this context, this paper explores Saudi Arabia's role in critical mineral supply chains, including its management strategies, challenges, and geopolitical value in the global resource industry and future energy transition.

2. Saudi Arabia's Strategies

Saudi Arabia is a strategic country for diversifying global critical mineral supply chains. It acts as an intermediary hub between Eurasia and Africa and provides access to major markets, granting it geopolitical and competitive advantages.

Traditionally dependent on oil and gas, the Gulf country is adapting to changing global demands. As a member of COP and Agenda 2030, it is committed to emission

[9] OECD, *OECD Inventory of Export Restrictions on Industrial Raw Materials 2025: Monitoring the Use of Export Restrictions Amid Growing Market and Policy Tensions*, mayo de 2025, consultado el 21 de agosto de 2025, https://doi.org/10.1787/facc714b-en

[10] Jarrett Renshaw y Ernest Scheyder, "Global Alarm as China's Critical Mineral Export Ban Takes Hold," *Reuters*, 3 de junio de 2025, consultado el 21 de agosto de 2025, https://www.reuters.com/business/autos-transportation/global-alarms-rise-chinas-critical-mineral-export-ban-takes-hold-2025-06-03/

[11] Luis Alberto Peralta, "China, un coloso a la captura de la industria mundial del litio," *Cinco Días* (El País), 23 de enero de 2023, consultado el 21 de agosto de 2025, https://cincodias.elpais.com/cincodias/2023/01/20/companias/1674239119_218817.html

reduction targets through its climate policy known as the Green Initiative[12]. The desire to remain a key economy in energy and technological development chains makes it imperative to implement strategic changes.

Its energy transition and diversification program is designed, precisely, to meet these global demands. Its energy consumption has gone from being 100% fossil fuels in 2022 (64.2% oil and 35.7% gas, according to data from the International Energy Agency[13]) to including 3.7 GW of renewable capacity in 2024, with forecasts of an increase for 2025[14]. In 2023, renewable energies would have accounted for 0.47% of the energy mix[15].

Saudi Vision 2030

The objectives and projects to implement change are encompassed in Saudi Vision 2030, an initiative announced in April 2016 by Saudi Crown Prince Mohammed bin Salman, based on investments to diversify the economy and boost industries beyond fossil fuels. The strategy places the Gulf country in the midst of transformation, with more than 45 large-scale projects in numerous sectors. Some notable areas are technological innovation, renewable energy, biotechnology, and artificial intelligence. Its goals are to promote sustainable development, diversify energy sources, and develop the country's economy in order to improve the standard of living of its population and continue to play an important role on the global stage[16].

A similar model for reducing oil dependency is being implemented by other countries on the Arabian Peninsula (Bahrain, the United Arab Emirates, Kuwait, Qatar, and Oman),

[12] Saudi Government, *SGI: steering Saudi Arabia towards a green future*, consultado el 21 de Agosto de 2025, https://www.sgi.gov.sa/about-sgi/?csrt=7783361093135248802

[13] International Energy Agency (IEA), "Saudi Arabia – Energy Mix," *IEA*, consultado el 21 de agosto de 2025, https://www.iea.org/countries/saudi-arabia/energy-mix

[14] MEES, *Saudi Renewables Sector Looks to Build on 2024's Record Growth*, 10 de enero de 2025, consultado el 21 de agosto de 2025, https://www.mees.com/2025/1/10/power-water/saudi-renewables-sector-looks-to-build-on-2024s-record-growth/134a8810-cf55-11ef-ae5f-a5744d95e8fa

[15] Ritchie, Hannah; Rosado, Pablo; y Roser, Max, *Energy*, Our World in Data, consultado el 21 de agosto de 2025, https://ourworldindata.org/energy-mix

[16] Saudi Vision 2030. *Overview*. Consultado el 21 de agosto de 2025, https://www.vision2030.gov.sa/en/overview

with plans similar to Saudi Vision 2030 led by their governments[17], demonstrating a regional trend.

Transition and diversification efforts

The case of oil producer Aramco illustrates Riyadh's energy transition process. Traditionally based on the exploitation of oil, gas, and petrochemicals, it is currently taking steps toward diversification. Its adherence to the Oil and Gas Decarbonization Charter during COP28 demonstrates its commitment to the 2050 sustainable development goals. Focused on long-term results, Aramco continues to pursue ambitious projects such as the unconventional Jafurah gas field and the Tanajib gas plant, which are key to the country's energy security. The company has signed an agreement to build new green hydrogen and ammonia production facilities, with the goal of producing 11 million tons of blue ammonia by 2030[18]. In addition, during the first half of 2025, the company signed up to 34 preliminary agreements with major US companies, including memoranda of understanding with Nvidia, ExxonMobil, Qualcomm, and AWS on AI infrastructure and petrochemical industry projects[19]. In the field of investment, it has expanded its relationships with funds such as BlackRock, Goldman Sachs, Morgan Stanley, and PIMCO [20].

[17] Centro Superior de Estudios de la Defensa Nacional (CESEDEN), Ministerio de Defensa de España, *La Visión 2030 en Arabia Saudita*, consultado el 21 de agosto de 2025, https://www.defensa.gob.es/ceseden/-/la-visi%C3%B3n-2030-en-arabia-saudita

[18] Hassan, Nadin, "Aramco signs 34 agreements worth $90bn with US firms to boost innovation, growth," *Arab News*, 14 de mayo de 2025, consultado el 21 de agosto de 2025, https://www.arabnews.com/node/2600725/business-economy

[19] Reuters, "Aramco Signs Up to $90 Billion in U.S. Deals as Trump Gulf Tour Spurs Flurry of Tie-Ups," *Reuters*, 14 de mayo de 2025, consultado el 21 de agosto de 2025, https://www.reuters.com/business/energy/saudi-aramco-signs-deals-worth-up-90-billion-with-us-companies-2025-05-14/

[20] Reuters, "Aramco Signs Up to $90 Billion in U.S. Deals as Trump Gulf Tour Spurs Flurry of Tie-Ups," *Reuters*, 14 de mayo de 2025, consultado el 21 de agosto de 2025, https://www.reuters.com/business/energy/saudi-aramco-signs-deals-worth-up-90-billion-with-us-companies-2025-05-14/

Saudi Arabia's mining industry

According to experts, the Saudi mining sector is clearly expanding globally. Its contribution to the country's gross domestic product is expected to rise from $17 billion in 2024 to $75 billion in 2030, within the framework of Saudi Vision 2030[21].

It should be noted that the country has reserves of copper, zinc, bauxite, and silver within its territory. The Arabian-Nubian Shield is one of the areas in the world with the most preserved young Neoproterozoic crust, being incredibly rich in gold deposits (such as the Mahd Adh-Dhahab or Bulghah deposits) as well as copper (Jabal Sayid mine), and other mineral deposits of tin, iron, lead, rare earths, tungsten, uranium, and zinc[22]. In addition, its bauxite extraction accounted for 1.3% of global reserves in 2024, along with 0.3% of copper, 0.2% of silver, and 0.3% of zinc[23]. According to official statements, the estimated value of untapped mineral resources has increased to $2.5 trillion, based on the recent discovery of rare earths, phosphate, gold, zinc, and copper[24].

Critical minerals play a key role in the country's transformation and its interaction with the international landscape. It is estimated that the Saudi Vision 2030 projects will create around 90,000 new jobs in the mining sector, including the exploration of new deposits, the granting of exploitation licenses, and the attraction of investments and strategic alliances to improve competitiveness[25].

In addition, the supply of these essential raw materials supports Saudi Arabia's ambition to produce at least half of its electricity from renewable sources by 2030. An illustrative example is the Sakaka Solar Power Plant project, which has more than 1.2 million solar

[21] El-Shaeri, Nour, "Saudi Arabia Ramps Up Mining Investment as Sector Outpaces Global Peers," *Arab News*, 24 de abril de 2025, consultado el 21 de agosto de 2025, https://www.arabnews.com/node/2598283/business-economy

[22] SGS, *The Precambrian Rocks*. Publicado en línea, consultado el 21 de agosto de 2025, https://sgs.gov.sa/en/pages/the-precambrian-rocks

[23] International Energy Agency (IEA), *Middle East's share of global mined production and reserves 2024*, 21 de mayo de 2025, consultado el 21 de agosto de 2025, https://www.iea.org/data-and-statistics/charts/middle-east-s-share-of-global-mined-production-and-reserves-2024

[24] Resource Governance Institute, *Life Beyond Oil: Saudi Arabia's Mining Ambitions*, consultado el 21 de agosto de 2025, https://resourcegovernance.org/articles/life-beyond-oil-saudi-arabia-mining-ambitions

[25] International Energy Agency (IEA), *Vision 2030*, última actualización el 6 de mayo de 2025, consultado el 21 de agosto de 2025, https://www.iea.org/policies/26804-vision-2030

panels[26]. Each of these requires large quantities of copper and aluminum for its construction, as well as other critical minerals such as cobalt, nickel, lithium, zinc, chromium, and rare earths[27].

Another noteworthy case is the NEOM megaproject, which aims to create a futuristic city in the northwestern region of the country, powered entirely by renewable energy. Manaar Al Monef, project coordinator, estimated that it would use 20% of the global steel market[28]. Green hydrogen production will also be key in this context, as demonstrated by the cooperation between NEOM, Air Products, and ACWA Power to create the world's largest hydrogen facility, also powered entirely by renewable energies such as solar and wind. The project, aligned with emission reduction targets, estimates that once operational it will mitigate the impact of 5 million metric tons of emissions per year[29]. These examples clearly demonstrate Saudi Arabia's future dependence on critical minerals, on which the production of energy transition technologies is based.

Tools for implementing the critical minerals strategy

The Saudi government intervenes decisively in the country's industrial projects, given that the potential of the sector and the market would not yet be sufficient to meet the ambitious objectives[30]. The Ministry of Industry and Mineral Resources is responsible for regulating and developing the country's industrial and mining sector, within which Saudi Vision 2030 is being built. Among the tools used are large investments, relations with other countries, and participation in international forums.

[26] Vision 2030, *Sakaka Solar Power Plant*, consultado el 21 de agosto de 2025, https://www.vision2030.gov.sa/en/explore/projects/sakaka-solar-power-plant

[27] International Energy Agency (IEA), *The Role of Critical Minerals in Clean Energy Transitions: Mineral Requirements for Clean Energy Transitions*, mayo de 2021, consultado el 21 de agosto de 2025, https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/mineral-requirements-for-clean-energy-transitions

[28] Hammond, Andrew, "Neom 'Uses One Fifth of World's Steel'," *AGBI*, 15 de octubre de 2024, consultado el 21 de agosto de 2025, https://www.agbi.com/giga-projects/2024/10/neom-uses-one-fifth-of-worlds-steel/

[29] ACWA Power, *NEOM Green Hydrogen Project*, consultado el 21 de agosto de 2025, https://acwapower.com/en/projects/neom-green-hydrogen-project/

[30] KPMG, *Advancing Industrial Policy*, noviembre de 2024, consultado el 21 de agosto de 2025, https://assets.kpmg.com/content/dam/kpmg/sa/pdf/2024/11/advancing-industrial-policy.pdf

Firstly, investments are dominated by the weight of the PIF (Public Investment Fund). It invests in both domestic and foreign projects, notably mining companies in Africa, Asia, and Latin America. Its ambitions are not limited to extraction, but extend to all stages of the value chain, including exploration, processing, refining, and manufacturing of end products[31]. Much of its investment is channeled through the state-owned company Ma'aden, Saudi Arabia's leading state-owned mining company, described as "one of the cornerstones of Saudi Vision 2030[32]"), which follows a vertical integration model perfectly aligned with the PIF's priorities.

In recent decades, this company has extracted large quantities of gold, bauxite, and copper, turning the country into one of the world's largest producers of phosphates[33]. Its mineral resources are estimated to be worth $2.5 trillion, and it exports to more than 55 countries[34]. Proof of the Saudi state's ambition to establish itself in global supply chains is Ma'aden's recent acquisition of 25% ownership of significant aluminum and bauxite assets from the US company Alcoa, which operated in Saudi territory in these deposits through its holdings in Ma'aden Aluminum Company and Ma'aden Bauxite and Alumina Company (previously co-owned), thus establishing itself as the majority shareholder[35].

Secondly, externally, Saudi Arabia maintains strategic relations in the field of mining with countries such as the United States, China, Egypt, Jordan, Iraq, and Turkey, attempting to balance these with the promotion of domestic industry. In March 2025, a collaboration

[31] Public Investment Fund (PIF), "How PIF Is Ensuring a Resilient Supply of Saudi Arabia," *PIF News Network*, 23 de diciembre de 2024. Publicación en línea, consultado el 21 de agosto de 2025, https://www.pif.gov.sa/en/news-and-insights/news-network/2025/how-pif-is-ensuring-a-resilient-supply-of-saudi-arabia/

[32] Saudi Arabian Mining Company (Ma'aden), *Maaden*, consultado el 21 de agosto de 2025, https://www.maaden.com/

[33] Public Investment Fund (PIF), "How PIF Is Ensuring a Resilient Supply of Saudi Arabia," *PIF News Network*, 23 de diciembre de 2024, consultado el 21 de agosto de 2025, https://www.pif.gov.sa/en/news-and-insights/news-network/2025/how-pif-is-ensuring-a-resilient-supply-of-saudi-arabia/

[34] Saudi Arabian Mining Company (Ma'aden), *Maaden*, consultado el 21 de agosto de 2025, https://www.maaden.com/

[35] Alcoa, *Alcoa Announced Closing of Ma'aden Transaction,* 7 de enero de 2025, consultado el 21 de Agosto de 2025, https://news.alcoa.com/press-releases/press-release-details/2025/Alcoa-Announces-Closing-of-Maaden-Transaction/default.aspx

was announced between the US company MP Materials and Ma'aden for the extraction, separation, refinement, and production of magnets from rare earth elements[36].

This agreement marks an important step in Saudi Arabia's strategy of vertical integration of critical mineral supply chains, with the aim of generating added value and taking a further step towards energy diversification and reducing dependence on China. However, the Asian giant remains a key strategic partner for Riyadh, as a result of the alignment of the Saudi Vision with the Belt and Road Initiative. The Silk Road Fund acquired a 49% stake in ACWA Power RenewCo[37], the world's largest private water desalination company (originally from Saudi Arabia). The Chinese giant is thus collaborating on key Saudi Vision projects such as the Sakaka Solar Project, with agreements worth more than $90 billion in the mining, digital infrastructure, and renewable energy sectors.

As for the Global South, the PIF and Manara Minerals are directing their investments toward mines in Pakistan, Zambia, and South America, focusing on connecting the value chains of Africa and Asia with the Middle East[38]. In addition to major acquisitions such as 10% of Vale Base Metals Brazil in 2024, this company is constantly seeking opportunities in the global mining industry[39].

Saudi Arabia also maintains relations in this area with other countries such as Egypt, Morocco, Turkey, the Democratic Republic of Congo, and Guinea, which are prominent in the supply chains of critical minerals due to their large reserves of bauxite, cobalt, phosphates, boron, copper, zinc, lead, diamonds, and rare earths, among others[40].

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[36] Reuters, *MP Materials, Maaden to Jointly Develop Rare-Earths Supply Chain in Saudi*, 14 de mayo de 2025, consultado el 21 de agosto de 2025, https://www.reuters.com/markets/commodities/mp-materials-maaden-jointly-develop-rare-earths-supply-chain-saudi-2025-05-14/

[37] ACWA Power, "ACWA Power Launches Its First Overseas Innovation Centre in China," *ACWA Power News*, 27 de enero de 2025, consultado el 21 de agosto de 2025, https://www.acwapower.com/news/acwa-power-launches-its-first-overseas--innovation-centre-in-china/

[38] Laury Haytayan, "En busca de minerales críticos en el Consejo de Cooperación del Golfo," *Política Exterior*, 21 de abril de 2025, https://www.politicaexterior.com/articulo/en-busca-de-minerales-criticos-en-el-consejo-de-cooperacion-del-golfo/

[39] Andrew Hammond, "PIF's Manara Seeks Long-Term Deals, Not Just a 'Quick Buck,'" *AGBI*, 31 de octubre de 2024, https://www.agbi.com/mining/2024/10/pifs-manara-seeks-long-term-deals-not-just-a-quick-buck/

[40] Nassar Al-Nassar, "Harnessing Saudi Arabia's Mineral Wealth for Economic Growth," *Arab News*, 2o de octubre de 2024, consultado el 21 de agosto de 2025, https://www.arabnews.com/node/2576007

Thirdly, in addition to investments, Saudi Arabia's international role in the mining industry is highlighted by the organization of the Future Minerals Forum since 2022 by the Saudi Arabian Ministry of Industry and Mineral Resources. In recent years, the forum has brought together representatives from major mining companies around the world, including Rio Tinto, Newmont, and Barrick Gold, where experts discuss and seek investment opportunities and knowledge exchange in value chains, infrastructure and investment, policy and governance, and technology[41]. At the last edition, held in January 2025, Deputy Minister of Industry and Mineral Resources Abdulrahman Al-Belushi announced a $32 million investment in incentives to support companies in the sector[42].

3. Challenges

On its path toward diversification, Saudi Arabia faces a number of challenges, including an economy heavily reliant on oil and gas, a lack of technical expertise and transparency, water scarcity, and other issues related to alignment with global governance and human rights compliance.

Oil dependency

The Saudi economy is clearly rooted in oil, both in terms of its productive structure and fiscally. The progress noted by the International Energy Agency in recent years shows a clear interest in future diversification, which is, however, very long term. The government has an obligation to maintain the living standards of its population, and the oil sector creates a large number of jobs[43], mainly distributed in activities related to oil. However, due to its expansion into other projects related to liquefied natural gas, lithium, renewable energies, and battery production, new jobs would be created to meet new demands. It is

[41] Future Minerals Forum, 2025. "Partnership Roundtables," *Future Minerals Forum*, https://www.futuremineralsforum.com/partnership-roundtables/

[42] Miguel Hadchity, “Saudi Arabia to Invest $32m in Mining Incentives to Drive Industry Expansion.” *Arab News*, 16 de enero de 2025, https://www.arabnews.com/node/2586659/business-economy

[43] Aramco, *About Us*, 2025, https://www.aramco.com/en/about-us#:~:text=75%2C000+%20total%20workforce,rewarding%20professional%20opportunities%20we%20offer

estimated that the Kingdom is launching more than 5,000 non-oil-related projects, which will receive 73% of investments[44].

Critical minerals therefore play an important role in these efforts, and a gradual increase in exploration, exploitation, and processing by the country is expected, which will be aligned with the internal needs of the Saudi Vision 2030 projects and global demands. The need for minerals will be calibrated according to these needs and periodically reviewed, given their fundamental pivotal role.

Water shortage

Another challenge facing Riyadh is water scarcity. The desert region faces this additional problem in the development of mining. It is estimated that the country consumes more than 12 million cubic meters of desalinated water per day[45]. This amount would be increased considerably in line with the objectives of Saudi Vision for 2030.

To alleviate this problem, the government is carrying out desalination projects. Back in 2024, the vice president of ACWA Power's center of excellence confirmed the commitment to invest $6.28 billion in distribution projects and water treatment plants, as well as wastewater collection plants[46].

For water supply, agreements were signed in June 2022 with the Japanese company Itochu and the French company Veolia, which will build a desalination plant powered by green hydrogen, as part of the NEOM sub-projects[47]. In addition, the Rabigh desalination plant will work to combat water scarcity by maintaining a sustainable water sector through

[44] Al-Kinani, Mohammed, "Beyond the Barrel: How Aramco Is Reinventing Energy Production for a New Era," *Arab News PK*, 16 de mayo de 2025, https://www.arabnews.pk/node/2600971/business-economy

[45] Reem Walid, "Saudi Arabia leads bold transformation to tackle water scarcity," 7 de junio de 2025, https://www.arabnews.com/node/2603778/business-economy

[46] Reem Walid, "Saudi Arabia Leads Bold Transformation to Tackle Water Scarcity," *Arab News*, 7 de junio de 2025, https://www.arabnews.com/node/2603778/business-economy

[47] ITOCHU Corporation, *ITOCHU in Partnership with ENOWA and Veolia Sign Joint Development Agreement to Build New Generation of Desalination Plant Powered by 100% Renewable Energy in NEOM*, 22 de diciembre de 2022, https://www.itochu.co.jp/en/news/press/2022/221222.html

industrial-scale crystalline absorption cooling technologies (which not only increase efficiency but also reduce environmental impact by not generating saline waste)[48].

Once again, large quantities of critical minerals are needed to produce these desalination plants. The Rabigh plant would consume up to 3.5 MW of thermal energy and 1.5 MW of electrical energy[49]. This creates a cycle of dependency between energy, water, and critical minerals. On the one hand, desalination requires high energy consumption and components manufactured from minerals. On the other hand, industrial processes in the mining and desalination industries require enormous amounts of water, creating a marked interrelationship that must be carefully managed.

Technical expertise

Human capital plays another important role in Saudi Arabia's future projects. An industrial transition of this magnitude requires major changes in terms of technical specialization. The emerging needs (which will continue to increase in the future) for educated and skilled workers will have to be met by the education system for long-term sustainability. The desire to improve this aspect in the medium and long term is one of the pillars of the Saudi Vision. An agreement signed by the Human Resources Development Fund with Ma'aden aims to improve human capital within the mining industry[50]. Strengthening Saudi talent in this area will be key to establishing Saudi Arabia as a geopolitical hub in global supply chains for strategic minerals.

Transparency, human rights, and international trust

Ensuring transparency, compliance with international agreements, and the protection of human rights will pose another challenge for the Gulf country, which will need international trust and support to bring its projects to fruition and meet its objectives. Despite committing in the Saudi Vision to increasing its transparency, particularly in matters of state financing and fiscal policies, the country is currently in the process of

[48] Vision 2030, *Rabigh Desalinitation Plant*, consultado el 21 de agosto de 2025, https://www.vision2030.gov.sa/en/explore/projects/rabigh-desalination-plant

[49] Vision 2030, *Rabigh Desalinitation Plant,* consultado el 21 de agosto de 2025, https://www.vision2030.gov.sa/en/explore/projects/rabigh-desalination-plant

[50] Daleel News, "Saudi Arabia Enhances Mining Sector with HR Development," 16 de mayo de 2025, https://news.daleel.gov.sa/mining/saudi-arabia-enhances-mining-sector-with-hr-development

improvement. Last April, new beneficial ownership rules came into force to improve corporate transparency and align with global financial regulations. In addition, the country is making efforts to combat money laundering and prevent financial crime[51]. However, the room for improvement that still exists will clearly affect the attraction of foreign investment and could slow down development in the strategic minerals industry.

Environmental governance

Finally, mining activity carries environmental risks that the country must mitigate, taking into account its adherence to international commitments in this area. Sustainable mining practices are therefore among the main objectives of Saudi diversification. These efforts include water management and recycling projects (mentioned above), energy efficiency and renewable integration, waste and waste management, biodiversity preservation, and other technological innovations such as the use of automation and artificial intelligence to monitor environmental impact[52].

4. Conclusion: future prospects

Balance of stregths and weaknesses

Saudi Arabia is therefore clearly emerging as a key player in strategic mineral supply chains, thanks to its strategic structural position and ambitious national objectives outlined in Saudi Vision 2030. Its significant role in the future of the industry is due to its geographical position, its access to various markets and flexible international alliances, the state's large financial capacity through the PIF, and the national business fabric with a vertical integration model and the weight of Aramco and Ma'aden in the international arena.

However, long-term sustainability will depend on overcoming certain structural weaknesses, including those already mentioned: the Saudi economy's dependence on

[51] Mohammed Al-Kihani, “Saudi Arabia Tightens Corporate Ownership Rules to Boost Transparency,” *Arab News*, 24 de febrero de 2025, https://www.arabnews.com/node/2591456/business-economy

[52] Saudi Arabia Mining, “Saudi Arabia Mining Expert. Consulting Firm,” 24 de enero de 2025, https://saudiminingconsulting.com/insights/articles/sustainable-mining-in-saudi-arabia-balancing-growth-and-environmental-stewardship

fossil fuels, water scarcity, lack of sufficient skilled labor, environmental governance challenges, and lack of transparency and human rights protection, which undermine the confidence of the international community. These challenges facing Riyadh will limit the speed of change, making it difficult to achieve the ambitious goals set in the short term. Attracting foreign investment and international visibility will play a key role in accelerating the process.

This way, Saudi Arabia will continue to strengthen its domestic industry, maintaining diversified international alliances, and attracting large-scale investments in the strategic minerals industry. Thus, the geopolitical landscape of this industry will continue to be dominated by China, combined with other players such as Saudi Arabia that will be competitive in global supply chains, with strong prospects for long-term growth.

STRENGTHS	WEAKNESSES	IMPACT
Global trend towards diversification in the industry to reduce dependence on China	Structural dependence of the economy on fossil fuels	Complicated energy transition in the short/medium term
Geographical position between Asia and Europe	Insufficient skilled labor in the industry	Dependence on foreign labor
Access to diverse markets and flexible international alliances	External competition	Short/medium-term dependence on external actors

Large state financial capacity through the PIF (Public Investment Fund)	Lack of transparency and human rights protection	International mistrust and foreign investment decrease
Extensive reserves of strategic minerals (Arabian-Nubian Shield)	Difficulty in complying with environmental governance	Additional mitigation costs and international mistrust
State-owned companies with significant international influence (Aramco, Ma'aden)	Model overly reliant on state power	Less private involvement and potential loss in technological innovation
Ability to control supply chains through vertical integration	Water scarcity and environmental constraints	Increased costs in desalination technologies and activity restrictions

Source: own work

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